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Arnold E. Kiv
Mariya P. Shyshkina
(Eds.)

CTE 2019

Cloud Technologies in Education

Proceedings of the 7th Workshop, CTE 2019

Kryvyi Rih, Ukraine
December 20, 2019

Kiv, A.E., Shyshkina, M.P. (Eds.): Cloud Technologies in Education. Proceedings of the 7th Workshop CTE 2019, Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online

This volume represents the proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), held in Kryvyi Rih, Ukraine, in December 20, 2019. It comprises 42 contributed papers that were carefully peer-reviewed and selected from 66 submissions. The accepted papers present the state-of-the-art overview of successful cases and provides guidelines for future research. The volume is structured in four parts, each presenting the contributions for a particular workshop track.

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CTE 2019 – When cloud technologies ruled the education

Arnold E. Kiv[1], Mariya P. Shyshkina[2[0000-0001-5569-2700]], Serhiy O. Semerikov[2,3,4[0000-0003-0789-0272]], Andrii M. Striuk[4[0000-0001-9240-1976]], Mykola I. Striuk[4] and Hanna M. Shalatska[4[0000-0002-1231-8847]]

[1] Ben-Gurion University of the Negev, P.O.B. 653, Beer Sheva, 8410501, Israel
kiv@bgu.ac.il
[2] Institute of Information Technologies and Learning Tools of the NAES of Ukraine, 9, M. Berlynskoho Str., Kyiv, 04060, Ukraine
shyshkina@iitlt.gov.ua
[3] Kryvyi Rih State Pedagogical University, 54, Gagarina Ave., Kryvyi Rih, 50086, Ukraine
semerikov@gmail.com
[4] Kryvyi Rih National University, 11, Vitaliy Matusevych Str., Kryvyi Rih, 50027, Ukraine
andrey.n.stryuk@gmail.com, stryukm@gmail.com, shalatska@i.ua

Abstract. This is an introductory text to a collection of papers from the CTE 2019: The 7th Workshop on Cloud Technologies in Education, which was held in Kryvyi Rih, Ukraine, on the December 20, 2019. It consists of short introduction and some observations about the event and its future.

Keywords: cloud technologies in education, digital transformation of learning, cloud-based learning environment, scloud services for learning foreign language, cloud technologies in STEAM education.

1 CTE 2019 at a glance

Cloud Technologies in Education (CTE) is a peer-reviewed international Computer Science workshop focusing on research advances, applications of cloud technology in education.

The CTE Workshop occupies contributions in all aspects of educational technologies and cloud-based learning tools, platforms, paradigms and models, functioning programmes or papers relevant to modern engineering and technological decisions in the IT age. There is urgent general need for principled changes in education elicited by current e-learning tools, services and IT communication.

CTE topics of interest since 2018 [43]:

- Mobile and blended learning.
- Cloud-based e-learning platforms, tools and services.
- Cloud-based learning environments.
- Cloud technologies of open education.
- Cloud technologies of mobile learning.
- Cloud-based learning management systems.

- Cloud technologies for informatics learning.
- Cloud technologies for mathematics learning.
- Cloud technologies for physics learning.
- Cloud-based and mobile learning technologies for teacher and VET.
- Seamless learning and holistic education modelling and design.
- Massive open online courses.
- Open learning systems and virtual conferences for training professionals.
- Methods of using cloud-based learning tools.

This volume represents the proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), held in Kryvyi Rih, Ukraine, in December 20, 2019 (Fig. 1, 2). It comprises 42 contributed papers that were carefully peer-reviewed and selected from 66 submissions. Each submission was reviewed by at least 3, and on the average 3.5, program committee members. The accepted papers present the state-of-the-art overview of successful cases and provides guidelines for future research.

Fig. 1. CTE 2019 opening

The volume is structured in five parts, each presenting the contributions for a particular workshop track.

2 Session 1: Digital transformation of learning

The article “Digital competence of pedagogical university student: definition, structure and didactical conditions of formation” (Fig. 3) of Mykhailo V. Moiseienko, Natalia V. Moiseienko, Iryna V. Kohut and Arnold E. Kiv [76] defines and substantiates didactic conditions of digital formation competences of students of pedagogical universities: actualization of motivational value training of students of pedagogical universities;

organization of interaction between students and teachers of pedagogical universities on the Internet through the creation of digital information educational environment; creation of individual educational trajectories of students.

Fig. 2. At the beginning of CTE 2019

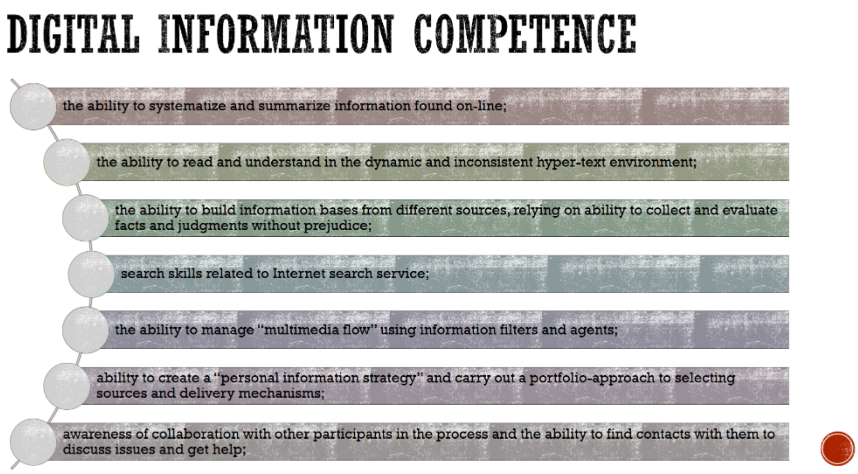
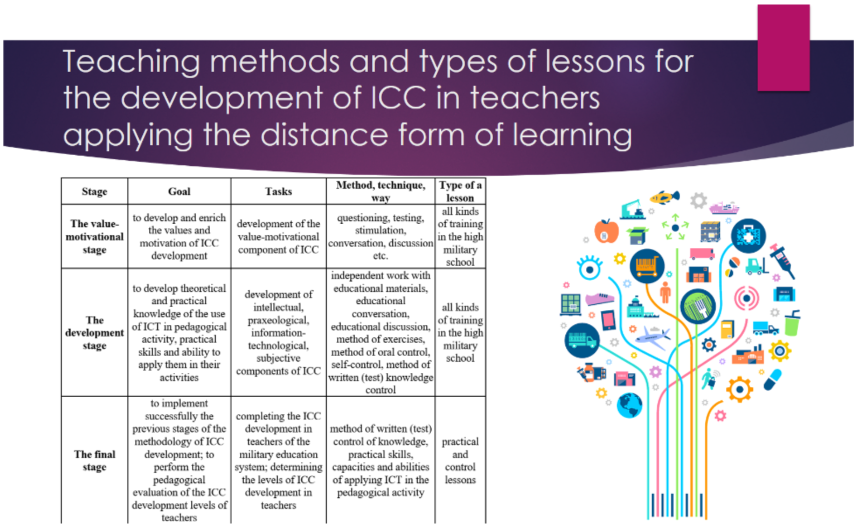


Fig. 3. Presentation of paper [76]

The article “The methodology of development of information and communication competence in teachers of the military education system applying the distance form of learning” (Fig. 4) of Vasyl V. Yahupov, Vladyslav Yu. Kyva and Vladimir I. Zaselskiy [159] theoretically substantiates the methodology of development of information and communication competence in teachers of the military education system applying the distance form of learning. Scientific approaches to the concepts of “methodology” have been analyzed and the author’s vision of “the methodology of development of information and communication competence in the military education teachers” has been suggested. In particular, they determine the methodological approaches to the methodology of its development, as well as its main stages, purpose, tasks, content, methods, types of training sessions, tools and organizational forms of learning.



Stage	Goal	Tasks	Method, technique, way	Type of a lesson
The value-motivational stage	to develop and enrich the values and motivation of ICC development	development of the value-motivational component of ICC	questioning, testing, stimulation, conversation, discussion etc.	all kinds of training in the high military school
The development stage	to develop theoretical and practical knowledge of the use of ICT in pedagogical activity, practical skills and ability to apply them in their activities	development of intellectual, praxeological, information-technological, subjective components of ICC	independent work with educational materials, educational conversation, educational discussion, method of exercises, method of oral control, self-control, method of written (test) knowledge control	all kinds of training in the high military school
The final stage	to implement successfully the previous stages of the methodology of ICC development; to perform the pedagogical evaluation of the ICC development levels of teachers	completing the ICC development in teachers of the military education system; determining the levels of ICC development in teachers	method of written (test) control of knowledge, practical skills, capacities and abilities of applying ICT in the pedagogical activity	practical and control lessons

Fig. 4. Presentation of paper [159]

The article “Technology of forming future journalists’ social information competence in Iraq based on the use of a dynamic pedagogical site” (Fig. 5) of Alla A. Kharkivska, Liudmyla V. Shtefan, Muntasir Alsadoon and Aleksandr D. Uchitel [32] reveals scientific approaches to substantiating and developing technology to form social information competence of future Iraqi journalists based on using a dynamic pedagogical site. After pre-interviewing students of the Journalism Faculty at Al-Imam Al-Kadhim University College for Islamic Sciences in Baghdad, the authors came to the conclusion there are issues on defining the essence of social information competences. It is established that the majority of respondents do not feel satisfied with the conditions for forming these competences in the education institutions. At the same time, there were also positive trends as most future journalists recognized the importance of these professional competences for their professional development and had a desire to attend additional courses, including distance learning ones. Subsequently, the authors focused on social information competence of future journalists, which is a key issue according to European requirements. The authors describe the essence of this competence as an integrative quality of personality, which characterizes an ability to select, transform information and allows to organize effective professional communication on the basis of the use of modern communicative technologies in the process of individual or team work. Based on the analysis of literary sources, its components are determined: motivational, cognitive, operational and personal. The researchers came to the conclusion that it is necessary to develop a technology for forming social information competence of future journalists based on the use of modern information technologies. The necessity of technology implementation through the preparatory, motivational, operational and diagnostic correction stages was substantiated and its model was developed. The authors found that the main means of technology implementation should be a dynamic pedagogical site, which, unlike static, allows to expand technical possibilities by using such applications as photo galleries, RSS modules, forums, etc. Technically, it can be created using Site builder. Further research will be aimed at improving the structure of the dynamic pedagogical site of the developed technology.

Fig. 5. Presentation of paper [32]

The article "An integrated approach to digital training of prospective primary school teachers" (Fig. 6) of Olga G. Yaroshenko, Olena D. Samborska and Arnold E. Kiv [160] emphasizes the importance of information and digital technologies in pre-service training of primary school teachers, substantiates the content and components of information and digital competence of prospective primary school teachers. It points out that the main purpose of information and digital training in the pedagogical higher educational institutions is to ensure the formation of digital competence of future primary school teachers, to prepare them for developing primary students' digital literacy in classes on various academic subjects, for active use of ICT in primary school teachers' professional activities. An integrated approach to the modernization of information and digital training of pre-service primary school teachers, which covers the main forms of the educational process – training sessions, independent work, practical training, and control activities is justified. The article presents the results the pedagogical experiment aimed at testing the effectiveness of the integrated approach to the modernization of information and digital training of prospective primary school teachers. The results are determined by the level of digital literacy and the ability of students in the control and experimental groups to use information and digital technology in the educational process of primary school.

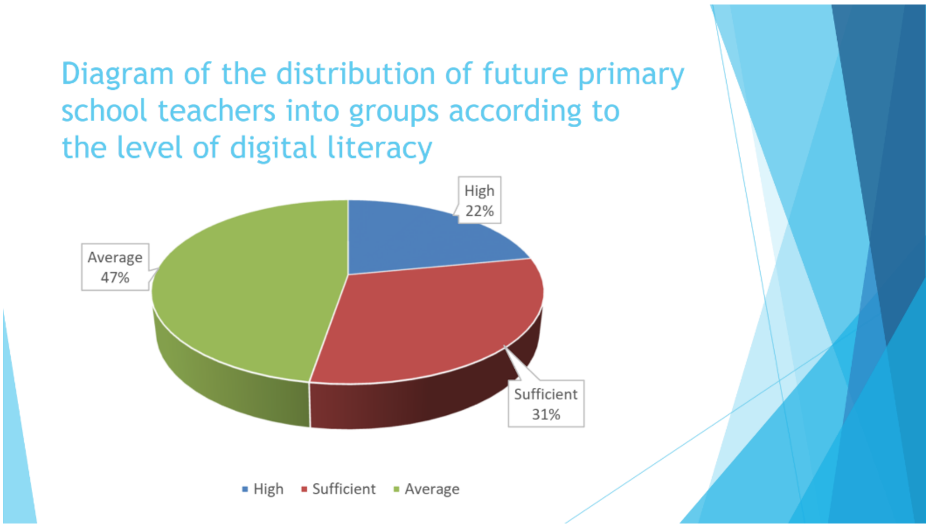


Fig. 6. Presentation of paper [160]

The article "Google cloud services as a way to enhance learning and teaching at university" (Fig. 7) of Tetiana I. Korobeinikova, Nataliia P. Volkova, Svitlana P. Kozhushko, Daryna O. Holub, Nataliia V. Zinukova, Tetyana L. Kozhushkina and Sergei B. Vakarchuk [46] highlights further research by the authors, begun in [99], [107], [139], [141], [142], [152] and [157]. This article is devoted to the issue of a cloud-based learning system implementation as a powerful strategy for future specialists' training at higher educational establishments. Using cloud computing in self-work management of the university courses is essential to equip students with a workload of appropriate educational materials and variable activities for professional training. Theoretical and empirical research methods were applied to select the appropriate services and tools for organizing students' self-work at university. Critical analysis of scientific literature, synthesis of the data, didactic observation of the educational process, designing of the skeleton for university courses, questionnaires enabled to facilitate the study of the issue. G Suite has been chosen to enhance the quality of training of prospective specialists at a higher educational establishment. This paper introduces the outcomes of the project on applying Google Classroom in the management of students' self-work while studying university courses. The focus of the first stage of the project was on testing pilot versions of the courses with the aim to work out the requirements and recommendations for incorporation general blended learning model of university courses. Particular attention is drawn to the designed model of the university course based on the curriculum with the necessary components of blended learning in the G Suite virtual environment. Cloud-based higher education is considered as a prospective tool for design of university courses with the need for further research and implementation.

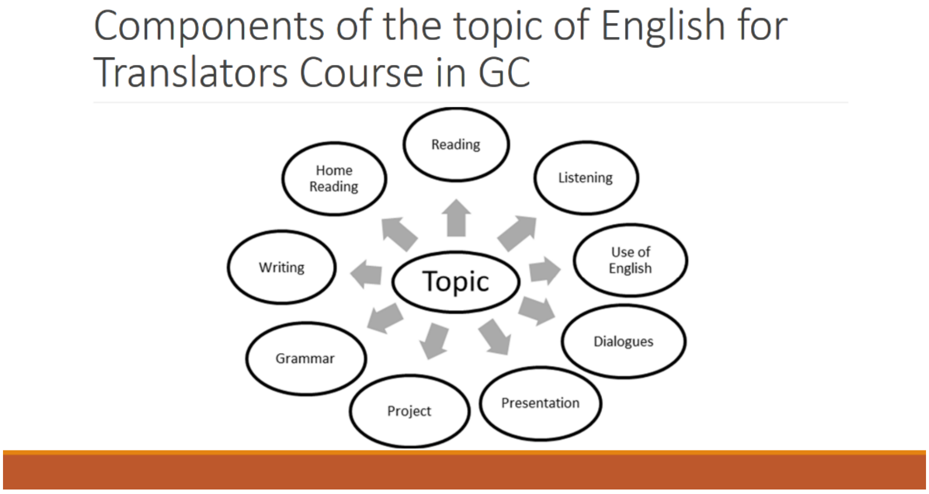


Fig. 7. Presentation of paper [46]

The article "The state of ICT implementation in institutions of general secondary education: a case of Ukraine" (Fig. 8) of Tetiana A. Vakaliuk, Dmytro S. Antoniuk and Vladimir N. Soloviev [147] highlights further research by the authors, begun in [109] and [102]. This article article presents the results of the analysis of the current state of implementation of ICT in the educational process of institutions of general secondary education in Ukraine. For this purpose, a survey was conducted among students of the first year of the Zhytomyr Polytechnic State University, within which 17 questions were asked to students related to the use of information and communication technologies in the educational process. As a result of the research, the introduction of the discipline "Educational technologies and digital education" into the training of future information technology specialists was substantiated, as well as the certification educational program "Information systems and cloud technologies in the educational process", designed for general education teachers, educators for higher education institutions, experts in the field of additional educational services, and other professionals.

The article "Application of augmented reality technologies for education projects preparation" (Fig. 9) of Anna V. Iatsyshyn, Valeriia O. Kovach, Volodymyr O. Lyubchak, Yurii O. Zuban, Andriy G. Piven, Oleksandra M. Sokolyuk, Andrii V. Iatsyshyn, Oleksandr O. Popov, Volodymyr O. Artemchuk and Mariya P. Shyshkina

[27] highlights further research by the authors, begun in [25], [26] and [28]. After analysis of scientific literature, authors defined that concept of “augmented reality” has following synonyms: “advanced reality”, “improved reality”, “enriched reality”, “mixed reality” and “hybrid reality”. Analysis of scientific literature and own practical experience of the use of augmented reality technologies application in educational practices allowed to state next: augmented reality technologies have a great potential for application in education; there are some cases of augmented reality use for school education; positive aspects of augmented reality technologies application in higher education institutions are confirmed by experiments (isolated cases); only few universities in Ukraine apply augmented reality technologies to educate students; only few universities in Ukraine have special subjects or modules in schedule to teach students to develop augmented reality technologies; various scientific events, mass events, competitions are held in Ukraine, and specialized training on the augmentation of augmented reality technologies is carried out, but this is non-systematic and does not have special state orientation and support. Features of introduction of virtual and augmented reality technologies at Sumy State University (Ukraine) are identified: “e-learning ecosystems” was created; in 2019, augmented and virtual reality research laboratory was established. Advantages and disadvantages of project activity in education are described: project activity is one of the most important components of educational process; it promotes creative self-development and self-realization of project implementers and forms various life competencies. It is determined that augmented reality application for implementation of educational projects will help: to increase students’ interest for educational material; formation of new competences; increase of students’ motivation for independent educational and cognitive activity; activation of educational activities; formation of positive motivation for personal and professional growth; conditions creation for development of personal qualities (creativity, teamwork, etc.). Current trends in implementation of educational projects were identified: most of the winner projects were implemented using augmented reality technology; augmented reality technologies were used in projects to teach different disciplines in higher education institutions. Augmented reality technology application for project activity has positive impact on learning outcomes and competitiveness of the national workforce; it will enhance the country’s position in the global economic space.

The article “Methodological aspects of preparation of educational content on the basis of distance education platforms” (Fig. 10) of Alexander F. Tarasov, Irina A. Getman, Svetlana S. Turlakova, Ihor I. Stashkevych and Serhiy M. Kozmenko [138] describes the experience of using the free distance education platform Moodle within the framework of the higher educational institution Donbass State Engineering Academy. Methodical aspects of training content preparation on the basis of distance education platforms on the example of MoodleDDMA system are given in this article. The General structure of the distance course and an example of evaluation of test tasks of the distance course (module) on topics are considered. An example of the presentation of the course on the basis of distance education platform MoodleDDMA is given. Conclusions about the experience of using the Moodle distance education system at the Donbass State Engineering Academy from the point of view of teachers and students are drawn. The perspective directions of researches and development of the Moodle distance education platform in completion and expansion of educational materials by multimedia elements and links, and also creation of the application for mobile devices for possibility of more effective use of the platform are allocated.

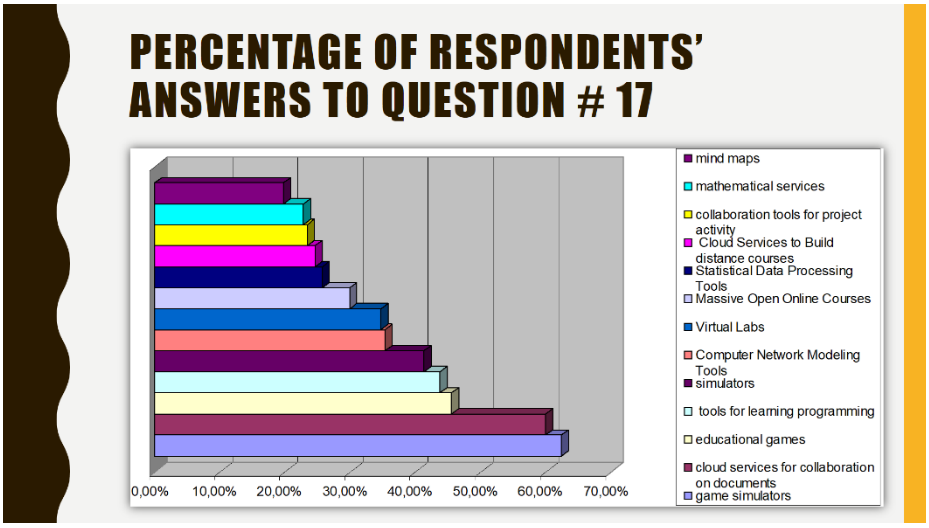


Fig. 8. Presentation of paper [147]

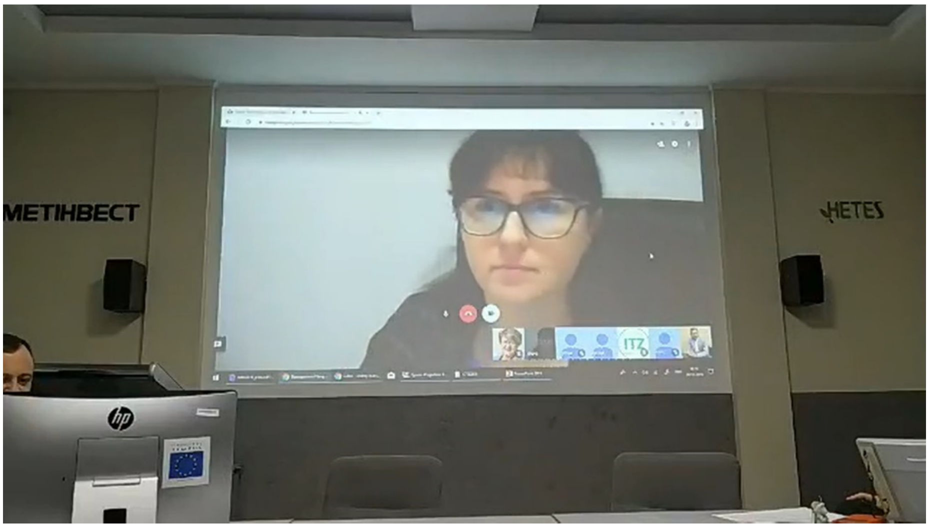


Fig. 9. Presentation of paper [27]

The purpose of the article "MarkHub Cloud Online Editor as a modern web-based book creation tool" (Fig. 11) of Vitalina O. Babenko, Roman M. Yatsenko, Pavel D. Migunov and Abdel-Badeeh M. Salem [4] is to analyze modern editors to create educational information content in the modern educational space and to present a modern tool for creating web books based on the latest IT technologies. Modern editors of web material creation have been analyzed, statistics of situations on mastering of knowledge by listeners, using interactive methods of information submission have been investigated. Using the WYSIWYG concept and analyzing modern information tools for presenting graphic material, an effective tool for teaching interactive web material was presented. An adapted version of the MarkHub online editor based on cloud technologies is presented. Using MarkHub cloud-based online editor for the unified development of educational content can significantly increase the author's productivity in the content creation process. At the same time, the effects of reducing the time spent on formatting the external presentation of the content, making synchronous changes to different versions of the content, tracking the versions of the content, organizing remote teamwork in the network environment are achieved.

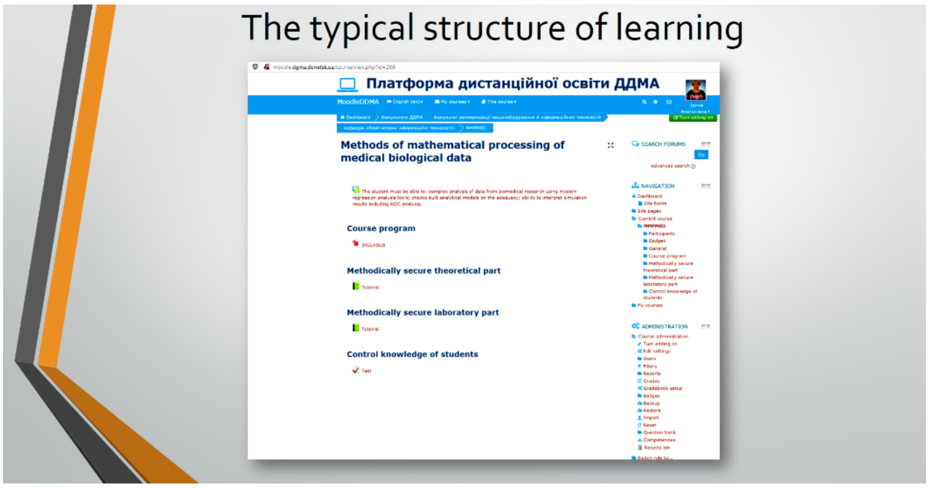


Fig. 10. Presentation of paper [138]

The article "The students' brainwork intensification via the computer visualization of study materials" (Fig. 12) of Halyna I. Ivanova, Olena O. Lavrentieva, Larysa F. Eivas, Iuliia O. Zenkovych and Aleksandr D. Uchitel [29] highlights further research by the authors, begun in [56], [57] and [94]. The paper the approaches to the intensification of the students' brainwork by means of computer visualization of study material have been disclosed. In general, the content of students' brainwork has been presented as a type of activity providing the cognitive process, mastering the techniques and ways of thinking, developing the capabilities and abilities of the individual, the product of which is a certain form of information, as a result of the brainwork the outlook of the subject of work is enriched. It is shown the visualization is the process of presenting data in the form of an image with the aim of maximum ease of understanding; the giving process of visual form to any mental object. In the paper the content, techniques, methods and software for creating visualization tools for study material has exposed. The essence and computer tools for creating such types of visualization of educational material like mind maps, supporting notes and infographics have been illustrated; they have been concretized from the point of view of application in the course of studying the mathematical sciences. It is proved the use of visualization tools for study materials helps to increase the intensity and effectiveness of students' brainwork. Based on the results of an empirical study, it has been concluded the visualization of study materials contributes to the formation of students' key intellectual competencies and forming their brainwork culture.

Fig. 11. Presentation of paper [4]

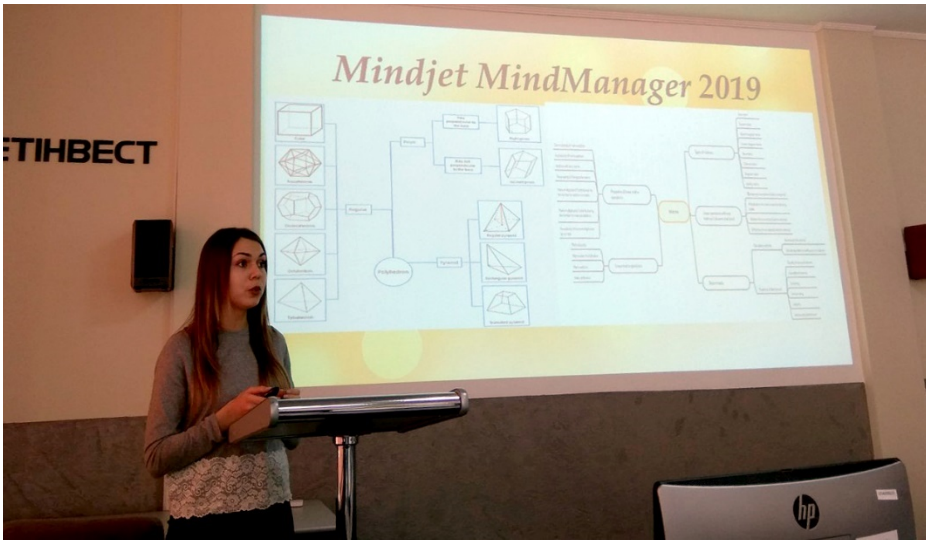


Fig. 12. Presentation of paper [29]

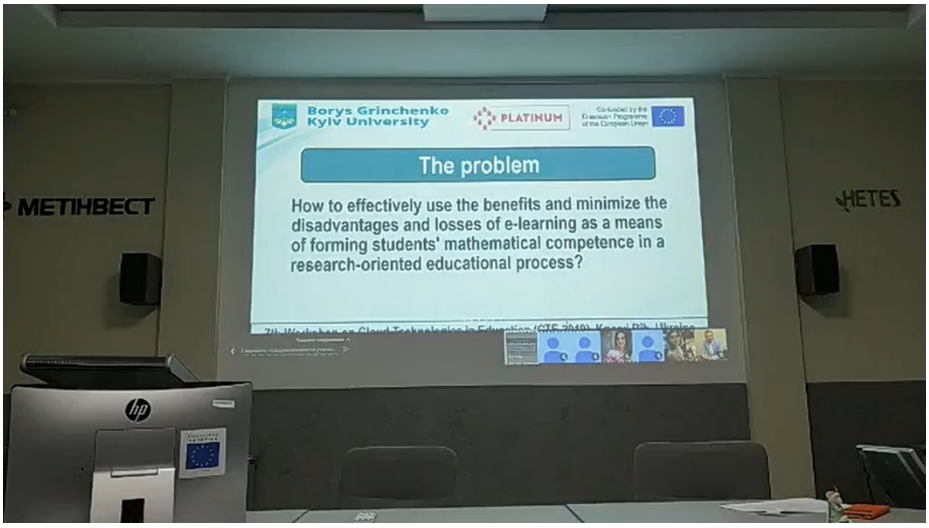


Fig. 13. Presentation of paper [23]

The article “The usage of digital technologies in the university training of future bachelors (having been based on the data of mathematical subjects)” (Fig. 13) of Oksana M. Hlushak, Svetlana O. Semenyaka, Volodymyr V. Proshkin, Stanislav V. Sapozhnykov and Oksana S. Lytvyn [23] highlights further research by the authors, begun in [22] and [114]. This article demonstrates that mathematics in the system of higher education has outgrown the status of the general education subject and should become an integral part of the professional training of future bachelors, including economists, on the basis of intersubject connection with special subjects. Such aspects as the importance of improving the scientific and methodological support of mathematical training of students by means of digital technologies are revealed. It is specified that in order to implement the task of qualified training of students learning econometrics and economic and mathematical modeling, it is necessary to use digital technologies in two directions: for the organization of electronic educational space and in the process of solving applied problems at the junction of the branches of economics and mathematics. The advantages of using e-learning courses in the educational process are presented (such as providing individualization of the educational process in accordance with the needs, characteristics and capabilities of students; improving the quality and efficiency of the educational process; ensuring systematic monitoring of the educational quality). The unified structures of “Econometrics”, “Economic and mathematical modeling” based on the Moodle platform are the following ones. The article presents the results of the pedagogical experiment on the attitude of students to the use of e-learning course (ELC) in the educational process of Borys Grinchenko Kyiv University and Alfred Nobel University (Dnipro city). We found that the following metrics need improvement: availability of time-appropriate mathematical materials; individual approach in training; students’ self-expression and the development of their creativity in the e-learning process. The following opportunities are brought to light the possibilities of digital technologies for the construction and research of econometric models (based on the problem of dependence of the level of the Ukrainian population employment). Various stages of building and testing of the econometric model are characterized: identification of variables, specification of the model, parameterization and verification of the statistical significance of the obtained results.

FEATURES OF MICROSOFT OFFICE 365 SERVICES

	File storage	File sharing	Joint work	Private communication	Public communication	Videoconferencing	Conducting surveys, polls, voting
One Drive for Business	+	+	+				
SharePoint Online	+	+	+				
Microsoft Teams	+	+	+	+	+	+	+
Yammer	+	+		+	+		+
Skype for Business				+	+	+	+
Outlook		+		+	+	+	

Fig. 14. Presentation of paper [131]

The article "Cloud technologies for enhancing communication of IT-professionals" (Fig. 14) of Svitlana V. Symonenko, Viacheslav V. Osadchyi, Svitlana O. Sysoieva, Kateryna P. Osadcha and Albert A. Azaryan [131] highlights further research by the authors, begun in [45], [88], [130] and [132]. This paper deals with the urgent problem of enabling better communication of IT-specialists in their business and interpersonal interaction using information and communication technologies, including cloud technologies. It is emphasized, that effective communication is an integral part of the successful professional work of IT-professionals, but in recent years it has undergone significant transformations, which have been expressed in new forms and means of communication, its content changes, its complications and volume increases, the need to improve its accuracy, and the level of understanding for a wide range of people. Certain peculiarities of communication in the IT-environment have been discussed. It is noted that typical forms of communication in the IT-environment are synchronous and asynchronous ones. The authors insist that during their professional career IT-specialists communicate in the professional community from a variety of positions and common types of task formulation can be expressed through verbal or symbolic communication means. Due to the specifics of their professional activities, IT-professionals often need to communicate using synchronous communication (chats, video chats, audio chats, instant messaging) and asynchronous communication (email, forums, comments) tools, hence there is a demand to teach corresponding communication skills at universities. Certain practical examples of teaching communication skills using modern technologies are given. Advantages of cloud technologies for better communication within a company or an educational institution are presented. Microsoft Office 365 services, which can be successfully used to enable better communication and collaboration within a company or an educational institution are analyzed.

The article "Modeling the training system of masters of public service using Web 2.0" (Fig. 15) of Yevhen M. Khrykov, Alla A. Kharkivska, Halyna F. Ponomarova and Aleksandr D. Uchitel [37] highlights further research by the authors, begun in [14], [59], [67] and [81]. This article concerns grounding the technology of training masters of public service with the use of Web 2.0. This technology is based on the concept of sign-contextual learning, the positions of the laboratory-brigade method, the concept of Web 2.0, case technology, project method, problem learning. The main features of this technology are changes in the correlation between theoretical and practical training, in-class and individual studying; changing teachers' functions; extensive use of information technology capabilities in learning.

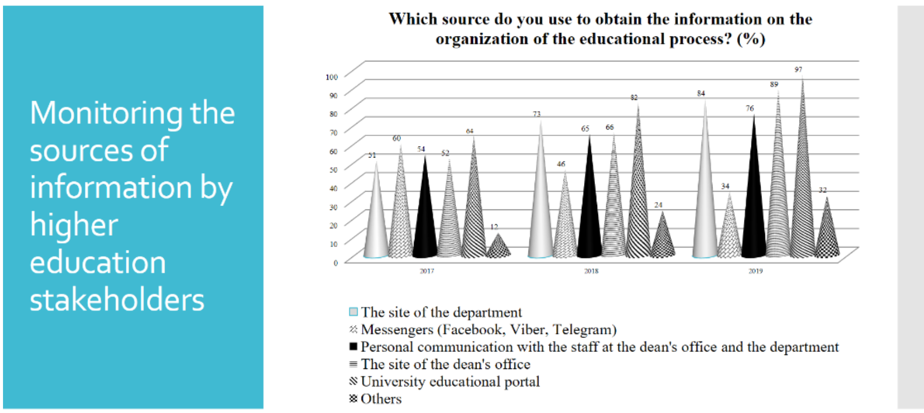


Fig. 15. Presentation of paper [37]

The article "Using Twitter in Ukrainian sociology majors training" (Fig. 16) of Liubov F. Panchenko, Andrii O. Khomiak and Andrey V. Pikilnyak [91] highlights further research by the authors, begun in [90], [92] and [93]. This article deals with the problem of using cloud technologies in the training of sociology students in Ukraine. The popularity of Twitter in Ukraine is analyzed. The possibilities of using Twitter as a learning tool in classroom are discussed. List of recommended tweeters, including Ukrainian resources as well as resources related to population censuses is proposed. The article offers examples of student activities for Social Statistics and Demographics courses. The article demonstrates that new forms of student's activity related to data analysis introduced by academics and practitioners (building art objects and storytelling based on data; shared data collection by citizens through mobile devices, "play with data" modern data visualization services) can be realized with Twitter resources and can help overcome the barriers that arise while studying quantitative methods.

Fig. 16. Presentation of paper [91]

The article "Technology of presentation of literature on the Emoji Maker platform: pedagogical function of graphic mimesis" (Fig. 17) of Rusudan K. Makhachashvili, Svetlana I. Kovpik, Anna O. Bakhtina and Ekaterina O. Shmeltser [49] deals with the technology of visualizing fictional text (poetry) with the help of emoji symbols in the Emoji Maker platform that not only activates students' thinking, but also develops creative attention, makes it possible to reproduce the meaning of poetry in a succinct way. The application of this technology has yielded the significance of introducing a computer being emoji in the study and mastering of literature is absolutely logical: an emoji, phenomenologically, logically and eidologically installed in the digital continuum, is separated from the natural language provided by (ethno)logy, and is implicitly embedded into (cosmo)logy. The technology application object is the text of the twentieth century Cuban poet José Ángel Buesa. The choice of poetry was dictated by the appeal to the most important function of emoji – the expression of feelings, emotions, and mood. It has been discovered that sensuality can reconstructed with the help of this type of meta-linguistic digital continuum. It is noted that during the emoji design in the Emoji Maker program, due to the technical limitations of the platform, it is possible to phenomenologize one's own essential-empirical reconstruction of the lyrical image. Creating the image of the lyrical protagonist sign, it was sensible to apply knowledge in linguistics, philosophy of language, psychology, psycholinguistics, literary criticism. By constructing the sign, a special emphasis was placed on the facial emogram, which also plays an essential role in the transmission of a wide range of emotions, moods, feelings of the lyrical protagonist. Consequently, the Emoji Maker digital platform allowed to create a new model of digital presentation of fiction, especially considering the psychophysiological characteristics of the lyrical protagonist. Thus, the interpreting reader, using a specific digital toolkit – a visual iconic sign (smile) – reproduces the polylaterial metalinguistic multimodality of the sign meaning in fiction. The effectiveness of this approach is verified by the poly-functional emoji ousia, tested on texts of fiction.

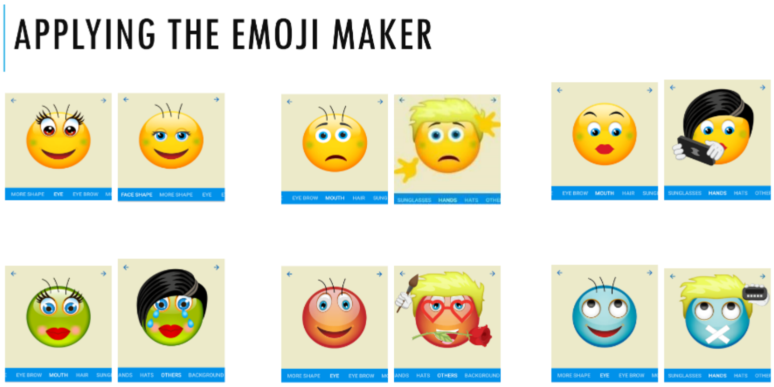


Fig. 17. Presentation of paper [49]

3 Session 2: Cloud-based learning environments

The article "Model of using cloud-based environment in training databases of future IT specialists" (Fig. 18) of Olha V. Korotun, Tetiana A. Vakaliuk and Vladimir N. Soloviev [48] highlights further research by the authors, begun in [40], [41], [47], [69], [108], [145], [146] and [148]. The authors substantiates and develops the model of using cloud-based environment (CBE) in the training of databases of future information technology (IT) specialists, which consists of interrelated units: target (purpose, task of using CBE), conceptual (pedagogical approaches, didactic principles), organizational and semantic (characteristics of CBE, basic requirements for CBE, subjects of training, CBE of the teacher, CBE of the student, curricula of institution of higher education, educational-methodical complex of discipline "Databases", installation and configuration of database management system, development of educational material from the database in electronic form, selection of cloud-based systems of distance learning, introduction of cloud-based systems of distance learning in the training of students' databases, selection of CBE in database training (databases, forms, methods, tools), evaluative (criteria, indicators, levels of professional and practical competence of future IT specialists on the use of CBE in database training), effective (increased formation of the information and communication technologies of future IT specialists on the use of CBE in database training).

Fig. 18. Presentation of paper [48]

The article “Using Learning Content Management System Moodle in Kryvyi Rih State Pedagogical University educational process” (Fig. 19) of Iryna S. Mintii [70] highlights further research by the author, begun in [68], [101] and [144]. Author analyzes the results of the survey of 75 lecturers on using learning content management system (LCMS) Moodle in the educational process. It is defined that more than 75% of the respondents use LCMS Moodle. The lecturers up to 30 or over 60 years old, with up to 3-year-work experience in Universities need methodic assistance. Textual e-learning resources are widely used in developed courses while video and audio are not used enough. LCMS Moodle is mostly used during exams or tests and student work, and using LCMS Moodle should be intensified in lectures, laboratory and practical classes. Among the most demanded resources are label, page, file, URL, book, assignment, attendance, glossary, quiz. Thus, the popularization of other resources is identified as one of the most important. An action plan how to improve LCMS Moodle usage: increasing the IT competencies of both teachers and students – planned long-term courses “IT in full-time (blended) learning”; seminars, consultations, (group and individual forms) both on general issues, and according to the specificity of the specialties; methodic handouts and recommendations; improving logistics; improving logistical support – ensuring constant access to the Internet, updating and equipping computer classrooms; creating of transparent, predictable and attractive for authors content of the regulatory framework.

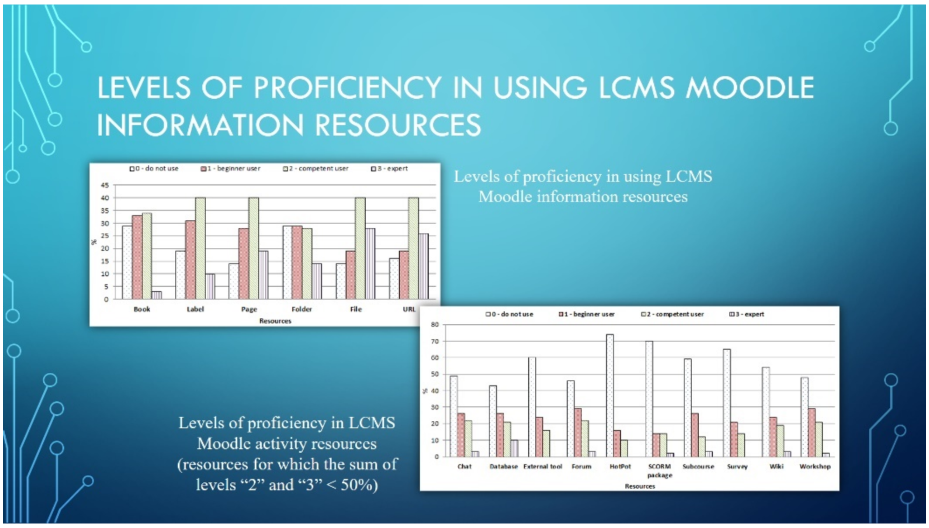


Fig. 19. Presentation of paper [70]

The article "Peculiarities of using of the Moodle test tools in philosophy teaching" (Fig. 20) of Andrii I. Abdula, Halyna A. Baluta, Nadiia P. Kozachenko and Darja A. Kassim [1] highlights further research by the authors, begun in [19], [50] and [95]. This paper considers the role of philosophy and philosophical disciplines as the means of forming general cultural competences, in particular, in the development of critical thinking. The article emphasizes that the process of forming over-subject and soft skills, which, as a rule, include also critical thinking, gets much more complicated under the conditions of the reduction in the volume of philosophical courses. The paper grounds that one of the ways to "return" philosophy to educational programmes can be the implementation of training, using the e-learning environment, especially Moodle. In addition, authors point to the expediency of using this system and, in general, e-learning as an instrument for collaborating students to the world's educational community and for developing their lifelong learning skills. The article specifies the features of providing electronic support in philosophy teaching, to which the following belongs: the difficulty of parametrizing the learning outcomes; plurality of approaches; communicative philosophy. The paper highlights the types of activities that can be implemented by tools of Moodle. The use of the following Moodle test tasks is considered as an example: test control in the flipped class, control of work with primary sources, control of self-study, test implementation of interim thematic control. The authors conclude that the Moodle system can be used as a tools of online support for the philosophy course, but it is impossible to transfer to the virtual space all the study of this discipline, because it has a significant worldview load. Forms of training, directly related to communication, are integral part of the methodology of teaching philosophy as philosophy itself is discursive, dialogical, communicative and pluralistic. Nevertheless, taking into account features of the discipline, it is possible to provide not only the evaluation function of the test control, but also to realize a number of educational functions: updating the basic knowledge, memorization, activating the cognitive interest, developing the ability to reason and the simpler ones but not less important, – the skill of getting information and familiarization with it.

Fig. 20. Presentation of paper [1]

The article “The technique of the use of Virtual Learning Environment in the process of organizing the future teachers’ terminological work by specialty” (Fig. 21) of Victoria V. Pererva, Olena O. Lavrentieva, Olena I. Lakomova, Olena S. Zavalniuk and Stanislav T. Tolmachev [96] highlights further research by the authors, begun in [55]. This paper studies the concept related to E-learning and the Virtual Learning Environment (VLE) and their role in organizing future teachers’ terminological work by specialty. It is shown the creation and use of the VLE is a promising approach in qualitative restructuring of future specialists’ vocation training, a suitable complement rather than a complete replacement of traditional learning. The concept of VLE has been disclosed; its structure has been presented as a set of components, such as: the Data-based component, the Communication-based, the Management-and-Guiding ones, and the virtual environments. Some VLE’s potential contributions to the organization of terminological work of future biology teachers’ throughout a traditional classroom teaching, an independent work, and during the field practices has been considered. The content of professionally oriented e-courses “Botany with Basis of Geobotany” and “Latin. Botany Terminology” has been revealed; the ways of working with online definer (guide), with UkrBIN National Biodiversity Information Network, with mobile apps for determining the plant species, with digital virtual herbarium, with free software have been shown. The content of students’ activity in virtual biological laboratories and during virtual tours into natural environment has been demonstrated. The explanations about the potential of biological societies in social networks in view of students’ terminology work have been given. According to the results of empirical research, the expediency of using VLEs in the study of professional terminology by future biology teachers has been confirmed.

Fig. 21. Presentation of paper [96]

The article “The use of digital escape room in educational electronic environment of maritime higher education institutions” (Fig. 22) of Serhii A. Voloshynov, Halyna V. Popova, Alona Y. Yurzhenko and Ekaterina O. Shmeltser [158] highlights further research by the authors, begun in [15], [30], [44], [60] and [82]. This paper is tended to investigate the gamification activities use in educational electronic environment of maritime higher education institutions. Gamification methods with examples are described (gamification testing, QR Code quest, storytelling and escape room). Comparative characteristic of traditional learning and learning using gamification in educational electronic environment is given in the article according to different criteria: the place and role of teacher or students in the learning process; type of information communication; methods of training; equipment; level of freedom of the actions; presence of the problems in educational process; level of its control and learning outcomes. The paper also presents examples of gamification activities based on escape room quest to form communicative competency of future maritime professionals. Escape room activity presented in the article contains storytelling element, crossword and electronic testing questions of different types. Question types listed in the paper are Drag and drop to the text, Short answer and Multiple choice. Escape room activity was done by second year cadets of Kherson State Maritime Academy. According to the received results, knowledge quality increased by 10% and success by 20%. Further investigation of gamification activities can also be done for learning system of maritime higher education institutions using simulation technologies of virtual, augmented and mixed realities.

Fig. 22. Presentation of paper [158]

4 Session 3: Cloud services for learning foreign language

The article “Improving the content of training future translators in the aspect of studying modern CAT tools” (Fig. 23) of Rostyslav O. Tarasenko, Svitlana M. Amelina and Albert A. Azaryan [136] highlights further research by the authors, begun in [134] and [135]. This article deals with the search for improving the content of training for future translators, taking into account the expansion of the use of information technologies in the field of translation. The results of a study of curriculums for translators at the universities of Europe, America and Asia are presented. The use of CAT systems in the work of translation agencies is shown. The presentation of various CAT systems in training programs for translators and their use in the market of translation services is analyzed. It has been established that both university curricula and translation agencies are oriented, as a rule, not to one, but to several CAT systems. The results of a student survey based on their practice in translation agencies are presented. Recommendations have been developed regarding the inclusion of the most common CAT systems in the training program for translators. The expediency of studying not just one, but several CAT systems is substantiated. The necessity of studying both desktop and cloud CAT systems is indicated.

The article “Integrated testing system of information competence components of future translators” of Rostyslav O. Tarasenko, Svitlana M. Amelina and Albert A. Azaryan [137] (Fig. 24) highlights further research by the authors, begun in [2]. This article deals with the diagnosis of the formation of the information competence components of translators through testing. The use of testing to determine the level of formation of the information-thematic component of the information competence of translators is demonstrated. It has been established that one of the ways to form the information-thematic component of information competence in the aspect of studying terminology can be the use of thematic networks. The development of a thematic network is shown on the example of the thematic network “Electrical equipment”. The stages of test control, which are consistent with the logic of the organization of the educational process and the process of forming the information competence of the future translator according to the scheme of the developed thematic network, have been determined. These stages are the current, thematic, modular, final testing. The main types of test tasks are defined, the combination of which allows diagnosing the level of formation of the information-thematic component of students’ information competence. Criteria and principles for the selection of test tasks for each of the testing stages are proposed. The ratio of test tasks of different types and complexity at the determined testing stages has been developed. The results of an experimental study on the diagnosis of the formation of the information-thematic component of the information competence of future translators by applying the developed integrative testing system using the Moodle platform are presented.

Fig. 23. Presentation of paper [136]

The article “The use of mobile applications and Web 2.0 interactive tools for students’ German-language lexical competence improvement” (Fig. 25) of Yuliya M. Kazhan, Vita A. Hamaniuk, Svitlana M. Amelina, Rostyslav O. Tarasenko and Stanislav T. Tolmachev [31] focuses on the use of mobile applications and Web 2.0 interactive tools to improve students’ German-language lexical competence. The composition and structure of lexical competence are described, the order of exercises for lexical competence formation is given, the didactic possibilities of using mobile applications, blogging technologies and other interactive tools to improve lexical skills are found out, examples of using mobile applications and Web 2.0 interactive tools in the learning process that prove their effectiveness are given. It is proved that the use of mobile applications and Web 2.0 interactive tools helps to organize students' work in and outside classrooms effectively for the formation and improvement of their lexical competence.

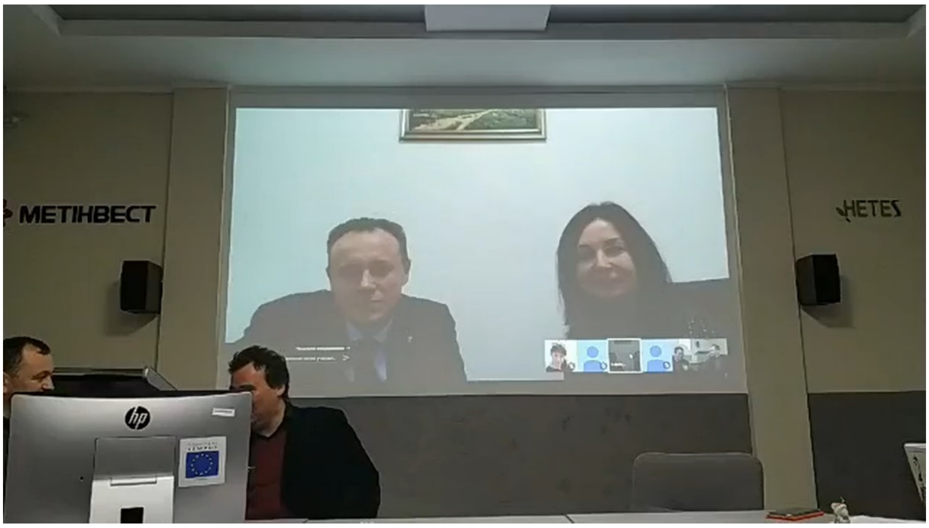


Fig. 24. Presentation of paper [137]

Fig. 25. Presentation of paper [31]

The article “Moodle course in teaching English language for specific purposes for masters in mechanical engineering” (Fig. 26) of Hanna M. Shalatska, Olena Yu. Zotova-Sadylo and Ivan O. Muzyka [113] highlights further research by the authors, begun in [54], [64] and [110]. The central thesis of this paper is that e-learning courses can have a significant impact on English language for specific purposes (ESP) proficiency of mining mechanical engineering students. The purpose of this study is to assess the effectiveness of ESP Moodle-based course “English for Mining Mechanical Engineers” and to reveal the results of its experimental approbation. In order to identify the lectures’ and learners’ needs we have applied the survey research. The survey confirmed the greatest demand for Moodle courses that include all the elements of a coherent training manual to provide self-development of engineering students. The interview results contributed to design of author’s ESP course syllabus. The importance and originality of this study are that to approbate the course materials’ effectiveness two approaches have been adopted simultaneously. The first is blended learning method based on e-learning platform applied in the experimental group and the second one is classic in-class instructor-led studying used in a control group. Students’ progress in ESP proficiency has been assessed using the cross assessment method. The experiment has validated the initial hypothesis that the special online courses focused on honing foreign language skills and integrated in the domain of specific professional knowledge have a beneficial effect on students’ communicative competencies in general. There were identified the advantages of self-tuition based on Moodle platform. The Moodle course lets the teachers save considerable in-class time to focus more on communicative assignments. The findings of this study have a number of practical implications in ESP online courses development.

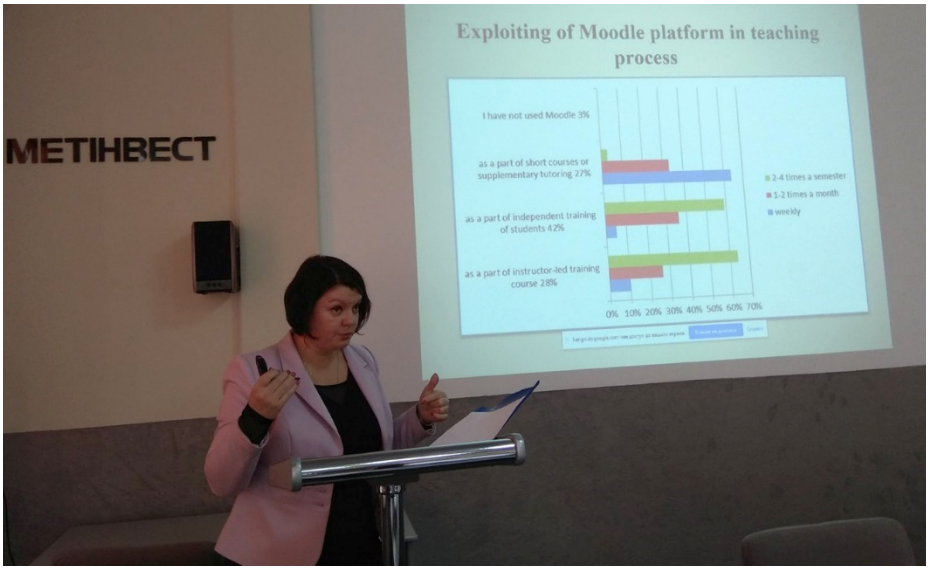


Fig. 26. Presentation of paper [113]

5 Session 4: Cloud technologies in STEAM education

The article “Cloud technologies for STEM education” (Fig. 27) of Nataliia V. Valko, Nataliya O. Kushnir and Viacheslav V. Osadchyi [150] highlights further research by the authors, begun in [149]. Cloud technologies being used in STEM education for providing robotics studying are highlighted in this article. Developing cloud robotic systems have not been used to their fullest degree in education but are applied by limited specialists’ number. Advantages given by cloud robotics (an access to big data, open systems, open environments development) lead to work with mentioned systems interfaces improving and having them more accessible. The potential represented by these technologies make them worth being shown to the majority of teachers. Benefits of cloud technologies for robotics and automatization systems are defined. An integrated approach to knowledge assimilation is STEM education basis. The demanded stages for robotics system development are shown and cloud sources which could be possibly used are analyzed in this article.

Fig. 27. Presentation of paper [150]

The article “Analyzing of main trends of STEM education in Ukraine using stemua.science statistics” (Fig. 28) of Yevhenii B. Shapovalov, Viktor B. Shapovalov, Fabian Andruszkiewicz and Nataliia P. Volkova [119] highlights further research by the authors, begun in [115], [116], [117], [118] and [120]. Authors propose to analyses it by using SEO analysis of one of the most popular STEM-oriented cloud environment in Ukraine stemua.science. It is proposed to use the cycle for cloud-based educational environments (publishing/SEO analysis/team’s brainstorm/prediction/creation of further plan) to improve their efficiency. It is found, that STEM-based and traditional publications are characterized by similar demand of educational process stakeholders. However, the way how teachers and students found the publication proves that traditional keywords (47.99 %) used significantly more common than STEM keywords (2.67 %). Therefore, it is proved that STEM-methods are less in demand than traditional ones. However, considering the huge positive effect of the STEM method, stemua.science cloud educational environment provides a positive effect on the educational process by including the STEM-aspects during finding traditional approaches of education by stakeholders of the educational process.

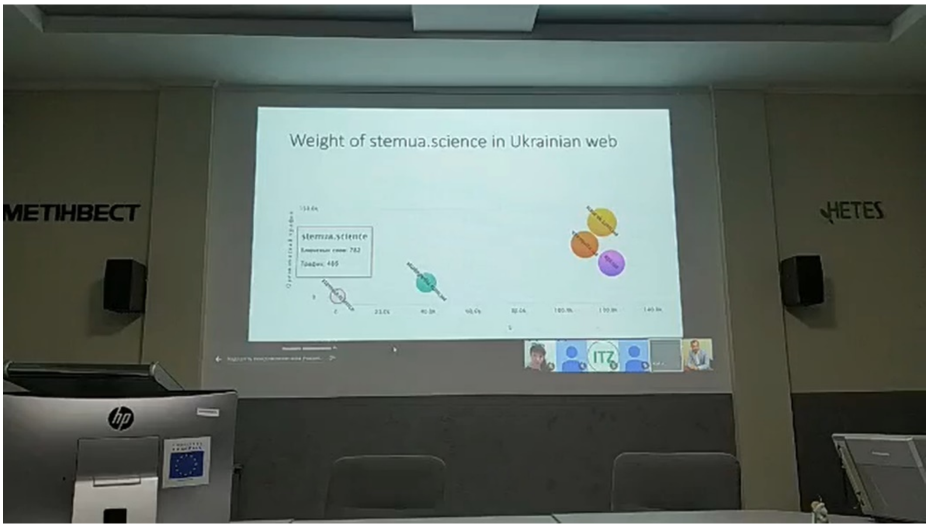
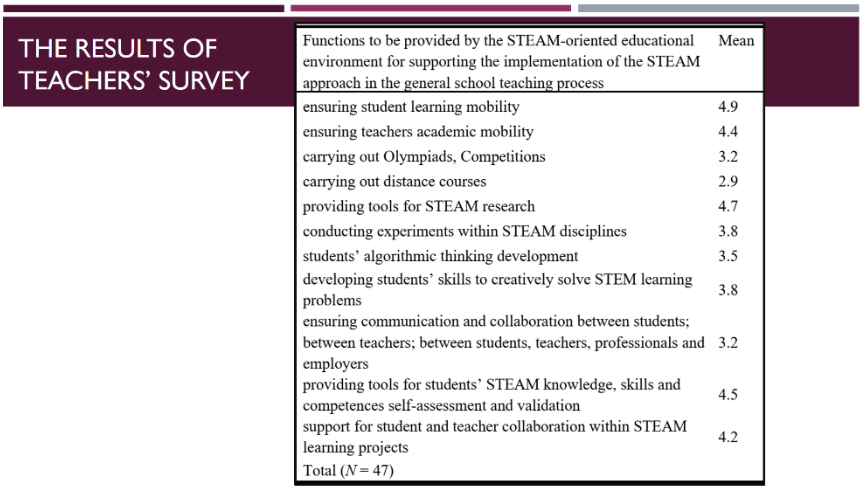


Fig. 28. Presentation of paper [119]

The article "Educational electronic platforms for STEAM-oriented learning environment at general education school" (Fig. 29) of Nataliia V. Soroko, Lorena A. Mykhailenko, Olena G. Rokoman and Vladimir I. Zaselskiy [128] highlights further research by the authors, begun in [12], [89], [51] and [156]. This article is devoted to the problem of the use of educational electronic platform for the organization of a STEAM-oriented environment of the general school. The purpose of the article is to analyze the use of educational electronic platforms for organizing the STEAM-oriented school learning environment and to identify the basic requirements for supporting the implementation and development of STEAM education in Ukraine. One of the main trends of education modernization is the STEAM education, which involves the integration between the natural sciences, the technological sciences, engineering, mathematics and art in the learning process of educational institutions, in particular, general school. The main components of electronic platform for education of the organization STEAM-oriented educational environment should be open e-learning and educational resources that include resources for students and resources for teachers; information and communication technologies that provide communication and collaboration among students; between teachers; between students and teachers; between specialists, employers, students, and teachers; information and communication technologies that promote the development of STEAM education and its implementation in the educational process of the school; online assessment and self-assessment of skills and competences in STEAM education and information and communication technologies fields; STEAM education labs that may include simulators, games, imitation models, etc.; STEAM-oriented educational environment profiles that reflect unconfirmed participants' data, their contributions to projects and STEAM education, plans, ideas, personal forums, and more. Prospects for further research are the design of an educational electronic platform for the organization of the STEAM-oriented learning environment in accordance with the requirements specified in the paper.



Functions to be provided by the STEAM-oriented educational environment for supporting the implementation of the STEAM approach in the general school teaching process	Mean
ensuring student learning mobility	4.9
ensuring teachers academic mobility	4.4
carrying out Olympiads, Competitions	3.2
carrying out distance courses	2.9
providing tools for STEAM research	4.7
conducting experiments within STEAM disciplines	3.8
students' algorithmic thinking development	3.5
developing students' skills to creatively solve STEM learning problems	3.8
ensuring communication and collaboration between students; between teachers; between students, teachers, professionals and employers	3.2
providing tools for students' STEAM knowledge, skills and competences self-assessment and validation	4.5
support for student and teacher collaboration within STEAM learning projects	4.2
Total ($N = 47$)	

Fig. 29. Presentation of paper [128]

The article "Cloud technologies as a tool of creating Earth Remote Sensing educational resources" (Fig. 30) of Ihor V. Kholoshyn, Olga V. Bondarenko, Olena V. Hanchuk and Iryna M. Varfolomyeyeva [35] highlights further research by the authors, begun in [10], [11], [18], [33], [34] and [36]. This article is dedicated to the Earth Remote Sensing (ERS), which the authors believe is a great way to teach geography and allows forming an idea of the actual geographic features and phenomena. One of the major problems that now constrains the active introduction of remote sensing data in the educational process is the low availability of training aerospace pictures, which meet didactic requirements. The article analyzes the main sources of ERS as a basis for educational resources formation with aerospace images: paper, various individual sources (personal stations receiving satellite information, drones, balloons, kites and balls) and Internet sources (mainstream sites, sites of scientific-technical organizations and distributors, interactive Internet geoservices, cloud platforms of geospatial analysis). The authors point out that their geospatial analysis platforms (Google Earth Engine, Land Viewer, EOS Platform, etc.), due to their unique features, are the basis for the creation of information thematic databases of ERS. The article presents an example of such a database, covering more than 800 aerospace images and dynamic models, which are combined according to such didactic principles as high information load and clarity.

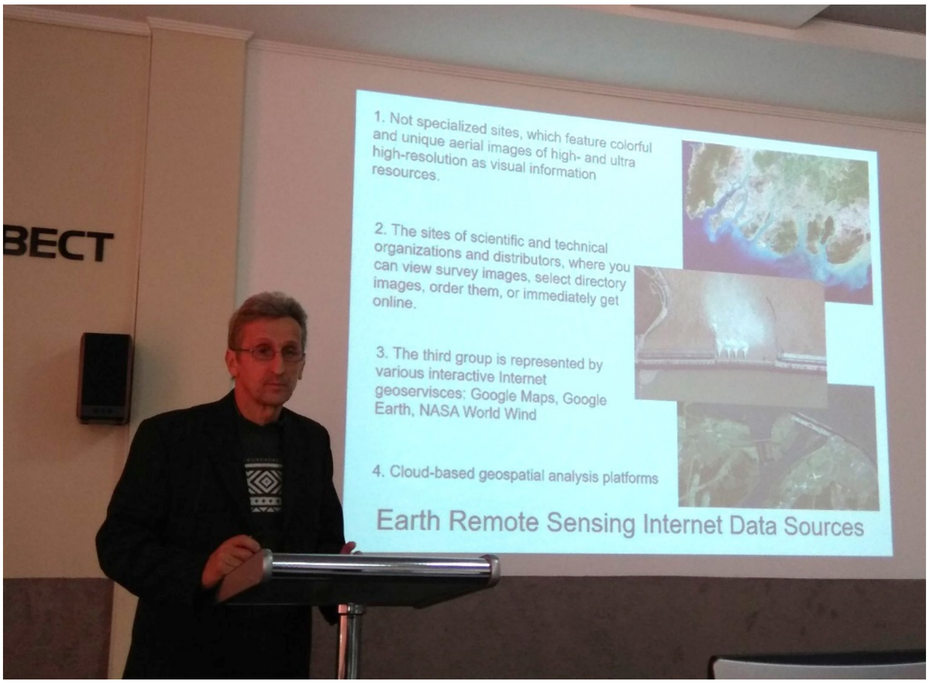


Fig. 30. Presentation of paper [35]

The article “Learning free software using cloud services” (Fig. 31) of Elena H. Fedorenko, Vladyslav Ye. Velychko, Svitlana O. Omelchenko and Vladimir I. Zaselskiy [16] highlights further research by the authors, begun in [17] and [151]. This article deals with the use of cloud technology services in the study of free software. Free software is a social phenomenon based on the philosophy of freedom and the right to intellectual creative activity. To date, a significant number of software products have been created that are licensed under free software and not used in educational activities. The conducted research revealed the factors promoting and hindering the use of free software in educational activities. Conducted questionnaires, analysis of open data, research of scientists made it possible to conclude on the expediency of using free software in educational activities. Cloud technology is not only a modern trend of effective use of information and communication technologies in professional activity, but also a proven tool for educational activities. To get acquainted with the free software, the use of cloud technologies has been helpful, which is the goal of our research.

The article “Methods of using mobile Internet devices in the formation of the general professional component of bachelor in electromechanics competency in modeling of technical objects” (Fig. 32) of Yevhenii O. Modlo, Serhiy O. Semerikov, Ruslan P.

Shajda, Stanislav T. Tolmachev, Oksana M. Markova, Pavlo P. Nechypurenko and Tetiana V. Selivanova [73] highlights further research by the authors, begun in [21], [38], [39], [42], [63], [65], [71], [72], [74], [75], [77], [78], [79], [80], [111], [112], [133] and [140]. This article describes the components of methods of using mobile Internet devices in the formation of the general professional component of bachelor in electromechanics competency in modeling of technical objects: using various methods of representing models; solving professional problems using ICT; competence in electric machines and critical thinking. On the content of learning academic disciplines “Higher mathematics”, “Automatic control theory”, “Modeling of electromechanical systems”, “Electrical machines” features of use are disclosed for Scilab, SageCell, Google Sheets, Xcos on Cloud in the formation of the general professional component of bachelor in electromechanics competency in modeling of technical objects. It is concluded that it is advisable to use the following software for mobile Internet devices: a cloud-based spreadsheets as modeling tools (including neural networks), a visual modeling systems as a means of structural modeling of technical objects; a mobile computer mathematical system used at all stages of modeling; a mobile communication tools for organizing joint modeling activities.

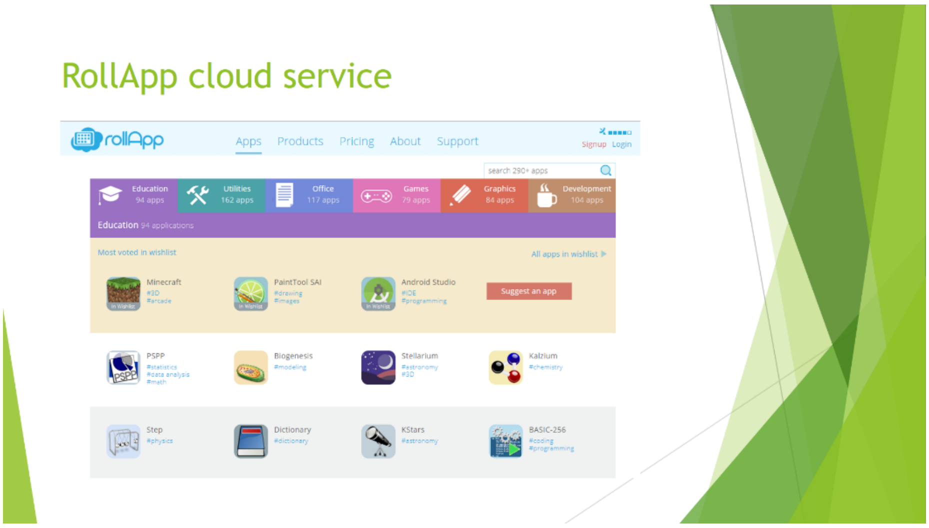


Fig. 31. Presentation of paper [16]

The article “Methodology of using mobile Internet devices in the process of biology school course studying” (Fig. 33) of Alla V. Stepanyuk, Liudmyla P. Mironets, Tetiana M. Olendr, Ivan M. Tsidylo and Oksana B. Stoliar [129] highlights further research by the authors, begun in [13], [20] and [143]. This paper considers the problem of using mobile Internet devices in the process of biology studying in secondary schools. It has been examined how well the scientific problem is developed in pedagogical theory and educational practice. The methodology of using mobile Internet devices in the process of biology studying in a basic school, which involves the use of the Play Market server applications, Smart technologies and a website, has been created. After the analyses of the Play Market server content, there have been found several free of charge applications, which can be used while studying biology in a basic school. Among them are the following: Anatomy 4D, Animal 4D+, Augmented Reality Dinosaurs – my ARgalaxy, BioInc – Biomedical Plague, Plan+Net. Their choice is caused by the specifics of the object of biological cognition (life in all its manifestations) and the concept of bio(eco)centrism, which recognizes the life of any living system as the highest value. The paper suggests the original approach for homework checking, which involves besides computer control of students' learning outcomes, the use of Miracast wireless technology. This demands the owning of a smartphone, a multimedia projector, and a Google Chromecast type adapter. The methodology of conducting a mobile front-line survey at the lesson on the learned or current material in biology in the test form, with the help of the free Plickers application, has been presented. The expediency of using the website builder Ucoz.ua for creation of a training website in biology has been substantiated. The methodology of organizing the educational process in biology in a basic school using the training website has been developed. Recommendations for using a biology training website have been summarized. According to the results of the forming experiment, the effectiveness of the proposed methodology of using mobile Internet devices in the process of biology studying in a basic school has been substantiated.

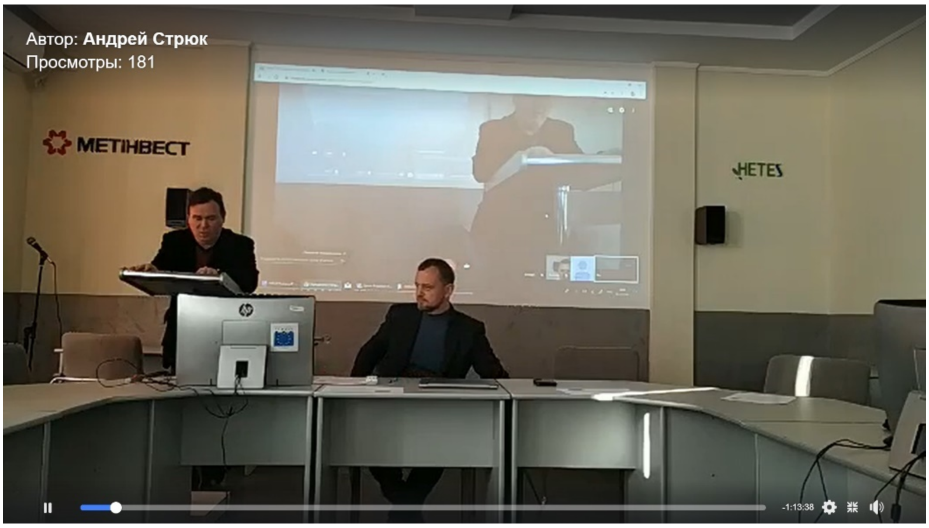


Fig. 32. Presentation of paper [73]

The article "Technologies of distance learning for programming basics lessons on the principles of integrated development of key competences" (Fig. 34) of Svitlana V. Shokaliuk, Yelyzaveta Yu. Bohunenko, Iryna V. Lovianova and Mariya P. Shyshkina [121] highlights further research by the authors, begun in [58], [66], [100], [103], [122], [123], [126], [127], [153] and [154]. The purpose of this article is to investigate the content of key competences of a secondary school student and to develop a method of teaching for the integrated development of multilingual and mathematical competences in the process of teaching Programming Basics with the help of distant technologies. The objectives of the research include generalizing and systematizing theoretical data on the structure and the content of key competences and the potential of informatics lessons for the development of separate components of multilingual and mathematical competences; generalizing and systematizing theoretical data on the ways of arranging distant support for informatics learning, Programming Basics in particular; to investigate the content and the methods of teaching Programming Basics in 7th-11th grades; to develop the e-learning Moodle course using Python for Programming Basics on the principles of integrated approach to developing separate components of multilingual and mathematical competence with determining some methodical special features while using it.

Fig. 33. Presentation of paper [129]

The article "Informatics teacher's training for design of innovative learning aids" (Fig. 35) of Liudmyla I. Bilousova, Liudmyla E. Gryzun, Julia O. Rakusa and Ekaterina O. Shmeltser [7] highlights further research by the authors, begun in [8], [9] and [84]. This paper covers practical aspects and experience of Informatics teachers' preparation for the design of innovative learning aids as one of the important components of the renewed model of teachers' training. Theoretical background of the research includes holistic educational approach and functional basics of electronic didactic aids development. The specific example of such an experience (students' project activity on the design of English multimedia tutorial for schoolchildren) is depicted in details. The prospects of further research are outlined.

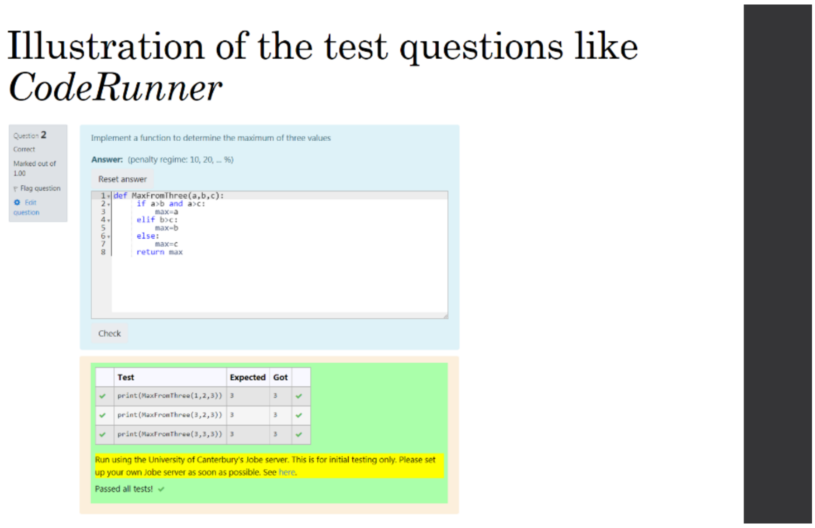


Fig. 34. Presentation of paper [121]

Fig. 35. Presentation of paper [7]

The purpose of the article “Training elementary school teachers-to-be at Computer Science lessons to evaluate e-tools” (Fig. 36) of Nadiia V. Olefirenko, Ilona I. Kostikova, Nataliia O. Ponomarova, Kateryna O. Lebedieva, Vira M. Andriievska and Andrey V. Pikilnyak [85] is to develop methodological support for students’ training for evaluation e-tools for young learners and to check its effectiveness experimentally. The module “Expert evaluation of the quality of e-tools for young learners” is offered for teachers-to-be. The determination of the weighting factor of each criterion by expert evaluations was organized. Educational principles, correlation e-tool content with the curriculum, interactivity, multimedia, assistance system, ergonomic requirements are mentioned. On the basis of the criterion rank, the significance of each criterion was calculated. The indicators to determine the level of preliminary expert evaluations of e-tools are proposed. The results are calculated with nonparametric methods of mathematical statistics, in particular, Pearson's criterion χ^2. The conclusion is the expert evaluation has different activity stages, gradually becoming a common phenomenon. Training teachers-to-be for e-tool expert evaluation at Computer Science, Mathematics, English is a complex process.

Fig. 36. Presentation of paper [85]

The article "Methodology of teaching cloud technologies to future computer science teachers" (Fig. 37) of Vasyl P. Oleksiuk and Olesia R. Oleksiuk [86] highlights further research by the authors, begun in [5], [6] and [87]. This article deals with the problem of training future computer science teachers for the use of cloud technologies. The authors analyzed courses from leading universities to study cloud technologies. On this basis the model of application and studying of cloud technologies in the process of training of future teachers of informatics was developed. The basic principles of this model are proposed: systematic, gradual, continuous. It contains target, content, operating and effective component. Therefore, the stages of using cloud computing technology were proposed: as a means of organizing learning activities, as an object of study, as a means of development. The article summarizes the experience of designing a cloud-based learning environment. The model is based on such philosophical and pedagogical approaches as systemic, competent, activity, personality-oriented, synergistic. Hybrid cloud is the most appropriate model for this environment. It combines public and private cloud platforms. Cloud-based learning environment also requires the integration of cloud and traditional learning tools. The authors described the most appropriate teaching methods for cloud technologies such as classroom learning, interactive and e-learning, practical methods. The article contains many examples of how to apply the proposed methodology in a real learning process.

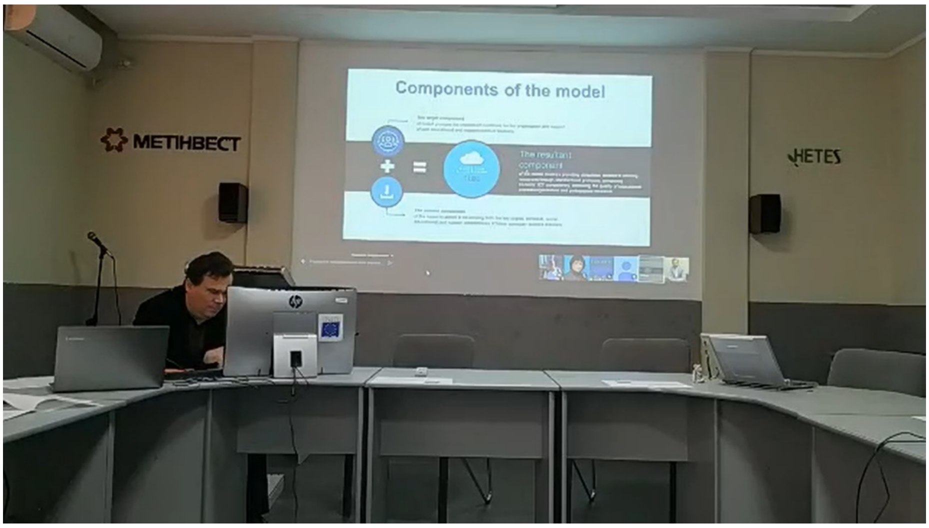


Fig. 37. Presentation of paper [86]

The article “The approaches to Web-based education of computer science bachelors in higher education institutions” (Fig. 38) of Svitlana L. Proskura and Svitlana H. Lytvynova [106] highlights further research by the authors, begun in [61]. This article is devoted to the problem of organizing of Web-based education of bachelors, and the bachelors of computer science in particular. The IT industry puts forward new requirements for future IT professionals training. This, in its turn, requires the educational process modernization: content specification, updating of forms, methods and means of training to meet the demands of socio-economic development of the society in general and bachelors of computer science in particular. The article analyzes and clarifies the notion of Web-based education of bachelors; as well as a line of approaches, such as approaches to the organization of Web-based learning for A La Carte, Station Rotation, Lab Rotation, Individual Rotation, Flipped Learning scenario; the necessity of cloud computing and virtual classroom use as a component of Web-based learning is substantiated. It is established that with the advent of a large number of cloud-based services, augmented and virtual realities, new conditions are created for the development of skills to work with innovative systems. It is noted that the implementation of the approaches to the organization of student Web-based education is carried out on international level, in such projects as Erasmus+ “Curriculum for Blended Learning” and “Blended learning courses for teacher educators between Asia and Europe”. The article features the results of programming students survey on the use of Web-based technologies while learning, namely the results of a new approach to learning organization according to the formula – traditional (30%), distance (50%) and project (20%) training.

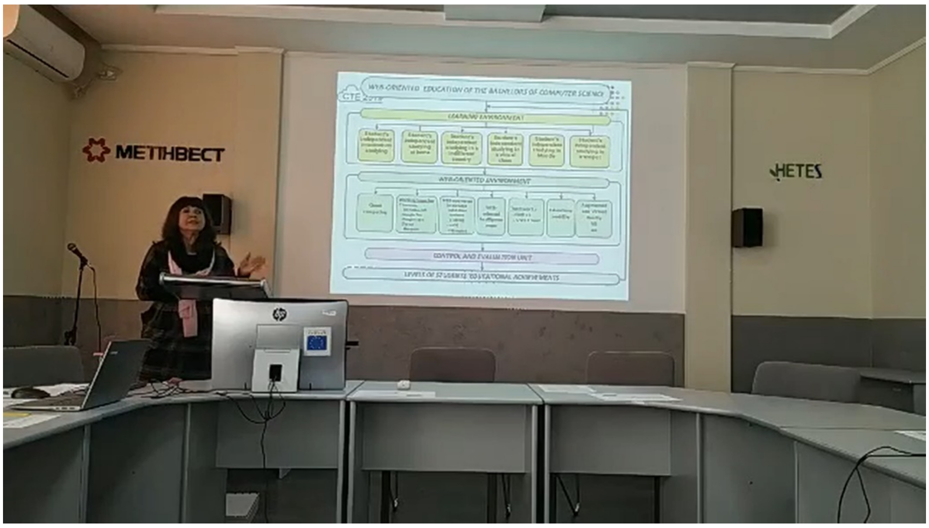


Fig. 38. Presentation of paper [106]

The article “Motivation readiness of future software engineer's professional self-improvement and prospects of its formation in college cloud environment” (Fig. 39) of Larisa M. Petrenko, Iryna P. Varava and Andrey V. Pikilnyak [98] highlights further research by the authors, begun in [24], [97] and [162]. The main article purpose is to analyze the state of the form of motivational readiness for future programmer’s professional self-improvement, to identify problems of its formation in colleges and to determine the ways of its increase as one of the main factors of quality improvement. To achieve it, a complex of theoretical and empirical methods was used, with help of which a number of problems were revealed which slow down the process of improving the quality of future programmers professional training. To eliminate them, a system of phased motivation for future specialists professional self-improvement has been developed on the basis of general secondary education, which can be integrated into the teaching of both general education and professionally-oriented disciplines; ways of improving the quality of the educational process through the creation of a cloud of oriented environment, the introduction of innovative teaching technologies, special training of teachers in the system of professional development.

The article “Web-based online course training higher school mathematics teachers” (Fig. 40) of Kateryna V. Vlasenko, Sergei V. Volkov, Daria A. Kovalenko, Iryna V. Sitak, Olena O. Chumak and Alexander A. Kostikov [155] looks into the problem of theoretical aspects of using Web 2.0 technology in higher education. This paper describes answers of 87 respondents who have helped to identify the most required types of educational content for the integration to pages of the online course training higher school mathematics teachers. The authors carry out a theoretical analysis of researches and resources that consider the development of theoretical aspects of using web tools in higher education. The research presents the characteristics common to online courses, principles of providing a functioning and physical placement of online systems in webspace. The paper discusses the approaches of creating and using animated content in online systems. The authors describe the methods of publishing video content in web systems, in particular, the creation and use of video lectures, animation, presentations. This paper also discusses several of the existing options of integrating presentations on web pages and methods of integrating mathematical expressions in web content. It is reasonable to make a conclusion about the expediency of promoting online courses, the purpose of which is to get mathematics teachers acquainted with the technical capabilities of creating educational content developed on Web 2.0 technology.

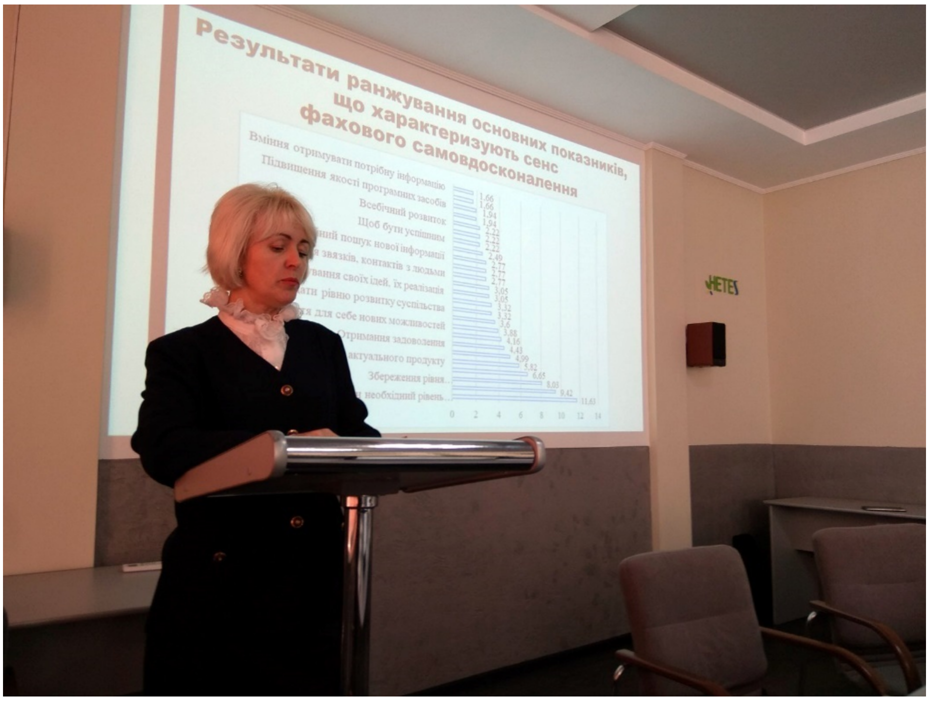


Fig. 39. Presentation of paper [98]

The article “Auto Checker of Higher Mathematics – an element of mobile cloud education” (Fig. 41) of Tetyana I. Zhylenko, Nataliia S. Martynova, Irina A. Shuda, Yevhenii A. Chykalov, Danyla A. Kuzmuk [161] presents the author’s development from the field of mobile cloud education in higher mathematics. The design architecture of this application is described in detail: QR generator and scanner, authorization, sending tasks. Block diagrams and images are presented that clearly demonstrate the operation of the application. Authors showed an example of solving the integral from the section of integral calculus for higher mathematics and showed how to download the answer in the form of a QR code and find out whether it is correct or incorrect (this can be seen by the color on the smart phone screen). It is shown how this technology helps the teacher save time for checking assignments completed by students. This confirms its effectiveness. Such an application provides students and teachers with the ability to store and process data on a cloud computing platform.

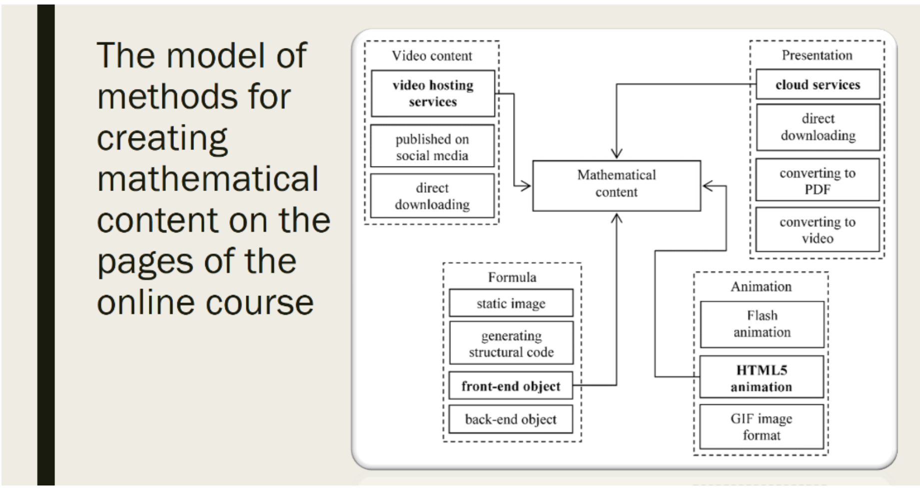


Fig. 40. Presentation of paper [155]

Fig. 41. Presentation of paper [161]

The article "E-learning as a mean of forming students' mathematical competence in a research-oriented educational process" (Fig. 42) of Mariia M. Astafieva, Oleksii B. Zhyltsov, Volodymyr V. Proshkin and Oksana S. Lytvyn [3] is devoted to the substantiation of approaches to the effective use of advantages and minimization of disadvantages and losses of e-learning as a mean of forming mathematical competence of students in the conditions of research-oriented educational process. As a result of the ascertaining experiment, e-learning has certain disadvantages besides its obvious advantages (adaptability, possibility of individualization, absence of geographical barriers, ensuring social equality, unlimited number of listeners, etc.). However, the nature of these drawbacks lies not as much in the plane of opportunity itself as in the ability to use them effectively. On the example of the e-learning course (ELC) “Mathematical Analysis” (Calculus) of Borys Grinchenko Kyiv University, which is developed on the basis of the Moodle platform, didactic and methodical approaches to content preparation and organization of activities in the ELC in mathematics are offered. Given the specifics of mathematics as a discipline, the possibility of using ELCs to support the traditional learning process with full-time learning is revealed, introducing a partially mixed (combined) model. It is emphasized that effective formation of mathematical competence of students by means of e-learning is possible only in the conditions of research-oriented educational environment with active and concerned participation of students and partnership interaction. The prospect of further research in the analysis of e-learning opportunities for the formation of students’ mathematical competence, in particular, research and investigation tools, and the development of recommendations for the advanced training programs of teachers of mathematical disciplines of universities are outlined.

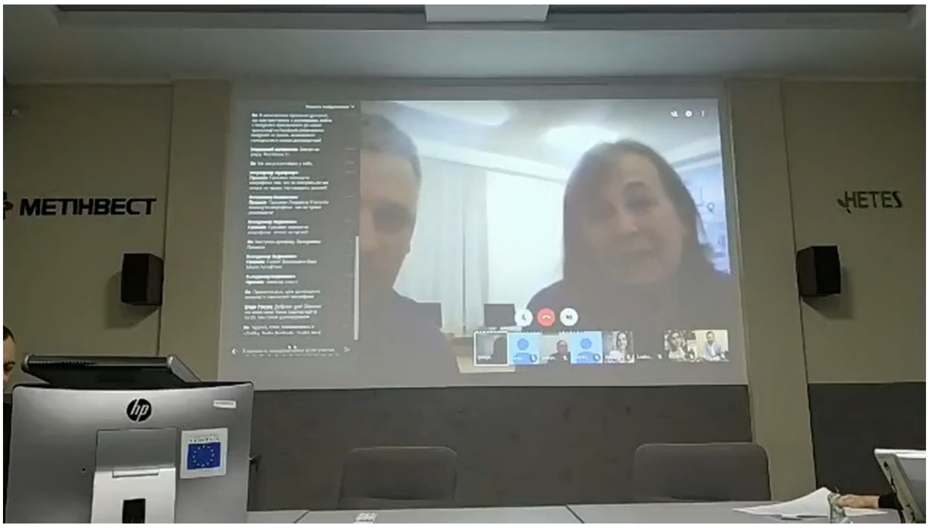


Fig. 42. Presentation of paper [3]

The article “The use of the cloud services to support the math teachers training” (Fig. 43) of Mariya P. Shyshkina and Maiia V. Marienko [125] highlights further research by the authors, begun in [62], [83], [104], [105] and [124]. The development of the information society and technological progress are significantly influenced by the learning tools. Therefore, to the variety of tools that could be used to support the study of any discipline new ones emerging lately are continuously being added. Along with the great deal of systems of computer mathematics (SCM), web-oriented versions of SCM mathematical applications and other math learning tools the cloud-based versions of mathematical software such as MapleNet, MATLAB web-server, WebMathematica and others are now being used. These tools accomplishment becomes the essential part of training mathematics teachers. Domestic and foreign experiences of using cloud services for forming professional competences of mathematics teachers are analyzed. The place of the CoCalc within the system of mathematical disciplines learning tools is investigated. The task of improving the math teachers' ICT competence by means of cloud services use in the process of training is considered. Among the new forms of learning rising along with the cloud services dissemination are such as collaborative learning, inquiry-based learning, person-oriented learning. At the same time, the use of the appropriate cloud service in the study of some mathematical discipline improves the assimilation of the learning material and improves the knowledge acquisition process on most topics. The analysis of current research of Ukrainian scientists on the problem in question shows that the progress is underway as for further elaboration and implementation of new learning methods and techniques of using cloud services in the higher education institutions.

Fig. 43. Presentation of paper [125]

The article "Application of GeoGebra in Stereometry teaching" (Fig. 44) of Tetiana H. Kramarenko, Olha S. Pylypenko and Ivan O. Muzyka [52] highlights further research by the authors, begun in [53]. The purpose of this study is improving of the methodology of teaching Mathematics using cloud technology. The task of the study is identifying the problems that require a theoretical and experimental solution. The object of the study is the educational process in the higher education institution, the subject of the study is modern information and communication technologies. The result of the study is the teaching aids of pedagogically considered and appropriate combination of traditional and modern teaching medium implemented into the educational process. The possibilities of using cloud technologies and Dynamic Mathematics system GeoGebra in the educational process on the example of Stereometry profile training are revealed. The use of GeoGebra Dynamic Mathematics in Stereometry teaching will assist the forming of students' STEM competencies. In order to orient Mathematics and Computer Science teachers to introduce the elements of STEM education, it is advisable to use cloud-based learning tools, such as GeoGebra, in their learning.

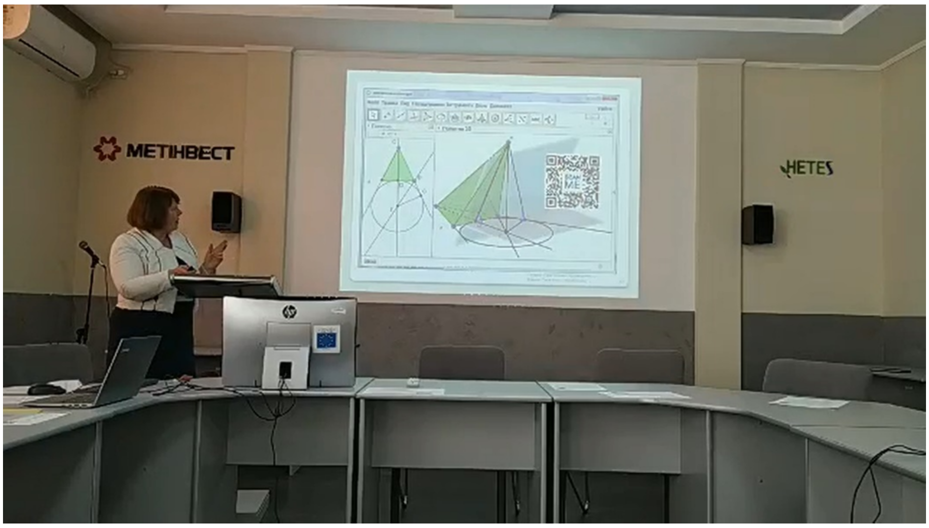


Fig. 44. Presentation of paper [52]

6 Conclusion

The vision of the CTE 2019 is provides a premier interdisciplinary platform for researchers, practitioners and educators to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions adopted in the fields of educational technology.

The workshop has successfully performing forum to transferring and discussing research result among the researcher, students, government, private sector or industries. Participants and presenters from several countries such as Egypt, Iraq, Israel, Poland, Ukraine have attended the workshop to share their significant contribution in research related to Cloud Technologies in Education.

The seventh instalment of CTE was organised by Kryvyi Rih National University, Ukraine (with support of the rector Mykola I. Stupnik) in collaboration with Kryvyi Rih State Pedagogical University, Ukraine (with support of the rector Yaroslav V. Shramko), Institute of Information Technologies and Learning Tools of the NAES of Ukraine (with support of the director Valeriy Yu. Bykov) and Ben-Gurion University of the Negev, Israel (with support of the rector Chaim J. Hames).

We are thankful to all the authors who submitted papers and the delegates for their participation and their interest in CTE as a platform to share their ideas and innovation. Also, we are also thankful to all the program committee members for providing continuous guidance and efforts taken by peer reviewers contributed to improve the quality of papers provided constructive critical comments, improvements and corrections to the authors are gratefully appreciated for their contribution to the success of the workshop.

We hope you enjoy this workshop and meet again in more friendly, hilarious, and happiness of further CTE 2020.

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Digital competence of pedagogical university student: definition, structure and didactical conditions of formation

Mykhailo V. Moiseienko[1[0000-0002-4945-202X]], Natalia V. Moiseienko[1[0000-0002-3559-6081]], Iryna V. Kohut[2[0000-0002-0856-7074]] and Arnold E. Kiv[3[0000-0002-0991-2343]]

[1] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
n.v.moiseenko@gmail.com
[2] Poltava V.G. Korolenko National Pedagogical University,
2 Ostrohradskyi Str., Poltava, 36003, Ukraine
irynakohut15@gmail.com
[3] Ben-Gurion University of the Negev, P.O.B. 653, Beer Sheva, 8410501, Israel
kiv@bgu.ac.il

Abstract. The article defines and substantiates didactic conditions of digital formation competences of students of pedagogical universities: actualization of motivational value training of students of pedagogical universities; organization of interaction between students and teachers of pedagogical universities on the Internet through the creation of digital information educational environment; creation of individual educational trajectories of students.

Keywords: digital competence; pedagogical university students; training; professional readiness; new pedagogical technologies.

1 Introduction

The current pace of digitalization of the world requires a shift to a higher quality of using digital technologies in education. One of the factors of the development of information society in Ukraine is the formation of the digital competence of the individual.

The key concepts of our research are “competency” and “competence”. Foreign scientists consider these concepts to be synonymous, Ukrainian scholars do not, but all interpret them differently [20]. The analysis of the scientific literature gives grounds to claim that a competency is a possession of a relevant competence that contains a personal attitude to the subject matter, and competence is a set of interrelated personal qualities (knowledge, abilities, skills, activities) [21; 22; 28; 30; 38].

The task of a teacher who teaches students of pedagogical universities is not only to give students knowledge of the curriculum, but also to develop important skills of finding, collecting and processing the necessary information, working at a team, taking on responsibility, present the results of your work, independently master new technologies and tools. Therefore, the problem of pedagogical university students’ digital competence formation is gaining relevance.

Theoretical analysis of scientific researches and publications on the problem of professional training of specialists in higher education shows that this matter of building a coherent concept formation of digital competence of students of pedagogical universities has not been studied separately in domestic pedagogy. Usually, they investigate either professional competence in general, or preparing future teachers for professional activities by means of digital educational technologies, the nature and structure of digital competencies and digital culture of future teachers as aim-setting categories (Andrii M. Hurzhii [8], Nataliia V. Morze [21], Oksana V. Ovcharuk [22], Yurii S. Ramskyi [27], Oleg M. Spirin [30], Vasyl V. Yahupov [36], Myroslav I. Zhaldak [38], and others).

One of the effective ways of solving the problem of preparing future teachers is regarded by Liudmyla I. Bilousova [3], Olga V. Bondarenko [11], Valerii Yu. Bykov [4], Tetiana H. Kramarenko [16], Olena O. Lavrentieva [25], Maiia V. Marienko [18], Iryna S. Mintii [34], Serhii A. Rakov [26], Serhiy O. Semerikov [19], Mariya P. Shyshkina [29], Aleksander V. Spivakovsky [31], Ivan M. Tsidylo [33], Vladyslav Ye. Velychko [35], Olga G. Yaroshenko [37], Myroslav I. Zhaldak [39] and other scientists as the introduction of ICT, in particular mobile learning tools.

Considering that, the purpose of this article is to define and justify the didactic conditions of digital formation competences of students of pedagogical universities.

2 Results and discussion

In accordance with the recommendation of the European Commission [6], competence is defined as a combination of knowledge, skills, and attitudes where:

- knowledge is a composition of established facts and figures, concepts, ideas and theories that necessary for understanding a particular subject area;
- skills are defined as the ability and capability to perform actions and to apply knowledge to achieve results;
- attitude describes the inclinations, preferences, and mind-set that determine the mode of action or reactions to ideas, personalities or situations.

Competence, including digital competence, is a category that belongs to the sphere of relations between knowledge and practical activity of the person. It integrates knowledge, skills and assimilated modes of activity in relation to specific conditions, in a particular situation [8]. So, the influence of the environment, the conditions and the way of life of the individual, their society have a significant impact on directions of formation of digital information competence.

The study has found that digital competence is a purposeful use of ICT to create, search, process, share information in the virtual space, information and media literacy, web and internet security skills cybersecurity, understanding the ethics of working with information in the student preparation process pedagogical universities.

David Bawden [2] states that the term “digital information competence” is broad and general. This term covers competencies such as networking competence, internet-competency, hyper-competency, and multimedia competence. The analysis of the literature allows us to identify the ten competencies that are necessary for mastering digital competence. These include:

- the ability to systematize and summarize information found on-line (art critical thinking on the Paul-Elder system [24]);
- the ability to read and understand in the dynamic and inconsistent hyper-text environment;
- the ability to build information bases from different sources, relying on ability to collect and evaluate facts and judgments without prejudice;
- search skills related to Internet search service;
- the ability to manage "multimedia flow" using information filters and agents;
- ability to create a "personal information strategy" and carry out a portfolio-approach to selecting sources and delivery mechanisms;
- awareness of collaboration with other participants in the process and the ability to find contacts with them to discuss issues and get help;
- understanding of the problem and the ability to develop a system of questions that will allow you to find and obtain the necessary information;
- understanding of supporting traditional forms of content information through telecommunication means;
- understanding the relativity of judgments regarding the validity and significance of reference material with hypertext links.

According to Volodar V. Kraevskii and Andrei V. Khutorskoi [15], we have identified such a structure digital competence:

- motivational value (target);
- cognitive;
- operating activity;
- personally-reflexive components.

The *motivational value* component includes the purpose, set of motives, interests, values orientations, professional abilities, focus on implementation in vocational training, needs for improvement, self-education, self-development, value installations of updating in professional activity, stimulates creative expression of a person in professional activity. He characterizes the presence of interest in professional activity, which means a person's need for knowledge in mastering effective ways of organizing professional activity.

The *cognitive* component is a set of professional knowledge, skills and their correspondence to professional competences, practical readiness to exercise professional activities. It provides fluency in information processing and handling skills information objects that also influence the improvement of professional knowledge and skill. The level of development of the cognitive component is determined by completeness, depth, a system of knowledge in the subject area.

The *active* component is the active use of information technology and computer technology in professional activity as a means of cognition and development, self-improvement, and creativity. In the business component of digital competence students of the pedagogical university can be divided into two levels: basic and subject-oriented. The basic level is the knowledge, skills, and abilities common to students of all specialties and necessary for solving educational problems by means of computer general-purpose technologies. It includes the use of modern information technologies (computer, multimedia, Internet, electronic media information, mobile phones, etc.) to search, access, store, create presentations and exchange information, as well as to communicate between people using the Internet. The subject-oriented level is the development and formation of readiness for implementation in the educational activities of specialized technologies and resources developed for the specific educational subject.

Personally-reflexive component of a pedagogical university student's digital competence is a set of personal qualities and self-reflection important for the professional pedagogical activities. It is determined by the relation to oneself and to the world, to their practical activity. It includes self-awareness, self-control, self-esteem, understanding their own importance in the team and understanding the results of their activities and responsibility for them, knowledge of oneself and self-realization in professional activity by means of ICT.

The development of each component of digital competence is linked to the formation of its characteristics and properties as a part of a coherent system. Digital competence involves confident, yet critical use of ICT to create, search, process, share information at work, in public space, and in private communication. Information and media literacy, programming basics, algorithmic thinking, working with databases, Internet security and cybersecurity skills. Understanding the ethics of working with information (copyright, intellectual property, etc.). Organization of the new educational environment requires the widespread use of new ICT in the educational process and the management of institutions and the education system must come to pass a tool for ensuring the success of the New Ukrainian School. The introduction of ICT is what the educational industry needs to move from one-off projects to a systematic process that covers all types of activities. ICTs significantly expand the capacity of the teacher, optimize management processes [23].

Preparation of students of pedagogical universities for professional activity according to the State standards should be implemented by forming their professional competence, which means a set of knowledge, skills, abilities, and experience that together enables them to effectively carry out activities or perform certain functions, ensuring that they can solve problems and achieve some meaningful results in the future professional activity [7; 13].

A specific feature of the concept of "didactic conditions" is that it includes elements of all components of the learning process: purpose, content, methods, forms, means. Iurii K. Babanskii identifies the following pedagogical conditions for the effectiveness of the educational process: methodological and theoretical training of teachers; creation of a certain base (preparation and creation of educational-methodical literature, technical means, visual aids); moral and psychological conditions [1]. That is, "didactic conditions" are conditions under which the components of the learning process are represented in their best relationship.

Based on the theoretical generalization of the above aspects, we can determine that formation of digital competence of students of pedagogical universities is the most important depends on the following didactic conditions: **actualization of the motivational value component** training of students of pedagogical universities; **organization of interaction of subjects of the educational process in the information-digital learning environment** based on individual student support; **creation and support of individual student education trajectories.**

Let's consider these conditions in more detail and determine their role in the process of forming pedagogical university students' digital competences.

Actualization of the motivational and value component of pedagogical university students' preparation. One of the main areas of modern higher education is vocational education orientation of the future specialist, which reflects the system of educational and professional motivation, interest in future professional activity, professionally important qualities, value orientations. The theoretical and practical value of knowledge and skills, their importance for personality development, value for future professional activity, need for mastery for this purpose, the methods of cognitive activity are the main motives of cognitive activity [28].

The cognitive activity of the future specialist is the basis of the motivational and value sphere of the personality. The need that becomes a motive contributes to the formation of different levels of motivation for the professional development of personality, and one of the most important elements of the motivation system is of interest.

Scientists identify three areas of interest: intellectual – interest associated with knowledge of the surrounding reality, that is, intellectual human activity; emotional - interest in a person is what particularly attracts attention and causes positive emotions; the third direction treats interest from the standpoint of personal volitional activity, according to which the interest is the stimulus of activity and is manifested in the desire of a person for the subject that interests them.

At a certain stage, interest causes the need to master the missing knowledge, that is, a cognitive interest. The essence of cognitive interest is that it's the object is the very process of cognition, characterized by the desire to grasp the essence of phenomena (not just being the consumer of information about them), knowledge of theoretical, scientific basics of a certain area of knowledge, a relatively stable desire for continuous deep study [10].

Therefore, professional interest is formed on the basis of cognitive awareness of lack of knowledge that drives the student to search, analyze new professionally significant information primarily in the Internet, i.e. cognitive interest arises as pedagogical university students' awareness of the need to develop informational-digital competence.

The second pedagogical condition is the **organization of interaction of subjects of the educational process in the information-digital learning environment.**

Valerii Yu. Bykov [5] defines the learning environment as an artificially constructed system, the use of structure and components which contribute to the achievement of the goals of the educational and educational process.

According to the scientists [17], the learning environment is an environment on the basis of which educational process is carried out, and the necessary conditions sufficient for its participants to ensure effective and safe achievement of training and education goals are provided.

At the level of common understanding, human support is a social interaction with other people whose functions of influence are the development of that person in the life path, in a variety of personal and social situations. Such support may be of a different nature.

Pedagogical support, first, contains the features of social interaction, secondly, it has its specificity. This specificity is the nature of support, the purpose of which is purposeful the development of the person being accompanied and carried out by means of special pedagogical systems (education, upbringing, training) in their institutional (structural) design.

We distinguish the main points of the concept of student support: the complexity of the approach to solving problems posed to students (individual trajectories, interaction student and teacher in remote mode); the need to accompany, not to guide the student's development, reinforcing his or her ability to make decisions independently; improving information support by solving the problem.

The current situation of a teacher's professional activity is defined as the set of internal and external factors that influence the logic of the activity and its results. The internal changes include the personal and professional development of the employee, external characteristics of the political, economic, social, environmental environment.

The intensive development and implementation of ICT in the educational process creates some difficulties for their timely mastering by future teachers, so the method of guiding is a necessary component of supporting all innovation processes as it emerged as a method of providing help and solving tasks for an employee.

During the research, it was found that the process of individual support involves an active position of the student in obtaining the required amount of knowledge, skills, and methods gaining experience of independent cognitive activity.

The next pedagogical condition is the **creation and support of individual educational institutions student trajectories**. Professional training of future specialists in higher educational establishments of Ukraine is oriented to the European dimension, where readiness for individualization of programs, self-improvement, and self-development, and the ability to acquire knowledge and productively use it in a professional activity are crucial. Research on issues related to the individualization of education in educational institutions of different types and levels has been going on for a long time [9]. But the question of introducing individual educational trajectories in them remains insufficiently disclosed.

Firstly, professional training based on individual educational trajectories allows implementing the personal approach in the education of students which most efficiently takes into account their intellectual abilities, and, secondly, determines the personal trajectory of development education in the process of mastering the educational program. In this case, the personal educational process is implemented as an individual educational trajectory when using functional opportunities for pedagogical support.

Andrei V. Khutorskoi considers the individual educational trajectory as one's own way of realization of the personal potential of each student in education [12].

Nadezhda N. Surtaeva treats individual educational trajectories as a certain sequence of elements of the educational activities of each student aimed to achieve their own educational goals that correspond to their abilities, opportunities, motivations, interests, exercised in coordinating, organizing, consulting activities of the teacher in interaction with parents [32].

Tamara P. Korostiianets believes that the individual educational trajectory is purposeful an educational program that provides student positions for the subject of choice, development, the implementation of the educational standard when teaching teacher support, self-determination and self-realization [14].

Let us follow the last interpretation. The concept of an individual education trajectory should be understood as the individual path of the student, which they choose to implement as their educational standard and which depends on the individual characteristics of the student.

Consider some general provisions regarding the construction of individual education trajectories. Tetiana L. Hodovaniuk [9] believes that they are necessary in the construction of the individual educational trajectories are the consideration of such elements of the educational paradigm as values: teaching for self-realization, for manifestation and development of one's personal qualities, for realization individual purpose; motives: the interest of learners in the process of learning, enjoyment of educational results; teacher's interest in student development, enjoyment of communication with them; norms: students take on responsibility for your teaching; The teacher's authority is created at the expense of his personal qualities and self-development of professional and personal competences, thus the goals are: focus on mastering the foundations of human culture and key competencies: value-meaning, information, cognitive, communicative, etc.; awareness of the student's and master's rights to personal educational goals; positions participants of the educational process: the teacher creates the conditions for independent learning; mutual partnership between teacher and student forms and methods: democratic, dynamic forms organization of the educational process; emphasis on independent work of students; remedies: traditional textbooks are supplemented with resources of information and telecommunication systems and media; control and assessment: shifting emphasis on student self-control and self-esteem. The process of creating an individual educational trajectory is characterized by three stages:

- psychological and pedagogical study of personal characteristics, needs, interests, requests students, analysis of results. Identification of capable students and students with learning problems. Diagnosis of their ability to work in the individual program mode;
- development of the content of the program by directions, introducing students to it, discussion of forms of work;
- monitoring and correction of the program.

The structure of the individual trajectory contains the components: target (definition of goals education based on state standards, students of pedagogical universities motives and needs); meaningful (content structure and selection, systematization and grouping, cross-domain linking) diagnostic (system definition maintenance diagnostics);

organizational and pedagogical (conditions and ways of achieving the goal).

In constructing the educational trajectory of students of pedagogical universities in the process study of subjects and passing of educational practices it is possible to use such an algorithm: diagnostics of the level of development and degree of formation students' personal qualities. At this stage, one identifies basic needs and motives of students, their readiness for mobile learning, students' initial level of knowledge and skills. In the second step, each student or group of students presents their learning outcomes, their collective discussion is held. Further work is organized to identify deficiencies, problems faced by students.

3 Conclusions

The analysis of the scientific literature provided a basis for the determination of the essence of the concept competence as a set of knowledge, skills, skills, and experience that together enables a person to effectively carry out activities or perform certain functions, ensuring that one can solve problems and achieve some meaningful results in the future professional activity. The study has found that digital competence has a purposeful use of ICT to create, search, process, share information with virtual space, information and media literacy, security skills in the Internet, understanding the ethics of working with information in the student preparation process of pedagogical universities. Selected competence structure: motivational value (target), cognitive, operational-activity, and personality-reflexive components.

Didactic conditions of information-digital formation are defined and substantiated competences of students of pedagogical universities: actualization of motivational value component training of students of pedagogical universities; organization of interaction of educational process subjects in a digital-based learning environment for individual student support; creation and support of individual student education trajectories.

We see the prospects for further scientific research in determining ways of implementing didactic conditions of the formation of digital competence of pedagogical university students.

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The methodology of development of information and communication competence in teachers of the military education system applying the distance form of learning

Vasyl V. Yahupov[1[0000-0002-8956-3170]], Vladyslav Yu. Kyva[1[0000-0002-6689-7530]] and Vladimir I. Zaselskiy[2[0000-0002-7517-5433]]

[1] National Defense University of Ukraine named after Ivan Cherniakhovskyi, 28 Povitroflotsky Ave., Kyiv, 03049, Ukraine
[2] State University of Economics and Technology, 5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
{yagupow1957, kyvavlad30101991, zaselskiy52}@gmail.com

Abstract. The paper theoretically substantiates the methodology of development of information and communication competence (ICC) in teachers of the military education system applying the distance form of learning. Scientific approaches to the concepts of "methodology" have been analyzed and the author's vision of "the methodology of development of ICC in the military education teachers" has been suggested. In particular, they determine the methodological approaches to the methodology of its development, as well as its main stages, purpose, tasks, content, methods, types of training sessions, tools and organizational forms of learning.

Keywords: a teacher of the military education system, development, the methodology of development, distance learning, stages, tools of distance learning, information and communication competence.

1 Research problem

Currently, all aspects of the social production, including the system of domestic vocational education are significantly influenced by factors of the information society, especially information and communication technologies (ICT), which create rather favorable conditions for providing citizens with a wide range of educational services. One may positively ascertain that they have substantially improved the modern education system at all levels, as well as the military education system itself, which provides vocational training for specialists of the Armed Forces of Ukraine.

In the information society, network educational data centers and modern ICTs can contribute to significant improvement of the military and professional training of specialists, including teachers. Firstly, the ability of teachers to use them comprehensively in accordance with the educational and military-professional needs of cadets (trainees) is of particular importance. In this regard, it should be emphasized that their information and communication training must meet the requirements of the information society, on the one hand, and of the military sphere, which widely uses the most up-to-date information technologies, on the other.

Secondly, the development and improvement of ICC by cadets (trainees) at higher military educational establishments (HMES) should be dynamic and sustainable as information technologies are updated and improved systematically and rapidly, especially in the military field. In this regard, teachers need to constantly improve their professional and pedagogical competence in line with the changes taking place in the information society and in the Armed Forces of Ukraine [11].

Thus, having analyzed the pedagogical practice in the military education system and having generalized and systematized scientific sources for the research of ICC in teachers, clarified its structure and content, we became convinced of the need to create a methodology for its development in teachers of the military education system applying the distance form of learning.

2 Analysis of recent research papers and publications

The analysis of scientific sources and thesis papers devoted to ICC of different specialists shows that the scientific researchers are conducted in the following problematic areas: interpretation of ICC (Anusca Ferarri [5], Mercè Gisbert [6], Isabel Gutiérrez Porlán [7], Rune J. Krumsvik [10], Virginia Larraz Rada [12], Yevhenii O. Modlo [14], Mykhailo V. Moiseienko [15]) and its formation (Yevhenii O. Modlo [13], Dirk Schneckenberg [16]) and development (Svitlana M. Amelina [1], Albert A. Azaryan [17], Olga V. Bondarenko [9], F. Xavier Carrera Farrán [4], Rostyslav O. Tarasenko, Olga G. Yaroshenko [22]).

However, the problem of creating a methodology for the development of ICC in teachers of the military education system remains unaddressed.

The purpose of the present article is to substantiate the author's methodology for the development of ICC in teachers of the military education system applying the distance form of learning.

3 Results of the study

Nowadays, in the conditions of development of the modern military education system in Ukraine, results of pedagogical science research, which should substantiate the educational process in HMES in the information society, develop innovative technologies and methods of professional training of military specialists, including with application of ICT, are of particular importance. One of the topical and promising areas of pedagogical research in both theoretical and practical aspects is the development of a comprehensive author's methodology for the development of ICC teachers of the military education system applying the distance form of learning, which should keep up with the requirements of today, and take into account all modern trends in military science and practice development, including the informational area.

In particular, the Decree of the Ministry of Defense of Ukraine dated December 21, 2015 No. 744 "On Approval of the Concept of Distance Learning in the Armed Forces of Ukraine" identifies the main directions of development of one of the main organizational forms of training in the Armed Forces of Ukraine – the distance form of learning, which emphasizes the importance and relevance of our scientific task of creating methods of ICC development in teachers applying the distance form of learning.

Thus, the Great Interpretive Dictionary of the Ukrainian Language defines the concept of "methodology" as "the doctrine of teaching methods of a certain science, subject" [1, p. 664], and according to Vasyl V. Yahupov, the methodology is "specific forms and means of using methods, through which the deeper knowledge of various pedagogical problems and their solution is realized" [21, p. 357].

We adhere to the opinion of Semen U. Honcharenko, who interprets the notion of "learning subject methodology" as "a branch of pedagogical science that examines the patterns of learning of a particular subject. The content of the methodology as a partial didactics includes: establishing the cognitive and educational value of a given subject and its place in the educational system; defining the tasks of learning the subject and its content; elaboration, according to the tasks and content of training, of methods, methodical tools and organizational forms of training" [8, p. 206].

Therefore, the methodology in pedagogy is a purposefully substantiated methodical system of teaching and learning methods, types of lessons, methodical tools and techniques, tools of training and education, forms of organization of learning and educational activities, aimed at solving specific pedagogical tasks of educational, developmental or other nature, perfection of certain personal, subjective, mental, professional and other qualities, formations and manifestations of students.

Taking into account results of the analysis on interpretations of the concept of "methodology" in pedagogy, we can conclude that the methodology of ICC development in teachers of the military education system is a set of purpose, hierarchy of goals and objectives, content, forms of learning organization, teaching methods, types of lessons and teaching tools, which are applied and implemented methodically, systematically and consistently at the main stages of its development. It should be based on leading methodological approaches – systematic, competent, informational, subject-activity and contextual [11, pp. 10-16].

It relies on modern methodological approaches, which are conceptual grounds for defining the purpose, objectives, principles, content, teaching methods, types of lessons, tools and organizational forms of learning for the development of their competence, i.e. the main components of the methodology, which are creatively applied in the three stages of development of the ICC in teachers of the military education system.

The purpose of the methodology is to develop ICC in teachers of the military education system, which is achieved by realizing the main and partial goals of its development.

In accordance with the stated purpose, **the main tasks for ICC development in teachers** are determined in accordance with the leading provisions of modern methodological approaches, in particular:

- development of the value-motivational component (values of pedagogical activity using ICT; motivation for ICC development);
- development of the intellectual component (the knowledge of: ICT theory; theoretical foundations of analysis and decision-making in the military sphere; technology of processes (phenomena) modeling in the teaching of general and military-specialized subjects; theoretical provisions of the cyber security in the use of ICC in their teaching; modern software and hardware; software development technologies according to the methodology of teaching specific discipline);
- development of the praxeological component (these are the following abilities: to use ICT effectively in pedagogical activity; to systematically develop and apply modern hardware and software in the process of teaching general and military-specialized disciplines and to identify their cyber vulnerability);
- development of the informational and technological component (these are the following abilities: to use ICT systematically and contextually in pedagogical activity; to synthesize various software tools for improving the effectiveness of teaching of specific educational disciplines; to develop information software tools for their teaching);
- development of the subject component (pedagogical subjectivity of a teacher in the information society; the ability to objectively self-evaluate as the subject of pedagogical activity within the framework of official functions of the teacher of specific general and military-specialized disciplines).

For their development, it is advisable to adhere to the pedagogical principles of training at a higher military school [19, p. 230] taking into account creatively the principles of distance learning. In particular, the following principles of study at a higher military school shall be applied:

- scientific training implies that all facts, knowledge, provisions and laws that are taught must be scientifically sound and in line with the modern developments of science and technology in general and the military sphere, in particular;
- systematic and sequential training means the systematic and consistent presentation of educational material and systematic work of cadets (trainees) with it; depending on the content and the specific discipline, the specifics goals, the teacher shall use a certain system of lessons, guiding cadets (trainees) from simple reproduction to independent creative activities with the studied material, including the direct modeling of specific military and professional situations using ICT;
- accessibility of training implies adherence to the following rules: from simple – to complex, from known – to unknown, from close – to distant, as well as taking into account the level of development of teachers, cadets (trainees), their individual characteristics; it requires the determination of time and labor costs, the level of mental and physical strain of students;
- the link between training and modern military practice is based on the objective links between science and military field, modern military theory and practice;
- awareness and activity in learning – it defines the subjective role and position of both the teachers and cadets (trainees) in the educational process; it requires awareness and self-stimulation of their pedagogical and educational activity and purposeful

management of it; formation of a positive attitude in cadets (trainees) towards a military specialty, an interest in educational material, close connection of training with military practice and its use in field, challenges of training, differentiated approach, use of modern information technologies and tools;

- visibility in training promotes conscious and holistic visual perception of educational information by teachers, cadets (trainees), its comprehension and assimilation, educates observation, attentiveness and develops practical thinking;
- sound knowledge and formation of practical skills and abilities – involves the repetition of the learning material by students by sections and structural parts, its memorization in combination with the learned, highlighting the repetition of main ideas, the use of various methods, organizational forms of learning and types of lessons;
- individualization of training allows each cadet (trainee) to master creatively and at an individual pace the educational material in the conditions of joint educational activity, taking into account the level of their own intellectual and military-professional development, individual cognitive and practical needs, interests, motivation activity, will and capacity;
- emotional component of the learning – involves the influence of the teacher on formation in cadets (trainees) of emotional and volitional sphere as a military professional, which directly activates their educational and cognitive activity, and prevents the emergence of negative impacts, by the way of logical, lively teaching of interesting examples, using various visual aids etc.

At the same time, it is necessary to creatively adhere to the pedagogical requirements and rules of **specific principles of distance education** (Valerii Yu. Bykov) [2]. These include:

- interactivity (involves the teacher's dialogue with a student);
- adaptability (provides the individual pace of the educational activity of cadets (trainees), provides for their own choice of the course, time for its study, term of consultations and examinations and tests, periodicity and intensity of their educational activity);
- humanity (consists in directing the educational process to an individual, creating the most favorable and comfortable conditions of study; mastering the military profession through the manifestation of creative individuality, civic, moral and intellectual qualities and their purposeful creative systematic development, which would provide cadets (trainees) with secure and comfortable conditions for professional education);
- priority of the pedagogical approach (the modeling of educational process provides for purposeful designing of distance learning taking into account the contingent of students, substantiation of specific concepts of formation, development and improvement of certain phenomena, creation of didactic models of those phenomena);
- pedagogical feasibility of application of modern information technologies (requires pedagogical evaluation of the effectiveness of each stage of the distance learning;

not only the ICT implementation, but the corresponding content of training courses and educational services should be brought to front);
- the choice of the educational content (the content of education must meet, on the one hand, the regulatory requirements of the State Educational Standard and the labor market, and on the other hand – the specific requirements of a student, and in our case, teachers and cadets (trainees) of the military education system);
- ensuring the protection of information circulating in the technological system of distance learning (involves the introduction of organizational and technical means of safe and confidential storage, transmission and use of various data and information in the educational process);
- adherence to the reference level of education (requires a certain amount of knowledge, skills, competences in both teachers and cadets (trainees));
- correspondence of information technologies to the goals, content and methods of training (adequacy of information training technologies to models of distance learning in the military education system);
- flexibility and mobility (creation of information networks, databases and banks of knowledge and data for distance learning in the military education system, which allows adjusting, supplementing and improving the educational program; preservation of information invariant education);
- correspondence of distance learning to the existing organizational forms of education (projected distance learning would give the required social, economic and educational effect, provided that the created and implemented information technologies do not become a foreign element in the traditional education system, but will be naturally integrated into it);
- cost effectiveness (involves rational use of financial and material resources, financial and technological calculation of the effectiveness of advanced training in the military education system by distance learning).

Learning methods and types of training used in the methodology. The distance education, line the full-time one, uses both traditional and active teaching methods [20]. For example, the following traditional teaching methods are:

- oral teaching of the educational material, which is divided into verbal-informative, verbal-heuristic, verbal-problematic, and verbal-research. It includes different types of stories, explanations, narrations, lectures;
- discussion of the studied material is divided into verbal-informational, verbal-heuristic, verbal-problematic, and verbal-research. It includes different types of conversations, seminars, discussions, brainstorming, intellectual briefings, situation analysis etc.;
- demonstration is divided into visual-informative, visual-practical, visual-heuristic, visual-problematic and visual-research. It includes presentation, illustrations, observations in the form of personal display to subordinates of some techniques and actions, demonstration of actions of individual soldiers, troops and units, display of natural and imaginative means of visualization, demonstration of films, etc.;
- practical methods are divided into practical-reproductive, practical-heuristic and practical-research (problematic). These include practical classes, group exercises,

laboratory work, lessons, maintenance of military equipment and weapons, command and control training, firing, driving military vehicles and more. For example, the main types of training at HMES that train officers for communication units and troops are tactical training and drill instruction, partial and comprehensive training, tactical and special training, command and staff training, training of troops. Accordingly, the methods of ICC development in teachers must be tailored to the special and general military disciplines;

- self-work is divided into all types of training applied in the above methods – verbal, visual, practical-information. It includes: work with printed sources; independent study of machinery; self-training; independent viewing of films, TV shows; work with information sources and the Internet, etc.;
- the methods of control and self-control in training include: individual control interview; questioning; written; testing; quests; machine control; self-control; exam; credit and more.

The combination of different teaching methods and types of training in the process of development of ICC in teachers of the military education system facilitates the development of subject actions, the development of actions inherent in their pedagogical activity through the means of ICT. The development of their ICC is not possible without the pedagogically balanced use of various types of training. It is also advisable to use all traditional types of training in their distance learning process. A compulsory methodological requirement is their adaptation to the ICT system and its application, taking into account the educational needs and capabilities of military education teachers.

Tools. In the technique it is advisable to use all the means used in the educational process, including ICT: computer-based educational systems in the conventional and multimedia versions; laboratory remote workshops; simulators; electronic libraries with remote access; didactic materials based on expert systems of educational purpose; didactic materials based on geo-information systems, etc.

The material basis is also profoundly changing in the development of teachers' ICC. It is an important component of the material support of the educational process in the conditions of distance learning, which is inextricably linked with the content and methodological systems of training of different educational disciplines in distance training courses for teachers of the military education system.

Forms of training organization are forms of organization and realization of the educational process at distance upgrade training courses for teachers, participants of which carry out educational interaction principally and mainly remotely (at a distance that does not involve direct educational interaction of participants when the participants are beyond the territory of possible direct educational interaction and when their personal presence in certain educational premises of the educational establishment is not obligatory in the course of training) [3].

The process of interaction of distance learning participants is usually synchronous (remote contact with the teacher, in real time) and asynchronous (contactless mode of interaction with the teacher).

Thus, the pedagogical practice of professional development by distance learning for teachers may creatively adapt and use the following well-known types of teaching: lectures; seminars; laboratory work; tests; credits; exams; consultations; self-work, etc. However, they must be adapted to distance learning in both the contact and contactless phases. It is most appropriate to use active learning methods that can be implemented through the use of computer networks, audio-video and another telecommunication tools, including directly and necessarily the Internet (see Table 1).

Table 1. Teaching methods and types of lessons for the development of ICC in teachers applying the distance form of learning.

Stage	Goal	Tasks	Method, technique, way	Type of a lesson
The value-motivational stage	to develop and enrich the values and motivation of ICC development	development of the value-motivational component of ICC	questioning, testing, stimulation, conversation, discussion etc.	all kinds of training in the high military school
The development stage	to develop theoretical and practical knowledge of the use of ICT in pedagogical activity, practical skills and ability to apply them in their activities	development of intellectual, praxeological, information-technological, subjective components of ICC	independent work with educational materials, educational conversation, educational discussion, method of exercises, method of oral control, self-control, method of written (test) knowledge control	all kinds of training in the high military school
The final stage	to implement successfully the previous stages of the methodology of ICC development; to perform the pedagogical evaluation of the ICC development levels of teachers	completing the ICC development in teachers of the military education system; determining the levels of ICC development in teachers	method of written (test) control of knowledge, practical skills, capacities and abilities of applying ICT in the pedagogical activity	practical and control lessons

Accordingly, the use of ICT tools in the process of development of ICC in teachers within the distance learning framework affects all the system components of its methodology, which allows setting and solving much more complex and applied pedagogical problems and situations in the process of its development, improving their creative intellectual and practical potential, critical and at the same time pedagogical thinking, independence in acquiring knowledge, working with various sources of educational information.

In the framework of our research, all the above elements of the ICC development methodology are prioritized in value-motivational, developmental and final stages, each having specific tasks and providing for specific educational results in accordance with the purpose of research and hierarchy of formulated goals for professional development of teachers in the distance form of learning. It is advisable to implement through the distance learning course for teachers “Information and Communication Technologies in the Scientific and Pedagogical Activity of Teachers” (108 hours, term – 2 weeks).

The value-motivational stage is aimed at the development and enrichment, first, of the ICC development values by solving the following tasks: development of a positive attitude of teachers to ICT and their systematic application in the pedagogical activity; enrichment of axiological sphere of their consciousness and awareness of ICT, their nature among the categorical concepts of the universe, transformation of their essential characteristics in the conditions of the information society development: value orientations regarding their pedagogical existence in the information society as a subject of professional activity; promotion of awareness of the value aspects of ICT and identification of the practical application thereof in the pedagogical activity.

Second, by improving the motivation for the ICT development through solving the following tasks: development of a motivational attitude of teachers to pedagogical activity, which includes mastering the guidelines for the systematic use of ICT in the pedagogical activity; development of their desire to enrich their own information and communication potential as a subject of the pedagogical activity.

Accordingly, teachers should be aware of the value-motivational aspect of the ICT use in the pedagogical activity, be clear about where they can and shall apply them purposefully and systematically, and understand the benefits of their ICC developing for as a teacher in the information society and the military education.

The developmental stage is aimed at fostering theoretical and practical knowledge about the ICT use in the pedagogical process, practical skills and abilities for their creative application in the pedagogical activity. In particular, the focus is on development of the ability to search and analyze information, its synthesis and comparison, abstraction, generalization and concretization through ICT, taking into account the specifics of teaching military and specialty disciplines. Particular attention should be paid to development of flexibility and criticality of practical military and professional thinking, development of a set of abilities to work with hardware and software and its systematic and creative use in the pedagogical activity; the proactive nature of practical application of ICT to design and model quasi-professional situations in military activity.

The final stage supposes that the successful implementation of the previous stages of the ICC methodology would promote the development of all its components; teachers are able and willing to use ICT in the pedagogical activity. Accordingly, to confirm this hypothesis, it is necessary to diagnose its development, which will allow evaluating the effectiveness of the proposed method.

4 Conclusions and prospects of future research

Therefore, the ICC development in teachers of the military education system is a pressing scientific and pedagogical problem, which involves the use of appropriate specialized methods for development. The created methodology for the ICC development for teachers of the military education system in distance learning can be successfully implemented upon implementation of the specialized course “Information and Communication Technologies in Scientific and Pedagogical Activity". Accordingly, a consistent study of the topics of the distance course using ICT is a necessary pedagogical condition for the effectiveness of the implemented methodology for the ICC development in teachers of the military education system.

Prospective directions for further research: experimental testing of the ICT development methodology for military education teachers in retraining and advanced training courses in the distance form of learning.

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Technology of forming future journalists' social information competence in Iraq based on the use of a dynamic pedagogical site

Alla A. Kharkivska[1[0000-0003-4782-1079]], Liudmyla V. Shtefan[2[0000-0002-9910-5499]], Muntasir Alsadoon[2[0000-0002-2921-2352]] and Aleksandr D. Uchitel[3[0000-0002-9969-0149]]

[1] Kharkiv Humanitarian-Pedagogical Academy, 7 Rustaveli Ln., Kharkiv, 61001, Ukraine
kharkivska_hgpa@ukr.net
[2] Ukrainian Engineering Pedagogics Academy,
16 Universytetska Str., Kharkiv, 61003, Ukraine
lvlshtefan@gmail.com, alsadoonmunaser7@gmail.com
[3] State University of Economics and Technology,
5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
o.d.uchitel@i.ua

Abstract. The article reveals scientific approaches to substantiating and developing technology to form social information competence of future Iraqi journalists based on using a dynamic pedagogical site. After pre-interviewing students of the Journalism Faculty at Al-Imam Al-Kadhim University College for Islamic Sciences in Baghdad, the authors came to the conclusion there are issues on defining the essence of social information competences. It is established that the majority of respondents do not feel satisfied with the conditions for forming these competences in the education institutions. At the same time, there were also positive trends as most future journalists recognized the importance of these professional competences for their professional development and had a desire to attend additional courses, including distance learning ones. Subsequently, the authors focused on social information competence of future journalists, which is a key issue according to European requirements. The authors describe the essence of this competence as an integrative quality of personality, which characterizes an ability to select, transform information and allows to organize effective professional communication on the basis of the use of modern communicative technologies in the process of individual or team work. Based on the analysis of literary sources, its components are determined: motivational, cognitive, operational and personal. The researchers came to the conclusion that it is necessary to develop a technology for forming social information competence of future journalists based on the use of modern information technologies. The necessity of technology implementation through the preparatory, motivational, operational and diagnostic correction stages was substantiated and its model was developed. The authors found that the main means of technology implementation should be a dynamic pedagogical site, which, unlike static, allows to expand technical possibilities by using such applications as photo galleries, RSS modules, forums, etc. Technically, it can be created using Site builder. Further research will be aimed at improving the structure of the dynamic pedagogical site of the developed technology.

Keywords: Social information competence, Future journalist, Dynamic pedagogical site, Technology.

1 Introduction

1.1 Research problem

Globalization of modern society, economic changes cause the intensification of the competent approach to training modern specialists. It is the level of its formation that determines their competitiveness in the labor market. As a result, there is a need to implement a competent paradigm in vocational education that involves radical changes in methods, forms and means of learning [11]. This trend is also common for training future journalists around the world [10]. It acquires particular importance in countries which are in conflict zones. It is Iraq today. Development of the modern information society and special conditions of personality in the society stimulate the need for particular attention of scientists to forming social and informational competence of future journalists in general and Iraqi ones in particular. There is a search of technological ways to meet the public demand based on information technologies that have recently tended to be dynamic pedagogical sites.

They introduce fundamental changes in the professional training of future journalists as they allow to implement a person-centered approach on a high level of requirements in following the competence paradigm. However, at the present stage, there is a clear discrepancy between the growing demands of society for forming social and information competence of future journalists and the lack of development of the necessary technologies, based on effective information resources, in relevant higher education institutions in Iraq.

The purpose of the paper is to substantiate and develop the technology of shaping the social information competence of future Iraqi journalists based on the use of a dynamic pedagogical site.

1.2 Problem statement

Today, there is no doubt that the competency-based approach should become the basis for fundamental changes in vocational education [9]. Indeed, according to John Raven, competence is a specific ability to effectively perform certain actions in a particular professional field [10]. And Iryna V. Demura agrees with the definition. She believes that competence is an appraisal category that characterizes a person as a subject in terms of the ability to make qualified judgments, to take adequate responsible decisions in problem situations, to plan and act to rationally and successfully achieve set goals [2, p. 66]. Taking into account the aim of the study, the most appropriate definition of professional competence is a special set of knowledge and skills that allows a specialist to successfully operate in the professional field in any, including extreme, conditions

[5, p. 46]. The very conditions take place in Iraq, which is in an unstable position due to the aggravation of conflict situations there. In addition, the country has a significant level of illiteral population, lack of qualified specialists, strict control of political forces [6; 8]. This complicates the working conditions of journalists and their achieving a high professional level. Undoubtedly, these peculiarities of professional activity must be taken into account in their professional training and in higher education institutions in Iraq, actively involving modern information technologies.

2 Results

To obtain objective information on the state of implementing the competency-based approach in the training of future journalists at higher education institutions of Iraq, we carried out a questionnaire survey among the students of the Journalism Faculty at Al-Imam Al-Kadhim University College for Islamic Sciences in the city of Baghdad.

The reliability coefficient for the questionnaire had a value from 0.85 to 0.91 (for $p < 0.01$), which proves its high reliability.

The survey was carried out during the 2018–2019 school year. There were 58 students in the second year of study. According to the respondents data, the age ranged from 20 to 25; there were 35 male and 23 female students.

The questionnaire had sixteen questions, mostly closed-ended questions and some open-ended, which were meant for open answers of respondents. At this stage of the research we focused on guaranteeing students' understanding of concepts "social" and "information" competencies. Next, there will be the results of the survey which students offered when answering open-ended questions (with the maximum of the original language).

The question "Do You know the concept of social competence?" got 85% positive answers. For the question "Are you aware of the concept of information competence?", 97% of respondents chose "Yes". From this, we concluded that most students are familiar with the concepts of "social competence" and "information competence". But further, there was a certain contradiction. Providing an answer to the question "How would you define the concept of "social competence?", 85% of respondents gave mostly chaotic answers, e.g. that it relates to the protection of people, especially those that have special needs. 5% of students understand this competence as "the ability to put the right person in the right place" and 10% did chose the option "I don't know".

More accurate responses were received from half of the respondents when answering the question about the essence of the concept "information competence": 28% of respondents stated that "it is when a journalist has sufficient knowledge in collecting information"; and 22% said "it is when a journalist has a full understanding of scientific, social, or political information". The other half of respondents chose the option "I don't know".

So, although most students have certain knowledge of "social" and "information" competence, as the answers to the first two questions proved, but they haven't got necessary profound knowledge. As the additional survey showed, the reason for this was the lack of attention to these competencies when teaching professionally oriented disciplines.

The questionnaire had a task of ranking qualities according to their importance for a journalist:

a. ability to study new ways of activity;
b. the ability to make a decision;
c. the ability to build communication;
d. the ability to study situations in society;
e. the ability to organize an individual and group work.

Unfortunately, only 46% of the respondents did the ranking task. Ranking the responses as the most important was as follows. “The ability to build communication” was number one in almost 58% of those who answered the question; “The ability to study situations in society” was number one for 23% of respondents; “The ability to study new ways of activity” was chosen by 11%; “The ability to make a decision” was the most important for only 4%; “The ability to organize individual and group work” was also chosen by 4% of the respondents. It’s crucial to emphasize that 54% of respondents did not answer this question. The results of the survey are in Figure 1.

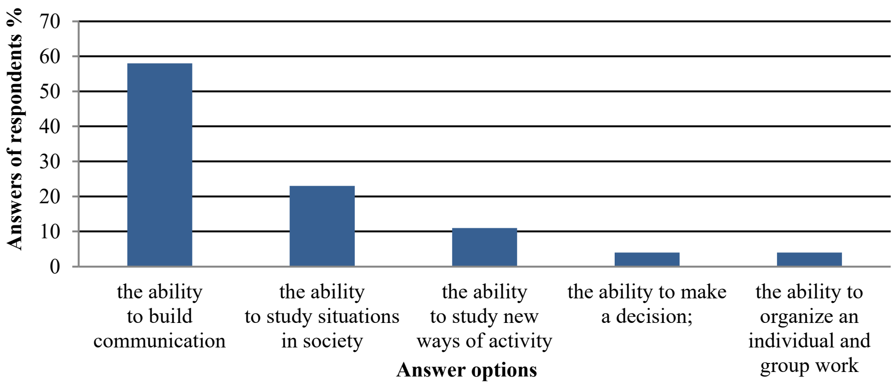

Fig. 1. The survey results of the respondents when ranking importance of certain qualities

When answering the question, “What, in your opinion, contributes to the formation of social competence?”, the answers were as follows: 10% chose the disciplines of Civil freedom and Sociology; 4% – Culture of freedom; 86% chose the option “I don’t know”. When answering the question, “What, in your opinion, contributes to the formation of information competence?”, 5% of the students chose Sociology, 5% – Information culture; and the vast majority (90%) chose the option “I don’t know”. Therefore, the answers to these questions can be traced to insufficient knowledge and understanding of the deep connections between academic disciplines and their influence on the formation of the concepts of social and information competence in general.

Students were asked to answer the question of whether they find the conditions of forming social competence satisfactory at the education institution. The results showed that only 14% of the respondents were satisfied with the conditions, while the majority (86%) believed that they were insufficient. When answering the question whether they find the conditions of forming information competence satisfactory, 100% of the respondents chose the answer "No". The results indicate dissatisfaction of students with the conditions for forming social, and especially information competences created at Al-Imam Al-Kadhim University College for Islamic Sciences.

The students were also asked the following question: "What contributes to the formation of a single information space?" with the following options to choose:

a. computer technology;
b. information resources;
c. international communication.

Only 48% answered it. Ranking on the most important position was as follows: "International communication" by 54% of the students who answered; "Information resources" by 29% of respondents and 17% of the respondents chose "Computer technology". The results of the survey are in Figure 2.

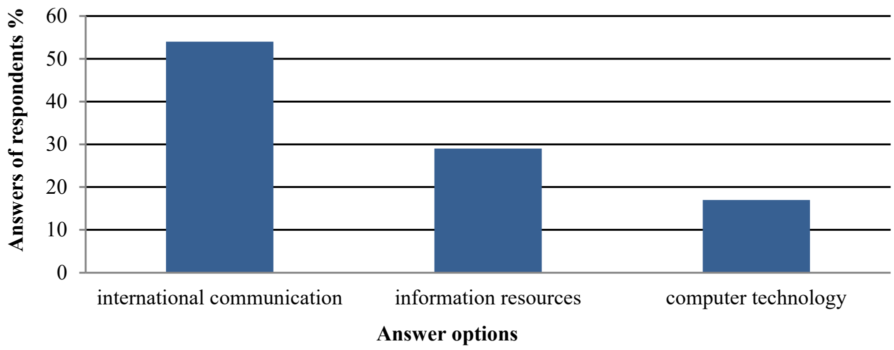

Fig. 2. The results of the respondents when answering the question What contributes to the formation of a single information space?

The students were asked to determine what classes stimulate the creativity of future journalists. Only 55% of the respondents offered answers. The ranking of the responses showed the following results: practical classes were chosen by 57% of the students, group classes – by 31% and 6% of the respondents chose individual tasks and lectures respectively (Fig. 3).

There was also the question: "Are you interested in the problems of forming future journalists competence?" 66% of the respondents answered affirmatively and 17% chose the option "Sometimes". The question was of no interest for 17% of the survey participants.

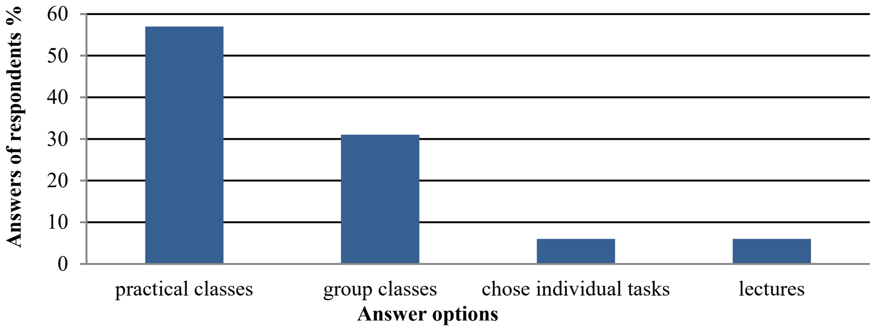

Fig. 3. The results of the respondents when answering the question What classes stimulate the creativity of future journalists?

The students were asked the following open-ended question: "What qualities, in your opinion, determine the level of competence of the future journalist?". The results showed that the overwhelming majority of them (90%) identified such qualities as honesty and determination; 5% pointed out that "they are the ability to collect information and to form a level of social relations"; and 5% of the respondents did not answer this question.

It was of interest to us whether students believe social and information competences have a significant impact on the level of journalist professionalism. The answer was unanimous: 100% of them chose the answer "yes". We got the same answer to the question of whether they would like to attend additional courses in order to form social and information competences. The students' answers prove importance of the competencies for professionalism and show they are ready for additional training. To clarify the last question, we asked whether the students would like the extra courses to be organized remotely? 96% of them chose the answer "yes". The answer demonstrates their readiness to implement new information technology of education in the process of vocational training.

Thus, the analysis of the survey results of the students at the Faculty of Journalism at Al-Imam Al-Kadhim University College for Islamic Sciences, Baghdad, shows that students were not always active, especially when it was necessary to show their knowledge and define the notion. The conditions for forming information and social competences created at the education institution were not satisfactory for most of the students. However, there are also positive trends – most of them recognize the importance of these professional competencies and are ready to attend additional courses for their formation, including those in the remote mode.

It is worth noting that for the Arab educational system, the competency-based approach is fundamentally new today. Its implementation doesn't get much attention and it remains at the periphery of vocational training. Therefore, managing the quality of education and training of journalists in Iraq requires urgent adjustments. Moreover, at the present stage, the training of future journalists should be directed towards the formation of their ability to use modern information technologies in their professional activities and the ability to manage information coming from different sources. The practical implementation of the competency-based approach will certainly increase the level of competence of Iraqi journalists.

The revision of curricula for journalists, changes in the content of curricula, the use of innovative forms and methods of organizing the learning process, the creation of a modern set of methodological support will help solve the task. It is extremely important to organize independent work of students, since it contributes to the development of motivation for further development of information technologies, self-organization of the student's activity, and allows them to be independent in decision-making.

Further, social information competence of the journalist was of prior interest to the study as it belongs to be the key competences and is viewed by the European community through such indicators as knowledge of information technology, critical attitude to social information, etc. [3, pp. 428–429]. It systematically covers the peculiarities of both the social and informational competences of future journalists.

The preliminary work allowed for the authors to define the concept of social information competence (SIC) of journalists as an integrative quality of personality, characterizing an ability to select, process, transform information and organize effective professional communication based on the use of modern communicative technologies in the process of individual or team work [1, p. 13].

When conducting the study, we determined the components of social information competence of journalists and their content:

1. *Motivational component*: implies an interest to the formation of social information competence, the development of motives for self-improvement.
2. *Cognitive component*: includes knowledge about information technologies used in journalism; knowledge of the social technologies of the journalist's activity; knowledge of norms (ethical and legal), regulating professional activity.
3. *Activity component*: ensures the formation of skills that allow collective and individual activity in the information environment for future journalists; abilities to search, collect, represent, and transmit information; abilities to analyze information from different sources and synthesize new knowledge; abilities to creatively comprehend information and create as well as share in the information space own tools based on information technology
4. *Personal component*: involves the formation of personal qualities necessary for future journalists, namely, responsibility, independence, diligence, organization, perseverance.

To address the problem of implementing these components in the process of professional training of future journalists is Iraq, technologies for forming social information competence of journalists were substantiated and developed.

Technological approach to education is traditional. In the study, there is the position that the structure of pedagogical technology includes the conceptual framework; content (learning objectives, contents, training material) and procedural (organization of educational process, methods and forms of educational activities, diagnosis of the educational process) parts [7, p. 907].

Based on these conclusions and taking into account the structure of social information competence of future journalists, the stages of study technology were identified, which included preparatory, motivational, operational, and diagnostic corrective.

The preparatory stage of technology has the objective of carrying out organizational and methodological work. One of the basic tools of technology will be a dynamic pedagogical site of the teacher and the textbook that will meet the requirements of forming social information competence of future journalists. They will be developed at this phase. Simultaneously, it is necessary to take organizational steps in introducing them in educational process of education institutions. Previuosly, it is necessary to deal with teachers to increase their attention to this competence in the educational process. Therefore, the enhancement of classroom training to form social information competence of future journalists is the first pedagogical condition of implementing the technology of study.

Next, it is about detailing the work on the development of a dynamic pedagogical website which is the main tool of the presented technology. Dynamic websites differ from static ones as they allow to expand opportunities through applications such as photo galleries, RSS modules, forums, etc. Today websites of this type are actively used by teachers, therefore, it's called "pedagogical". In our study, this dynamic pedagogical site should be the tool of the teachers, which will allow them to systematically and promptly provide information on the formation of social information competence of future journalists.

Thus, a dynamic pedagogical site for formation a journalist's social information competence is an information-pedagogical construct that allows the teacher to positively influence the formation of the communicative and information components of the professional activity through the complex use of measures to form theoretical and practical training, also professional qualities through the mobile use of information technology.

Site builder was used. This is an online service that allows to create a website and publish it in the Internet without programming skills. Only an Internet-enabled computer and a web browser are required to use it.

The advantage of Site builder is that it allows you to customize virtually every element of the template without programming. In particular, it allows you to make the following changes to the template:

1. Adjust the position of the header.
2. Change the font layout of the entire site.
3. Specify the font, height and spacing of the logo font.
4. Change the background image, types and kinds of links, etc.

Based on this constructor, during the study, the website was developed to organize the independent work of future journalists. It includes the following structural components, which are located in the menu bar:

1. Home.
2. The program of organizing independent work of students.
3. Tutorials, textbooks and teaching materials for self-education.
4. Dictionary.

5. Video appendices (including video lectures by the teacher on the “Student Independent Work Program”, interesting video information on journalistic topics, etc.).
6. Audio Add-ons.
7. News in Journalism.
8. Conferences, forums symposia on journalism.
9. Grants, training for journalists.
10. Knowledge tests.
11. Tests to determine the personal qualities of future journalists.
12. Forum.
13. Help.

The last component is not obligatory. It consists of information about the basic elements of using a pedagogical site and includes instructions that are necessary to navigate there.

The site has a photo of the teacher, contains the national symbols, allows learning in two languages: Arabic and English (Fig. 4).

Fig. 4. The page of the dynamic pedagogical site

Creating a learning social informational environment based on a dynamic pedagogical site that promotes self-education of future journalists is the second pedagogical condition for implementing the mentioned technology.

The motivational stage of the technology is aimed at encouraging students to form their social information competence as an important component of their professionalism. This will be done through a dynamic pedagogical site, the materials of which will collectively give an idea of importance of the competence and the process of managing its formation. A significant role is assigned to the teaching staff of the education institution, which should pay much attention to the competence in the process of teaching academic disciplines in order to provide relevant professional interest in it.

Forms of stage implementation: lectures, seminars, individual work.

Methods of stage implementation: persuasion, interactive conversations in the Internet, case-technology.

Means of stage implementation: dynamic pedagogical site, computer.

The operational stage of the technology is the basis of the formative stage of the pedagogical experiment. It is aimed at forming necessary knowledge, skills, experience and professional qualities of students that will correspond to the essence of the future journalists' social information competence. To implement these tasks, all the webpages of the dynamic pedagogical site and a set of cases will be used. It is necessary to strengthen the work of the teaching staff by intensifying attention to the formation of this competence.

Forms of stage implementation: problem lectures; seminars, individual, group and pair work; individual work.

Methods of stage implementation: persuasion, interactive conversations and online case decisions, case-technology, personal example.

Means of stage implementation: dynamic pedagogical site, computer, cases.

The diagnostic corrective stage of technology is aimed at clarifying qualitative changes in the formation of social-information competence of future journalists and to carry out corrective technological measures (if necessary) on this basis. This work was carried out at the control stage of the pedagogical experiment.

The model of technology of forming social information competence (SIC) of future journalists on the basis of a dynamic pedagogical site, which in addition to educational functions, included also managerial (organization, planning, decision-making, control over the qualitative formation of SIC). This model was implemented in the educational process of Anbar University (Er Ramadi) and Tikrit University (Tikrit). The study involved 52 individuals. The implementation of the developed technology led to positive changes in the quality of students education. A complex of diagnostic methods was created, which included three blocks: a cognitive block of test tasks for testing students' knowledge, an activity block of tests for testing their practical skills and a personal block of psychological tests for determining the formation of professional qualities. The results showed that almost 42% of the respondents improved theoretical knowledge and 38% – practical skills. Among personal changes, abilities to self-development, to work with information, and attentiveness were reported improved. More detailed results will be presented in the following article.

The model of the technology developed during the study is shown in Figure 5.

Thus, the use of the technology of forming social information competence of future journalists on the basis of a dynamic pedagogical site led to positive changes in the quality of professional training.

3 Conclusions

1. The analysis of scientific literature provided grounds for determining the essence of the concept of "social informational competence" of future journalists as an integrative quality of personality, which characterizes an ability to select, process, transform information and allows to organize effective professional communication

based on the use of modern communicative technologies in the process of individual or team work and identify its components (motivational, cognitive, activity and personal).

DYNAMIC PEDAGOGICAL SITE

<table>
<tr><td colspan="4">The aim of the technology: to form SIC of future journalists</td></tr>
<tr><td colspan="4">The content of the structural components of SIC for future journalists</td></tr>
<tr>
<td>Motivational component: implies an interest to the formation of social information competence, the development of motives for self-improvement</td>
<td>Cognitive component: includes knowledge about information technologies used in journalism; knowledge of the social technologies of the journalist' s activity; knowledge of norms (ethical and legal), regulating professional activity</td>
<td>Activity component: ensures the formation of skills that allow collective and individual activity in the information environment for future journalists; abilities to search, collect, represent, and transmit information; abilities to analyze information from different sources and synthesize new knowledge; abilities to creatively comprehend information and create as well as share in the information space own tools based on information technology</td>
<td>Personal component: involves the formation of personal qualities necessary for future journalists, namely, responsibility, independence, diligence, organization, perseverance</td>
</tr>
<tr><td colspan="4">Stages of technology</td></tr>
<tr><td>Preparatory</td><td>Motivational</td><td>Operational</td><td>Diagnostic corrective</td></tr>
<tr><td colspan="4">Technology Toolkit:
Forms: lectures, seminars, independent work of students, individual and group forms.
Methods: persuasion, interactive conversation and online case management.
Tools: dynamic pedagogical site, computer, set of cases.</td></tr>
<tr><td colspan="4">Pedagogical conditions: intensification of students' classroom education in the direction of forming SIC; creating an educational social information environment on the basis of the dynamic pedagogical site.</td></tr>
<tr><td colspan="4">Expected result: SIC of future journalists</td></tr>
</table>

Fig. 5. The model of technology for forming social information competence of future journalists on the basis of a dynamic pedagogical site

2. In the course of the study, based on the survey of the students the Journalism Faculty at Al-Imam Al-Kadhim University College for Islamic Sciences, Baghdad, there was an issue of implementing competency-based approach. Next the focus of the study

was on social information competence of future journalists, which is one of the key issues according to European requirements. The technology of forming this competence for future journalists based on the use of modern information technologies through the implementation of preparatory, motivational, inductive, activity and diagnostic, correctional stages has been substantiated and developed, and its model has been developed.

3. The main means of implementing this technology has become a dynamic pedagogical site, the technical basis of which is Site Builder. The contents of the website pages create all the necessary conditions for organizing qualitative self-education in order to form social information competence of future journalists.
4. Further trends will be aimed at improving the dynamic pedagogical site of the developed technology.

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An integrated approach to digital training of prospective primary school teachers

Olga G. Yaroshenko[1[0000-0003-1555-0526]], Olena D. Samborska[2[0000-0002-8071-9730]] and Arnold E. Kiv[3[0000-0002-0991-2343]]

[1] Institute of Higher Education of the NAES of Ukraine, 9 Bastionna Str., Kyiv, 03056, Ukraine
yaroshenko_o@ukr.net
[2] Bar Humanitarian and Pedagogical College named after Mykhailo Hrushevsky, 1 Hrushevsky Sq., Bar, 23000, Ukraine
samborska@ukr.net
[3] Ben-Gurion University of the Negev, P.O.B. 653, Beer Sheva, 8410501, Israel
kiv@bgu.ac.il

Abstract. The article emphasizes the importance of information and digital technologies in pre-service training of primary school teachers, substantiates the content and components of information and digital competence of prospective primary school teachers. It points out that the main purpose of information and digital training in the pedagogical higher educational institutions (HEI) is to ensure the formation of digital competence of future primary school teachers, to prepare them for developing primary students' digital literacy in classes on various academic subjects, for active use of ICT in primary school teachers' professional activities. An integrated approach to the modernization of information and digital training of pre-service primary school teachers, which covers the main forms of the educational process – training sessions, independent work, practical training, and control activities is justified. The article presents the results the pedagogical experiment aimed at testing the effectiveness of the integrated approach to the modernization of information and digital training of prospective primary school teachers. The results are determined by the level of digital literacy and the ability of students in the control and experimental groups to use information and digital technology in the educational process of primary school.

Keywords: information and digital training, information and digital competence, training by means of network services, prospective primary school teachers, academic discipline, pedagogical practice, pedagogical experiment.

1 Introduction

The State Standard of Primary Education focuses the educational process on shaping students' information and digital competence, mastering the basics of digital literacy for development and communication, the ability to use digital technologies safely and ethically in teaching and other life situations [6]. The Concept of the New Ukrainian

School recognizes Information and Digital Competence as one of the 10 key competences to be mastered by students [7]. The Professional Standard of Primary School Teacher defines the capabilities of a pedagogical employee of a New Ukrainian School, among which there is the capability to use digital technologies in the educational process [16]. These documents outlined the guidelines of our study regarding the development of an integrated approach to the modernization of information digital training for prospective primary school teachers.

Modernization is improvements, changes that meet the requirements of modern times [12]. In particular, Olena S. Bereziuk and Vira Smoliar consider the process of educational modernization to be "… an important step towards the social, political and economic development of Ukraine. That is why it is important to update the education system in accordance with today's requirements, the needs of modern society and the development of modern personality in it ... " [2, p. 8]. Vira M. Andriievska has developed a model of training pre-service primary school teachers using ICT, in which she has identified the target, content processing, and result-evaluation components [14]. Liudmyla I. Bilousova and Nataliia V. Zhytyenyova consider the intensification of the educational process to be the main way to improve the professional training of prospective primary school teachers. The researchers conclude that the process of intensification of the educational process is closely related, first, to the search and introduction of pedagogical technologies based on the use of digital means, through which large-scale educational programs for the development of practical skills in the use of ICT are implemented [3]. These and other studies are aimed mainly at the modernization of learning technologies, but do not completely cover the ways of modernization of the basic forms of organization of the educational process.

The purpose of the article is to substantiate an integrated approach to the modernization of information digital training of prospective primary school teachers, covering the main forms of educational process in the higher education establishment such as training, independent work, practical training, control measures, and to experimentally test its effectiveness.

2 Results and discussion

Regarding our research, the result of the professional training of prospective primary school teachers is formedness of their ICT competence. The experimental study was preceded by an analysis of the works of Olga V. Bondarenko [4], Vita A. Hamaniuk [5], Lilia Ya. Midak [11], Pavlo P. Nechypurenko [13], Nadiia V. Olefirenko [14], Oksana V. Ovcharuk [15], Lina M. Rybalko [9], Serhiy O. Semerikov [10], Aleksander V. Spivakovsky [19], Oleksandra I. Yankovych [20] and others. The results of the analysis allowed to clarify the terminology in the field of information and digital technologies, to determine the essence of information and digital competence of the future primary school teacher. They are disclosed in our publications [17], [18].

It was also found that the information and digital competence of the future primary school teacher is formed on the basis of:

- conscious understanding and knowledge of ICT, opportunities for their use in personal and social life, education and work;
- awareness of the role of digital technology in supporting creativity and innovation, responsibility for the use of information;
- ability to find, collect and process various information through digital technologies, to use it according to real and virtual environment;
- understanding the importance of ICT for lifelong learning [17].

In choosing an integrated approach to modernize the training of future primary school teachers, we proceeded from the assumption that "the approach is a less directive methodological formation ... that has or provides an alternative to other approaches and eliminates the possibility of a single methodology (for example, in some humanities directions)" [21, p. 58]. The rationale for the integrated approach to information and digital training of future primary school teachers is carried out in accordance with the principles of systematicity, consistency, activity, independence; continuity, a combination of individual and group work using network services; self-development; reliance on subjective experience.

Let us focus on the main characteristic of the integrated approach to the modernization of information and digital training of future primary school teachers. The Law of Ukraine "On Higher Education" [24, Art. 50] determines that the main forms of organization of the educational process in the higher education system are training sessions, independent work, practical training, and control activities. However, the approach to the modernization of information and digital training of future primary school teachers, justified in our research, concerns the specified forms of organization of the educational process of HEI.

The analysis of the curricula of HEI that train specialists for primary schools [22] gave grounds for strengthening the content of the academic disciplines such as "Modern Information and Digital Technologies of Teaching", "Practical Course of Computer Science with Programming Elements", "Methods of Teaching the Subject "I explore the world" (information area)" with professionally oriented information regarding the use of ICT in primary education.

To improve methodological training of students, the variant component of the curriculum was supplemented with an optional course "Modern Information and Digital Technologies in the Educational Process of Primary School". The course curriculum consists of three modules. The module "Using Network Services as a Teaching Tool" refers to the development of the learning tools with G Suite for Education. Its main purpose is to prepare students for shaping the foundations of information and digital competence in primary school students.

Educational classes can be modernized by organizing group work of students using network services, systematic application of research, project, and problem methods of teaching, analysis of pedagogical situations, game modeling of educational activities.

By means of the integrated approach, students acquire the skills to work in a team, communicate in the process of group activities in the state language working in small groups (3–4 students) using network services. During group learning activities, in order to form the key and subject competencies of students, the classes make use of the resource potential of social networks and mobile applications [8] that allow students to create a group for free communication, online exchange of information and access to important resources. According to the rules of group work, you need to create effective small groups and elect leaders in them. The effectiveness of the group is ensured by the psychological compatibility of its members and the ability of at least 50% of them to carry out educational activities properly [23].

To organize learning activities in groups using network services, we suggest choosing a G Suite cloud service (or any other by students' wish). While working, small groups get access to Google Drive, where students can upload all the information, they need to complete a group task, giving each member of the group access to it.

During the information processing, students need to create presentations. To do this, they use Google Slides. It's allows the whole group to participate in making the presentation and some adjustments. Teacher evaluates students, monitors their progress and educational outcomes using Google Classroom technologies.

Working in small groups using network services, students have the opportunity to work with other applications and platforms, including messengers (Skype, Viber, Telegram etc.).

In our approach to the modernization of information and digital training of future primary school teachers, independent work of students is significantly transformed, which, according to the Regulation "On the Organization of the Educational Process in Higher Education Institutions", is the main form of developing students' competencies during their free time from mandatory training sessions. The upgrade is that students' independent work is organized on the G Suite platform using the Google Classroom service. For independent work, students are offered an electronic educational resource developed by us on the disciplines of information and digital training. It is hosted in the Google Classroom environment. Software and methodological support for remote forms of interaction between students and teachers through dialogue communication "student – teacher" and "student – student" has been established.

E-learning technologies are used in organizing students' independent work. These are new forms and methods of teaching, organizing students' independent work, and a new approach to the educational process [1]. To use them in studying the discipline "Modern Information and Digital Technologies in the Educational Process of Primary Schools", an electronic educational and methodological kit was created, which includes: a working curriculum for students (syllabus), a lecture course, guidelines for practical work, guidelines for independent work, test tasks, criteria for evaluating students' educational achievements, and a glossary.

Doing independent tasks, students can use G Suite elements such as personal email (Gmail), Google drive (Google Drive) to download and save documents. By means of Google Docs, Google Sheets, Google Slides, which allow to process text documents in almost all formats, students build charts, graphs and tables without installing additional programs on their gadgets, as well as present the results of their activities in the form of self-created presentations.

According to the integrated approach, students' independent work with using network technologies is carried out in the following stages:

- preparatory stage-setting tasks, drawing up methodical cards, distribution of tasks among students;
- practical phase – execution of tasks using network services;
- pre-evaluation stage – current verification of the implementation of tasks online;
- generalizing stage – summing up the achieved results, making conclusions, preparation for the delivery of the developed materials to the teacher;
- final assessment stage – checking and evaluating the work by the teacher in the student's personal account at Google Classroom.

We also suggest that students use G Suite services to create and maintain their own blogs, using the basics of Blogger or Sites Creator to create and maintain a personal website. Using these applications, future primary school teachers have the opportunity to share their own developments and achievements in compliance with copyright and use the acquired experience not only during their studies, but also in further professional activities.

Practical training in the context of the integrated approach to information and digital training of future primary school teachers is a long-term involvement of students in the use of ICT in the educational activities of primary schools. It should be noted that getting a systematic education (from the level of a professional junior bachelor to a bachelor's degree) students undergo five types of practices. At each of them, future teachers perform tasks related to the use of information and digital technologies in the educational process of primary schools. Preparing for practice, students also visit primary schools, where they carry out educational projects, conduct educational activities for students, get advice from teachers, and perform the experimental part of course work. Mastering the methods of teaching mathematics, Ukrainian language and literary reading, computer science, the integrated course "I explore the world" (natural, civil and historical, social, healthcare aspects), students develop plans and summaries of training sessions using digital technologies. They prepare multimedia presentations for lessons, select additional text and illustrative materials, create cards with individual tasks and additional educational texts, use an electronic database for monitoring student learning results, systematize and store their own methodological developments on personal blogs and websites. All this is used during all kinds of pedagogical practice.

The integrated approach to modernization of information and digital training of future primary school teachers has been pilot-tested in conditions of real educational process at Bar Humanitarian Pedagogical College named after Mykhailo Hrushevsky, Uman Humanitarian and Pedagogical College named after T. G. Shevchenko and Pedagogical College of Khmelnytskyi (Khmelnytskyi Humanitarian Pedagogical Academy).

Its effectiveness was established according to the criteria, indicators and diagnostic tools listed in table 1. The participants of the pedagogical experiment were 114 students enrolled in the colleges having basic general secondary education. The time of the ascertaining phase of the pedagogical experiment coincided with the end of the study of the Computer Science, which refers to general education and the overall preparation for professional junior bachelor's degree (junior specialist). Measurement was carried out to identify the residual knowledge and practical skills of students who completed the third year of training at the educational and professional level of a professional junior bachelor (junior specialist). To test students' digital literacy, we used a test that consisted of 30 test tasks. According to the results, the respondents were divided into three groups – with high, sufficient and average levels of digital literacy (table 2, fig. 1).

Table 1. Criteria, indicators and diagnostic tools for the formation of information and digital competence of future primary school teachers

Criteria	Indicators	Diagnostic tools
The effectiveness of information and digital training for the program of general secondary education.	Assimilation of knowledge about methods of transmission, search, transformation, use of information and about resources of information and digital technologies used in educational activities	Computer successfulness tests. Questionnaire. Observation.
The ability of students to teach junior high school students using information and digital technologies.	Awareness of electronic educational resources (EER) for primary school. Ability to use the tools of information and digital technologies in the preparation and training for primary school students. Ability to independently create electronic educational resources.	Average values of semester assessment in the disciplines "Modern Information and Digital Technologies in the Educational Process of Primary School", "Practical Course of Computer Science with Programming Elements", "Methods of Teaching Computer Science". The results of the practical task. Expert assessment of primary school teachers and methodologists during the period of pedagogical practice. Electronic portfolio of students.

Table 2. Results of the ascertaining stage of the pedagogical experiment

Level of the students' digital literacy	Students	
	People	%
High	25	21,93%
Sufficient	35	30,70%
Average	54	47,37%
Total	*114*	*100,00%*

According to the results of the ascertaining stage of the pedagogical experiment, near half of the respondents had an average level of digital literacy. Of course, this is not enough for effective shaping the digital literacy of primary students and implementing the educational process in primary schools using IT.

At the forming stage of the pedagogical experiment, the purpose of which was to test the effectiveness of an integrated approach to the modernization of information and digital training of future primary school teachers, the respondents were 54 students of the control and 58 students of the experimental groups.

The groups consisted of students who started the fourth year and expressed a desire to continue their studies at college to obtain a bachelor's degree in a reduced period of study (120 ECTS credits). The experiment continued until the pre-graduate practice at the final year of applicants for an educational bachelor's degree. During this period, students studied the subjects of information and digital training such as "Practical Course of Computer Science with Programming Elements", "Methods of Teaching Computer Science", "Modern Information and Digital Technologies in the Educational Process of Primary School". They conducted three types of pedagogical practice (summer practice in health camps, trial lessons and classes at school, practice "The first days of a child in school").

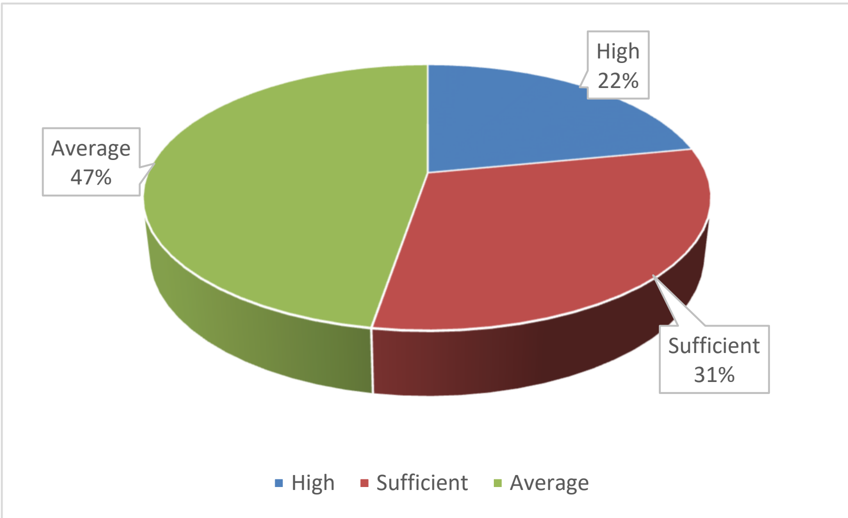

Fig. 1. Diagram of the distribution of future primary school teachers into groups according to the level of digital literacy (stating the stage of the pedagogical experiment, in %).

The main differences between studying these subjects by students of the control and experimental group were as follows:

- the students were actively influenced by the educational environment of educational institutions of the first level, interacted with students and teachers of primary classes in person and remotely;
- the future teachers studied the course "Modern Information and Digital Technologies in the Educational Process of Primary schools" included in the variable part of the curriculum;
- educational classroom and independent work of higher education applicants was carried out according to the methods of training described above;
- group training activities were optimally combined with front-line and individual training and took place using network services;
- the mandatory task of all types of practices was the systematic use of information and digital technologies in the educational activities of educational institutions of the first level.

Since the pedagogical experiment is still in progress (there is still a pre-graduate practice), then, as stipulated by the methodology for conducting the formative stage of the pedagogical experiment, two intermediate measurements were made before it began. One – after studying the disciplines of professional information and digital training, the second after completing the practices "The first days of the child in school" and "Trial lessons and classes in primary school".

The first measurement is the results of the semester control in the disciplines of information and digital training (figure 2).

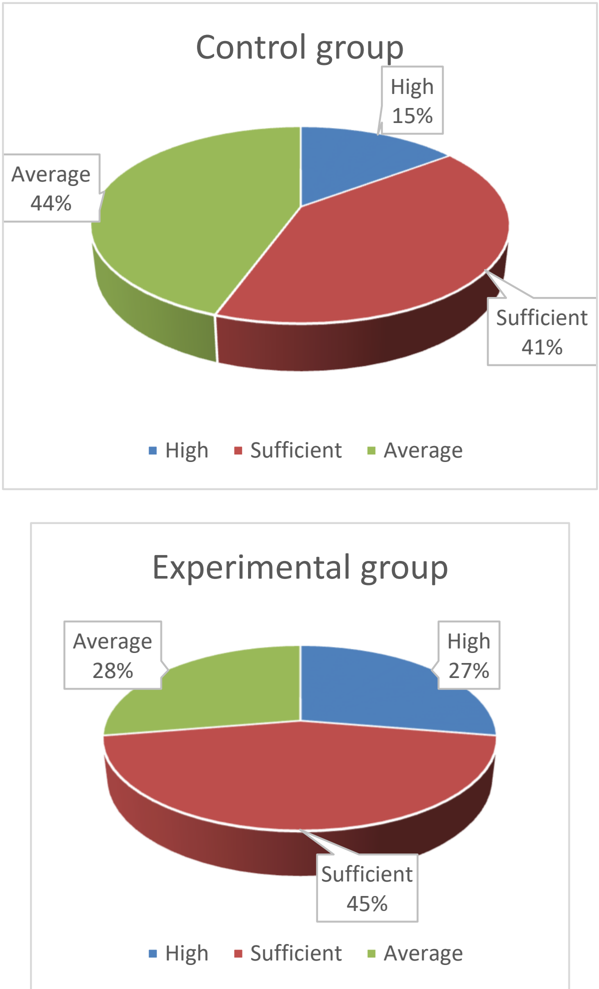

Fig. 2. Levels of formation of *digital* competence of students in the control and experimental groups (in %) based on the results of the first measurement.

The second measurement concerns doing a complex task by students before the beginning of pre-graduate practice, consisting of electronic testing (30 test tasks) and a practical task. The practical task was to design and implement one's own portfolio at Google Sites as a way to systematize and store documentary evidence of one's own achievements in the process of information and digital training. The maximum score for completing the complex task was 100 points. Students who scored 90-100 points were assigned to a high level of digital competency, 70-89 points – to sufficient and less than 70 points – to the average level. This distribution is shown in figure 3.

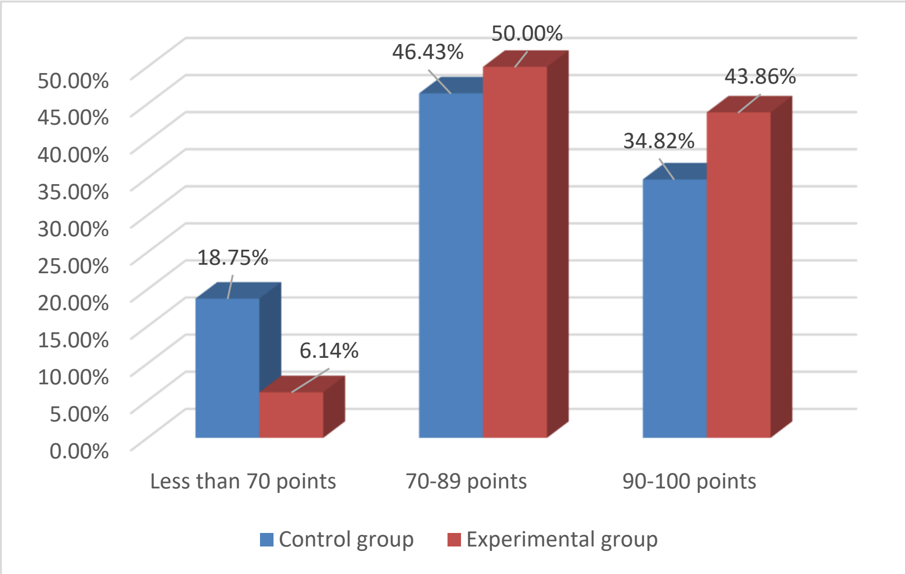

Fig. 3. Levels of digital competence of participants of the forming stage of the pedagogical experiment (in %) based on the results of the second measurement.

Figure 3 illustrates that the vast majority of students in the control and experimental groups scored more than 70 points. In a didactic sense, this is a positive result. However, the qualitative indicator of the effectiveness of ICT training (the number of students who have reached a high and sufficient level of competence under study) in the experimental group is 93.86%, in the control group – 81.25%.

In order to arrive at a statistical conclusion about the reliability of the results obtained, the χ^2 criterion was used for independent samples at a significance level of 0.05. The resulting value χ^2 is equal to 8.118. Compare it with the critical value $T = 7.82$, indicates that: $\chi^2 > T$. So, the obtained results of the formation stage of the pedagogical experiment are statistically reliable. This leads to the conclusion about the positive impact of the integrated approach to the modernization of information and digital training of future primary school teachers both on the process and results of development of the information and digital competence of prospective teachers of the New Ukrainian School.

3 Conclusions

1. The standard of higher education of the first (bachelor's) level of specialty 013 Primary Education, the Professional standard "Primary School Teacher of General Secondary Education Institutions", the State standard of primary education determine the need to develop information and digital competence of prospective primary school teachers, preparing them for shaping digital literacy of primary students in classes of various academic subjects. As the analysis of practice has shown, there are some issues in pre-service pedagogical training, which need to be solved. One of them, the modernization of information and digital training of future teachers, including primary classes, is an important task of the theory and methodology of professional education. Modernization of information and digital training of student teachers is necessary to ensure the quality of higher education in the personal and professional directions.
2. Modernization of information and digital training of prospective primary school teachers can be carried out in various ways. In our study, it is proved that one of them can be the application of the integrated approach to improving the main forms of the educational process – training sessions, independent work, practical training of students, and control measures. In the practical implementation of the integrated approach, a significant role is played by game modeling of pedagogical situations by students, during which they are teachers who plan, develop and implement the educational process using ICT.
3. The results of the pedagogical experiment were higher among the students of the experimental group. Processing of the results obtained using a statistical assessment based on the χ^2 criterion allowed to make a firm conclusion that the proposed integrated approach to the modernization of information and digital training of prospective primary school teachers improves their overall professional training, and ensures the quality development of their information and digital competence.

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Google cloud services as a way to enhance learning and teaching at university

Tetiana I. Korobeinikova[0000-0001-9218-5409], Nataliia P. Volkova[0000-0003-1258-7251], Svitlana P. Kozhushko[0000-0002-6383-5182], Daryna O. Holub[0000-0003-3872-72216], Nataliia V. Zinukova[0000-0002-4561-7886], Tetyana L. Kozhushkina[0000-0002-6839-7441] and Sergei B. Vakarchuk[0000-0002-2562-8844]

Alfred Nobel University, 18 Sicheslavska Naberezhna Str., Dnipro, 49000, Ukraine
tikorobeinikova@gmail.com, npvolkova@duan.edu.ua, lana@duan.edu.ua, darja.golub@gmail.com, natzinukova@gmail.com, tb146@ukr.net, sbvakarchuk@duan.edu.ua

Abstract. The article is devoted to the issue of a cloud-based learning system implementation as a powerful strategy for future specialists' training at higher educational establishments. Using cloud computing in self-work management of the university courses is essential to equip students with a workload of appropriate educational materials and variable activities for professional training. Theoretical and empirical research methods were applied to select the appropriate services and tools for organizing students' self-work at university. Critical analysis of scientific literature, synthesis of the data, didactic observation of the educational process, designing of the skeleton for university courses, questionnaires enabled to facilitate the study of the issue. G Suite has been chosen to enhance the quality of training of prospective specialists at a higher educational establishment. This paper introduces the outcomes of the project on applying Google Classroom in the management of students' self-work while studying university courses. The focus of the first stage of the project was on testing pilot versions of the courses with the aim to work out the requirements and recommendations for incorporation general blended learning model of university courses. Particular attention is drawn to the designed model of the university course based on the curriculum with the necessary components of blended learning in the G Suite virtual environment. Cloud-based higher education is considered as a prospective tool for design of university courses with the need for further research and implementation.

Keywords: cloud technologies, G Suite, Google Classroom, higher education, blended learning, students' self-work.

1 Introduction

1.1 The problem statement

The national policy of the preparation of specialists at higher educational establishments has undergone considerable positive changes in Ukraine due to supporting the line of European integration processes. The main legal aim is to implement innovations in the system of university courses learning and teaching. Current educational settings rely on a computer-based paradigm according to the strategy of the creation of the modern digital student-friendly environment. Notable achievements in making Ukrainian education competitive appear in developing blended learning courses for universities.

The discrepancy of the current situation in Ukraine is that it is a real challenge for a university to find the appropriate computer tools and ways to digitalize the process of preparation of future specialists. The urgent requirement of the modern educational process is based on the use of cloud-based technology and it should be recognized by a university through the strategy of the renovation of the curriculums. Such a strategy should address enhancing learning and teaching, improving outcomes of training of prospective specialists, and building congruent accessible e-learning environment.

1.2 Literature review

Bearing in mind the idea that the chosen cloud environment is to ensure both the general educational goals and digitalization of study we have analyzed the experience of educational establishments and scientific works and publications concerning the issue.

In order to select the appropriate services and tools for organizing students' self-work at university, a complex of theoretical and empirical research methods was applied. Critical analysis of scientific literature, synthesis of the data, didactic observation of the educational process, designing of the general didactic model of university courses, questionnaires enabled to facilitate the study of the issue.

In recent years a considerable amount of valuable works has been done in the field of implementation of cloud technologies into education. The benefits and limitations of cloud computing in education were introduced by Saju Mathew in 2012 [12]. Svitlana H. Lytvynova et al. have described the special features of the use of cloud services in non-formal education [9].

The issue of cloud-based learning was repeatedly raised by scholars around the world. The analysis of the current approaches to cloud-based learning systems interpretation has been done by Maiia V. Marienko and Mariya P. Shyshkina [20]. The profound analysis of the model of combined learning at higher education establishments is given by Serhiy O. Semerikov and Andrii M. Striuk [22]. Marinela Mircea [13], Veselina Nedeva [18], Oksana M. Markova [10], Serhiy O. Semerikov [15], Andrii M. Striuk [23], Hanna M. Shalatska [21], Pavlo P. Nechypurenko [14], Vitalii V. Tron [11] et al, devoted their works to the investigation of different aspects of cloud computing in higher education. At present much has been done in the field of implementing of information and communication technology (hereinafter ICT) for teaching university courses in Ukraine. There is considerable experience in the creation and use of computer aid learning [3], [7], [8], [9], [11], [17], [19], [24].

Although there is a number of existing articles, books, monographs, concerning cloud-based e-learning this is one of the first paper to be devoted solely to Google cloud-based management of university courses.

2 Application of Google Classroom for managing university courses

Before proceeding to the subject of the discussion the question is bound to rise, whether Cloud technology can serve the educational process at university and whether it is able to replace successfully the existing schemes for students' self-work management.

However, the academic standards for university students are very high as well as the workload of courses, the urgent need to intensify students' self-work is vital. At the same time, the interrelation and interdependence of in and out class activities manage the system of higher education. According to the curriculum, during the study at university, students' professional competencies and sub-competencies are developed through their activities in general and professional-oriented theoretical and practical courses. The next point to be taken into account is that a large amount of a student's learning activity is his/her self-work and its share is about sixty per cents of academic hours of the university courses. We couldn't deny the fact that students' active involvement in studying enables the learning outcomes. What matters for a successful educational process in such a situation is the way by which the students are equipped with the materials for self-work. The students' performance as future specialists and efficiency of their learning tasks as well as the quality of learning outcomes depend greatly on effective management of information [9].

We are strongly convinced that a wide range of modern web technologies can be used for students' self-work management. The high-speed Internet and a gadget (laptop, tablet, etc.) are the two components that can be attributed to the special features of the organization of the mentioned training. Moreover, all educational materials should be selected and organized with the aim to ensure general educational needs, students' motivation for professional development and coincide with students' interests.

Being obsessed with consuming of modern gadgets, students drive the educational process as its active participants. We are at the point that using mobiles, smartphones, tabs, etc. in higher education is neither entertainment nor a tribute to fashion but an integral part and urgent requirement of European-oriented specialists' preparation. One may note that using smartphones provides students with resourceful access to learning materials and information on the Internet [1]. It would be mistaken however to suppose that educational establishment cannot make up a profit of it. The adoption of students' favourable gadgets for educational purposes solves a task to lessen the universities' budget spent on classroom equipment and software.

The use of smartphones and tablets or other devices improves students' availability to access course materials anytime and anywhere [4]. One more advantage of using mobile devices in and out classrooms is that it is a solution to stressful situations as many people suffer anxiety if they are separated from their mobile devices [5].

It leads to the formulation of the new concepts of incorporating appropriate ICT into the curriculum. The modern shift towards combining the traditional in-class students' activities with their out-of-class autonomous self-work in a virtual environment enables tutors and lecturers to take benefits of the digitalization of education. One of the most important points is reducing the universities' and students' expenses on the educational process [13], [16]. The number of users, who are working today in the form of collaborative communities in clouds, has been increased, so this technology is becoming a new drawn to higher education as well [13].

It means that universities should develop their own policies in the sphere of the incorporation of special applications to promote and support modern educational services. In this connection, two questions are of a great interest for us as Ukrainian educators. The first one deals with the choice of the most efficient cloud services and applications to manage university courses and at the same time to support using smartphones. One more aspect under investigation is students' attitude and evaluation of a new cloud-based learning environment.

Due to the fact that cloud based G Suite provides the opportunity for free downloading its services and applications and enables users to take advantage of favourable gadgets or devices, especially smartphones. It means that G Suite can be considered as mobile cloud computing as it enables the use of services via mobile devices [5, p. 44].

All mentioned points justified the choice of G Suite for Education as a core set of services to ensure the blended learning at the university. It seems to us that the integration of Google apps, tools, services in preparation of the future specialists deserves attention as it is an appropriate way to manage university courses. Moreover, Google provides effective universities' infrastructure and at the same time supports to reduce cost, make quick and effective communication, collaboration with the range of security, privacy, flexibility, and accessibility [2].

It is important to note that the positive students' attitudes towards the incorporation of a new learning environment lead to a higher level of self-motivation for course study and education as a whole. Though, it couldn't be denied the fact that designing a virtual environment depends greatly on the university course, its aim, prospective outcomes, the students and the author's ideas. Moreover, it is necessary to point out that some requirements for managing the course with the use of G Suite are obligatory. Firstly, the chosen platform is a powerful tool to support the educators and it cannot be recognized as an educator. Secondly, all the applications provided by Google are to serve self-work management and need time limits according to the curriculum. The third but not the least point is based on university strategy, especially, on its part of the standardization of courses.

G Suite as a part of Google Cloud's robust set of solutions and technologies provide tutors and lecturers with the tools to create effective online courses. This platform is used worldwide by communities, schools, instructors, courses, teachers, and even in businesses. Although initially designed for higher education environment, G Suite has quickly become used to conduct courses fully online or support face-to-face teaching and learning.

The choice of Google cloud implementation into the preparation of specialists at university should be analyzed both from the students' and lecturers' points of view. The heart of the discussion is the students' needs and their interests.

When a course is on its early way to digital transformation, it is the lecturer's choice of the design and set of technologies useful to ensure students' professional development as well as their motivation to study. To achieve success as the author of a special course the creator is to take into account the main factors of intensification of teaching by means of cloud computing at higher education. They are as follows:

- increasing the purposefulness of learning;
- increasing motivation for learning;
- increasing the informative capacity of educational content;
- increasing the pace of training actions;
- applying of active methods and forms of training;
- applying a wide range of electronic training tools, in particular, ICT;
- providing a student's individual educational path.

All above-mentioned means that using ICT the lecturer is the one who makes such psychological and pedagogical conditions that are aimed at creating a favourable environment for the student's successful development as a future specialist as well as a personality.

Here we need to consider these factors in detail from G Suite users' vision. The purposefulness of students' self-work can be supported by adding a syllabus to the contents of courses. One more idea is in providing Personal Journals of Learning Outcomes (hereinafter PJLO) for each university course taught by means of G Suite. Creating a chart that includes sequence, time limits, assessment scale, requirements for performing self-work, a lecturer directs a student to self-reflection and self-evaluation of his/her achievements in the course learning. Such journals are made as Google documents and shared in the Google Classroom (hereinafter GC) by copies for each student.

When a learner knows the ultimate goal and prospective outcomes of the course, it is not difficult to understand the purpose of the activities suggested.

In the vast majority of cases, to cope with the self-work assignments students grab a great deal of information from the sources of precarious accuracy and reliability. The explicit data and sources are valuable for each and every definite course, and they should be introduced as obligatory by the lecturers and tutors. It is easy to set the list of printed references but the accumulation of a wide range of open access sources materials has brought a need for a document management system at universities. Sharing the collections of papers and web links on a particular educational issue the lecturer is the driver and facilitator for appropriate knowledge consumption. Moreover, students' perception of their gargets shifts from the devices for entertainment towards the powerful source for education.

The system of posting assignments in GC supports a lot of active methods and forms of training. The lecturer can divide participants of the course into small groups, pairs, and even appoint individual tasks. GC also provides students with the opportunity to interact and collaborate anytime and anywhere. When there is a question or misunderstanding of a self-work task, students have ‘a teacher at hand in GC’. All charts between an educator and a learner in GC are personal as well as feedback.

The particular feature of theoretical courses is a huge amount of information to be studied and it calls for intensive reading. We suggest the materials for lectures to be organized according to the flipped class approach [18]. The idea is to give a portion of the material for studying in advance.

The templates of GC tasks make it possible to give students tests, questions for group discussions, assignments with the schemes, tables, open documents, presentation samples, etc. Educator chooses the way of the arrangement of course material, posting it in sets according to the topics or in free order. The distinguishing feature of GC is based on the opportunity to appoint the deadline for the performance of the self-work and grades of outcomes.

3 Google Classroom model of university course: stages of design and application

The question of how one and the same Google App or set of e-tools can serve different practical aims of university courses deserves special attention. As educators, we are interested in G Suite special component Google Classroom due to the fact that it is a free web application that can be used to organize seminars, lectures, tutorials, group, and individual self-work. One of its main advantages is an open-source allowing students even with basic programming knowledge to install it for their own needs or educational purpose. Having Google Classroom installed on any laptop, tablet, smartphone, etc., students are equipped with all the material of the chosen course.

We are strongly convinced that G Suite use for blended learning should be the prior focus of developing higher education in Ukraine. Our idea has been proved by the data analysis of the lecturers’ and students’ questionnaires.

To determine learner’s preferences in the usage of gadgets and their experience in the e-learning environment a special online questionnaire has been prepared. It contains 7 questions: indication of age/gender, rating of gadgets according to the frequency of its usage in everyday life (smartphone, tablet, laptop, personal computer, other), their predominance in educational process and in self-work, e-learning tools familiar to the learners (Moodle, Google Classroom, iSpring, Habr, other) and the same list of e-learning platforms distinguishing the most favored ones in educational process. The results are presented in Table 1.

The majority of respondents are female students aged 18 – 23. Smart phones have been rated as the most frequently used gadgets – 67 %. The questionnaire proves that learners use their gadgets both in educational process and in self-work as well that contributes to the development of university courses with blended learning. As for e-learning tools, Google Classroom takes the leading position, which makes it possible to assume that Google Cloud services are learner’s choice.

Nearly three-quarters of the respondents from Alfred Nobel University consider Google Apps to be a supportive tool in course management and at the same time, the lecturer is the driver of the cloud-based learning environment at university. But, face-to-face teaching in the class plays a major role in the professional development of students. Meanwhile, GC successfully assists this process under the wise supervision of a lecturer.

According to students' views, the learning outcomes greatly depend on the way of the educational material representation and the most important role plays the possibility to access the tasks and the theoretical issues for their performance.

Table 1. Results of the students' questionnaire

No	Items	Data
1	Gender of respondents	male – 15% female – 84%
2	Age of respondents	18-19 – 45% 20-23 – 46% 24-35 – 9%
3	Rating of the gadget's type	**smart phone – 67%** PC – 12% tablet – 10% laptop – 10% other – 1%
4	Usage of gadgets in educational process	**very often – 69%** often – 24% seldom – 4% rarely – 2 % never – 1%
5	Usage of gadgets in self-work	**very often – 68%** often – 25% seldom – 3% rarely – 2 % never – 2%
6	Usage of e-learning tools	**GC – 95%** Moodle – 2% Habr – 2% iSpring – 0% other – 1%
7	Preference in e-learning platforms	**GC – 95%** Moodle – 2% Habr – 2% iSpring – 0% other – 1%

We would like to give a brief description of our experience at Alfred Nobel University. The experimental teaching was carried out on the basis of GC management service in the G Suite learning environment.

The most important requirements are as follows: to embrace current trends of implementing cloud-based learning and to enable all students to be involved as active participants in developing professional competences through blended learning of university courses.

Alfred Nobel University has gained the right to use services Gmail, Calendar, Classroom, Contacts, Drive, Docs, Forms, Groups, Sheets, Sites, Slides, Hangouts, and others under G Suite for Education agreement. To support the university policy of implementing these services the team of lecturers was engaged in the project of GC management of university courses.

Collecting all the discussed results the University staff approved the G Suite implementation to the curriculum and the pilot version of theoretical and practical courses self-work in GC were started in the 2017.

The first step of implementing G Suite at Alfred Nobel University included two stages. The objectives of the first stage were formalizing the idea of implementation, launching pilot versions of courses designed by means of G Suite, analyzing the first experience and suggesting recommendations for incorporation. The second stage is devoted to launching pure experimental practical study.

The first stage of the project has several theoretical and practical results that enable the preparation of specialists at higher educational establishments. Despite the lack of empirical data, there is a contribution to practical issues by providing the model and recommendations for GC management of students' self-work at university.

There is the practical study and its results conducted in the years from September 2017 until May 2019. It was only the first stage of implementation of G Suite into specialists' preparation at higher educational establishment in Ukraine. The main aim of the stage was to decide whether it would be possible to ensure the general goal of specialists' preparation at universities in the Google learning environment. Another task was in the setting recommendations for a university course design.

In the period of the first stage, several lecture and practical courses were suggested by the staff of the University. It was approved the following skeleton for a university course (Fig. 1).

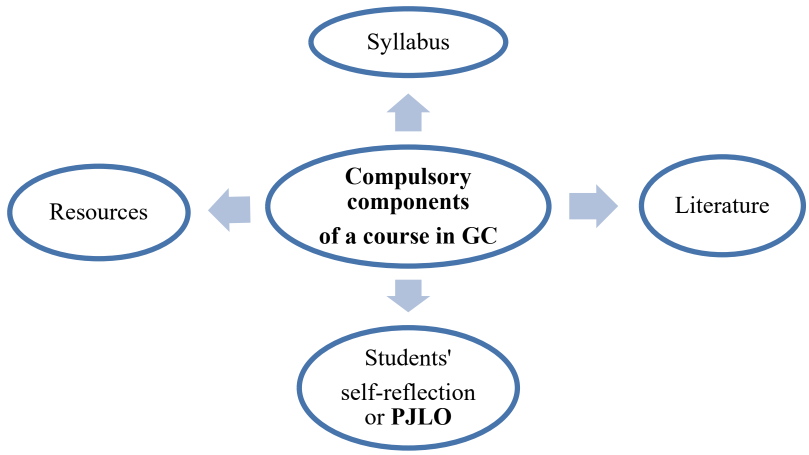

Fig. 1. Skeleton of a university course designed in Google Classroom

The next step to success in Google Classroom university management is the standardization of the design of the course. The following model has been introduced (Fig. 2): the syllabus of the course, literature, and resources of the course, a strict schedule of task performance and scoring, and assessment of the course (its types, criteria, scoring). Each pilot version of the courses must have a module arrangement that presupposes the diversity of the assignments and the possibility of their combining.

In this connection, it was designed and applied the model of the First Year of English for Translators Course [6]. As it is showed in Fig. 3, this practical course includes all compulsory elements and is supplied with the PJLO but special components have been added.

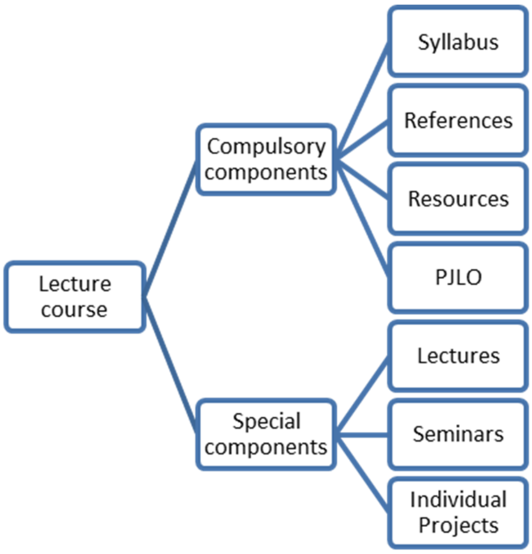

Fig. 2. Skeleton of a lecture course in GC

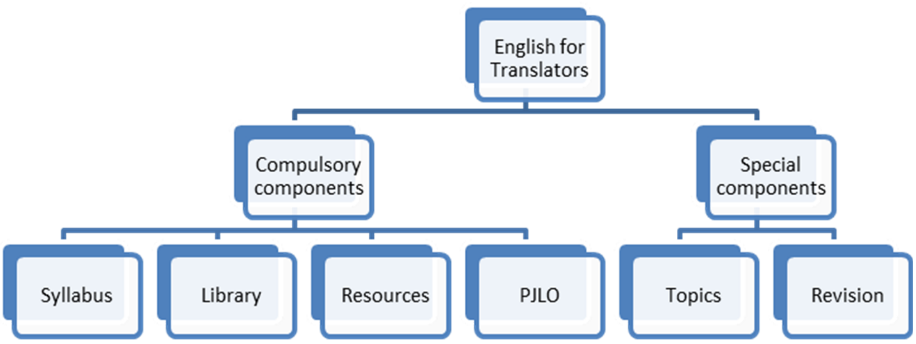

Fig. 3. Skeleton of English for Translators Course in Google Classroom

The GC architecture of this course includes eight topics according to the curriculum and extensive reading section posted as ‘material’. Each topic contains rubrics-tasks: Reading, Listening, Writing, Use of English, Grammar, Dialogues, Presentations, Home reading, Project (Fig. 4). As for the progress check, the model includes four Revision Sections after two topics. This section provides students with samples of Module Tests based on the studied topics and out of class self-work activities. Students choose the pace and the order of doing the tasks and decide what and how many times should be completed.

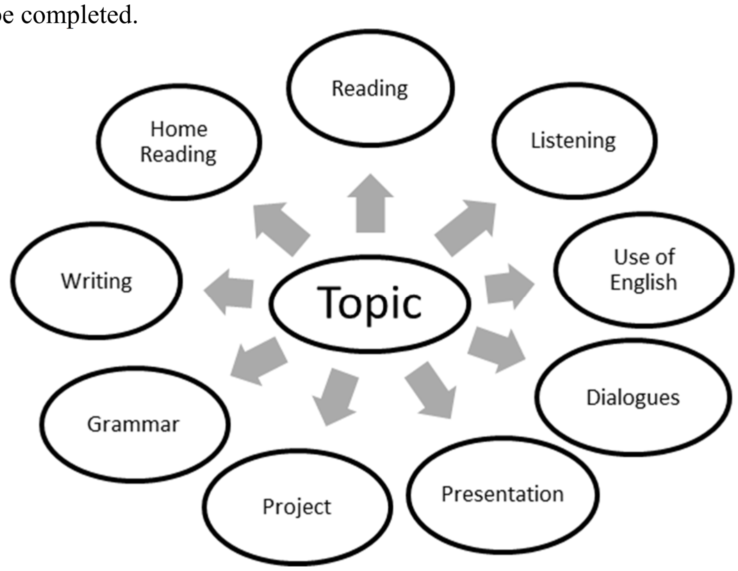

Fig. 4. Components of the topic of English for Translators Course in GC

On the basis of such outcomes, it is planned to launch the further stages of the research project to collect the data of efficiency of blended learning university courses implementation in specialists’ preparation in the G Suite virtual environment.

The pure experimental part is scheduled to be organized from September 2019, with the results to be collected, analyzed, and published June-August 2020. At the beginning of the autumn semester, the first-year students of 14 departments of the University have been already engaged in the second stage of the experiment. Each course of the curriculum except Physical Education has been started in the Google Classroom.

The further stages of the practical part of our research will be held in other Ukrainian universities.

4 Conclusions

It is possible to make a conclusion that nowadays higher education with Google applications can support the renovation of methods, strategies, and technologies of professional training of prospective specialists. The theoretical and practical background of G Suite for education enables us to design university courses for blended learning.

The Google Classroom has been chosen as the prior and dominant way to manage students' self-work. The selection of tasks and materials are based on the following general principles: circulation, progressive development in complexity, professional relevance. It means that the content of the materials, tasks, tests in terms of topics is selected according to the curriculum and range of standards of specialty. Moreover, self-work assignments on a course are supported by theoretical materials, sufficient examples, schemes, templates, additional resources, by links in a virtual learning environment that is accessible from any students' devices, especially smartphones. The great success in self-work management of a university course in Google Classroom depends greatly on an educational establishment policy.

The awareness of the importance of cloud-based higher education for the design of university courses is prospective both for further research in the methodology of teaching as well as for the programming.

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The state of ICT implementation in institutions of general secondary education: a case of Ukraine

Tetiana A. Vakaliuk[1[0000-0001-6825-4697]], Dmytro S. Antoniuk[1[0000-0001-7496-3553]] and Vladimir N. Soloviev[2[0000-0002-4945-202X]]

[1] Zhytomyr Polytechnic State University, 103 Chudnivsyka Str., Zhytomyr, 10005, Ukraine
tetianavakaliuk@gmail.com, dmitry_antonyuk@yahoo.com
[2] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
vnsoloviev2016@gmail.com

Abstract. The use of digital technology in various fields of education today is one of the most important trends in the educational process in the world. The article presents the results of the analysis of the current state of implementation of ICT in the educational process of institutions of general secondary education in Ukraine. For this purpose, a survey was conducted among students of the first year of the Zhytomyr Polytechnic State University, within which 17 questions were asked to students related to the use of information and communication technologies in the educational process. As a result of the research, the introduction of the discipline "Educational technologies and digital education" into the training of future information technology specialists was substantiated, as well as the certification educational program "Information systems and cloud technologies in the educational process", designed for general education teachers, educators for higher education institutions, experts in the field of additional educational services, and other professionals.

Keywords: information and communication technologies, massive open online courses, cloud technologies, cloud services, game simulators, simulators, general secondary education institutions.

1 Introduction

The Law of Ukraine "On Education" states that the formation of information and communication competence in students is mandatory [49] because digital competence is recognized by European Union as one of the key competences [25]. As a result, as stated in the conceptual framework of the digitalization of Ukraine, target audiences in the implementation of the state program on digital literacy are elementary school, secondary school, vocational school, and higher education institutions (HEI) [32].

The use of digital technology in various fields of education today is one of the most important trends in the educational process in the world [16; 21; 29; 30]. Such technologies allow making the learning process more qualitative and interesting, because using the media and interactive tools the teacher can introducing the different methods of working in the classroom: project method, research and development work, educational games, etc. [9; 32; 42; 44; 46; 52].

Also, the latest situation with pandemic spread of COVID-2019 and corresponding measures that cause disruptions in the educational process around the world one more time emphasizes the importance of ICT in Education [14; 36].

The issues of computerization and informatization of the educational process are widely considered in the works of Olga V. Bondarenko [4], Oleksandr Yu. Burov [17], Valerii Yu. Bykov [6], Vita A. Hamaniuk [8], Andrii M. Hurzhii [7], Anna V. Iatsyshyn [51], Olena O. Lavrentieva [19], Oksana M. Markova [27], Iryna S. Mintii [22], Yevhenii O. Modlo [24], Pavlo P. Nechypurenko [26], Serhii A. Rakov [33], Natalya V. Rashevska [34], Lina M. Rybalko [20], Zarema S. Seidametova [35], Serhiy O. Semerikov [23], Svitlana V. Shokaliuk [40], Mariya P. Shyshkina [31], Aleksander V. Spivakovsky [39], Nina F. Talyzina [41], Illia O. Teplytskyi [37], Yurii V. Tryus [43], Vladyslav Ye. Velychko [13], Myroslav I. Zhaldak [50] and others.

Also, the issue of the introduction of various ICT in the educational process of educational institutions is considered by foreign scientists.

In particular, Alkhansa A. Shakeabubakor, Elankovan Sundararajan and Abdul Razak Hamdan considering cloud computing services and applications to improve the productivity of university researchers [38].

Gonzalo Almerich, Natividad Orellana, Jesús Suárez-Rodríguez and Isabel Díaz-García analyze teachers' information and communication technology competences [1]. Sourya Biswas ascertains how cloud computing can help in education [3]. Marwin Britto [5], Snejana Dineva and Veselina Nedeva [10], Silky Bansal, Sawtantar Singh and Amit Kumar [2], Tuncay Ercan [12] considered the use of cloud computing in higher education.

Chipo Dzikite, Yvonne Nsubuga and Vuyisile Nkonki investigated lecturers' competencies in ICT for effective implementation of ICT-integrated teaching and learning in textiles and clothing degree programmes [11]. Dana Hanson-Baldauf and Sandra Hughes Hassell reveals issues the information and communication technology competencies of students enrolled in school library media certification programs [15]. Andreas M. Kaplan and Michael Haenlein analyze the problem of higher education and the digital revolution [18].

The *purpose of this article* is to establish the current state of implementation of ICT in the educational process of institutions of general secondary education in Ukraine.

2 Results

To find out the current state of implementation of various ICT in the educational process of institutions of general secondary education, as well as to form a group of selective disciplines, a survey of students of the first year of the Zhytomyr Polytechnic State University was conducted. In total, 167 respondents participated in the survey.

Students were asked to answer the following questions [28]:

1. Do you know what application packages are?
2. Did you study application packages at school/college?

3. What kind of application packages have you studied/reviewed?
4. From which package did you study office application packages (text editors; spreadsheets; database management systems; demo tools)?
5. Do you know what "cloud services" is?
6. Which of the following programs and services is cloud-based?
7. Do you know what massive open online courses are?
8. Do you use these courses at school/college?
9. If the answer to the previous question is "Yes," which one?
10. Have you used massive open online courses for self-study?
11. Did teachers use any other tools when studying programming in Computer Science?
12. If the answer to the previous question is "Yes", what are the tools?
13. Did any information and communication technology tools (curricula, multimedia, simulators, games, virtual laboratories, etc.) be used in the school/college by non-CS teachers?
14. If the answer to the previous question is "Yes", in what lessons did the teachers use such tools?
15. Which one did you enjoy the most and why (also indicate the item on which it was used)?
16. Was the teaching of this subject more interesting using a variety of tools than without using them?
17. What additional services would you like to consider and explore how to use them?

Let us analyze the answers to each question. First question "Do you know what application packages are?" the purpose was to establish whether the first-year students have basic concepts of the school course in Computer Science (CS). The results of the survey indicate that 91% of students have basic concepts, 9% do not (see Figure 1).

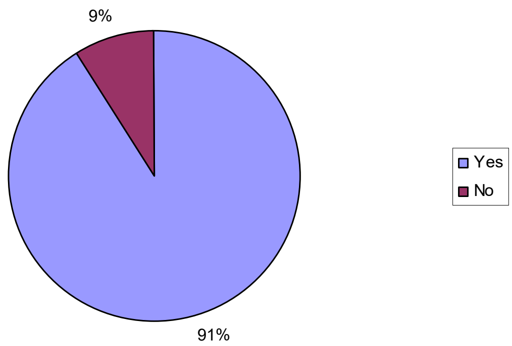

Fig. 1. Percentage of answers to question # 1

Regarding the second question, "Did you study application packages at school/college?", 18% said no and 82% said yes (see Figure 2). This indicates that either the teacher did not adhere to the standard of general education, or the first-year students do not understand the basic concepts of CS.

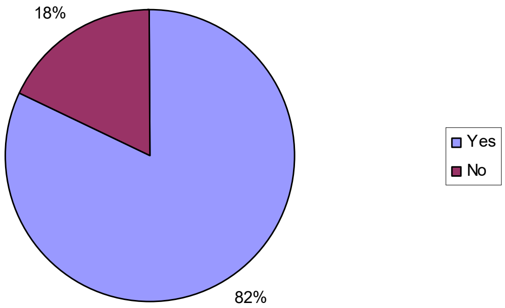

Fig. 2. Percentage of answers to question # 2

The answer to what exactly served as this distribution of answers to the previous question is to analyze the answers to the following. In response to the question "What kind of application packages have you studied/reviewed?", all 167 respondents chose one of the suggested options, which means that as a student they studied everything they needed, they just did not have the necessary terminology. In this case, 88% of respondents noted that they studied text editors, 77,8% – spreadsheets, 65,3% – tools for creating demonstration material, 38,3% – database management systems, 32,3% – graphic editors, 22,2% – educational programs, 16,8% – multimedia systems and computer games (see Figure 3).

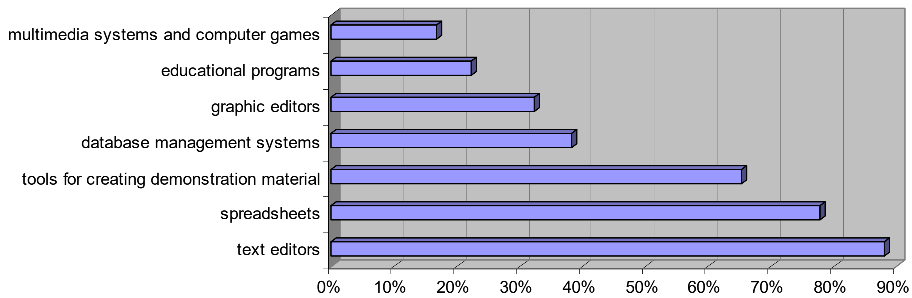

Fig. 3. Percentage of respondents' answers to question # 3

During the informatization of society, new ICT are constantly appearing, which are replacing the usual applications. One of such ICT is a cloud technology – a service that allows remote use of data processing and storage tools [48].

The next question was to find out whether schools use the standard MS Office suite, or whether some teachers use cloud services. Results of the answers to the question "From which package did you study office application packages (text editors; spreadsheets; database management systems; demo tools)?" 80,2% of those surveyed had studied MS Office, 22,2% had studied Office 365, and 24% had studied Google services (see Figure 4). In particular, 59,3% (99 people) of the proposed list chose MS Office only.

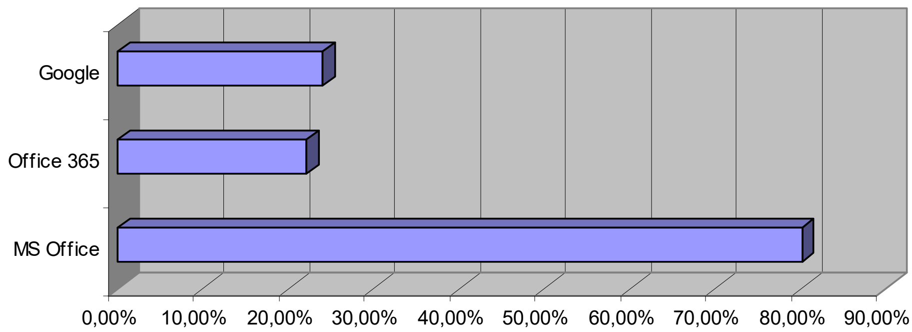

Fig. 4. Percentage of respondents' answers to question # 4

That is why the next question was "Do you know what "cloud services" is?", to which 84,3% answered "yes" and the other 15,7% answered "no" (see Figure 5). Although the study of cloud services is also included in the CS curriculum, not all school teachers adhere to the relevant document.

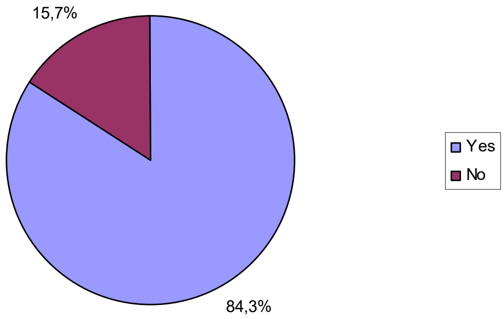

Fig. 5. Percentage of respondents' answers to question # 5

Answers to the following question "Which of the following programs and services are cloud-based?" are quite interesting as 13,4% of respondents said that MS Office is a cloud service. Also, 12,7% said Office 365 was cloud-based, 82,6% noted Google services, and 7,6% noted Prezi (see Figure 6). It's worth noting that Office 365, Google, and Prezi are among the cloud ones listed.

As Zhytomyr Polytechnic State University actively introduces massive open online courses, the following question "Did you know what massive open online courses are?". The survey results indicate that 74,3% know what it is, the other 25,7% do not (see Figure 7).

In doing so, in response to the question "Do you use these courses at school/college?" 88,6% of students (percent of those who answered "yes" to the previous question) answered, "yes" (see Figure 8).

To find out what kind of open online courses are used in the educational process of general secondary education institutions, the following question was analyzed: "If the answer to the previous question is "Yes", which one?". The analysis of the results shows that in most cases (50%) are Cisco Academy courses, in some cases (13,6%) are Prometheus, and all others are isolated cases of other courses (see Figure 9). It should be noted that Zhytomyr Polytechnic is closely cooperating with Cisco Academy, as a result of cooperation in the institution of higher education actively used courses of the said academy in the educational process (when studying courses “Computer Networks”, “Python Programming”, “Cybersecurity”).

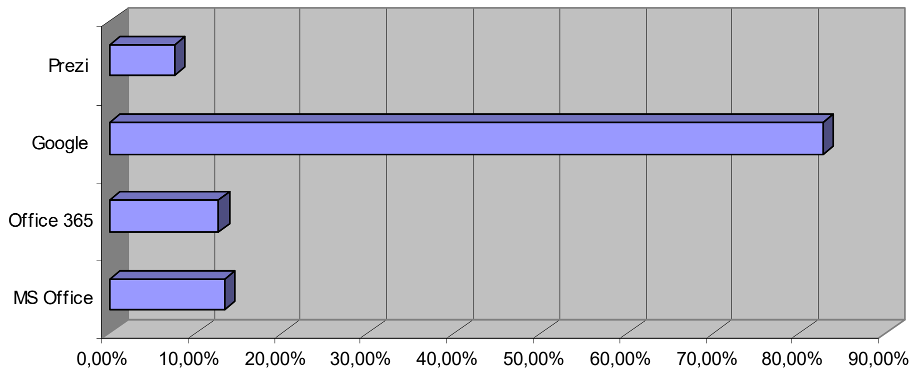

Fig. 6. Percentage of respondents’ answers to question # 6

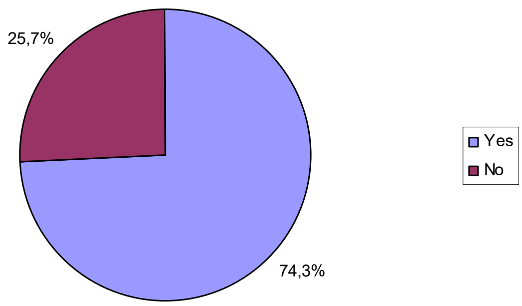

Fig. 7. Percentage of respondents’ answers to question # 7

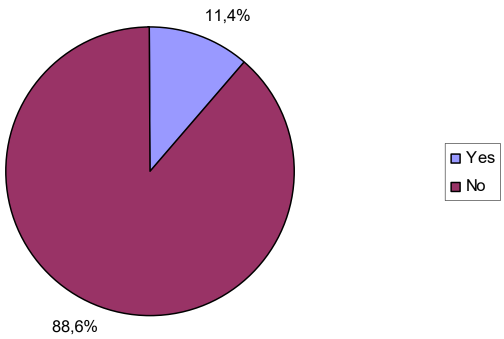

Fig. 8. Percentage of respondents’ answers to question # 8

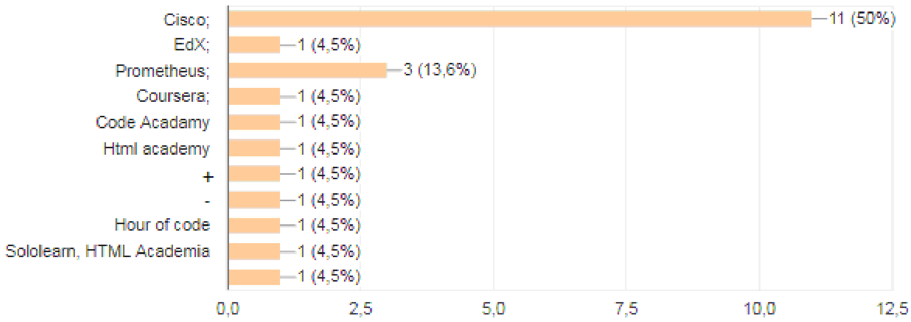

Fig. 9. Percentage of respondents' answers to question # 9

Also, to facilitate the use of massive open online courses (MOOC) in students' independent work, the following question "Have you used massive open online courses for self-study?" The results of the survey (67,1% – yes, 32,9% – no, see Figure 10) indicate that not all students used MOOC for independent work, and therefore, before using these courses, it is worth conducting coaching for students who do not know how to use such MOOC.

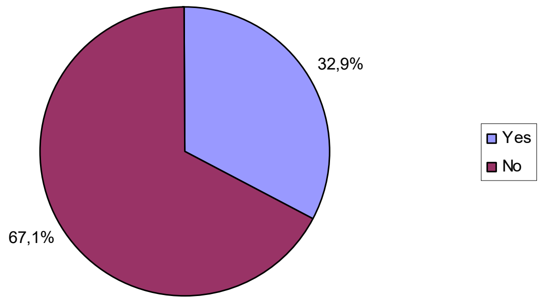

Fig. 10. Percentage of respondents' answers to question # 10

Also, an important question was, "Did teachers use any other tools when studying programming in Computer Science?", in which 50,9% said "yes, they used", 49,1% – no (see Figure 11).

To find out what kind of tools were still used in CS lessons, the following question was asked: "If the answer to the previous question is "Yes", what are the tools?". The results (see Figure 12) indicate that 32,2% of the respondents worked with online compilers, 33,3% – with automated programming tasks, 50,6% – with simulators, 52,9% – with training games. According to previous research [48], it is with online compilers and automated systems for checking programming tasks that computer teachers want to work in the educational process, but for some reason, they are not used yet.

As ICTs can be used not only in CS lessons, the next question was "Did any information and communication technology tools (curricula, multimedia, simulators, games, virtual laboratories, etc.) be used in the school/college by non-CS teachers?".

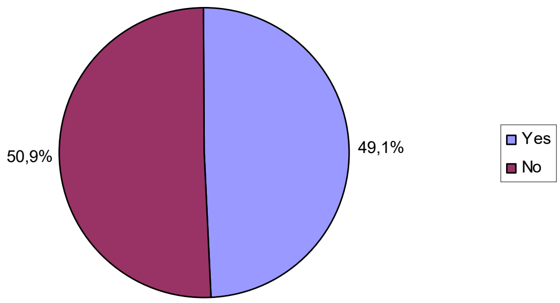

Fig. 11. Percentage of respondents' answers to question # 11

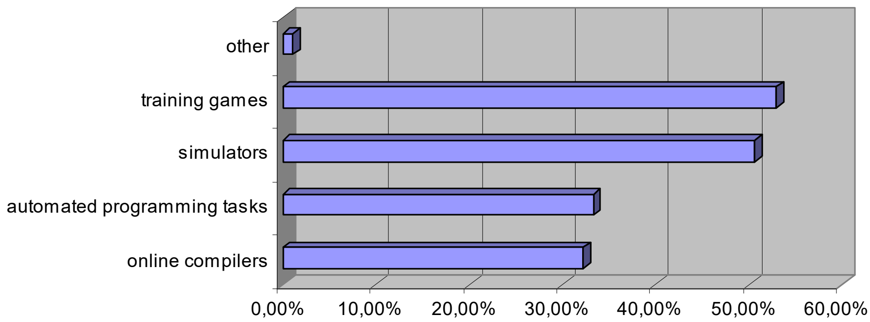

Fig. 12. Percentage of respondents' answers to question # 12

Survey results indicate that in 51,5% of cases ICT was used in other lessons, in 48,5% it was not (see Figure 13).

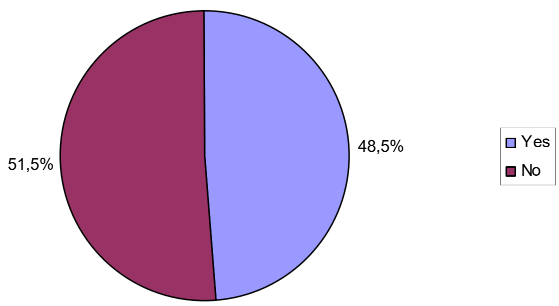

Fig. 13. Percentage of respondents' answers to question # 13

Among those who answered "yes" to the following question "If the answer to the previous question is "Yes", in what lessons did the teachers use such tools?" were distributed as follows (see Figure 14): 50% – ICT used in language and literature lessons; 48,8% – in mathematics lessons; 43,8% – physics; 38,8% – history; 33,8% – chemistry; 30% – biology; 20% – geography etc.

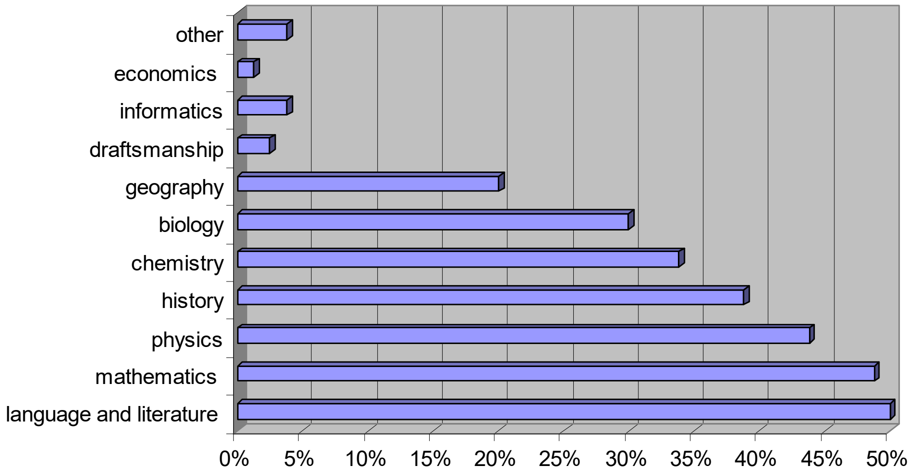

Fig. 14. Percentage of respondents' answers to question # 14

This indicates that most teachers still do not use different ICTs in their activities, although there are currently many tools that can be used in the educational process of a general secondary education institution.

The next question is, "Which one did you enjoy the most and why (also indicate the item on which it was used)?" made it possible for teachers to use the following ICT tools in their activities: multimedia, presentations, games, documentary, online quiz, educational films, simulators, and automated verification systems.

Analysis of the distribution of answers to the question "Was the teaching of this subject more interesting using a variety of tools than without using them?" (see Figure 15) indicate that it is still more interesting for students to use ICT in the educational process than not use.

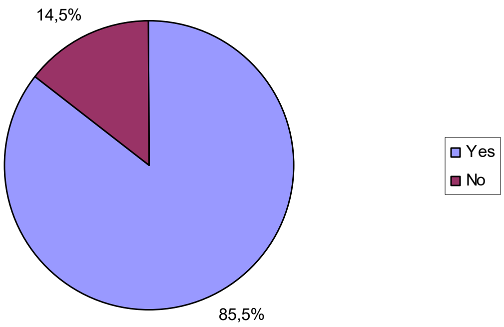

Fig. 15. Percentage of respondents' answers to question # 16

To determine what other services could be considered with students, the answers to the question "What additional services would you like to consider and explore how to use them?" were analyzed. The results show that students want to study game simulators in detail – 62,3%, cloud services for collaboration on documents – 59,9%, educational games – 45,5%, tools for learning programming – 43,7%, simulators – 41,3%, computer network modeling tools – 35,3%, virtual labs – 34,7%, massive open online courses – 29,9%, statistical data processing tools – 25,7%, cloud services to build distance courses – 24,6%, collaboration tools for project activity – 23,4%, mathematical services – 22,8%, mind maps – 19,8% (see Figure 16).

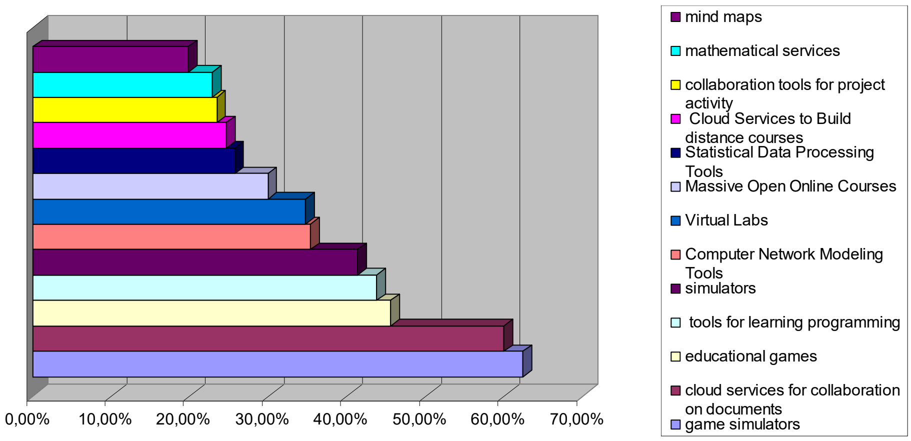

Fig. 16. Percentage of respondents' answers to question # 17

3 Conclusion

As a result of the research, the introduction of the discipline "Educational technologies and digital education" into the training of future information technology specialists was substantiated [45], and the certification program "Information systems and cloud technologies in the educational process" was developed [47], which is aimed at teachers of general schools, teachers of HEI, specialists in the field of additional educational services, and other specialists.

Certified educational program "Information Systems and Cloud Technologies in the Educational Process" aims at forming knowledge about the peculiarities of using information systems and cloud technologies in the educational process of educational institutions, forming the ability to plan, develop courses at the methodological and information-technical levels using modern information systems and cloud technologies, to organize various forms of higher education by applying modern information systems and cloud technologies.

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Application of augmented reality technologies for education projects preparation

Anna V. Iatsyshyn[1,5][0000-0001-8011-5956], Valeriia O. Kovach[2,3][0000-0002-1014-8979], Volodymyr O. Lyubchak[4][0000-0002-7335-6716], Yurii O. Zuban[4][0000-0002-6596-894X], Andriy G. Piven[4][0000-0002-0317-7966], Oleksandra M. Sokolyuk[1][0000-0002-5963-760X], Andrii V. Iatsyshyn[1,5,6][0000-0001-5508-7017], Oleksandr O. Popov[3,5,6][0000-0002-5065-3822], Volodymyr O. Artemchuk[6][0000-0001-8819-4564] and Mariya P. Shyshkina[1][0000-0001-5569-2700]

[1] Institute of Information Technologies and Learning Tools of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine
[2] National Aviation University, 1 Cosmonaut Komarov Ave., Kyiv, 03058, Ukraine
[3] Interregional Academy of Personnel Management, 2 Frometivska Str., Kyiv, 03039, Ukraine
[4] Sumy State University, 2, Rymskogo-Korsakova Str., Sumy, 40007, Ukraine
[5] Institute of Environmental Geochemistry of the NAS of Ukraine, 34a Palladin Ave., Kyiv, 03680, Ukraine
[6] Pukhov Institute for Modelling in Energy Engineering of the NAS of Ukraine, 15 General Naumova Str., Kyiv, 03164, Ukraine
anna13.00.10@gmail.com

Abstract. After analysis of scientific literature, we defined that concept of “augmented reality” has following synonyms: “advanced reality”, “improved reality”, “enriched reality”, “mixed reality” and “hybrid reality”. Analysis of scientific literature and own practical experience of the use of augmented reality technologies application in educational practices allowed to state next: augmented reality technologies have a great potential for application in education; there are some cases of augmented reality use for school education; positive aspects of augmented reality technologies application in higher education institutions are confirmed by experiments (isolated cases); only few universities in Ukraine apply augmented reality technologies to educate students; only few universities in Ukraine have special subjects or modules in schedule to teach students to develop augmented reality technologies; various scientific events, mass events, competitions are held in Ukraine, and specialized training on the augmentation of augmented reality technologies is carried out, but this is non-systematic and does not have special state orientation and support. Features of introduction of virtual and augmented reality technologies at Sumy State University (Ukraine) are identified: “e-learning ecosystems” was created; in 2019, augmented and virtual reality research laboratory was established. Advantages and disadvantages of project activity in education are described: project activity is one of the most important components of educational process; it promotes creative self-development and self-realization of project implementers and forms various life competencies. It is determined that augmented reality application for implementation of educational projects will help: to increase students’ interest for educational material; formation of new competences; increase of students' motivation for independent educational and cognitive activity; activation of educational activities; formation of positive motivation for personal and professional growth; conditions creation for development of personal qualities (creativity, teamwork, etc.). Current trends in implementation of educational projects were identified: most of the winner projects were implemented using augmented reality technology; augmented reality technologies were used in projects to teach different disciplines in higher education institutions. Augmented reality technology application for project activity has positive impact on learning outcomes and competitiveness of the national workforce; it will enhance the country's position in the global economic space.

Keywords: augmented reality, project activity, method of educational projects, preparation of students, preparation of postgraduate students, institutions of higher education.

1 Introduction

1.1 The problem statement

Increasing digitalization of society cannot bypass sphere of education. It actualizes research of opportunities and prospects for use of digital technologies in higher and secondary schools. Didactic capabilities of modern digital technologies and their application in education is one of the topical areas of scientific research. Augmented reality (AR) technology application in educational practices is now promising [75]. We agree with the paper [10] that virtual (VR) and AR technologies occupy an important place in new stage of innovative development of society (it is called Industry 4.0). These technologies have both common and distinctive features, which are reflected in specifics of their application by companies in the process of relevant products creation. VR and AR technologies include creation of themed visual content that can be used by target audience to meet specific needs with modern electronic devices. The presented technologies are implemented in production processes, in marketing companies [40], in medical sphere, in educational processes, etc. [10]. Users have the opportunity to receive additional product information that is presented as animated 3D models, videos, graphics, audio content, or text messages using AR.

One of the directions of modern state policy of Ukraine in the field of education is infrastructure improvement of information educational space. Necessary condition and priority for development of education system in Ukraine is its digitization. It is important to create appropriate IT resources for higher education institutions (HEIs) [71]. AR technologies have significant potential for implementation in educational process of Ukraine, since visualization of teaching materials during classes allows to increase level of communication with students, enhance their activity and promotes better material learning. There is an urgent need for comprehensive study of possibilities available for introduction of AR technologies for teaching in the HEIs of Ukraine [10].

Modern students are focused on global trends, which is why educational institutions in Ukraine need to address issue of innovation in educational process. It is advisable to adapt advanced teaching methods and techniques to specificities of the country. It will stimulate student activity during their studies and motivate them to self-study which will eventually contribute to raising level of national higher education. Main problems of modern education in the universities of Ukraine are following:

- low level of student interest. Presence of the Internet in combination with large assortment of gadgets, psychological features and value system of modern youth require bringing educational process in a methodological, technical and pedagogical direction in accordance with modern realities;
- insufficient level of provision of modern methodological materials and technical means;
- level of lecturers' qualifications. It is necessary to increase number of specialized professional development programs to increase the level of knowledge of lecturers. Also, lecturers should be involved in cooperation with public and private companies and international organizations in the framework of grant programs;
- impossibility of all real processes realization in educational audiences. Practical implementation of certain processes during practical training is impossible because of their considerable cost, considerable time investment or health hazard [10].

AR technology is one of the effective tools that will help solve outlined above problems. It does not require significant financial resources to be introduced into educational process in higher education. A lot of training materials and video tutorials can be used to learn technology. There are AR constructors that can be used to create necessary visualizations over a short period of time. Presence of smartphones and tablets in most students makes it easy to learn using AR technology [10].

New evolutionary stage of society is called technological. It is important to train specialists who will be competitive and able to quickly master professions of the future. We believe that the use of digital technologies, in particular VR and AR, is important in preparing new technology professionals. Therefore, it is important to encourage HEI teachers to develop their own digital competence [44] and to use digital technologies in training, in particular AR technologies.

1.2 Literature review

Application of information and communication technologies (ICT) for various industries is a relevant topic of researches [18; 32; 77; 78; 81]. Various aspects of AR technologies application were explored in publications [2; 3; 13; 14; 16; 21; 22; 24; 27; 34; 41; 47; 48; 51; 56; 57; 58; 59; 61; 65; 67; 68; 80]. Preparation of students and teaching of students using digital technologies were subject of research [6; 8; 20; 17; 22; 28; 35; 42; 43; 50; 64; 66; 71; 72]. It remains important topic for further scientific research. There is an important desire to meet educational purposes needs of society which does not require large financial costs and do not harm the environment [19; 45; 46; 53; 54; 52; 63]. There is a need to continue research of AR technologies application to train specialists in various specialties. At present, application of AR technology is modern trend, and therefore research in this area is relevant and timely.

1.3 The aim of the research

Research aim is to analyze features of augmented reality technologies for preparation of educational projects.

2 Research results

2.1 Analysis of main terms and definitions

Let's consider and analyze basic terms and concepts of this research, namely "augmented reality", "project method", "design", "educational project" and others.

The work [31] defines concept of "augmented reality" as group of technologies that allow to supplement real-world images with different objects of virtual environment. VR provides fully artificial synthesized world (video series) while AR involves the integration of virtual objects into natural video scenes.

Internet sources also state that AR is a term referred to all projects aimed to augment reality with any virtual element. AR is considered as a component of mixed reality, which also includes "augmented virtuality" (when real objects are integrated into virtual environment). There are different interpretations of this term, particularly researcher Ronald T. Azuma defined AR as a system that: combines virtual and real, interacts in real time, works in 3D [4].

In [39] AR is described as a kind of virtual environment. Unlike virtual reality AR allows user to see the real world with virtual objects added to real world. Therefore, AR complements reality not completely replaces it.

Authors of [23] define concept of AR as technology that allows to combine layer of virtual reality with physical environment in real time with a computer to face 3D world. This technology is necessary for the visualization of objects or the visual augmentation of printed matter – newspapers, booklets, magazines, maps and more. Supplementary information can be in form of text, images, videos, sounds, three-dimensional objects. Labels are scanned by special browsers of tablets or smartphones to get augmented content.

The publication [14] describes that concept of AR was introduced in 1992 by Tom Caudell, who collaborated with engineers of the Boeing Corporation over a simple headset. It assisted aircraft engineers in complex wiring diagrams. Purpose of AR is to reduce costs and improve efficiency in many human-aircraft operations. Terms "advanced reality", "improved reality", "enriched reality" are used as synonyms for AR. In recent years AR technology was often used. AR-based applications developed by various companies becomes popular in marketing, medicine, aviation, tourism, design, shopping and gaming. All you need is a smartphone (or another device connected to the Internet). Some classification of AR technologies for training are: AR applications; AR cubes; AR magazines; AR books; AR tutorials; AR textbooks; 3D coloring; maps, globes with AR, etc.

Blurring of terminological boundaries is showed in the work [11]. Therefore, such concepts as "mixed reality", "hybrid reality", "virtual reality with immersive VR", "programmed reality" are often synonymous. It indicates need for further theoretical study of AR technology application. Also it proves practical importance of these technologies, as it is predicted that significant growth in revenues from the use of AR in various sectors of the economy. Implementation of AR technology required to improve user interface of 3D rendering using hardware and software. Computer-aided real-time digital data is added to observable reality to supplement our knowledge of our environment [11].

The term "project" is borrowed from Latin. It means "thrown forward". "Project" means intention that will be implemented in future. It is an idea, idea, image, purposeful change of certain systems with established requirements for quality of results, costs of means and resources. "Project" is embodied in the form of description, justification, calculations, drawings that reveal essence of concept and possibility of its practical realization. Modern understanding of "project" concept is considered as a complete cycle of productive (innovative) activity: as activities of an individual, group, organization, region or country as a whole, or group of countries (international projects). There is a separate area of knowledge – project management [15; 38].

The publication [38] states that basis of project method is idea which reflects essence of "project" concept and its pragmatic focus on result that can be obtained when solving a particular problem. Project method is related to direct activity of its implementation - design. "Design" is understood as a purposeful activity that involves finding ways to solve problems and make changes in the environment.

Design in competence-oriented education is didactic mean of creation of certain prerequisites for development of key competencies (social, information, digital, communication, etc.) and student's independence in achieving new one, stimulating its natural curiosity and creative potential. Educational design involves clear statement of purpose – result of student solving a particular problem. Efficient mastery of students' basic life and professionally-oriented competences will be more successful if they ensure transition from search to step-by-step validation of received information and implementation of main goal of project. Project provides an opportunity to interest future specialist not only in specific subject of study, but to large extent process of mastering knowledge [38].

2.2 Experience of AR technologies application in domestic and foreign practices

We consider it expedient to analyze existing experience of AR technologies application in foreign and Ukrainian educational practices, as well as scientific publications on this issue in order to further implement the best results in the work of the HEIs and activities of scientific institutions of Ukraine.

The team of authors [3] analyzed scientific publications and revealed major trends in recent years regarding AR application in educational goals. The analysis revealed that the most common keywords in the articles are mobile learning and e-learning. The most used words in the abstracts of the articles were: education, knowledge, scientific education, experiment and efficiency. The most cited journals are Computers & Education, Journal of Science Education & Technology, Educational Technology and Society, Computers in Human Behavior, and British Journal of Educational

Technology. These are the most famous journals on use of different technologies in education. Mobile markers and paper-based applications were found to be the most convenient type of AR materials, as they can be easily and practically developed and easy to use.

The work [21] reviewed literature on AR technology application to support education and science. Following conclusions were made: most AR applications for STEM training offer research simulation activities; programs under consideration offered number of similar functions; most studies evaluated effect of AR technology on student learning outcomes; little research with recommendations for assisting students in learning with AR [21].

AR application in training games was conducted at the Massachusetts Institute of Technology in 2006 and 2007 is described in publications [25; 60].

In a collective study [68] historical and technological analysis of experience of AR tools application for development of interactive educational materials was carried out. Software for designing of AR educational tools was characterized. Technological requirements for optional "Development of virtual and augmented reality software" were determined and separate components of educational methodological complex for designing VR and AR systems for future computer science teachers were developed.

We agree with the publication [10] that AR technology has significant potential for implementation, in particular in educational process. Visualization of teaching materials during the classes allows to increase level of communication with students, enhance their activity and promotes better learning of the material [30]. At present, there is a need for comprehensive study of possibilities available for introduction of AR technologies for teaching in the HEIs of Ukraine.

The work [61] emphasizes that one of conditions for successful scientific and pedagogical work is exchange of methodological materials, including AR application. This publication analyzes approaches to systematization of methodological materials using AR. It is suggested to use STEMUA platform to organize them. Teachers, lecturers, and methodologists are encouraged to add their developments and teaching materials using AR to the STEMUA platform.

Impact of teaching materials (developed with AR technology) on achievement of high school students was investigated in [58], and attitude of students to AR technologies was determined. Results of pedagogical experiment are described, where students were divided into experimental and control groups. The experimental group completed the "Solar System and Beyond" module of their training course using AR technology, while the control group completed the same module using traditional methods and textbooks. It was determined that the students in the experimental group had higher level of achievements and more positive attitude towards the course than in the control group; the students were pleased and wanted to continue using AR applications in the future.

Also, the teaching of students using AR technology is described in [14]. It is noted that in study of biology, anatomy, chemistry, astronomy, and integrated in the study of other subjects you can use AR-applications such as "Animals 4D", "Anatomy 4D +", "Planets 4D", "Elements 4D +", and more. Ukrainian encyclopedias AR IEXPLORE familiarize students with magical world of animals, insects, beetles, dinosaurs. It brings animal world from the pages of the book into our reality. Also the author [14] proposed classification of AR technologies for teaching and provides examples of AR-cards, encyclopedias, fiction and textbooks, tutorials, coloring books that describe AR technology application for education in schools [13] analyzed impact of AR technologies on learning environment and the results of student assessment.

Prospects of AR application as a component of the cloud environment are discussed in [51]. There is experience in using AR tools in cloud technologies. Involvement of AR technologies for education requires development of new methodologies, didactic materials, and curriculum updates. Main features of AR application in educational process are described: design of flexible environment; correction of educational content for assimilation of material stipulated by curriculum; development of research methods that can be used in training with the elements of AR; development of adaptive materials, etc.

Theoretical substantiation of AR technology application and its features in technical universities is described in [16]. It is suggested to use AR objects during laboratory practical work on physics. It is determined that introduction of AR technology into educational process at technical universities increases efficiency of learning, promotes learning and cognitive activity of students, improves quality of learning, provokes interest to subject, promotes research skills and competencies of the future specialist.

Features of AR technologies application in higher education are described in [59]. Some students have difficulty understanding of mechanical systems, starting with two-dimensional design plan. Therefore, real system manipulations related to different perceptions were implemented, especially for students who do not have technological skills. AR can answer difficulty of establishing a connection between imagination and real system. Since AR technology is not yet fully used in mechanics of mechanical design, an assessment was made and relevance of AR technology application was determined to facilitate understanding of different mechanisms creation. AR script is implemented on electromechanical mechanism. It makes possible to identify components and their location, to study mechanism and to make it easier to identify, for example, kinematic circuit or flow of transmit power. Two different interfaces were used by students (tablet and HoloLens glasses), each with its own advantages. Also a pedagogical experiment is described. It was conducted with students of technical specialties. The results of the experiment showed that students using AR technologies had better learning outcomes [59].

Digital transformation of society led to the need for future professionals with ability to quickly adapt to changing activities, apply digital technologies and constantly increase their competency in order to be competitive. We support statement in [65] that different technologies can be used to support employees in different industries. Also, this paper explores potential of AR as an innovative learning environment that can be applied in variety of cases. The research outlined teaching and learning goals that can be achieved through AR technology application in learning [65].

The researchers [49] emphasized that the availability and convenience of technical devices used by students is very important during distance education, and degree of their involvement in educational process and its effectiveness depends on it. Interactive technologies that can be used in educational process include: computers, mobile devices (smartphones, tablets), electronic devices (smart watches, fitness bracelets, etc.), VR and AR devices (HMD).

The preparation of future IT teachers for use of AR systems is described in the study [68]. The authors noted that it is advisable to use an integrated approach in professional training of future IT teachers to use AR systems for development of interactive teaching materials. Common use of "Unity" for visual design, "Visual Studio" or virtual (Google VR or similar) and augmented (Vuforia or similar) platforms is advisable. Content of optional course "Development of virtual and augmented reality software" for future computer science teachers consists of two content modules: "Development of virtual reality software" and "Development of augmented reality software" [68].

AR technology can be used for both leisure and professional activity. It helps to navigate in unfamiliar places and sometimes unknowingly change our appearance. AR technology makes possible to project digital information (images, videos, text, graphics) beyond screens of devices and integrate virtual objects with the real world. Device's processor, screen, and camera [62] will be used to combine virtual objects and elements with real objects.

Following means can be used for implementation of AR technology in educational process: 1) Textbooks and manuals that contain specialized objects with AR technology. With specialized mobile applications, printed illustrations are transformed into 3D animated objects that can perform certain movements and be accompanied by sound information; 2) Educational games. Best practice shows that in many cases information provided in the form of interactive games is positively perceived by students. It activates motivation to participate in the process and promotes the development of learning materials; 3) Modeling of objects and situations. Creating graphic objects and constructing certain situations that can be used to learn material saves considerable material and financial resources; 4) Skills training applications. During teaching of different disciplines it is possible to create content in AR format that can be used as a tool to acquire certain professional skills. It can be used by students to independently work out specific practical tasks outside the school [10].

Creation of specialized applications for the disciplines in order to modernize the educational process in HEI is advisable. It will represent training complexes by 3D stereoscopy. There is a need to develop educational and methodological complexes of disciplines using AR technology. It will raise quality of education to new level [10].

We agree with the paper [2] that in modern conditions, smart technologies should be one of the main topics of scientific research. AR technologies can be useful tools to help modernize higher education. Advantages of AR technology application in universities of Saudi Arabia in terms of its economic and environmental component are analyzed. It was identified that Saudi staff believe that AR application in higher education has positive environmental and economic benefits [2].

Algorithm of AR technology is described in [37]. It means that camcorder of mobile device reads image containing tags (markers) and transmits video signal to the computer (smartphone, tablet). Special program processes the received signal (recognizes markers) and overlays virtual object on the screen of real object. Texts, sitelinks, photos, three-dimensional elements, sounds, videos can be used as virtual objects. The most common ARs are QR codes, AR browsers, auras. All of these technologies have the following characteristics: they complement real world with virtual elements; add-on happens in real time; complement must occur in three-dimensional space [37].

AR technology allows you to augment the real world with certain virtual objects that require users to use one of the electronic devices with screen, camera and specialized software to view relevant content. AR-based interactive visualizations can be placed on the walls of any building exterior and interior. You can also use VR glasses, special helmets, hologram technologies (such as Google’s Magic Leap) for AR rendering. [10].

The author [14] describes various examples of AR applications. After downloading the “New Horizon AR +” program students required to point cursor to correct part of page in book and watch videos where characters speak English in different topics of life. “Livit Studios” company specializes in the development of VR and AR software and also develops books on AR and full-featured applications in various functions (visualization, animated 3D models and animated characters, audio and interactive 3D games). For example, there is a book on human body with AR. There you can explore all the organs and functions of the body with help of interactive objects AR [14]. Indeed, such a book can be useful for children and adults.

In the work [20] we briefly describe examples of AR application in various fields: social communication, leisure and games; education; sphere of tourism; sphere of purchase/sale and presentation. We agree that rapid development of AR and VR technologies and expansion of their scope led to demand for highly skilled professionals in the field. A number of studies began on development of AR technologies. However, it is important to increase competencies of teachers and to educate students to develop and apply AR technologies in various public sectors. It is also important to share best practices in this field and to prepare educational and methodological materials for HEI based on world best practices [20].

AR mobile applications designed for education use two main scenarios of user interaction with the environment: 1) using label attached to virtual object; 2) with layer of virtual objects over entire frame space of external camera of device. Classifications regarding use of AR in the educational field are given in foreign sources [76]. The authors refer to the following types: books with AR technology that form a bridge between the physical and digital worlds; educational games; educational programs; object modeling; skills training apps. Analyzing use of AR technology in education the researchers noted such positive characteristics as [36]: interactivity, ease of use, use of surprise effect and student motivation.

However, there are some limitations related to technical issues on AR technology application [79]. Lack of single methodology is important problem: AR technologies are developed so rapidly that research in education and pedagogy simply does not have time to provide theoretical understanding or develop a systematic methodology [7]. It also requires integration of applications into educational process. AR is interactive interactivity but it is not possible to establish student feedback that is necessary to control the acquisition of knowledge and skills. AR technology application also requires considerable resources and special training for teaching and research staff.

2.3 Features of implementation of virtual and augmented reality technologies at Sumy State University (Ukraine)

Information system of modern HEI is an integrated information system based on totality of subsystems providing basic types of HEI activities. Interaction of all subsystems at different levels of the hierarchy is clearly constructed in accordance with the methodology of organizing the university's business processes due to its structured architecture and multi-level integration. Organizing methodology of each business process in an integrated information system is determined by ultimate goal - to ensure quality of the university's educational activities. Operation of each of the subsystems is based on their own technological, software and technical solutions, which ensure the stable operation of the system as a whole [71].

Granted projects and research contracts provide access to up-to-date software. For example, access to mobile portal software development under the TEMPUS INURE project, DELCAM and LabView engineering products under TEMPUS ENGITEC, access to Unity Technologies (VR and AR) software [71].

Sumy State University develops technical and informational resources, regulatory framework to implement a model of multidisciplinary innovation-oriented university. This model provides harmonization of educational, research and active international activities, the generation and transfer of knowledge in business, socially significant projects, etc. [69]. The management of the university is determined to form such scientific and educational environment where scientific achievements of the university's scientists would significantly affect content of educational process and all spheres of activity. It is done with aim to continue taking a university model that adheres to ideology of research-type educational institution which has an inherent unity of scientific and educational processes and "portrait" of graduate who is able to perceive and implement innovation, to work in a multifunctional IT environment. In order to intensify student's scientific activity and deepen its interaction with the educational process the Target Comprehensive Program "Organization of Student Scientific Work in Organic Combination with the Educational Process" was created.

The university pays great attention to motivation system of students and teachers for engaging in scientific activities. System of internal grants was introduced, the competition for which is held annually to increase the level of interest in research activities. Main tasks of introducing grants for undergraduate and graduate students are:

- promotion and involvement of student youth in scientific and innovative activity;
- achievement of scientific result and/or creation of scientific and technical products, which will have continuation in preparation of commercial proposals for implementation of grant projects, creation of start-ups, etc.;
- acquisition of skills of preparation of scientific grant projects by students and graduate students;
- stimulation of scientific researches of students and graduate students;
- support and development of activity of student scientific associations (laboratories, centers);
- financial support for research and applied development of undergraduate and graduate students;

- identifying undergraduate and graduate students who are capable to deliver innovative developments that are commercially attractive, in particular on an outsourced basis [69].

Grants for undergraduate and graduate students are funded by funds determined by the University's Academic Council. Procedure for competitive selection of projects for grants is open and all information is published on the University's websites. Ability to find reliable information, critically analyze, create and disseminate own intellectual product is key competency of successful specialist. Comfortable information environment was formed at the university. It contributes to development of information and digital competences and introduction of innovations.

The university created an "online learning ecosystem" based on software that automates most of the university's business processes, including support of online training courses for various categories of learners (students, teachers), creation and management of electronic content, project management, quality assurance of training materials and the learning process. Basic idea of the developed software of the university is to create maximum number of multipurpose components. This has following advantages: 1) it is easy to launch service that offers different ways of learning: from mass open online courses to corporate online learning; 2) online content can be easily converted from HTML/JS learning objects to modern AR/VR elements. This technological solution allows the university to significantly reduce cost of study compared to individual implementation of each local learning task. Benefits of coherent solution include complete control of all inputs/outputs, easy integration of learning outcomes from one learning method (for example, through open online courses) [12].

Developed own methodical model of online courses promotes high level of interactivity of educational content, in particular on widespread use of virtual simulators. Our own technological solutions to optimize work on creation of interactive learning content allowed to create more than 2,000 virtual simulators based on Java, JS, Flash, Unity3D (including using VR and AR). In 2019 the University established VR and AR research laboratory. It is part of the online learning ecosystem and allows us to reach a new level of VR/AR application in education in future [12].

The University's ecosystem development plan envisages complete transition of university's educational process to E-learning technology, active introduction of blended learning models, use of VR and AR for learning, development of its own VR online course concept, increase and active dissemination of non-academic, online courses transferring results to academic disciplines [12].

Digitalization of society requires universities to consistently develop and implement modern ICT trends, to demonstrate ability to solve digital transformation problems, enabling them to significantly enhance competitiveness, attract additional resources, including upgrading their facilities, and improving the quality of education. Important trends in education are: use of cloud technologies, access to virtual computing systems, business analytics and Internet of Things, virtual laboratories, AR technologies and more [69].

Nowadays, the university's educational process uses unique technical equipment obtained through active international cooperation: biomedical engineering laboratory, modal analysis complex, multispiral tomography, electron microscopes, 3D printers, etc. The university's potential makes possible to make more intensive use of modern technologies and solutions, for example, not to be limited to support and development of traditional resources (computers, software, equipment, etc.), but also to implement virtual laboratory complexes, access to remote laboratories and educational and scientific activities [69].

At the university AR technologies are actively introduced into the courses "Essential Geometry", "Engineering Graphics", "Computer Graphics in Mechanical Engineering" and when studying other disciplines and for training in various specialties.

The staff and students of the university are involved in processes of IT development, since the university is a member of the Association of Industrial Automation Enterprises of Ukraine. In 2019 a Memorandum of Understanding was signed on establishment of Industry 4.0 Center at the University with the support of the Sumy City Council. Process of Industry 4.0 is primarily understood as complete automation of Ukraine's production with introduction of cutting-edge digital technologies: artificial intelligence, Internet of Things, robotics, AR. Such innovative transformation is needed to improve business models, accelerate state development, enhance scientific capacity and provide skilled creative workplaces with training at the university. First results of such cooperation are: 3D Innovation Group of the University became a member of the Fablab international network and is marked on its world map [1]. Currently, there are only 10 such centers in Ukraine [33].

Also, the university pays great attention to continuous professional development of scientific and pedagogical staff. Number of competitions was introduced to encourage teachers to study and apply modern technologies and teaching methods, to ensure quality of higher education, to disseminate better experiences. These are competitions: pedagogical innovations; "The best teacher by eyes of students"; for the best collection of educational materials published on OpenCourseWare; to choose content of mass open online courses; ICT Innovation for Contemporary Education ICT4EDU [55] by nomination: "Mobile Devices in the Learning Process", "Access to Remote Equipment and Virtual Laboratories", "Introduction of Artificial Intelligence Technologies into the Learning Process", "Developing Learning Resources Using VR and AR Technologie"; experiment on testing of blended learning model. Cumulative system of accounting for basic professional development results was developed and implemented in order to obtain competencies required for modern-day teachers. It enables to determine personalized indicators, including participation of employees in international internships, formalized certification programs, trainings, workshops and other types of professional development [69].

2.4 Project activity in education: advantages and drawbacks

Scientists define project activity as one of the most important components of educational process. It promotes creative self-development and self-realization of project implementers and forms various life competencies. Project technology combines theoretical knowledge and practical application to solve specific life or professional problems.

Project technologies are derived from the "project method" that emerged in the 1920s in the United States. Initially, it was called the "method of problems" and it was developed within humanistic direction in philosophy and education. William H. Kilpatrick called project organization a way of working with students [26]. Project at time meant purposeful act of activity based on the student's interest. Then first classification of projects was proposed (created projects, consumer projects, problem solving projects, exercise projects), as well as the main stages of the project [29].

In Ukraine theoretical and methodological principles of project application were laid by Hryhorii H. Vashchenko [70]. A prominent Ukrainian educator attributed project method to active teaching methods, characterized by "practical bias of learning and a connection with life". In course of project implementation one should pay attention to organic combination of theory and practice, since project task is not only to do some useful work but to broaden one's worldview, to acquire theoretical knowledge that enables one to understand better life [29].

Practical skills are formed in solving practical problems during the implementation of the project. There is a mastery of knowledge in the process of using information and assessing its importance and subsequent use. Project executor analyzes, performs certain actions, simultaneously learns techniques and methods of design and assesses its own experience in terms of readiness for life. Development of project thinking provides individuals with opportunity for sustainable development along their chosen trajectory of activity. Paradigm of project learning corresponds to personally oriented pedagogy: it is characterized by humanistic and psychotherapeutic orientation, aimed at the free, versatile and creative development of individual characteristics of cognition subject [73].

Educational project is one of the methods of educational project activity. The essence of educational project is to stimulate the students' interest in the problems, to find ways to solve them through project activity; provide opportunities for practical application of acquired knowledge and skills. It is assumed that during project implementation student must acquire some knowledge on the subject under study. Main characteristic of creative projects is that their content and structure depend on creativity and interests of the authors [73].

The publication [29] states that project method (project technology) gives each participant of educational process an opportunity to develop their own cognitive interests and ability to independently construct their knowledge, to navigate information space. Educational design is always focused on independent activity of students – individual, paired, group, which they perform for certain period of time. Design technology provides successful solution of problem. It involves use of variety of different methods and learning tools and need to integrate knowledge and skills from different fields of science, technology and creativity. Students have opportunity to generalize, consolidate and practically apply theoretical knowledge in disciplines and professional methods, to improve the skills of independent research activity [29] during creation of teaching methodical project.

Project activity will be able to play leading role in the formation of positive motivation for personal and professional growth, readiness to find new, original methods of solving professional problems in students in process of their professional formation in higher education. Designing, as a special type of activity, is characterized by ability and willingness of person to predict certain professionally-oriented tasks and to search necessary tools for their complete and speedy solution [38].

During project activity students acquire following skills: reflexive (task comprehension), research (ability to generate ideas independently, independently search for information, propose their own hypothesis, establish cause and effect relationships); managerial (ability to plan activities, time, resources; ability to make decisions, predict consequences); communicative (ability to engage in dialogue, discussion, defense of one's point of view, etc.); presentation (monologue, public speaking, artistic skills, etc.); self and mutual evaluation (adequate assessment of their work and those of other students); cooperation skills (collective planning of group work, interaction with various group members, mutual assistance, business partner communication skills, etc.) [29].

Decisive role in modern educational process is played by student ability to use information for realization of their tasks and goals. Analysis of theoretical and practical achievements makes possible to state that project is a special form of educational philosophy, which allows combining values and content foundations of culture and process of activity socialization. Designing is complex activity that characterized by: features of auto-didactics (participants of design seem to automatically learn without specific didactic task from organizers, new concepts, new ideas about different spheres of life, industrial, personal, socio-political relations between people, new understanding of content those changes that life requires); designing fundamentally different subjective rather than objective form of participation of each person in social activity; adoption of design as specific individual-creative process which requires each of original new decisions [38].

Rapid spread of computer technology led to dramatic changes affecting learning process itself. There is a widening gap between level of knowledge of those who have access to modern information technologies and those who do not have such access. There are changes in pedagogy as result of emergence of new technologies. Expansion of curricula is caused by technological changes. They have a direct impact on learning culture. Their competitiveness and activities of higher education institution as a whole is criterion that determines the quality of graduates' training in today's economic realities [12].

The publication [82] proposed to use special software "Salamstein Studio" to perform project activities (it was designed for developers of distance training courses, graduate students and doctoral students). Salamstein Studio's Project Management tools provide: implementation management of work set on planning, development and verification of training facilities; ability to monitor status of tasks; communication between all participants. Each started task in Studio has responsible executor and status that captures status of its completion. Status of the task and its responsible executor are changed automatically after each type of work at different stages of learning object development. Assignment status changes from "not started" to "completed" sequentially in absence of any comments from the Project participants. If necessary, the status of task may be repeatedly returned to previous stage. Moderator and Programmer are usually involved as part of the development of interactive practical tasks. Work on these objects actually goes through two stages: developing of script and creating of software product based on it. Certain quantitative characteristics are used to manage and analyze the Project. Status of the task is determined in percentage and depends on the status of the task and the type of educational object [82].

Based on Ruby on Rails framework, Salamstein Studio is a module of the automated distance learning system of Sumy State University. It implements project approach to organize process of development of distance learning courses. Project at Salamstein Studio is set of all tasks for development of distance learning training objects. It requires certain sequence of work stages and corresponding performers. It provides monitoring of task performance by all project participants in automated mode. The authors of the Project are teacher, group of teachers, graduate students, doctoral students responsible for development of distance courses. Project Expert is selected from the most experienced teachers in the automated distance learning system. This person controls observance of Methodological requirements for distance learning courses. There are following participants in addition to the listed above: the Programmer provides software implementation of interactive learning objects, the Moderator performs complex structural and functional verification of distance learning materials, and the Tutor coordinates the students' educational process relevant direction. They are involved at different stages of the development of distance courses. training [82].

Introduction of AR technology into education is in its beginning. Taking into account prospects for their development, it is necessary to study and analyze experience of their application and to find opportunities to integrate them into educational practice, for example, through the project activities of students.

Information projects involve collection, analysis and formulation of conclusions about information and object under study. This type of project does not involve experimental work. It can be widely used in high school chemistry or physics, especially for 7th grade pupils. At this time pupils deal with science of chemistry, methods of handling chemical equipment, methods of conducting the simplest chemical experiments. Finding of additional information, analyzing it and being able to interpret it from a chemical scientific point of view, drawing up own (correct) conclusions in the form of an abstract (indicating the purpose, tasks, results of work, conclusion), part of the information stand, booklet are serious work, especially for students with humanitarian inclinations. Research projects are as close as possible to scientific research. They include writing of scientific essay and presentation in form of a report or a poster defense. According to requirements of the Minor Academy of Sciences the experiment should be present in the pupils works starting from the 10th grade. It is said that tenth graders work under scientific guidance and chose chemistry or physics as a subject to study in future [73].

Currently, there are following existing curricula: "Physics and Astronomy", Curricula for 10-11 classes of general secondary education institutions (standard level, profile level), approved by Ministry of Education and Science of Ukraine (Order No. 1539 in 2017); "Natural Sciences" Integrated Course for 10-11 classes of general secondary education institutions, approved by Ministry of Education and Science of Ukraine (Order No. 1407 in 2017), "Physics" 7-9 Grades Curriculum for secondary education institutions, approved by Ministry of Education and Science of Ukraine

(Order No. 804 in 2017). These programs include implementation of educational projects in physics: “Nuclear energy” (section “Quantum physics”, class 11), “Physical foundations of atomic energy” (section “Physics of atom and atomic nucleus”, grade 9), “Energy” (section “Technology course” Integrated Course, Class 11). These include advantages and disadvantages of using nuclear energy, development of Ukraine’s nuclear energy, ways to ensure safety of nuclear reactors and nuclear power plants, the Chernobyl problem, effects of nuclear energy on the environment, protection against radioactive radiation, and more.

Application AR APP Chornobyl NPP ARCH AR [9] was officially launched in 2018. It can also be used for educational purposes (Fig. 1). According to the State Agency of Ukraine on Exclusion Zone Management this application helps to take closer look at the construction of the Arch and the Shelter object on a smartphone. You can look at the various details and get a real picture of the little things about the Shelter without risking human health. Its example is shown in fig. 1. It should be emphasized that in the such applications can be used to increase efficiency of emergency preparedness, response system and emergency situations on potentially hazardous sites. Such applications can be used to educate students in preparation of future specialists in the field of ecology and environmental protection. Also, new methods, algorithms and software need to be developed to address environmental security issues in areas of impact of potentially hazardous sites [5; 53; 54; 52; 63].

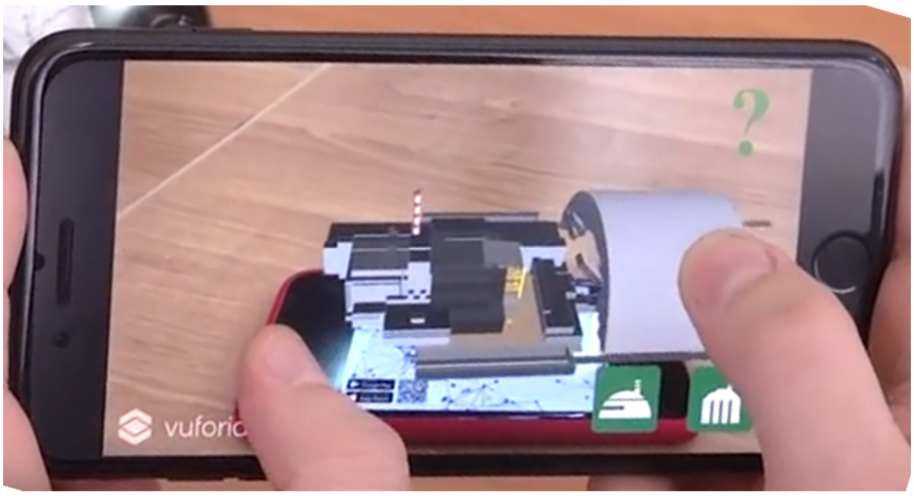

Fig. 1. Use example of application Chornobyl NPP ARCH AR

Results of educational and cognitive activity of students during implementation of educational projects on topic “Nuclear energy” should know: component knowledge (they know principle of nuclear reactor action, they know about impact of radioactive radiation on living organisms); activity component (they explain ionizing effect of radiation, use dosimeter (if available, use acquired knowledge for safe life); value component (aware of advantages, disadvantages and prospects of development of nuclear energy, possibility of using fusion energy, efficiency of methods of protection against the effects of radioactive radiation).

AR is one of the most advanced learning information visualization technologies. Application of this technology will increase motivation for learning, will increase level of assimilation of information due to variety and interactivity of its visual representation and will allow transferring of part of research work in the field of distance learning [14].

Digital transformation of society influences changes that need to be made in higher education system to train new generation professionals. Future professionals in addition to professional skills should also be: creative, adaptive, with critical thinking, independent in decision-making, focused, capable of professional growth and use of digital technology in a variety of professional situations. That is why it is important to use design technologies to train specialists in new technological era.

2.5 Project activity in education: advantages and drawbacks

Nowadays the University's work on innovation is aimed to ensure sustainable functioning of internal quality assurance system of education, development and implementation of unique organizations-methodological solutions, flexible information technologies, creation of various information services, target databases and access to them through personal offices, implementation of IT-projects both regionally and nationally. Global trend of universities in the world is to extend their lifelong learning services. One of the important issues facing higher education institutions today is transformed demand of modern students. Young people want to build their individual learning trajectory by choosing both academic and non-academic courses; both offline and online [12]. Therefore, teachers often use method of education projects for further interest students in the university. Advantages of this method were described above. Also, the university management constantly introduces innovations, conducts various competitions among teachers and students.

We describe experience of implementing educational projects at Sumy State University, where for several years "All-Ukrainian competition on use of mobile devices in educational process" is held. Description of competition: competition for development of the best training (lectures, practicals, etc.), provided by curriculum, using students' mobile devices (laptops, netbooks, tablets, smartphones). The competition is based on study of current trends in technology implementation and understanding of educational space transformation. It is based on experience of implementing BYOE (bring your own everything) and "flipped learning" technologies. The peculiarity of the Competition is need to confirm in practice their own projects, real cooperation between students and teachers. Contest nominations: "Efficient use of existing software" and "Creation and using of own software development". Specialized competition site was created and maintained for implementation of this competition [74]. Its main page is shown in Fig. 2.

The main page of the competition contains following information: About the contest; Evaluation criteria; Tender Commission; Apply; Consultations; Useful materials; Social Network and Sitemap. Information about the winners of the contest and photos is also available. For example, in 2018-2019, the first place in the nomination "Efficient use of existing software" held the project "Application of AR and VR technologies in the conditions of holding QR code of the quest for formation of English-speaking competence of future sailors" (the project implementation in practice is presented at https://tinyurl.com/ydef66jn). The nomination "Creation and using of own software development" was won by the project "Augmented reality – methodical tool for mathematics" (the project implementation in practice is presented at https://tinyurl.com/yavsrlte). Fig. 3 shows examples of use of AR technologies in competition works, and Fig. 4 – photos of winners and active participants of the competition 2016-2017.

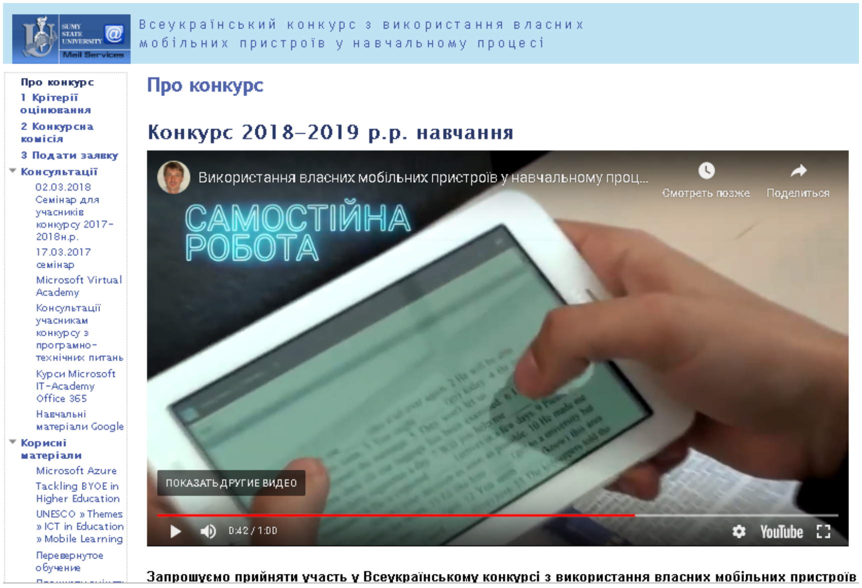

Fig. 2. Main page of the site "All-Ukrainian competition on the use of own mobile devices in the educational process" [74]

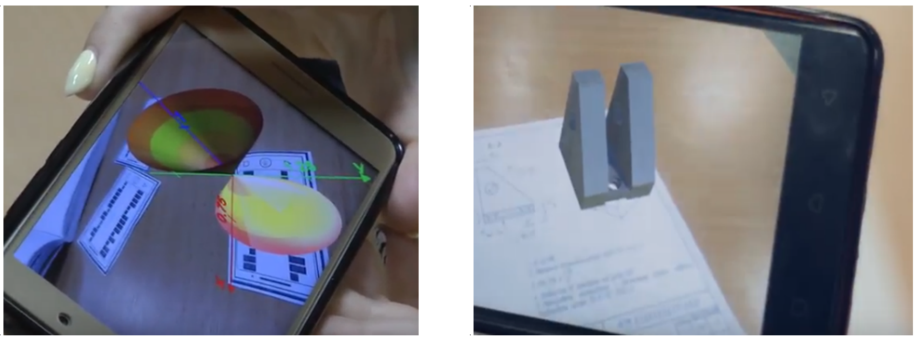

Fig. 3. Application of AR technologies application in the competition works

Fig. 4. Winners and active participants of the competition in 2016-2017

So, works with AR technologies were the best ones and won the competition. It happens because AR technology is a really up-to-date trend in educational projects.

3 Conclusions and prospects for further research

1. Basic terms and concepts are analyzed and determined: terms “advanced reality”, “improved reality”, “enriched reality”, “mixed reality” and “hybrid reality” are used as synonyms for “AR”; “AR” is term that refers to all projects aimed at augmenting physical reality with any virtual element.
2. Results of analysis of the scientific literature (Ukrainian and foreign) and our own practical experience of AR technologies application in educational practices allowed to state that: AR technologies have great potential in many application fields, in particular, for education; there are some difficulties with AR technologies application in educational institutions (financial, professional, methodological); there are some cases of AR application in schools; positive aspects of AR technologies application in higher education institutions are confirmed by experiments, however, these are isolated cases; only a few universities in Ukraine apply AR technology to educate students; only a few universities in Ukraine supplemented their curricula with special subjects or modules to educate students to develop AR technologies; various scientific events, mass events, competitions are held in Ukraine and specialized training is performed for promotion of AR technologies, but this is non-systematic and has no special state orientation and support.
3. Features of implementation of VR and AR technologies at Sumy State University (Ukraine) are identified: the “e-learning ecosystems” are created at the university. Its basis is software that automates most of the university’s business processes. These processes includes: support of online training courses for different categories of students (students, teachers); creation and management of electronic content, management procedures (project management, quality assurance training s materials and learning process). Advantages of the developed university software are following: 1) it is easy to run a service that offers different ways of learning: from mass open online courses to corporate online learning; 2) it is possible to convert

online content from standard HTML/JS training objects to modern AR/VR elements; 3) reducing the cost of training. Also in 2019 the University created VR and AR research laboratory. It is part of the online learning ecosystem.

4. Advantages and disadvantages of project activity in education are described: project activity is one of the most important components of educational process. It which promotes creative self-development and self-realization of project implementers and forms various life competencies. Project technology combines theoretical knowledge and practical application to solve specific life or professional problems. AR application for implementation of educational projects will help: to increase students' interest in learning material through interactive content; to form new competencies through augmented reality technology; to increase level of students' motivation for independent educational and cognitive activity through introduction of game, competitive incentives; to activate educational activities; to form positive motivation for personal and professional growth; to provide process of developing educational materials with a new organizational form that is attractive to students; to create conditions for development of personal qualities (creativity, teamwork, etc.). All listed above will increase students' self-esteem.
5. Current trends in implementation of educational projects were investigated and determined based on experience of Sumy State University. It is defined following: most of the projects that won the competition "All-Ukrainian competition on using mobile devices in the educational process" were implemented using AR technology; AR technologies used in projects to teach different disciplines for HEIs.

AR technology application for project activity has positive impact on learning outcomes and competitiveness of national workforce. It will enhance the country's position in the global economic space. It is important to carry out series of national and international events on promotion and application of AR technology – conferences, seminars, project competitions, etc.

Areas of further research can be: AR technology application in training of specialists of various specialties.

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Methodical aspects of preparation of educational content on the basis of distance education platforms

Alexander F. Tarasov[1[0000-0002-0493-1529]], Irina A. Getman[1[0000-0003-1835-4256]], Svetlana S. Turlakova[2[0000-0002-3954-8503]], Ihor I. Stashkevych[1[0000-0002-7411-9835]] and Serhiy M. Kozmenko[3[0000-0001-7710-4842]]

[1] Donbass State Engineering Academy,
39 Mashinobudivnykiv Blvd., Kramatorsk, 84313, Ukraine
alexandrtar50@gmail.com,{getman_irina, stashkevich_dgma}@ukr.net
[2] Institute of Industrial Economics of the NAS of Ukraine,
2 Marii Kapnist Str., Kyiv, 03057, Ukraine
svetlana.turlakova@gmail.com
[3] University of Social Science, 9 Sienkiewicza Str., 90-113 Łódź, Poland
serhiy@businessperspectives.org

Abstract. The urgency of application of technologies and means of distance learning in educational process of higher educational institutions is designated. The growing frequency of using cloud services and electronic textbooks in mobile and distance learning is noted. The importance of building educational environment is highlighted, where the key element is e-learning resources in digital form, including structure, subject content and metadata about the course. For higher educational institutions, the need for methodical support for the preparation of educational content on the basis of distance education platforms is determined. The experience of using the free distance education platform Moodle within the framework of the higher educational institution Donbass State Engineering Academy is considered. Methodical aspects of training content preparation on the basis of distance education platforms on the example of MoodleDDMA system are given. The General structure of the distance course and an example of evaluation of test tasks of the distance course (module) on topics are considered. An example of the presentation of the course on the basis of distance education platform MoodleDDMA is given. Conclusions about the experience of using the Moodle distance education system at the Donbass State Engineering Academy from the point of view of teachers and students are drawn. The perspective directions of researches and development of the Moodle distance education platform in completion and expansion of educational materials by multimedia elements and links, and also creation of the application for mobile devices for possibility of more effective use of the platform are allocated.

Keywords: educational content, electronic textbook, distance education, distance education platform, mobile learning, Moodle.

1 Introduction

Distance education as a form of education is now quite widespread in the training system. The introduction of distance learning in the educational process allows you to solve a number of problems facing higher education institutions. The priority among them can be attributed:

- ensuring equal access of young people to a full quality education in accordance with their interests and inclinations, regardless of the material wealth of the family, place of residence, nationality and health status;
- ensuring the flexibility of the education system, expressed in its organization, taking into account the individual schedule of classes of the student;
- ensuring the possibility of obtaining “lifelong education”;
- elimination of problems of regional higher education institutions consisting in supply of regions with qualified engineering personnel according to the changing strategy of development of the region.

That is why the use of technologies and means of distance learning in the educational process of higher educational institutions is reflected in the works of a large number of researchers.

2 Review

Active use of cloud data storage in distance education is becoming more and more common and even necessary. The use of cloud services and electronic textbooks in mobile and distance learning has been reflected in the works of many scientists. So, in [15] the directions of educational researches of cloud systems of training are studied. In [7] V. Ivashova, V. Goncharov, A. Erokhin, O. Kolosova, M. Migacheva and V. Berkovsky discuss the general problems of education in a digital society, including electronic educational environments of educational organizations.

In [4] Isaías González, Antonio José Calderón, João Figueiredo and João M. C. Sousa are presented an overview of the latest open communication platforms for various fields, research projects, education. In the analysis, the authors pay special attention to new paradigms related to the Internet of things, cyber-physical systems, Industry 4.0 and emphasize the need to take them into account in the work of such open systems.

In [6] Purwono Hendradi, M. Khanapi and Siti Nurul Mahfuzah Mohamad is considered the architecture of e-learning system based on cloud computing in Education 4.0. However, consideration of problems and errors used for virtual training systems remains not sufficiently open. In addition, there is an important question of the quality of electronic textbooks and the possibility of access to them from mobile devices both on the Internet and in specialized applications and distance education platforms, methodical aspects of the preparation of educational content on the basis of such platforms.

Continuous improvement of mobile devices and intensive development of cloud technologies and cloud computing has led to the emergence of a new direction of application of information technologies in education – mobile learning or m-learning, which is closely related to the concept of distance education. The main technical tools of such training are mobile Internet devices [12], such as tablet computers, smartphones, navigators, readers and other devices that provide work with information, i.e. devices that have IMEI (international identifier of mobile equipment, running on mobile operating system iOS, Android etc.), supporting work in mobile networks (preferably 3G and 4G generations) and Wi-Fi technology.

Meeting the above requirements for mobile devices and communication channels and allows you to implement information and educational environment of mobile learning based on cloud services. The advantage of such devices is that they always accompany modern man, have a small size and can be connected to the Internet almost anywhere in the world. From this perspective, mobile learning can be considered to be any learning activity that primarily or exclusively uses mobile devices and networking technologies, but not conventional desktop computers with installed software.

The success of such training for which the main factor is independent work depends on the development of the information educational environment, where the key element is e-learning resources in digital form, including structure, subject content, and metadata about them. Most often, electronic educational resources in mobile and distance learning are presented in the form of electronic courses, the principles of which are constantly changing [13]. Currently, there is an intensive tendency to replace closed courses with open ones, accessible not only to a certain circle of users, but also to all interested students. For higher educational institutions in such conditions, it is important to provide methodical support for the preparation of educational content on the basis of distance education platforms.

3 Discussion and results

There are many applications (most of which are web applications) available under an open source license for the development of e-courses. They also include platforms for creating interactive books or textbooks.

Integration of electronic textbooks and cloud services into the learning management system is one of the most important tasks in higher education institutions. Building a virtual learning system based on cloud services allows you to use new methods of managing educational content and organizing interaction with students. But for its high-quality use, it is also necessary to prepare high-quality electronic textbooks themselves.

Electronic textbook – (E-book) is a software and methodical training complex corresponding to the standard curriculum and providing the opportunity for the student to master the training course or its section independently or with the help of a teacher. This product is created with built-in structure, dictionaries, search`s capability. An electronic textbook is an information product of an educational nature, unlike a “paper” textbook in that it can be viewed only with the help of a computer. It can be designed for self-study of educational material in a particular discipline or to support a lecture course for its in-depth study.

E-books come in several types:

1. Full or partial copies of paper editions. As a rule, these copies are distributed not quite legally, because the authors of the publication wanted to sell a paper book, and did not plan to engage in charity. It is even difficult to imagine a person scanning a textbook on 800 sheets and placing it on the network for free, but there are such. Scanned textbooks, magazines and other literature can be found electronically on the Internet.
2. Free e-books and magazines. Most often, authors release them to create viral traffic. The essence of viral traffic is as follows: users download e-books, which have links to the author's website and advertising of the author. If users like the book, they give links to the book on forums, blogs, on their websites, and thus contribute to the distribution of the book. Thus, it turns out some flow of visitors to the author's website and response to advertising in the book. Examples of books for creating viral traffic can be downloaded from the link at the bottom of the article. This is usually a small volume of the book, though there are large. If you take the sellers of electronic books and manuals, they either make translations of books by foreign authors, or make collections of articles.
3. Paid e-books. Authors write them for the purpose of the subsequent sale. These are various manuals and guides, often in one way or another related to earnings. In terms of volume, books often fall short of paper editions, but can be much more informative [5].

E-books allow you to save time and get up-to-date information. In e-books, you can find more concentrated and useful information, in this case, the price will be justified. It would seem that the cost of an e-book may exceed the cost of paper books, but the paper counterpart you can simply not find, or find, but not quite what you need. E-books can be an important source of information. E-book has a number of fundamental differences from the textbook made by the typographic method: the possibility of multimedia; providing virtual reality; a high degree of interactivity; the possibility of an individual approach to the student. The introduction of multimedia elements into the structure of the electronic textbook allows simultaneous transmission of various types of information. This usually means a combination of text, sound, graphics, animation, and video. Many processes and objects in the electronic textbook can be represented in the dynamics of their development, as well as in the form of 2D or 3D models, which causes the user the illusion of reality of the objects depicted [9]. Interactivity allows you to establish feedback from the user of information (student) to its source (teacher). For interactive interaction is characterized by immediate response and visually confirmed reaction to the action, message [1].

Electronic textbook has certain advantages over traditional types of textbooks:

1. The study of the material may not be related to the time frame (schedule of classroom classes).
2. It can develop skills of independent work by students.
3. The structure of the textbook helps to establish control over the study of certain blocks of topics.

4. Electronic textbooks may have additional features compared to the paper version. One such possibility is the use of links to access the Internet. The teacher connects the PC to the network and can comment on certain Internet sites with literature.

Currently, the Internet is replete with offers of many electronic textbooks for universities. The teacher, before applying a particular textbook in the educational process, must understand the program of the subject and the textbook itself.

Electronic textbooks (ET) of the new generation should be focused on new teaching methods, especially distance learning, active knowledge of the world of students, increasing the role of independent work of students with information, filling the shortage of laboratory equipment in some universities. They should provide methodical support for the learning process, using the full range of multimedia capabilities of the ET to create new tools and forms of learning. The electronic textbook should meet the tasks of forming a new content of education and new models of educational activity using information and telecommunication technologies, models of formation and application of information and communication competence of students in educational activities, taking into account the variability and individualization of education.

The next generation of ET should include (as minimum) the following systems:

- the nucleus (the control module) course;
- illustrated educational and reference complex;
- complex of virtual laboratories and interactive models;
- testing complex integrated with the task database;
- search complex;
- help system;
- methodical support system;
- search system for similar information on the Internet.

The principles of mobile and distance learning using cloud services and electronic textbooks are increasingly being implemented in the practice of higher education by students. Thus, in the Donbass State Engineering Academy of the Ministry of Education and Science of Ukraine (DSEA, Kramatorsk), students have the opportunity to use the distance education platform Moodle (http://moodle.dgma.donetsk.ua/) have access to electronic textbooks and other teaching materials on the Internet, including on mobile devices. The choice of the Moodle system is justified by the fact that Moodle is open source software (under the GNU Public License). This means that Moodle is protected by copyright law, but users have ample opportunities to use it. Moodle can be installed on any computer on which a Web server that supports PHP is installed, as well as a SQL-type database (for example, MySQL). It can be started on Windows and Mac operating systems and many versions of Linux (such as Red Hat or Debian) [13]. Moodle has a large number of partners who works with Moodle and can help in working with it. Main features of Moodle: the system implements the philosophy of "Pedagogy of social constructionism" (cooperation, action, critical thinking, etc.); 100% suitable for the organization of online classes, as well as suitable for the organization of traditional learning; distance learning system Moodle is: simple, easy, effective, compatible with various products, making low requirements to the browser; the system is easily installed on most platforms that support PHP; the system requires only one database; the list of courses hosted in the Moodle distance learning system contains a description for each course; distance courses can be categorized; searchable by distance courses; special attention is paid to the high level of security of the system; most pages can be edited with the built-in editor [2; 3; 11; 14; 17].

The main advantage of Moodle distance learning system is the possibility of its free using. At the same time, the functionality of the distance learning system in the Moodle system is not inferior to commercial analogues. Another important advantage of the distance learning system Moodle is that it is distributed in open source, which allows you to adapt it to the specifics of the tasks that must be solved with its help. Distance learning tools built into the Moodle distance learning system reduce the cost of developing educational content and solve compatibility problems of distance learning courses [11; 15].

Methodical aspects of the preparation of educational content on the basis of the Moodle platform involve the development of specialized distance learning courses by higher education institutions. In the Donbass State Engineering Academy, appropriate plans for such courses are developed and approved at the departments. The structure and content of the distance course must meet the requirements that are put forward by the decision of the specialized Methodical Council of the Academy. Thus, the distance learning course should be considered as an information product developed on the basis of Internet technologies (Moodle platform), which provides presentation of the content of training, organization of interaction of participants of the educational process, support for management and monitoring of independent educational activities of students. For technical and methodical reasons, optimal the block-modular structure of distance learning software is considered. The Moodle platform is designed as a set of modules and allows you freely to add or remove elements at different levels, and therefore fully complies with the specified requirements.

Taking into account the above the general structure of the distance course is as follows (Table 1).

Table 1. The general structure of the distance course

<table>
<tr><td colspan="2">Discipline forum (created automatically by the Moodle system)
Educational and Methodical Complex of Discipline
Goals and objectives of the discipline</td></tr>
<tr><td>Module 1
Theme 1.1
Question 1.1.1, Question 1.1.2
*** Question 1.1.m
Conclusions on the theme
Question for self-control
Test (training) exercises for theme 1.1
Literature for theme 1.1
Theme 1.2 *** Theme 1.k
Final control on the theme</td><td>Module N
Theme N.1
Question N.1.1, Question N.1.2
*** Question N.1.m
Conclusions on the theme
Question for self-control
Test (training) exercises for theme N.1
Literature for theme N.1
Theme N.2 *** Theme N.k
Final control on the theme</td></tr>
<tr><td colspan="2">Glossary</td></tr>
</table>

The formation of web-pages with lecture material within the information and reference block is proposed to be implemented with the help of an internal text editor of the Moodle system. The display of mathematical formulas and chemical reactions in the course topics is provided by the using of add-ons – Math & Science by WIRIS and Chemistry editor. The functionality of the add-ons almost completely corresponds to the capabilities of the formula editor Microsoft Equation 3.0.

An additional possibility of transformation of complex mathematical formulas created in the Microsoft Word editor into a format compatible with the Moodle system is provided by the Math Type 6.9 program. The formation of drawings and graphic illustrations is recommended to implement through the program Lightshot 5.1.4.1 for Windows (open-source). The link to these programs is presented on the main page of the MoodleDDMA platform.

A prerequisite for the effective functioning of the control and evaluation unit of the distance course is the presence and sufficient filling of the “Bank of questions”. “Bank of questions” provides integration of tests as control elements in separate subjects of a course or formation of final (training) testing. The formation of the “Bank of questions” is possible directly in the Moodle environment, or by importing tests prepared in an external program “Izido-Converter”. Each course topic is expected to end with 20 practice tests. The sample of the assessment of test problems for the course (module) from 10 topics is given in Table 2.

Table 2. Assessment of test tasks of a distance course (module) on 10 topics

Course component	Points	Explanations
Training part of the course 10 themes * 20 tests = 200 tests	200*0,1= 20 points	Passing the training part is possible at any time during the study of the course (module) and is not required. (At the same time, only training testing allows the student to get acquainted with the tests and the correct answers to them). The student has several attempts (from 3 to 5) to provide the correct answer to the tests. After exhausting the attempts, the student is credited with the points actually received and the Moodle system provides a bug report and correct answers.
The control part of the course (module) - 20 tests [formed randomly] of a theoretical and practical orientation (including in the form of an essay that can be independently assessed by the teacher)	20*4= 80 points	The passage of the control part is possible only at a certain and limited time on the eve of the examination session. The student has one attempt to provide the correct answer to the tests. After passing the control test, the student is credited with the points actually received and the Moodle system provides a bug report and the correct answers.
Total	100 points	Remote study of the course (module) is considered credited if the student receives a minimum of 55 points. In case of insufficient points, an additional attempt to pass the control test is provided.

Thus, it is proposed to use the proposed distance course structure and the principle of assessment of test items as the basis for the formation of courses in the MoodleDDMA system. At the same time, when developing distance learning courses, it is necessary to take into account the requirements of the basic structure of the distance learning course and the volume of test tasks in the Question Bank.

On the Fig. 1 is shown as an example the structure of course The Methods of Mathematical Processing of Medical Biological Data System of MoodleDDMA. Example of placement of the course program of the discipline The Methods of Mathematical Processing of Medical Biological Data system MoodleDDMA is presented on the Fig. 2.

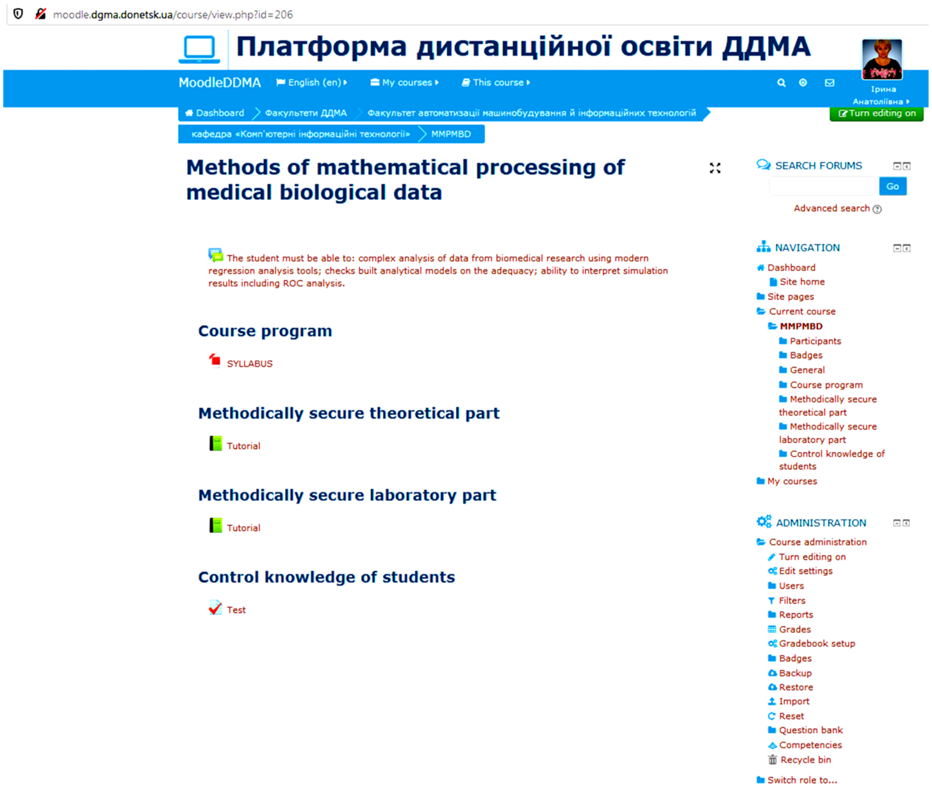


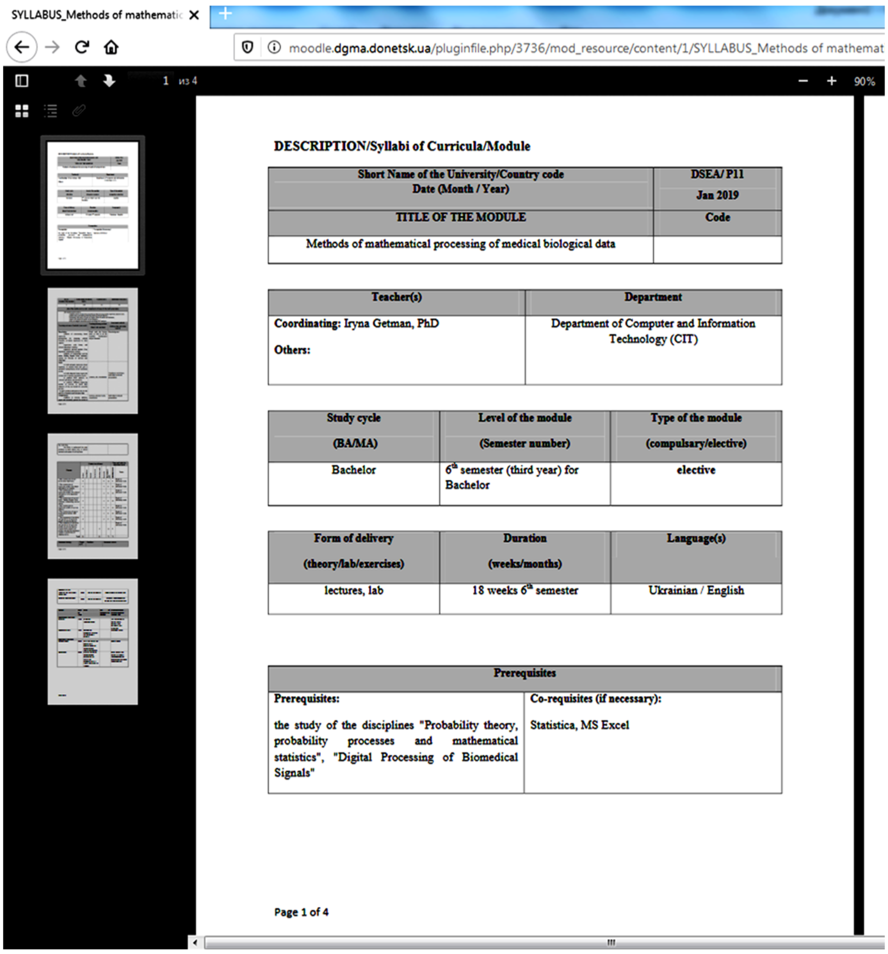
Fig. 1. The typical structure of learning courses as an example of discipline The Methods of Mathematical Processing of Medical Biological Data of distance education platform MoodleDDMA

The advantages of the Moodle distance learning system include ease of installation, as well as updates when switching to new versions.

Learning with using of the Moodle platform allows:

- to organize productive independent work of the student on mastering of an educational discipline;

- to contribute to the formation of professional competencies, mobility, ability to seek and acquire new knowledge;
- to give a new quality to learning, providing constant access to information at any time;
- to promote flexible learning based on new opportunities (cloud services, e-books, video conferencing and video lectures);
- to provide effective feedback.



DESCRIPTION/Syllabi of Curricula/Module

Short Name of the University/Country code Date (Month / Year)	DSEA/ P11 Jan 2019
TITLE OF THE MODULE	**Code**
Methods of mathematical processing of medical biological data	

Teacher(s)	Department
Coordinating: Iryna Getman, PhD **Others:**	Department of Computer and Information Technology (CIT)

Study cycle (BA/MA)	Level of the module (Semester number)	Type of the module (compulsary/elective)
Bachelor	6^{th} semester (third year) for Bachelor	elective

Form of delivery (theory/lab/exercises)	Duration (weeks/months)	Language(s)
lectures, lab	18 weeks 6^{th} semester	Ukrainian / English

Prerequisites	
Prerequisites: the study of the disciplines "Probability theory, probability processes and mathematical statistics", "Digital Processing of Biomedical Signals"	**Co-requisites (if necessary):** Statistica, MS Excel

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Fig. 2. The example of placement of the course program of the discipline The Methods of Mathematical Processing of Medical Biological Data System MoodleDDMA

The use of the educational platform Moodle in teaching students contributes to the implementation of the principles of consciousness and activity in learning, the development of self-consciousness. At the same time, consciousness in mastering the material by students largely depends on the activities of the teacher, who needs to constantly monitor the attention of students in the learning process, stimulate it with the formulation of problem situations. The advantage of such training is the emergence of opportunities for students to perform training tasks in any convenient place and in their spare time. In addition, the use of modern computer technology in the learning process allows you to get skills that will be useful in work and everyday life.

The experience of using such courses in the correspondence Department with distance learning allows us to conclude that in addition to the progress of the course program, the student has the opportunity to access the material that is given for independent study. The system also provides the ability to test their knowledge by testing, which makes more effective using of electronic learning materials.

A typical disadvantage of distance education systems is the lack of contact with the physical object of the educational process. MoodleDDMA is no exception. This problem can be eliminated by providing an interface between the system and the physical object using specialized application packages, however, as a rule, they are paid [8; 10]. In addition, augmented reality technologies are not currently presented in the MoodleDDMA system. Such technologies can be provided using development platforms for creating multi-platform 2D and 3D interactive content such as Unity3D [8; 10; 18].

On the other hand, not all students are comfortable working with digital sources presented in the MoodleDDMA system. For this reason, many students print materials and work with printed versions of courses downloaded in the MoodleDDMA system. In addition, there are a number of conflicting opinions about the use of digital material for teaching, in particular the Manfred Spitzer study [16].

However, the predominance of the advantages of using the MoodleDDMA distance learning platform and the ability to eliminate the indicated system shortcomings allow us to conclude that the use of such systems is effective for organizing the educational process in modern higher education.

4 Conclusions

Thus, to improve the quality of distance learning, the use of cloud services and electronic textbooks in mobile learning is promising and effective for students, such as:

- facilitates the understanding of the study material due to other than in the printed educational literature, methods of presentation of the material;
- allows adaptation according to the needs of the student, his level of training, intellectual abilities and ambitions;
- allows you to focus on the essence of the subject, consider more examples and solve more problems;
- provides a wide range of opportunities for self-examination at all stages of the study of educational literature;
- plays the role of an infinitely patient mentor, providing almost unlimited number of explanations, repetitions, hints.

The electronic manual will allow the student in the process of using cloud services and electronic textbooks in mobile and distance learning to gain strong and comprehensive knowledge and skills in the subjects.

In turn the use of cloud services and electronic textbooks in mobile and distance learning by teachers shows the effectiveness and usefulness as follows:

- allows the teacher to conduct classes in the form of independent work on various mobile devices, reserving the role of leader and consultant;
- allows the teacher to use mobile devices to effectively monitor the knowledge of students, set the content and level of complexity of the control event;
- allows to make lectures and practical classes material at its discretion, perhaps smaller in volume, but the most significant in content, leaving for independent work with the electronic manual that was outside the classroom;
- frees from the tedious checking of homework, typical calculations and control works, transferring the effectiveness with the help of mobile devices by testing;
- allows to optimize the ratio of the number and content of examples and tasks considered in the audience and asked at home;
- allows you to individualize work with students, especially in terms of homework and control activities.

The experience of using the Moodle distance education system at the Donbass State Engineering Academy allows us to conclude that the new generation of electronic textbooks should be focused on new methods of teaching, active knowledge of the world, increase the role of independent work of students with information. They should provide methodical support for the educational process, using a full set of multimedia capabilities to create new tools and forms of learning and should comply with the following rules:

- information on the chosen subject or course should be well structured, and represented complete fragments of the course with a limited number of new concepts;
- key topics with hypertext, illustrations, audio and video comments should correspond to the structural elements of the training course;
- the main parts of the textbook along with the text should contain video and audio recordings containing material on the topic under study;
- the text information should be able to print out the required text fragments. It should be possible to adapt the font used to the user's needs;
- a system containing complex models must contain instantaneous hints that appear and disappear in sync with the movement of the cursor to the individual elements of the program, in addition to the ability to increase the individual elements of illustrations and copying;
- a multi-window interface should be used, with each window presenting related information;
- the text part should be built on the basis of cross-references, allowing to reduce the search time of the necessary information, as well as a powerful search center and index;
- it is useful to connect audio signals to indicate the correct navigation of the electronic

textbook;
- the entire course should contain the ability to copy the selected information, as well as its editing and printing on the printer;
- electronic textbook should have fundamentally new qualities compared to a traditional textbook.

Thus, the use of cloud services and electronic textbooks in mobile and distance learning is a modern and effective means of obtaining higher education. Training using the Moodle platform and the proposed methodical aspects of the preparation of educational content allows you to organize a productive independent work of the student to master the discipline, contributes to the formation of professional competence, mobility, the ability to seek and acquire new knowledge, gives a new quality of learning with constant access to information at any time, and also contributes to the formation of flexible learning based on new opportunities (cloud services, electronic textbooks, video conferencing and video lectures) and allows you to provide effective feedback of the teacher and the student.

Typical shortcomings of distance learning platforms, including the lack of contact with the physical object of the educational process, the temporary lack of presentation of augmented reality technologies in some systems, the presence of conflicting opinions on the use of digital material for learning, do not reduce the relevance and effectiveness of their use for organizing the educational process in modern higher education.

A promising area of research and development of the MoodleDDMA distance education platform is the refinement and expansion of educational materials with multimedia elements and links, as well as the creation of an application for mobile devices to enable more efficient use of the platform.

Disclaimer

The Erasmus+ BIOART project is co-funded by the European Commission. This publication reflects the views only of the authors, and the Commission is not responsible for any use that may be made of the information contained therein.

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MarkHub Cloud Online Editor as a modern web-based book creation tool

Vitalina O. Babenko[1[0000-0002-4816-4579]], Roman M. Yatsenko[2[0000-0001-7968-6890]], Pavel D. Migunov[1] and Abdel-Badeeh M. Salem[3[0000-0001-7710-4842]]

[1] V.N. Karazin Kharkiv National University, 4 Svobody Sq., Kharkiv, 61022, Ukraine
vitalinababenko@karazin.ua, xa12462349@student.karazin.ua
[2] Simon Kuznets Kharkiv National University of Economics,
9-a Nauky Ave., Kharkiv, 61166, Ukraine
roman.yatsenko@hneu.net
[3] Ain Shams University, El-Khalyfa El-Mamoun Str., Cairo, Egypt
abmsalem@yahoo.com

Abstract. The main criterion for the competitiveness of a teacher or expert in the field of science is a good ability to present their knowledge to students in an interactive form without spending a lot of time in preparation. The purpose of the study is to analyze modern editors to create educational information content in the modern educational space and to present a modern tool for creating web books based on the latest IT technologies. Modern editors of web material creation have been analyzed, statistics of situations on mastering of knowledge by listeners, using interactive methods of information submission have been investigated. Using the WYSIWYG concept and analyzing modern information tools for presenting graphic material, an effective tool for teaching interactive web material was presented. An adapted version of the MarkHub online editor based on cloud technologies is presented. Using MarkHub cloud-based online editor for the unified development of educational content can significantly increase the author's productivity in the content creation process. At the same time, the effects of reducing the time spent on formatting the external presentation of the content, making synchronous changes to different versions of the content, tracking the versions of the content, organizing remote teamwork in the network environment are achieved.

Keywords: web-book, interactive material, WYSIWYG, WYSIWYM, cloud-based online editor MarkHub, book modeling.

1 Introduction

In the modern educational space, new technologies are being created every day, and they are the ones that give the pace of social development. There are many challenges that need to be addressed quickly to prevent large-scale consequences. This is influenced by several factors: the surrounding atmosphere, the system of education and the demand of young people for learning [15]. Not so long ago, when preparing for lectures, the teacher used printed sources – mostly textbooks and other literature from scientific libraries. He wrote the main topics he needed to convey to the students, and then gave lectures. More often, this process took a lot of personal time. This has significantly reduced the time needed to improve their professional skills. But in recent times the preparation of lecture material on the basis of printed sources alone is insufficient. The generation of students changes over time, they become more progressive and have more demand for information. Generation Z mostly refers to the "digital person" [5]. Therefore, the lecturer needs to increase the level of creativity in creating quality content for young people. They are used to visualized content, such as on social networks. Theoretical material should be supplemented with presentations and interactive assignments that help you discover and learn practical skills. Studies show that students' achievement in course development is improved by 38% using interactive video instruction, and learning time is reduced by 31% [10]. This trend is observed not only in students. An average employee in a firm that is advanced training using modern methods of studying material, demonstrates a high degree of mastering the course (more than 80%) [1]. So now, the requirement of interactivity in teaching is added, through which the teacher can impart knowledge through the latest information technologies. Therefore, being competitive in the present is very difficult and, at the same time, it is important to be successful in the professional field. But to reach a certain level, it is necessary to use information tools that will not only reduce the time, for example, to prepare lectures, but also make them interesting.

2 Approaches to the formation of educational content

Modern approaches and technologies used in the preparation of content in the educational environment, require a lot of time and effort of the author. In preparing educational content (guidelines, textbooks, e-courses), the author often devotes most of his time not to the production of new knowledge, but to their visual design. Dissemination of different forms and mediums of content delivery, as a rule, entails the use of different software tools to create appropriate visual versions of the same educational content. At the same time, insufficient attention is paid to the application of methods and models in risk management, taking into account the particularities of the implementation of IT projects, in particular the methodologies used in the creation of software. In this regard, an urgent scientific and applied challenge is to improve the risk management processes of information technology projects by developing appropriate methods and models that combine the benefits of different methodological approaches to software development.

Many of these tools use the concept of user interface What You See Is What You Get (WYSIWYG) [4]. To implement this UI concept, content creation tools use the visual formatting tools of the document closest to the output, using a mouse and predefined keyboard shortcuts. Because in this concept, working on the external representation of content occurs simultaneously with its creation, this entails the following negative consequences:

- working on the external presentation of content distracts the author from his content side, thereby reducing the author's productivity and quality of the creative process;
- content transformation when necessary to form another external representation of it, which often leads to changes in its content and the appearance of new versions;
- versioning the external presentation of content with differences in content negates the quality of the first versions, which often leads to the need to make substantially the same changes in different versions.

The WYSIWYG Content Generation Approach was first introduced in 1974 in a Bravo text editor developed by the Xerox PARC Research Center. In the future, this approach became widespread due to the active introduction of a graphical user interface [14], which actively used visual methods of presenting information and inputting information using the mouse and keyboard manipulator. By the end of the twentieth century, this approach had become the de facto standard when working with content in an educational environment [7]. The most common content preparation package with a similar interface is the Microsoft Office application suite, which includes text, spreadsheet, and presentation applications that are both screen and printable. Moreover, software supporting the WYSIWYG concept, both for different purposes and for different manufacturers, requires the use of individual approaches to create and change the appearance of a document.

Unlike WYSYWIG, the What You See Is What You Mean approach (WYSIWYM) implies the use of content preparation methods in which the logical structure and content of the document are separated from its appearance [8]. This is accomplished by applying different design templates and styles to one original document content. In this way, content independence from form is achieved, which gives the following advantages when creating educational content [11]:

- creating different forms of visual representation of content without the need to make changes to the content or minimize their volume;
- making changes to the contents of a document occurs once without the need for duplication of changes in different versions of the visual representation;
- at the same time, making changes to the layout in one version of the visual representation does not affect the content of the document and its other visual representations;
- increases the ability to automatically analyze and convert content by using text storage formats.

The WYSIWYM concept appeared historically before WYSIWYG, but initially required the use of a sophisticated tag model of document content markup (similar to modern HTML and XML markup languages). In the academic world, the typesetting system TeX (1978, by Donald Knuth [9]) has become widespread, which contains advanced tools for document structuring, typography, link creation, work with complex mathematical formulas, etc. Many large scientific publishers use the modern LaTeX package, which is an extension of TeX. The original content in LaTeX documents can be compared to a computer program because it is a text file containing special markup commands. The use of predefined macros allows to automate many content creation tasks without involving complex programming skills, which does not remove the need for initial preparation and training for the author before applying this package.

The next step in the development of the WYSIWYM concept is the emergence of lightweight markup languages (Markdown Language, 2004, by John Gruber), which have taken advantage of the separation of content and form but use a much simpler model of content markup. Lightweight markup languages feature the use of a simple set of special characters to denote various logical blocks of content in such a way that its visual perception is as it is, without the involvement of additional tools, which in turn are only necessary to convert the format of the external content representation.

The rapid development and dissemination of the lightweight markup language family that has emerged in the coming years makes it possible to consider the use of the WYSIWYM approach as a basis for forming the concept of unified development of educational content. The proposed concept implies a technology for creating and disseminating educational content based on the WYSIWYM concept, which will meet the following requirements:

- support of various formats of external presentation of content;
- realization of creation of different types of content;
- lack of significant and specific requirements for the level of technical competence of content authors;
- the use of tools with a friendly user interface;
- providing version control and joint remote development of content;
- extensibility by embedding complex visual elements of content, including those created in WYSIWYG editors.

3 Analyzing tools for creating educational content

Educational content has undergone several stages of its evolution and the most common of these are oral knowledge transfer, manuscripts, book printing, e-books. Educational systems in some countries already use e-books in training. It is first and foremost accessibility and mobility that helps students to continuously learn. But nowadays, interactive e-books have more advantages than static e-books. The student has the opportunity to interact with different types of content: videos, pictures, tests, presentations, audio files and not interrupt the learning process. All items are in one online e-book.

Let's analyze the advantages and disadvantages of the most common WYSIWYM editors used in the educational space (Table 1, 2).

Table 1. Editors Characteristics.

Editor	Advantages	Disadvantages
Sublime Text is a text editor for code, markup and prose that supports Python plugins [3]	– Nice and easy interface. – Ability to display from 1 to 4 panels, thus you can display 4 files at a time.	– No graphical interface to create color schemes. – No clickability of links.

Editor	Advantages	Disadvantages
	— Automatic command completion. (During the process of code-typing, the editor recognizes the programming language and proposes to finish the command, as when writing a SMS to a friend, you are already given a ready-made version of the word). — There is an auto-save feature so that a person does not lose their job in an emergency. — Dark background of the editor allows to increase the contrast of the text.	— It is not possible to add interactive material.
Notepad++ is an open source text editor for Windows with support for a large number of markup languages [16]	— Syntax highlighting. — The ability to auto-complete the code. — Work with many tabs at one time. — Small file size and easy to install. — Shortcuts: create, paste, delete, copy and so on.	— Does not auto-indent after colon. — There is no syntax check. — Does not show docstring users (ability to comment on algorithm or command). — It is not possible to add interactive material.
Vim is a text editor, one of the most powerful editors with the freedom to customize and automate through advanced add-ons [17]	— Ability to work with multiple documents simultaneously; — Auto-completion. — Unicode support. — History of words, commands. — Ability to compare two files and transfer data from one to another.	— The modal user interface seems strange to people who are used to Windows user interfaces; — The habits of working with this editor (commands, scripts, syntax) will not be with you, if you switch to another editor, they will remain in Vim; — In the Vim editor, writing training takes a lot of time and most people work slower than other editors; — It is not possible to add interactive material.
Emacs is a family of extensible text editors [18]	— Functionality of the editor: basic and additional modes. — Each function or variable can have its own documentation, like a database, and if you click on it you can see the contents. — Ability to customize editing parameters. — Modifying editor features using Elisp language.	— Slow loading process. — Elisp is not easy to learn. — This editor is in some sense an entire operating system, so some users run because of the lack of bits or the need for a regular and simple editor. — It is not possible to add interactive material.

Editor	Advantages	Disadvantages
LyX is a word processor that helps you focus on the structure and content of your documents instead of constantly being distracted by their formatting [13]	— Provides complete control over margins, headers / footers, spacing / indentation, alignment, types of multi-level list markers. — There is a well-worked spreadsheet editor, Emacs-style version control interface for collaborative projects, a change tracking system, and “branching” for parallel versions of documents. — You can increase the fonts on the screen according to your tastes and see all the text on the screen without affecting the margins and other formatting of your final result. — You can export the document in various formats.	— The set of paragraph styles is limited to exactly those styles that are specified in the original document class. — Very low prevalence of .lyx format. Not one package except LyX opens. — It is advisable to know LaTeX to get started with LyX, as many functions may overlap. — There is no way to add interactive material. — You will not be able to make a space between paragraphs as the editor cleans it up, so you will first need to choose a style that suits you according to the text structure.
LaTeX is the most popular set of macro extensions of the TeX computer layout system, which facilitates the collection of complex documents [6]	— A large number of macropackages. — Supports any language within a single document. — Mathematical formulas are extremely simple to type. — The user needs to know only a few easy-to-remember commands that define the logical structure of a document, and almost no knowledge of how the document is formatted.	— Simultaneous training and use are not supported, which makes the approach to the development of technology more serious. — No WISIWIG. It is necessary to have the skills to work in a text editor. — Requires knowledge of elementary basics of typesetting. — Focuses on multitasking environments. — It is not possible to add interactive material.

Table 2. Editors Comparison.

	Sublime Text	**Notepad++**	**Vim**	**Emacs**	**LyX**	**LaTeX**	**MarkHub**	**MS Word**
Text formatting	Easy interface and display from 1 to 4 panels	Easy interface for working with text, but doesn’t support automatic syn-	To format, you need to know the basic commands	There are 3 modes and they have a different role in creating material	Easy access to text formatting	Easy access to formatting, just master a couple of easy	Just formatting the text is enough	Simple enough, but may take a little time due to the frequent use of the mouse

	Sublime Text	Notepad++	Vim	Emacs	LyX	LaTeX	MarkHub	MS Word
		tax correction				commands		to text formatting
Insert videos and images	Perhaps, but only with the support of plugins	Supported by plugins	It is possible to add video and photo files	Supported by plugins	Supported by plugins	Yes	Yes (without leaving the book)	It is possible to insert an image, but video does not support
Interactivity	Supported by plugins	Supported by plugins	Maybe depending on language you use	Yes	Yes, you can add video or photo	Yes, they are mainly used to create slides and documents	Yes	Only direct links or images are possible
Document format	Saved locally in the editor	Supports html, css, php, js and many other formats	Supports html, css, php, js and many other formats	Saved to disk or locally. Doesn't interact with GitHub	Saved in different formats	Convert dvi to pdf	pdf, SCORM, epub, universal web book link generation	pdf, docx, xml, html, txt
LaTeX support	Yes	Yes	Yes	Perhaps, with limitations	Yes	No	Yes	Perhaps, with various apps

4 MarkHub Cloud Online Editor

Thus, an analysis of the editors and the state of the market for educational content creation technologies allowed us to offer a cloud-based online editor, MarkHub (https://markhub.io), which allows you to generate web books using Markdown markup language with advanced native notation. Investigating other editors, it is clear that modern approaches and technologies take a lot of time when designing a product. This is a major benefit of our online editor, with the MarkHub online editor not only simplifying the interface but also shortening the time when working with MarkHub.

The main advantages of the proposed solution over other editors are:

- extended Markdown notation;
- two windows for work, one of which you write, the other reformat your text in a proper visual appearance;
- the ability to work together;
- sync content with Google Drive and GitHub;
- support for media, audio files, images, tables, direct links, tests;
- export in SCORM, PDF, EPUB formats;

- help material in the form of tips for content collection;
- versatility of browsing the web through your phone, tablet or laptop.

The main element around which MarkHub's cloud-based online editor is built is Markdown Markup Language [19]. Today, the use of this tool affects both the competitiveness of authors and gives wide opportunities to users of such popular systems as: Wikipedia, GitLab, Dropbox, Slack and many others. Turning to the benefits of Markdown, I would like to say that those who first encounter this tool, within a few hours, get used to its functionality and logic [2]. Now, the main thing is, why did we put this system behind the editor:

1. Convenience of distribution

In general, documents written with Markdown are a standard TXT file that is open in all applications. It should be noted that the TXT file will not have a visual design, it will require editors such as MarkHub or StackEdit. The document will only contain commands for the editor. Below you will see an example of how a TXT file was modified with the Markhub editor.

2. Simplicity

The syntax of this technology is very simple. When writing, you need to use characters such as: # (grid), - (dash), * (asterisk), and so on. For example, if you want the author to make a title in a document using MarkHub, just put # - # in front of the title.

3. Rigor and predictability

One of the reasons why we put Markdown technology at the heart of the editor is the existence of strict rules that cannot be ignored – service marks.

To sum up, Markdown technology has strict rules for content design. This can be considered a benefit, because the author who worked with MarkHub notation will easily understand the design of the material. In addition, the result will be predictable and live up to expectations with a clear and simple notation. If small bugs do occur, they can be quickly identified through a preview mode that automatically transforms the commands into visual content visualization. Thus, Markdown is a popular and progressive way to quickly design content that, thanks to its versatility and simplicity, saves considerable time when writing technical text, scientific articles or educational materials. In turn, such advanced editors as MarkHub will significantly simplify and diversify the text based on Markdown principles and principles [12].

As for tools inside the online editor, there are many options for creating content:

- text;
- lists (ordered and unordered);
- definitions and quotations;
- drawings from external sources (photographs, diagrams and diagrams in different notations, mathematical graphs and diagrams);
- circuits built using standard blocks and connectors;
- tables;

— mathematical formulas;
— literal blocks (fragments of printouts, program listings, etc.);
— links and footnotes;
— media content;
— tests.

Let's take a look at the steps of preparing educational content in an e-book format in the cloud-based online editor MarkHub. The user interface in the editor is built using the WYSIWYM concept – the main elements of the interface are the source editor (left in the center) and the preview area (right in the center) (Fig. 1). The user in the editor works with the source text (content), applying to it the rules of Markdown markup language, and in the preview area, continuous rendering (formation "on the fly") of the appearance of the content is carried out.

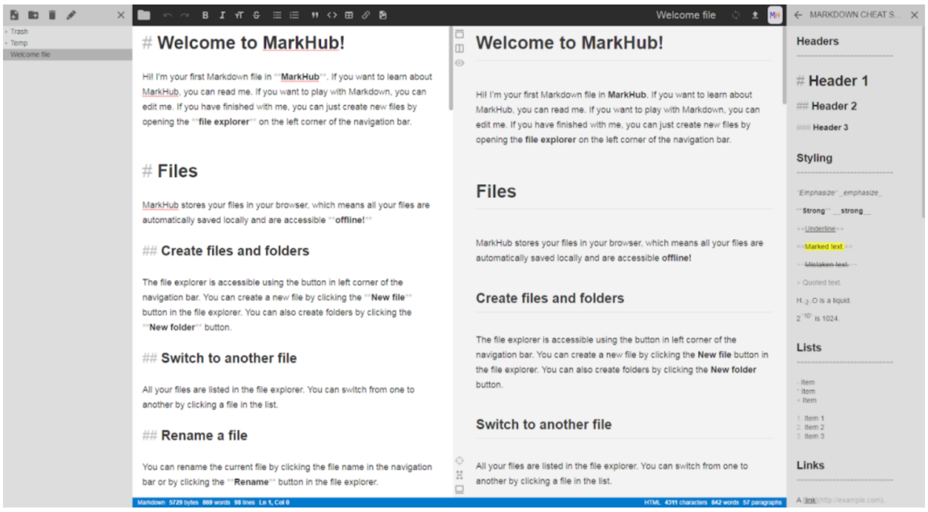

Fig. 1. MarkHub Cloud Online Editor User Interface

At any point in time, the user can use the Build button on the top toolbar on the right, which allows them to generate an e-book and place it online on MarkHub server resources for further dissemination and use through the link. The appearance of the generated web book is shown in Fig. 2.

The proposed toolkit in a single MarkHub platform provides a huge impetus for competitiveness among other authors. Interactivity can easily capture the reader's attention, and the easy content creation functionality will reduce the time spent on routine operations by 30% and move on to the more significant tasks of the learning process.

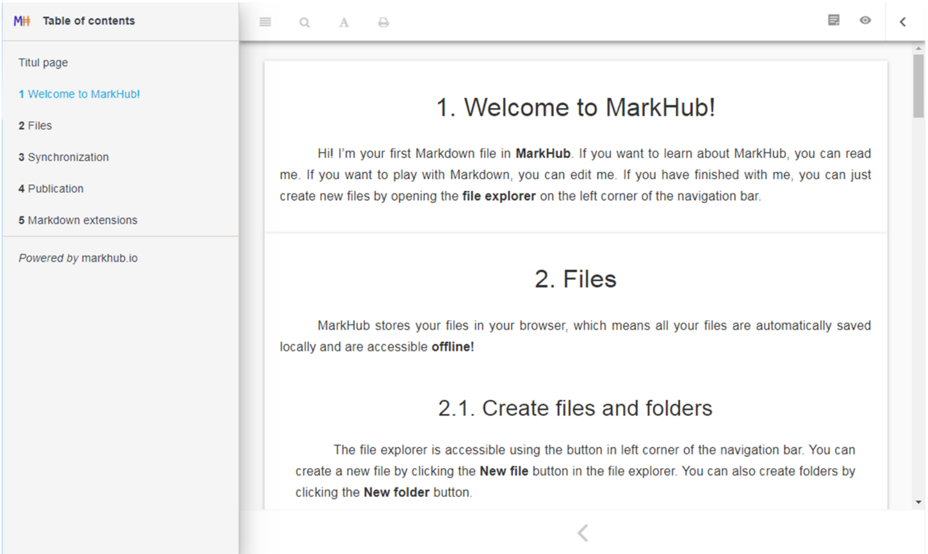

Fig. 2. An example of a finished web book after creating content in the editor

5 Conclusions

Using the WYSIWYM approach to unifying educational content development can significantly increase the author's productivity in the content creation process. This becomes possible on the basis of:

— reducing the cost of time to format the external presentation of content,
— making synchronous changes to different versions of content,
— tracking versions of content,
— organization of remote teamwork in a network environment.

All these workflows have a high proportion in the author's educational activities, so their optimization is important in the current conditions of rapid creation and dissemination of information in the world.

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The students' brainwork intensification via the computer visualization of study materials

Halyna I. Ivanova[1[0000-0001-6432-2154]], Olena O. Lavrentieva[1[0000-0002-0609-5894]], Larysa F. Eivas[1[0000-0001-6718-8464]], Iuliia O. Zenkovych[1[0000-0002-0996-6384]] and Aleksandr D. Uchitel[2[0000-0002-9969-0149]]

[1] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
galina.ivanova.2308@gmail.com
[2] State University of Economics and Technology,
5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
o.d.uchitel@i.ua

Abstract. The paper the approaches to the intensification of the students' brainwork by means of computer visualization of study material have been disclosed. In general, the content of students' brainwork has been presented as a type of activity providing the cognitive process, mastering the techniques and ways of thinking, developing the capabilities and abilities of the individual, the product of which is a certain form of information, as a result of the brainwork the outlook of the subject of work is enriched. It is shown the visualization is the process of presenting data in the form of an image with the aim of maximum ease of understanding; the giving process of visual form to any mental object. In the paper the content, techniques, methods and software for creating visualization tools for study material has exposed. The essence and computer tools for creating such types of visualization of educational material like mind maps, supporting notes and infographics have been illustrated; they have been concretized from the point of view of application in the course of studying the mathematical sciences. It is proved the use of visualization tools for study materials helps to increase the intensity and effectiveness of students' brainwork. Based on the results of an empirical study, it has been concluded the visualization of study materials contributes to the formation of students' key intellectual competencies and forming their brainwork culture.

Keywords: brainwork, intensification, visualization of study materials, computer visualization tools, mind map, infographics, supportive notes.

1 Introduction

The global informatization of society, transformation the Internet into a world repository of any information has substantially influenced the content of the educational process, methods and techniques of students' brainwork.

Thanks to the free access to the massif knowledge, there is no need for the traditional information accumulation because of its rapid aging and avalanching growth.

Therefore, the content of higher education should gradually change its direction, envisage measures to intensify the educational process, facilitate the formation of students stable processing skills and the use of constantly changing information in practice. Due to this fact, higher education should use special mechanisms that will reduce the emotional load on the central nervous system of both students and lecturers, and at the same time promote the intensification of students' brainwork. All these needs increasing the overall lecturers' teaching skills, as well as professionalization of education at the level of time's requirements.

It is the intensive teaching methods combining modern advances in scientific and technological progress in the form of automated systems and learning technologies that can be attributed to attempts to search in this direction. The most promising areas in this context are computerization and informatization [19], which provide increase the students' mental activities, and ultimately, the quality and continuity of higher education, mobility and competitiveness of graduates.

The *purpose* of this research is discovering and investigate the mechanisms of the students' brainwork intensification in the course of teaching mathematical sciences; studying the possibilities and check the effectiveness of the use of computer visualization tools in this process.

2 Materials and methods

In this paper we use methods of analysis and systematization of pedagogical and psychological literature, works of domestic authors, methodological materials in order to determine the conceptual and categorical apparatus of the research.

In general, the various aspects of the students' brainwork have been studied by Dmitrii N. Bogoiavlenskii [8], Boris P. Esipov [18], Petr Ia. Galperin [20], Valentyna M. Grineva [23], Yuliia S. Ibrahim [25], Nina V. Kuzmina [31], Nina F. Talyzina [59], Simon L. Soloveychik [56] and others. Scientists' investigations clarify the sense of culture and hygiene of brainwork, offer valuable ideas and recommendations on how to learn more quickly, how clearly comprehend and memorize of training material, how to work through and learn it, how to check the quality of mastered one. Separate attention scientists paired to those aspects of the researches revealing the psychophysiology of brainwork, to an analysis of the mechanisms of forming the mental activity's techniques, a rational organization and management of students' brainwork, and a reading culture, the methods of independent work with the educational book, etc. [43].

The intensification of brainwork is defined as the phenomenon of increasing its productivity in each unit of time. In view of this significant interest is the works of Iurii K. Babanskii [2], Vladimir P. Bespalko [5], Aleksei K. Gastev [21], Boris S. Gershunsky [22], Anatolii I. Kuzminskyi [32], Olena O. Lavrentieva [34], Oleksandr V. Malykhin [37], Leonid V. Zankov [66], and others. Scientists have characterized the following main directions of intensification and optimization of the educational process, such as: enhancing students' cognitive motivation, increasing the learning's content informative capacity, the use of active didactic methods and forms, scientific-based management by the mastering knowledge process, development of skills and ability of brainwork with use the mnemotechnies, visualization, self-control, and self-efficacy techniques.

It should be notes that among the technologies of processing a large amount of data lately the technologies of visualization of educational material are actively used; they created on the basis of the works of Tony Buzen [10], Vasilii V. Davydov [11], German K. Selevko [52], Viktor F. Shatalov [55], Andrey A. Verbitsky [63] and others. Scientists' researches, including Alexei G. Baryshkin [3], Mark I. Bashmakov [4], Natalia V. Brovka [9], Hsinchun Chen [69], Viktor A. Dalinger [49], Thurston Domina [16], Nataliia A. Reznik [3], Joshua Saldana [16], Bin Zhu [69], and others, confirmed the fact that in the modern dynamic world where the computer-driven and smart-technologies are increasingly becoming a reality of our lives, the approaches to visualizing of educational content are must changing. Natalia M. Biloshapka [7], Steve Cunningham [70], Irina S. Dereza [12], Petro I. Dovbnia [17], Hennadiy M. Kravtsov [29], Pavlo P. Nechypurenko [44], Tatyana A. Oleinik [30], Valery M. Rakuta [50], Yurii S. Ramskyi [51], Olena V. Semenikhina [53], Andrii M. Striuk [57], Oleh O. Tsys [35], Oleg P. Zelenyak [67], Myroslav I. Zhaldak [68], Walter Zimmermann [70] have devoted their studies of the use of computer visualization tools in the educational process. Scientists justified the feasibility and necessity of using modern computer visualization tools, including computer mathematics systems and dynamic mathematics programs, as powerful tools to refine abstract mathematical models and processes.

This work will be analyzed the content and classification of computer visualization software offered by Jörg Müller, Daniel Polansky, Petr Novak, Christian Foltin and Dimitry Polivaev [36], XMind Ltd [65], Corel Corporation [41]. The results of empirical study of their effectiveness for intensification of students' brainwork in the teaching mathematical subjects' process will also be presented.

3 Theoretical background

3.1 The student's brainwork and leading approaches to its intensification

In our previous works [26], we have found that the concept of "brainwork" in most scientific studies is interpreted as a creative activity, which is accompanied by the tension of the sensory apparatus, the emotional sphere of the person and at the same time does not require however considerable physical effort [25, p. 16].

From a physiological viewpoint, brainwork requires less energy expenditure of the body compared to physical work. However, this fact does not mean its ease and simplicity. The main working body in the brainwork is the brain as such. Physiologists say that in intensive brainwork, its energy requirement increases to about 15-20% of its total volume in the human body. At mental load the oxygen is used as like 5 times as at maximum physical activity [26, p. 122]. The physiology state during of intensive brainwork is characterized by impaired balance of the processes of inhibition and excitation, deviates from the norm of the tone of the vessels of the heart and brain, increases protein and carbohydrate metabolism, growths blood pressure and respiratory rate, etc. [43, p. 72].

That is, the interpretation of brainwork as an antithesis to physical one is very conventional. Moreover, these types of work make a mutual impact on each other. According to Boris P. Esipov [18] and Nina V. Kuzmina [31], the brainwork is characterized by strain of attention, memory, perception. In addition, a sedentary lifestyle and a monotonous posture cause stagnation in the leg muscles and, in the end, poor brain's oxygen supply [43].

As Simon L. Soloveychik is considered, the phenomenon of brainwork is the most complex type of human activity that goes unnoticed and inviolable [56]. Scientist states the brainwork is more difficult than any physical work, after that the person gets tired faster and recovers longer, besides the results of brainwork are not always visible and generally elusive. For example, when performing any physical work, anybody always sees changes in the labor object. However, somebody can work on solving a particular math problem for a long time, and eventually he/she can't find its solution. At the same time, representatives of psychological scientific thought (Dmitrii N. Bogoiavlenskii [8], Petr Ia. Galperin [20], Nina F. Talyzina [59], and others) argue the main difference between brainwork and any other type of work is its result. Product of brainwork is not only solution of a certain intellectual problem, but the enrichment of the outlook of the subject of work, change his/her attitude to reality [25, pp. 18–19].

Therefore, brainwork is a type of activity that provides the cognitive process, mastering the techniques and ways of thinking, developing the capabilities and abilities of the individual; the product of such work is a certain form of information, as a result of the brainwork the outlook of the subject of work is enriched.

When considering performance brainwork's indicators, takes into account its quality, productivity, as well as the optimal organization to achieve maximum results in a short time. It is not accidental in this conceptual chain the intensification of mental activity process has not last role.

The Latin term intensive (*intensio*) means tense, reinforced, doing increased productivity. Derived from it the term intensification (from French, Intensification – "the hard work") implies the achievement of the desired results in the work due to qualitative factors, it in the investigated by us context – due to the tension of the individual's mental capacity [32, p. 212]. In reference sources, intensification is defined as the process of increasing tensions, productivity, as the use of more and more efficient technologies, advanced methods of work, the achievements of science.

Nina F. Talyzina sees the intensification as a process decrease in the duration of training while increasing its quality and rising the amount of information assimilated [59, p. 59]. Similar definitions are typical of the works of Sergei I. Arkhangelskii [1], Natalia V. Kovalenko [27]. In the view of Sergei I. Arkhangelskii the essence of intensification of learning process lies simultaneously in the effectiveness of teaching, the effectiveness of studies and the effectiveness of study material [1].

The fact that in the process of extensive training (in contrast to intensive one) brain capacity is used only by 15-20% is indicated about necessity of the students' brainwork intensification. At the same time, intensive techniques require excessively high mental energy costs. Thus, the discrepancy between the requirements of scientific-and-technological progress on improving the effectiveness of learning and lack of modern methods of information mastering put forward a problem of developing certain tools that ensure the efficiency and productivity of students' brainwork.

For the successful students' brainwork, and its intensification, it is advisable to strengthen the visual-figurative component of the study material. It is necessitating the use of knowledge imaging technologies, as well as providing compactness, expressiveness and dynamic presentation of the study material's content.

3.2 Visualization of study material as one of the ways of intensification of the students' brainwork

The term "visualization" (from Latin *visuals* – to perceive visual one) is defined as the process of presenting data in the form of an image for the maximum convenience of their understanding; it is visualizing any mental object [61]. At the same time, scientists are cautioned against such a simplistic concept of visualization if it comes to a didactical method or principle, and offer to separate visualization from a visibility.

As Andrey A. Verbitsky points out the process of visualization involves the collapsing of mental meanings into a visual image which in the future can be actualized in certain situations and serve as a support for mental and practical actions. For its part, a visibility is only a demonstration of those objects or phenomena, the presentation of the finished image, set from the outside. Thus, a visibility serves to support thought processes by performing an illustrative function, whereas the visualization implies active brainwork [63].

At the heart of the visualization method are important psychological processes. Viktor F. Shatalov proved that for better memorization and understanding, the study information must be formed into an image. Within the visualization process it is normalized, systematized and curtailed. In the following, the student who has processed study information via visualization will be able to reconstruct the ones content, to establish connections between facts or phenomena, what's more to give examples and to formulate conclusions [55].

In the educational process, such leading forms of visualization of study materials as supportive notes or schemas, intellect cards and infographics are widely used [7, p. 167].

Supportive Notes or schemas, by definition of Viktor F. Shatalov, are a system of reference signals that have a structural connection and a visual construction replacing the system of senses, concepts, and ideas as interdependent elements. The supportive note is built on the basis of a boundary one generalization, coding, "collapsing" of knowledge by means of conventional signs, symbols, diagrams, graphs, tables, and whatever [55].

Actually, not every laconic record can be the supportive notes. There are main theirs features, namely: 1) conciseness and clarity while the completeness of the information presentation are maintaining; 2) availability of keywords and nodal concepts; 3) the presence of structure both visual and logical; 4) simplicity and clarity of structure; 5) the existence of meaningful accents made with the help of different ways of design – colors, frames, fonts, graphics, schemes; 6) the use of abbreviations and conventional symbols [60]. In Fig. 1 is shown the example of supportive note that demonstrate main ideas for designing such schemes.

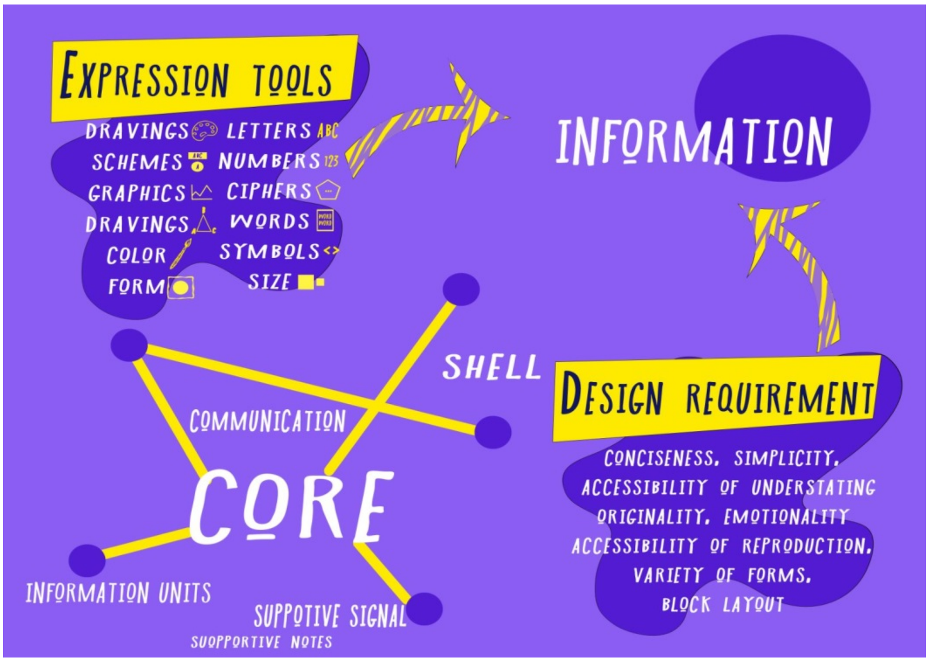

Fig. 1. It's example of supportive notes that devoted to main idea of such schemes (it prepared by authors with use [60])

Working with the support notes eliminates automatic rewriting of the study material. If, in normal note taking, a student either copy a text from a textbook or blackboard, as a rule without much thought in its meaning, then when student is drawing up a support notes this process involves pretreatment the information, isolating nodal elements and connections between them, creates anchor points for memorization [60]. At the same time, reprocessing the support notes, compared to reading the text, is considerably less time-consuming.

Mind Maps is a visualization of information in which step-by-step detailing of the art and graphic means of the studied concept or phenomenon is represented in a convenient format with the arbitrary addition of drawings and other auxiliary elements (arrows, lines, graphic symbols, etc.) [10]. With all their similarities to the supporting notes, mind maps are a dynamic means of visualization, that is, they are created in a certain period of time being required to process a certain part of the study material. The mind maps can help those whose personal and professional tasks suppose planning, organizing, and structuring.

Mind maps are a way of depicting the process of thinking through schematics usually in the form of a tree displaying ideas, concepts, keywords related to branches that extend from the central object of the map. Sometimes other translations of the term are used: “intelligent card”, “associative cards”, “memory cards”, “mental cards”, “smart cards”, “maps of consciousness”, “maps of mind”, “maps of representations”, “diagrams of communication”, etc. [45].

The advantage of using mind maps is follow. Firstly, they allow capturing everything with one look, since these schematic diagrams show the most important in associative comparisons and interactions. Secondly, mind maps are an example of a rational correlation of verbal, symbolic information and visual images. These are contributes to the development of students’ visual thinking, which in turn organizes images, systematize, structures and makes them holistic. These things far and away make students’ brainwork more purposeful, concentrated, and resulting.

Mind maps as an effective visualization tool was re-invented by well-known expert in intellect field Tony Buzen. The scientist paid attention that human thinking is nonlinear but has a kind of branch structure. Here each concept is connected with other concepts, in turn; these other concepts are connected with third ones and so on. Therefore, working with mind maps significantly intensifies the development of new concepts, ways of thinking and the general students’ brainwork. Throughout a such activity, students study to express thoughts briefly and clearly, to encode information, to structure it, to restore causation, to do conclusions [10] (see Fig. 2).

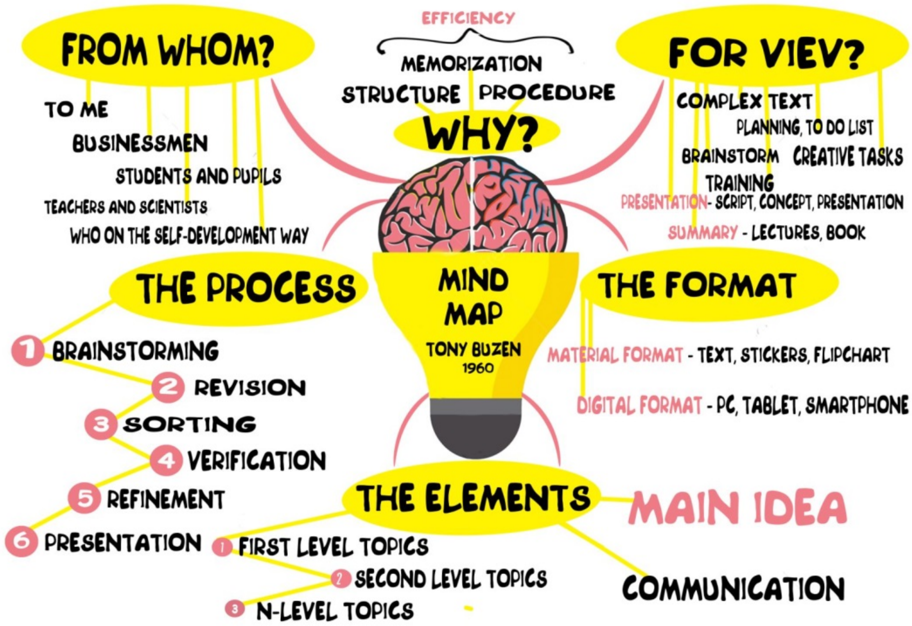

Fig. 2. The Mind Maps by Tony Buzen concept (it prepared by authors on the analogy of [41])

Infographics (one combines the terms “information” and “graphics”) are representation of interconnections between data sets (concepts, phenomena, etc.) in a convenient visual form by art and graphical means. In contrast an image, infographic conveys meaning, content, or data with the help of drawing but not the text [13]. A sign of infographic is the preservation of meaning in the image, from which mentally or technically the text explanations are removed [33].

In the heart of infographic technology is the fact that images makes the data more attractive to perceive by whomever, and increase his/her memory efficiency. It is well known that to 90% of information is perceived by a person visually, an additionally human brain processes visual information much faster than textual. In line with this regularity it is advisable to use infographics when you need to present a large amount of information in a compact and logical way [69].

The tutorials with infographics activates the process of perception and understanding of information, increase students' ability to think critically. The principal advantage of infographic images is providing information saturation and clarity of study materials, appeal to the existing user experience. Accordingly, information graphics is an intermediary in the path of choosing the trajectory of perception and information processing by student [64, p. 200] and so it is a significant tool in students' brainwork organizing. In general, Iryna B. Chebotarova [14] based by way of presentation and type of information proposes to consider 5 types of infographics (Fig. 3 shows it).

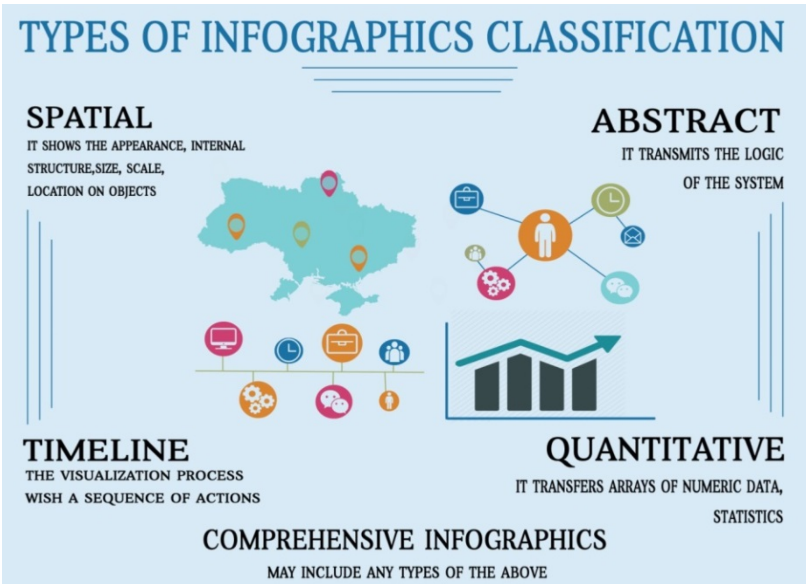

Fig. 3. Types of infographics by way of presentation and type of information (it prepared by authors on the analogy of [14])

These are such as:

- The spatial infographic showing the appearance, internal structure, size, scale, location of objects, path from one to another.
- The timeline infographic illustrating either chronology or a sequence of actions.

- The abstract infographic transmitting the system's logic (hierarchy, block diagram, diagram of relations, mind maps, etc.).
- The quantitative infographic reproducing arrays of numeric data or statistics.
- The comprehensive infographics that can include any above-listed types [14, p. 10-11].

These visualization tools are widely applied in textbooks and all kinds of reference books containing summary information and commonly used knowledge.

In view of the above, infographics have a high potential that can be used as a useful tool to intensify the students' brainwork. Infographic objects stimulate the simultaneous operation of the left and right hemispheres of students' brains complementing the imagery of an abstract model of the object, making the perception more comprehensive, the thinking – deeper, the learning – more interest and intense [58].

The review of major visualization tools (mind maps, infographics, support notes) made determines their essential importance for the fruitful students' brainwork thanks to the physiological and psychological mechanisms of its intensification that realized in them.

4 Techniques of computer visualization the study materials

4.1 An overview of leading ways to visualization

Different tools can be involved in the visualization including computer and non-computer ones. The first way is based on use widely available computer software, which developers provide opportunities for visual representation on the screen or in the printed form of abstract objects, processes, their models, and whatever. In spite of all the attractiveness of prepared computer visualizations, self-created diagrams, maps and infographics have considerable advantages, in particular: it is the quickness and the possibility to reproduce at any moment and wherever, better memorization and more painstaking students' thinking activity [70]. Consider the methods of their creation and approaches to use in the mathematics learning process.

The technique of "supportive notes" was proposed by Viktor F. Shatalov. He developed and put into practice the technology of study intensification that showing the huge, not yet discovered reserves of the traditional class-and-lesson system [55]. We mean the following aspects. The "support" is an indicative basis of actions, a way of external organization of the student's internal mental activity. The "support signal" is an associative symbol (sign, word, diagram, pattern, etc.) replacing a certain semantic meaning. In turn, the "supportive note" is a system of support signals in the form of a short conditional synopsis. In it all basic concepts and methods are introduced and explained, the illustrative examples, control questions for self-testing, and the solutions of typical problems are given. The material is presented in the same sequence like in the lectures but without evidence. Only definitions, formulations and explanations of the material, its interpretation, as well as drawings, conclusions, rules are given. The secondary issues are generally being omitted here.

Pedagogical experience usually uses teacher-pre-prepared supportive note, for example, to prove theorems, explain complex concepts, interrelations between mathematical concepts, memorize patterns, and so on. The lecturer presents the students with a supportive note, explains its structure. During the course of the explanation students redraw the note, or, using a ready one, make explanations, notes or markings in it. While working out this material at home, the student as if reproduces it according to the supportive note's logical structure. Individual students may be asked to write supportive note independently [60].

The supportive notes on mathematics can be made in the form of frames, logical circuits, part-whole schemes, radial circuits, clusters, Euler-Venn diagrams, Pyramid-type circuits, tree structures, and whatever [70].

A mind map is a way to visualize the process of thinking by creating non-linear schemes. This is a way of fixation the process of thinking, which most similar to how thoughts and ideas are being born and developed in our brain.

The map has a so-called radial structure, remotely resembling a tree, or a spider, or an octopus, or whatever that has a center and branches. The procedure for working on the creation of mind maps implies the following sequence of actions. In the center of the sheet the main image (generic concept, phenomenon, and problem) is being drawn. From it the key branches of the first level to the images illustrating the specific concepts that associated with central image is being led. It is recommended the branches reflect top ideas revealing these associative links. Further the branches of the first level will be digress from the branches of the second level, and so on until the whole issue is clearly worked out or the task is not addressed. Blocks should not be placed tight enough, as they can be supplemented, become surrounded by new connections, branches, data, examples, etc. [10].

The geometric data (families of triangles and quadrilaterals and their properties, shapes in space and plane) are conveniently to represent on mind maps. Algebraic mind maps are also popular. They show methods of solving logarithmic, trigonometric, quadratic, etc. equations, actions with numbers, and rule of differential and integral calculus.

The infographic is one of the forms of graphic and communication design of study material intended to present information quickly and clearly [62]. Not only infographics organize large volumes of information, but it also more clearly shows the links between objects and facts in time and space, as well as demonstrate trends. This visualization tool is widely used in textbooks and all kinds of reference books for math containing summary formulas and commonly used mathematical transformations, heuristics, and other interesting things.

As researchers consider there are two approaches to infographic design [33]. One is the explorative way elaborated by Edward Tafty [15]. This approach is characterized by a minimalist format. Here everything irrelevant isn't being indicated, and the information is being conveyed as accurately as possible. Another direction is the storyline or narrative approach based by Nigel Holmes, who created the explanation graphics [24]. The specified direction of infographic is characterized by attractive images, expressive design, illustrative [46]. In our opinion it is advisable to use a harmonious combination of both approaches for intensification the students' training as well as their brainwork.

Evidently, it's not easy to create quality infographics. So as to work up a functional infographic, one has to go through many variants of their presentation, has basic knowledge about tools of information's performance, and a high level of understanding of this process. Infographic is atypical visualization. It has own peculiarities and differences. As researches emphasize the infographic is an individual manual work for a particular dataset [46].

The creation and use of paper non-computer visualization tools are quite painstaking and ungrateful work. It's no wonder that in nowadays the computer visualization is haven a number precedence over non-computer one and being use more and more in educational process.

Natalia M. Biloshapka interprets the concept of "computer visualization" as an app, in which it's possible to visually present on the computer screen abstract mathematical objects and processes, their models in a compact form (if necessary in various viewpoint), or vice versa, in detail – with the possibility of demonstrating the internal interconnections between the components that are usually hidden in the real world [6].

When all's said and done the impact of computer visualization on the intensification of students' brainwork should be resulted and generalized.

We suppose the visualization of study materials is:

- contributes to the better assimilation its scientific structure by students;
- enables to independently select the pace of mastering a new study material;
- opens the possibility of manipulation of information for the purpose the efficiency of the organization of independent work and repetition of previously studied material;
- presented the dynamic information activates the simultaneous operation of different types of memory that in turn increases the degree of the information perception, and in the end enlarges the efficiency of the student's brainwork.

The aforementioned features allow students to integrate both traditional statistical information and dynamic knowledge during the brainwork.

4.2 A survey of computer visualization software

Computer visualization tools designed to support the teaching of mathematical subjects are divided into two types: general purpose software and specific mathematical one [54].

General purpose software tools provide a presentation of study material in a compact, logical, holistic form that makes it possible to intensify learning, effective of learning activities and, in the end of the day, to shape the culture of students' brainwork.

In the heart of general purpose tools is computer graphics allowing to create, edit, and convert graphics for any goals. Appropriate software has been developed for working with graphic information including viewers, graphic editors, photo editors, as well as specific tools – a graphic tablet, a digitizer.

There are various graphic editors and packages (Adobe Photoshop, CorelDraw, 3D Studio MAX, AutoCad and others), multimedia product development and demonstration programs, text editors, and desktop publishing apps, etc. They allow adding arsenal of visualization tools of educational information. In particular, these are enable to use elementary and complex geometric shapes; to correct and to draw fairly complex lines of different thickness and texture, to adjust points of various sizes, to do fill, repaint, exchange colors and their brightness and transparency, to work with fonts and graphic templates, to experiment with scaling, proofs and layout of elements, with shadows and whatever [70]. However, successful work with such software requires lecturers and students specific art and graphic abilities and skills. The Figs. 1-4 are shown the results of the creation of such tools for visualization of study materials. So, further it will be look at computer visualization tools that can be mastered by any average person at the competence's level.

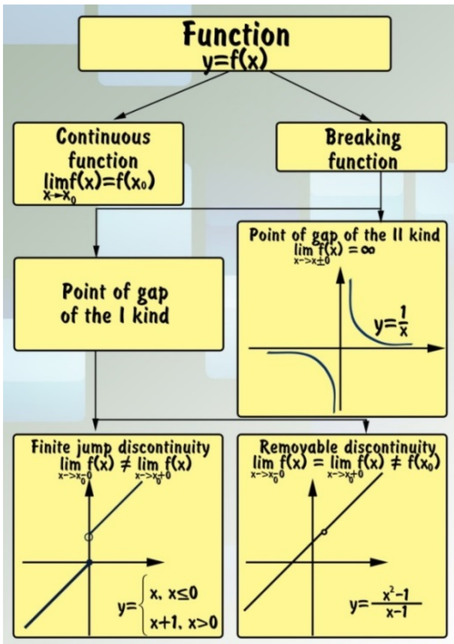

Fig. 4. The supportive notes prepared by one of authors in Adobe Photoshop environment

Researchers (for example, Olena V. Semenikhina and Natalia M. Biloshapka) include to general purpose software set following: 1) office software packages with Smart-Art objects; 2) apps for realization of mind mapping technology; 3) apps for creating infographics; 4) apps for creating a scribing presentation [53].

Smart-Art objects are a new type of graphic objects allowing the data in a text document are being structured or presented their in schematics. It makes possible to do the mastering of a new study material visual and step-by-step (by algorithmic way).

Mindmapping is a technology enabling to systematize and synthesize the knowledge gained through the formation of mind maps [45].

Scribing – sketches or drawings – the latest presentation technique, in which speech is illustrated with drawings. It creates a “parallel passage effect”. In result we hear and see the same thing, but the graphic is fixed only the key points of audio series. In this sense, scribing can be put on a par with infographics. Computer scribing presentation can be made with the PowToon service and the VideoScribe software, as well as modern smart-systems. It should emphasized the scribing presentation also requires mastering a certain art and graphic skills [38].

Therefore, we would like analyze in more detail the software environments for making the computer visualization of study material. Among the applications that allow the creation of mind maps and infographics there are the standalone applications – XMind, FreeMind, Mindjet MindManager 2019, as well as the cloud services – MindMup 2 For Google Drive, Bubbl.us, Mindomo Basic, and a lot of others.

XMind is a software tool to make visualization means that is installed on different operating systems. The program contains a large set of pre-made templates that can edit and create author’s visual products. The software toolkit lets to do export documents to Microsoft Word, Microsoft PowerPoint, PDF-editors, to choose image format (bmp, jpg, gif, and png). The program has several versions: free proposal with cut-down features and paid one with advanced functionality [65].

The main disadvantage of using the XMind free version is the inability to add images, mathematical formulas, videos, audio and more things to the illustration. In a word, such visualization tool can contain only text and character information.

Mind maps created in the XMind free version can be used in higher mathematics practical classes at the stage of actualization students’ supporting knowledge. For example, during students study the content of topic “Straight line on the plane” the lecturer at the beginning of the practical training indicates by means of mind map (see Fig. 5) names of the basic types of the equations and main simplest tasks about straight lines on the plane. From one’s part students must supplement each name with the corresponding mathematical description that they got to know within a lecture.

A such form of consolidated of study material contributes to the intensification of students’ brainwork, because the completed mind maps can be used repeated, after addition and processing. It causes the model of study information to be fixed in the students’ imagination and fasten into long-term memory.

FreeMind is a free mind maps builder running on any Java-enabled platform. The program has advanced export capabilities in png, jpeg, xml, html, xhtml, OpenDocument Text formats; plugin for export to svg and pdf. Exporting xhtml allows to create a mind map with links to external sources. In fact, the program has all the tools and features that need to make high-quality vizualization tools [36].

Consider an example of a mind map created in the FreeMind software environment. In course of the presentation study material “The derivative and its application” at the lecture session the main topic’s directions could be advisable determined via the structural and logical scheme (it shown on Fig. 6). Further this mind map can serve for a guide mark at the stage of generalization and systematization of students’ knowledge for establish gaps in the studied material.

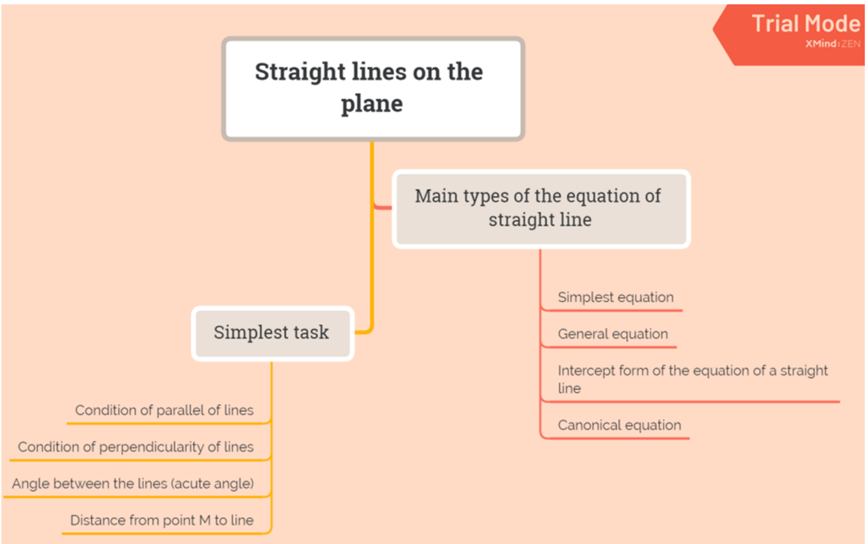

Fig. 5. Mind map created by one of authors into XMind

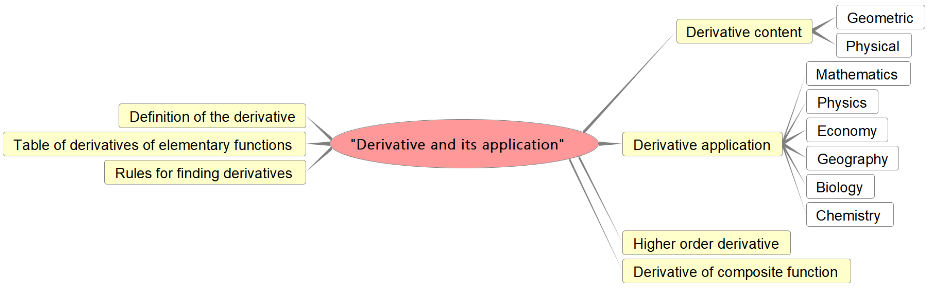

Fig. 6. The structural and logical scheme "The derivative and its application" created into the FreeMind software environment

Mindjet MindManager 2019 is commercial software for managing visualization tools. This app offers the different ways to create mind maps. It can be a blank map to which one adds all the necessary data, or a template, or a part of an existing map as the basis for a new one. MindManager cards can be exported to Microsoft Word, PowerPoint, Visio, and Project, saved both web pages and PDF documents. It should be noted the capabilities of MindManager in the stylistic design of different types of mind maps are quite wide [41].

Let's consider an example of using MindManager cards in course of studying the topic "The Polyhedron". The structure of mind map (see Fig. 7) is reflecting the classification of polyhedron based on the properties polygons that are the faces of polyhedron. Apparently, such maps help to develop the students' abilities to generalize and classify objects by generic, species and other characteristics; as well as they contribute to the streamlining of knowledge and a deeper understanding of the semantic structure of the topic. To general advantages of the mind map “Polyhedron” should be add possibility to create a set of tasks with incomplete data. It can be cards with polyhedron names but without corresponding images, and vice versa; as well as cards with images but without formulas, and on the contrary.

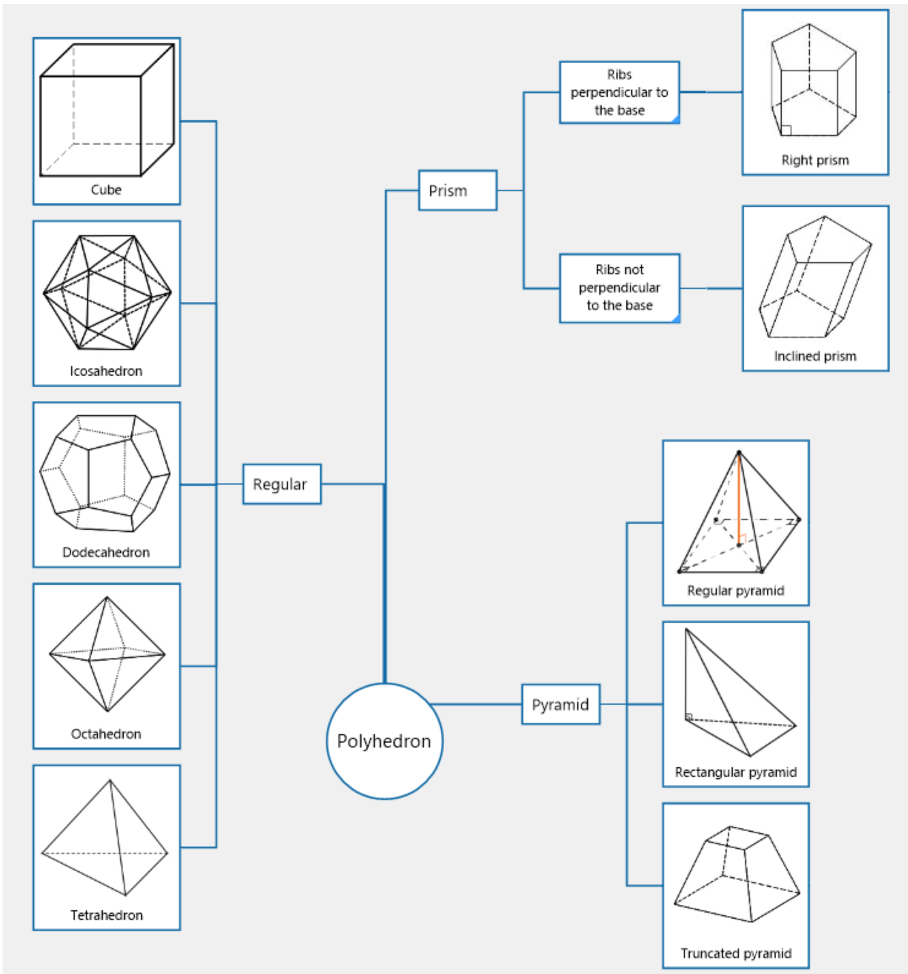

Fig. 7. The mind map for studying the topic “The Polyhedron” prepared in MindManager environment by one of authors

Let’s consider an example of using MindManager cards in course studying the topic “Matrix” (see Fig. 8). Such mind map can be used as basis to task solution on highlight key concepts of the topic. What’s more it can also be used as a basis for hands-on exercises on to supplement the mind map with missing information, in particular: to add a images of the matrices types, the scheme of actions over matrices, formulas of properties of actions with matrices, schemes and formulas for calculating the determinant of the matrix, and whatever.

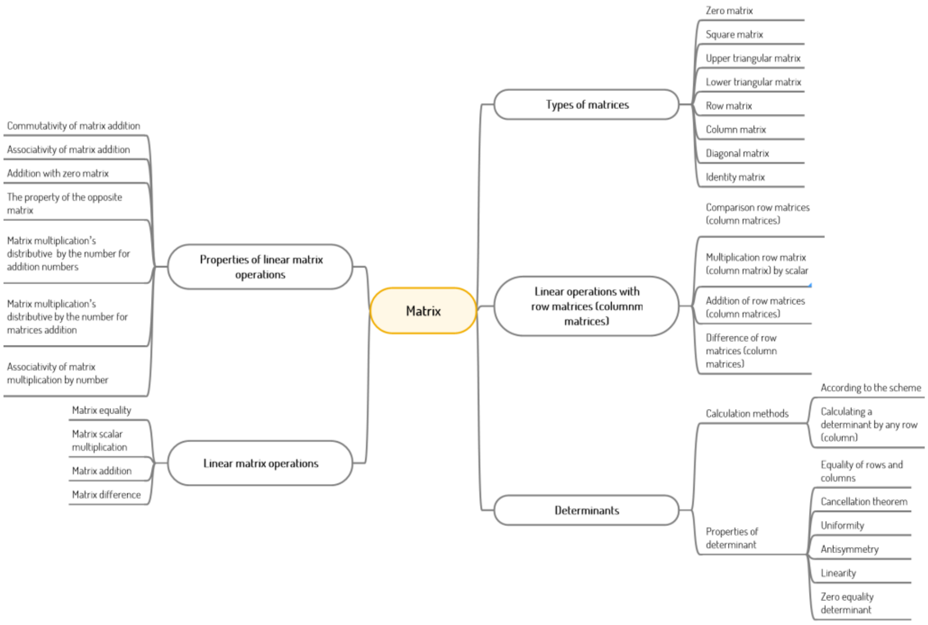

Fig. 8. Mind map "Matrix" prepared in MindManager environment

Students are able to do it, either in MindManager app or in any other graphic editor or by hand on the printed maps.

MindMup 2 For Google Drive is a local app that integrates with Google Drive users. Mind map created in this online service saves automatically. However, the possibility to export mind maps for the free version is limited only objects to 100kb in size. In addition, Google Drive mind maps can only be stored for 6 months. A Custom Gold package allows creating mind maps already to 100MB and store them on Google Drive. The Corporate Gold package removes any restrictions for users [42].

Bubbl.us is a relatively free local software environment for creating simple mind maps and exporting them in image format. The program can change the color and font of the text, the color of the nodes, and the general color scheme of the intellect card [40].

Thus, despite the various functional capabilities, the apps that were discussed above are built on the basis of a united principle for creating visualization tools of study material for any educational subjects.

4.3 The special mathematical visualization software

Special mathematical visualization software includes programs of dynamic mathematics. They provide dynamic operation of various mathematical objects with the possibility of interactive obtaining of information about their properties [6]. These programs allow doing animation and manipulation with mathematics' objects. One such software environment is GeoGebra [28].

GeoGebra is a free math program including tables, graphs, statistics and arithmetic. It benefits embrace a friendly interface and powerful features that allow creating interactive study material [48].

Major resources of this system cover to: calculation of mathematical functions, creation of Java applets for insertion into Web pages, integration with the system of distance learning courses [17]. The GeoGebra can also use as a virtual lab for developing interactive models of mathematical objects, as a scribing tool, as an environment for creating illustrative material and developing interactive exercises.

Consider the functionality of the GeoGebra in course of study of the unit "Derivatives and its application". As our experience is shown the most effective and expedient is the use of a dynamic mathematics system on such stages of studying a topic, namely:

- finding a derivative of function (students can perform a self-test by comparing their results with the result of a program; it contributes to saving time);
- finding the equation of tangent line to the graph of the function (students construct the graph of function and find equation of tangent line analytically, and then on the type of completed construction they determine whether the desired line is tangent one);
- using the derivative of function to solve applied tasks (exploring the models into GeoGebra);
- studying the monotonicity and extrema, convexity and inflection points of the function (student checks the correctness of conclusions by plotting the graph of a derivative function by means of GeoGebra) [12].

The tasks are being carried out into the GeoGebra software environment aren't just illustrations. While the working the app saves an algorithm with all the steps and raw data that can be edited as needed. Any changes to the algorithm are immediately reflected in the graph. This significantly reduces the time spent on correcting errors, since it does not require repeated execution of the task from the first step [67].

One advantage of using the GeoGebra system is the possibility to manipulate of mathematical objects that allows keeping track the changes in their geometric interpretation. In Fig. 9 the intermediate and final results of modeling into the GeoGebra environment while studying the topic "Sum and Difference of Complex Numbers" is shown. In this model the complex numbers are given in algebraic form then the results of actions on them in graphical form are represented. To change the parameter values into the environment there are sliders located on the top right of the screen.

The solving higher mathematics tasks in the GeoGebra software environment, students should not be given a readymade dynamic model or a readymade demonstration algorithm. Initial skills in working with GeoGebra should be given, and then offer to students to create of graphic images of the studying subject.

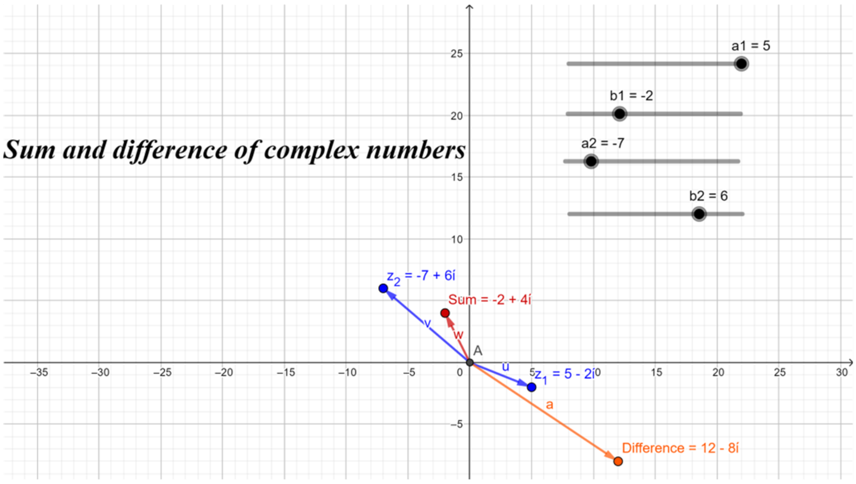

Fig. 9. The results of work into the GeoGebra environment

It can be concluding that the use of the GeoGebra mathematical program allows submit calculations in an easy-to-read form, to combine calculations and construction on united worksheet, thus increasing the studying productivity. It taken into account that getting outcome during changing the value of the parameters does not require additional calculations, any notes or create consistent conclusions. The involvement of the dynamic GeoGebra program leads to an intensification of the students' brainwork as the process takes place against the background of instant visualization [47].

The solving higher mathematics tasks in the GeoGebra software environment, students should not be given a readymade dynamic model or a readymade demonstration algorithm. Initial skills in working with GeoGebra should be given, and then offer to students to create of graphic images of the studying subject. This kind of activity contributes to the students' brainwork intensification and the deeper learning of the mathematic.

4.4 The investigation of effectiveness of usage the computer visualization tools as a means of intensification the students' brainwork

In order to test the effectiveness of the study material visualization for the purpose of intensifying the students' brainwork the experimental work has been organized. The investigation has been conducted on the Technology and Preschool Teacher Faculty of Kryvyi Rih State Pedagogical University throughout 2017-2018 years and covered 213 number of participated.

During the experimental work it has been developed and tested: a set of mind map, infographics, supportive notes to the main units of the course "Higher Mathematics"; methods of working with them both in the classroom and in the process of students' independent study activity; a system of training tasks based on computer visualization tools including mining and scribing presentation. Some aspects of the above are disclosed in the previous text of this paper.

The intensification of students' brainwork in the teaching of mathematical sciences was ensured by the involvement of certain computer visualization tools to solve competently oriented tasks, among them: creating of visual models to basic mathematical concepts, laws and rules; working with the prepared visualization tools manually and with use visualization software; compiling a task system via the computer and ICT tools.

The effectiveness of the developed methodology the students' brainwork intensification via the computer visualization of study materials has been evaluated by such indicators as: the degree of mastering the main concepts of the topic (diagnostic control work); interest in the subject and in the study of visualization tools (questionnaires and interviews with students and lecturers); time required for learning mathematical concepts and laws (chronocards methods).

It has been fixated the students highly appreciated the opportunity not only to reduce the time for the preparation to the classes but also to acquire the professional skills of the organization of brainwork by means of computer visualization tools. 63,2% of the students give preference to use general-purpose tools of computer visualization to develop their professional careers. At the same time 81,6% of students are inclined to apply the special mathematical visualization software. 51% perceive would like be able to obtain specialist knowledge in the management of the other people's brainwork (students, subordinates, project team members and whoever).

By virtue of the experiment results an increase in the degree and completeness of mastering knowledge in mathematical sciences by students has been noted (see Fig. 10).

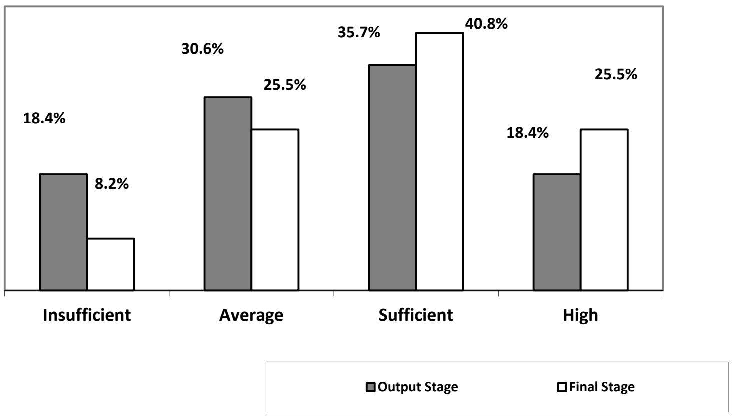

Fig. 10. Dynamics of the levels of students' knowledge mastering in line with experimental work's results

In order to find out the degree of intensification the students' brainwork a chronocards method has been applied. They have been used to record the time spent on by students to solve learning tasks via computer visualization tools. The degree of intensification the students' brainwork has been estimated by the coefficient of intensification. This is a correlation between time that students spend on to execute the tasks with use the computer visualization tools and non-computer ones (to take more details see Table 1).

Table 1. The coefficient of effectiveness the use of computer visualization tools in the process of higher mathematics study

Types of tasks	The coefficient	
	Output Stage	**Final Stage**
Definition of mathematical concepts	1,1	0,8
Terminological work	1,2	0,5
Graphic, computational and practical tasks	1,0	0,7
Educational projects	0,8	0,5
Mastering the mathematical concepts and laws	0,8	0,5
Concretization of knowledge	1,2	0,8
Systematization of knowledge	1,3	0,7
Search for interrelation between mathematical concepts	1,4	0,6
Building models of mathematical phenomena	0,9	0,5
Independent study work	1,1	0,6
Creation of schemes, technological cards, consolidated tables, construction of charts and diagrams	1,2	0,7
Mindmapping	1,3	0,7
Self-monitoring, test-control	1,0	0,6

It should be noted that the obtained results confirmed the high efficiency of computer visualization tools to intensify the students' brainwork in the process studying of higher mathematics. Meanwhile, it has been confirmed the introduction of computer visualization tools should be integrated one and provides for a variety of visualization forms, the methods of their creation and processing, and, last but not least, a necessity development of a special series of tasks which directed on working with them.

5 Conclusion

The analysis of the research results on the intensification of students' brainwork via the computer visualization tools has made it possible to draw the following conclusions:

1. The brainwork is a leading aspect of students' study and cognitive activity. This phenomenon implies mastering the techniques and ways of thinking, developing the individual's capabilities and abilities. Therefore, the issue of improving the efficiency of students' brainwork in the terms of the introduction of student-centered learning is an important pedagogical problem.
2. The intensification is defined as the process of increasing tensions, productivity, as the use of more and more efficient technologies, advanced methods of work, the achievements of science. The intensification of learning process lies simultaneously in the effectiveness of teaching, the effectiveness of studies and the effectiveness of study material. The computer visualization tools are such mechanisms. Thanks they are being used the speed of perception of information flows by means of visual

images increases significantly, and as a consequence the student's brainwork becomes more intense and productive.

3. The term "visualization" is defined as the process of presenting data in the form of an image for the maximum convenience of their understanding; it is visualizing any mental object. This phenomenon does not boil down to illustrating and demonstrating the study materials. In the educational process, such leading forms of visualization of study materials as supportive notes or schemas, intellect cards, mind maps and infographics are widely used. Different tools are involved in the visualization including computer and non-computer ones.
4. Computer visualization is thought like an app, in which it is possible to visually present on the computer screen abstract mathematical objects and processes, their models in a compact form or vice versa, in detail. There is the computer visualization tools designed to support the teaching of mathematical sciences. They are being divided into two types: the general purpose software and specific mathematical one. The intensification of students' brainwork via computer visualization tools requires the development of a special methodology to use it in the Higher Mathematics course, and a system of training tasks based on so-called "minding" and "scribing".
5. An empirical research confirmed the effectiveness of using the computer visualization of study materials to intensify the students' brainwork in the teaching mathematical sciences' process. It was recorded that students praised the opportunity not only to reduce the time for preparing for classes, but also to acquire professional skills in organizing brainwork by means of computer visualization. Last, but not least, an increase in the degree and completeness of students' assimilation of knowledge in mathematical sciences is noted.

The presented study does not exhaust the problem of the students' brainwork intensification. On authors opinion it should expediently develop the content of special courses aimed at forming the culture of students' brainwork both with the help of modern information technologies and traditional non-computer ones.

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The usage of digital technologies in the university training of future bachelors (having been based on the data of mathematical subjects)

Oksana M. Hlushak[1[0000-0001-9849-1140]], Svetlana O. Semenyaka[1[0000-0001-5083-1433]], Volodymyr V. Proshkin[1[0000-0002-9785-0612]], Stanislav V. Sapozhnykov[2[0000-0001-6674-7631]] and Oksana S. Lytvyn[1[0000-0002-5118-1003]]

[1] Borys Grinchenko Kyiv University, 18/2 Bulvarno-Kudriavska Str., Kyiv, 04053, Ukraine
o.hlushak@kubg.edu.ua, s.semeniaka@kubg.edu.ua, v.proshkin@kubg.edu.ua, o.lytvyn@kubg.edu.ua

[2] Alfred Nobel University, 18 Sicheslavska Naberezhna Str., Dnipro, 49000, Ukraine
sapozhnikov70@meta.ua

Abstract. This article demonstrates that mathematics in the system of higher education has outgrown the status of the general education subject and should become an integral part of the professional training of future bachelors, including economists, on the basis of intersubject connection with special subjects. Such aspects as the importance of improving the scientific and methodological support of mathematical training of students by means of digital technologies are revealed. It is specified that in order to implement the task of qualified training of students learning econometrics and economic and mathematical modeling, it is necessary to use digital technologies in two directions: for the organization of electronic educational space and in the process of solving applied problems at the junction of the branches of economics and mathematics. The advantages of using e-learning courses in the educational process are presented (such as providing individualization of the educational process in accordance with the needs, characteristics and capabilities of students; improving the quality and efficiency of the educational process; ensuring systematic monitoring of the educational quality). The unified structures of "Econometrics", "Economic and mathematical modeling" based on the Moodle platform are the following ones. The article presents the results of the pedagogical experiment on the attitude of students to the use of e-learning course (ELC) in the educational process of Borys Grinchenko Kyiv University and Alfred Nobel University (Dnipro city). We found that the following metrics need improvement: availability of time-appropriate mathematical materials; individual approach in training; students' self-expression and the development of their creativity in the e-learning process. The following opportunities are brought to light the possibilities of digital technologies for the construction and research of econometric models (based on the problem of dependence of the level of the Ukrainian population employment). Various stages of building and testing of the econometric model are characterized: identification of variables, specification of the model, parameterization and verification of the statistical significance of the obtained results.

Keywords: digital technologies, e-learning course, economic and mathematical modelling, econometrics, university training, future bachelor.

1 Introduction

In the conditions of modern development of the economy of Ukraine, special attention is paid to solving complex theoretical and applied problems that quantitatively and qualitatively describe the relationship between different economic objects [10]. It demands the development and study of new areas of economic theory and related scientific disciplines. First of all, there is a need for the development and implementation of innovative teaching methods, the usage of which would make it possible to form for future bachelors new economic thinking and understanding of the essence of economic processes or phenomena, to obtain appropriate know-how of regulation and management of these processes at any level of complexity, to predict their development [23]. In this regard, the formation and development of competencies associated with the ability to optimally combine the possibilities of logical analysis with knowledge not only of the laws of mathematics and economics, but also the basics of mathematical modeling become important.

Mathematical modeling with the maximum usage of its potential makes it possible to identify and solve professional problems of different nature: to define clearly the purpose of the research, to find quickly possible ways to achieve it, to develop appropriate models of economic objects or phenomena and on the basis of these models to create effective algorithms and programs for optimal solutions to current problems [19]. Obviously, mathematics in the system of higher education has outgrown the status of the general educational subject and should become an integral part of the professional training, on the basis of intersubject connections with special subjects [14]. In this regard, it becomes actual to resolve the contradictions between the needs of highly qualified specialists who effectively use mathematical tools in their professional activities, and the lack of scientific and methodological support for mathematical training of students, in particular by means of digital technologies.

In Ukraine, the development of educational informatization takes place in accordance with national and European programs ("Digital agenda of Ukraine – 2020" [18], containing priority areas, initiatives, projects of digitalization of Ukraine until 2020, the thesis of the updated recommendations of the European Parliament and the EU Council for lifelong learning [7], etc.). Various aspects of educational informatization in the context of mathematical training of students have become the subject of research for a number of scientists. Thus, Natalya V. Rashevska [11; 20] investigated mobile information and communicational technologies of higher mathematics teaching. Kateryna I. Slovak [21; 22] developed a methodology for the use of mobile mathematical environments in the process of higher mathematics teaching for students of economic specialties. Oksana I. Tyutyunnik [15] described the usage of computer math systems in the process of linear programming teaching. Mariia A. Kyslova [12; 13] presented the development of mobile educational environment of higher mathematics, Mariia M. Astafieva, Dmytro M. Bodnenko and Volodymyr V. Proshkin [2; 1] found out the possibilities of the educational environment for the formation of critical thinking of students in the process of mathematics learning. Oksana M. Hlushak, Volodymyr V. Proshkin and Oksana S. Lytvyn [9] revealed the possibilities of e-learning course (ELC) on “Analytical geometry” in the process of professional training of students. In these works, the theoretical and methodological foundations of the usage of electronic educational environment in the process of professional training of bachelors are revealed, the tendencies of the development of mathematical educational informatization are indicated. The studies on the use of ICT in the process of economic and mathematical modeling learning are of particular interest. So, Dana Országhová [16] investigated the e-learning approach in mathematical training of future economists. Dimitros Asteriou, Stephen G. Hall [4, pp. 29–91] and Roberto Pedace [17, pp. 59–134] reviewed the classical linear regression model.

In the above mentioned works the features of formation of qualitative modern cloud-oriented educational environment in the context of mathematical subjects learning are presented. In addition, the experience of using e-learning courses is interesting for our research. Thus Charlotte Brooke, Pamela McKinney and Angie Donoghue [5] claim that students who take e-learning courses on the distance learning platform use their own time allocated for training more efficiently. Similar ideas are found in the works of other scientists (Jana Burgerova, Martina Adamkovičova [6], Paul Drijvers, Carolyn Kieran, Maria-Alessandra Mariotti, Janet Ainley, Mette Andresen, Yip Cheung Chan, Thierry Dana-Picard, Ghislaine Gueudet, Ivy Kidron, Allen Leung, Michael Meagher [8] etc.). At the same time, the analysis of scientific researches testifies the limitation of investigation methodical questions of learning econometric modeling in combination with ICT.

2 The objective of research

The purpose of the article is to highlight the areas of the use of digital technologies in the university training of future bachelors (having been based on the data of mathematical subjects).

3 Research methodology

The usage of appropriate methods such as scientific literature analysis with the aim of establishing the state of readiness of the studying problem, the definition of categorical and conceptual apparatus of the research; synthesis, generalization, systematization of theoretical justification of the use of digital technologies in the educational process at the university and empirical ones: diagnostic (interview, content analysis, testing), statistical (Fisher and Student criteria) to test the statistical significance of mathematical model promoted to achieve the purpose of the research.

The research was carried out within the framework of the project “Partnership for mathematics learning and teaching at the university” (PLATINUM) of the EU Erasmus + KA203 – Strategic partnership for higher education, 2018-1-NO01-KA203-038887 and the complex scientific theme of the department of computer science and mathematics of Borys Grinchenko Kyiv University "Theoretical and practical aspects of the use of mathematical methods and information technologies in education and science", SR No. 0116U004625. The experimental base of the research is Borys Grinchenko Kyiv University and Alfred Nobel University (Dnipro city).

4 Results and discussion

We believe that in order to implement the task of high-quality training of students studying economic and mathematical modeling in "Econometrics", "Economic and mathematical modeling" subjects, it is necessary to introduce digital technologies in two directions: for the organization of educational space and in the process of solving applied problems at the junction of the branches of economics and mathematics branches.

The background for the organization of educational space is the availability of the necessary material and technical base (computers, software, communication channels) and informational educational environment, the effectiveness and basis of which are digital technologies. We believe that the informational and educational environment can be organized through the activities of the teacher with the use of an e-learning course of the subjects that are aimed at teaching economic and mathematical modeling, on the basis of the distance learning platform. The Moodle distance learning platform has been introduced into the educational process at the Borys Grinchenko Kyiv University. Therefore, electronic courses of "Econometrics", "Economic and mathematical modeling" subjects are presented on the basis of this platform.

Let us present the advantages of ELC using in the educational process.

Firstly, it is providing the individualization of the educational process in accordance with the needs, characteristics and capabilities of students. The basis for the implementation of this ELC characteristic is clearly structured nature, so that the placement and sequence of teaching materials corresponds to the logic of the mathematical subject studying. For example, the ELC can be presented in the form of a chain: a description of the ELC indicating the educational and professional program; general information of the academic subject (working curriculum, syllabus, assessment criteria, sources, glossary, announcements, information about the author); teaching materials for each module: theoretical material, practical (laboratory, seminar) works, tasks for individual work of students, modular control, accompanied by video materials and hyperlinks that allow students to increase the amount of information. Besides, ELC provides information for the final assessment (advancement questions, self-assessment test, final test) and contains a list of references and addresses of Internet sources for the implementation of independent students' work.

Indeed, the structure of ELC allows students to choose a convenient time and rate of assimilation of mathematical material, based on their own rhythm of life, individual characteristics and abilities. This helps in the best way to realize an individual educational trajectory consistent with the following principles: education is for everyone and is lifelong.

Secondly, it is improving the quality and efficiency of the educational process. This characteristic is directly correlated with the quality of teaching materials, allowing to form the mathematical competence of students [3]. The advantage of ELC is the following one: its content can be constantly updated in accordance with the development of mathematical science, the latest methods of the educational process. As a rule, the ELC consists of two types of electronic resources:

- resources designed to present the content of educational material (lecture notes, multimedia presentations of courses, audio and video materials, guidelines, etc.);
- resources that provide the consolidation of the studying material, the formation of skills, acquisition of competencies, self-assessment and evaluation of educational achievements of students (tasks, questionnaires, testing, forums, including using of Web 2.0).

The ability to receive advice, recommendations and explanations through digital interaction, for example, in forums, also contributes to the quality of students' education.

It should also be noted that the quality of the ELC is also related to the fact that these resources are created and reviewed by a number of teachers whose mathematical competence meets the immediate requirements of the time.

Thirdly, it is ensuring systematic monitoring of the education quality. In order to implement this characteristic, a clear schedule of the curriculum for implementation by students has been submitted on the ELC website. There are also opportunities for interactive communication between teachers and students, as well as students among themselves. ELC contains a system of monitoring and evaluation of all types of educational activities of students. Thus, for the self-test, the testing is submitted. Assessment of tasks is carried out automatically that excludes subjective assessment from the teacher.

According to the above mentioned, electronic educational courses of "Econometrics", "Economic and mathematical modeling" subjects have the unified structure (Fig. 1): general information on the subject (curriculum of the subject, plan, assessment criteria, printed sources and Internet resources, glossary); thematic modules, which include information about the main topics of the module the theoretical material in the form of a structured lecture material submitted by means of the lesson, multimedia presentations of lectures, audio, video learning materials and tests (training and advancement); laboratory work, which reflect the content of the work, list of individual tasks and methodical recommendations about performance of work; tasks for individual work with the guidelines of the performing task, a list of individual tasks and their assessment criteria; tasks for module test, which provides individual tasks and criteria of assessment of the work performed.

Each of these ELC blocks contributes to the implementation of individual tasks. Thus, the theoretical material is built in such a way that a student who missed classes could easily master the training material, and a student who was in the audience at the lesson could systematize the material obtained at the lesson, test himself for understanding and perception of the topic with the help of tests, which had been built into the lectures. If students have questions, they have the opportunity to ask them on the forum discussion on the topic of each content module.

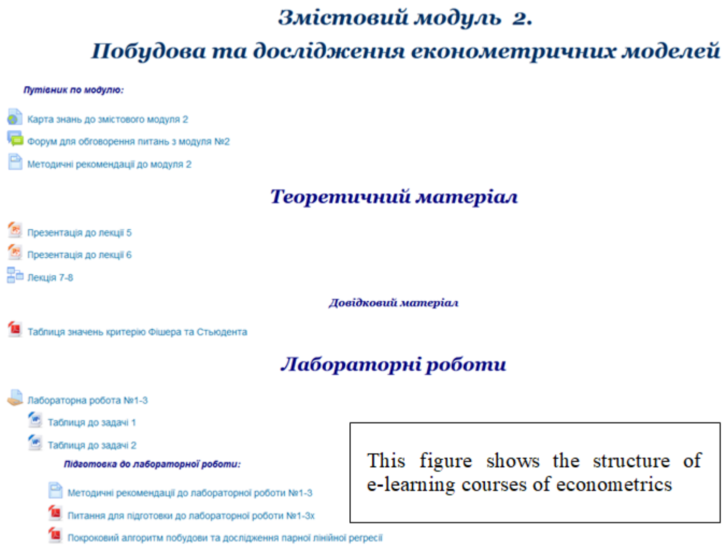

Fig. 1. ELC structure of “Econometrics”

ELC laboratory works are presented in the form of web pages with a common structure: theme, purpose, tasks, form of result presentation, deadlines and assessment criteria (Fig. 2). Educational and methodological materials recommended to read are presented under the laboratory work: these are guidelines for tasks, questions for laboratory work, preparation step-by-step algorithms for tasks, examples of construction and research of models. In addition, the block of laboratory works contains instructional videos for performing tasks according to protocol of the laboratory work.

For self-test is planned the block of the task for individual work of students which provides individual tasks for each student, methodical recommendations to their performance and advancement questions.

At the end of the study of each module, a modular test work is offered for students of economic and mathematical specialties. The form of module tests for each content module is different: a complex test that involves answers to 40 questions of different types: multivariate, alternative, with a short answer, numerical, questions to establish compliance, or the construction and research of economic and mathematical models for an individual set of input data.

In our opinion, such a methodological approach to supply educational material with the use of digital technology for building electronic educational environment will promote student’s motivation for the subject learning, implementation of a systematic approach to mastering academic content and implementation of the principles of personality-oriented approach. Therefore, due to the use of this ELC in the educational process of studying “Econometrics”, “Economic and mathematical modeling” subjects, the teacher will be able to organize individual, group and frontal form of student work.

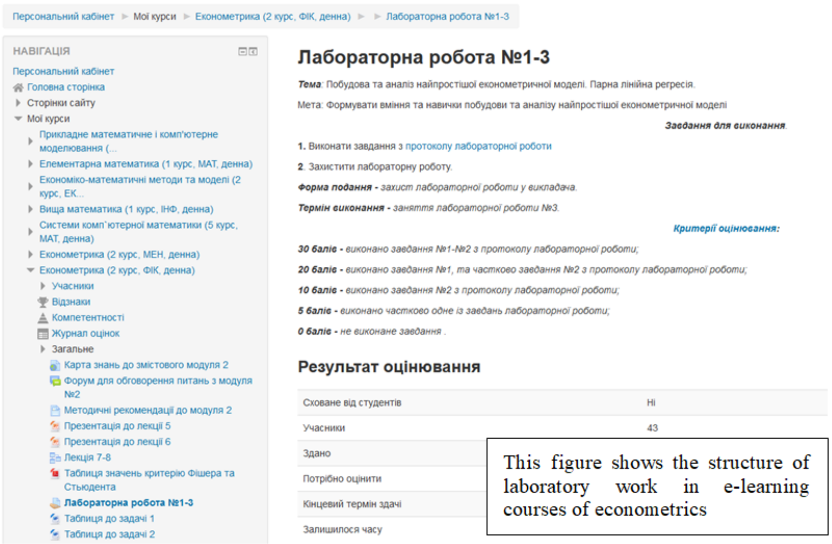

Fig. 2. Example of the structure of laboratory work

To find out the real attitude of students to the use of ELC in economic and mathematical modeling, we conducted a pedagogical experiment during 2018-2019. The basis of the experiment was Borys Grinchenko Kyiv University and Alfred Nobel University (Dnipro city). In total, 125 students of “Finance, banking and insurance”, “Management”, “Economics”, “Accounting and taxation” specialties took part in the research. Respondents were asked 10 questions about the usefulness of the ELC with economic and mathematical modeling with the following answers: “Yes”, “rather Yes than No”, “rather No than Yes”, “No”. In the research, we were interested only in “Yes” answer, which we considered as a clear indicator of readiness for the effective use of ELC in the educational process.

As a result of the survey, the following results were obtained (see table 1).

According to the results of the research, students generally express a positive attitude to the use of ELC with economic and mathematical modeling in the educational process. Special noticeable dynamics in the evaluation of the following indicators: is constant communication with the teacher (+7.2%), ability to study mathematics conveniently (+5.5%), favorable conditions for learning (+3.4%). The following indicators need to be improved: availability of educational mathematical materials that meet the requirements of the time; individual approach in teaching; self-expression of students and development of their creativity in the e-learning process.

The second direction of the introduction of digital technologies in the process of economic and mathematical modeling teaching of future bachelors is the demonstration of ICT as a tool for the construction and research of econometric models. Let’s consider more detailed influence of the following factors on the example of the problem of dependence of the level of employment of the population of Ukraine:

1. share of employees with higher education in % to the list number;
2. labor productivity growth rate;
3. growth rate of the average wage;
4. capital investment index;
5. export-import coverage ratio.

Table 1. Attitude of students to the use of ELC in economic and mathematical modelling

Questions	Answer: "Yes"	
	At the beginning of the experiment	At the end of the experiment
1. ELC provides opportunities to conveniently study mathematics (at any time, in a convenient place and pace)	16.3	21.8
2. The use of ELC improves the results of teaching mathematical subjects	12.2	14.2
3. ELC helps students to keep in touch with the teacher (on-line or off-line)	8.0	15.2
4. ELC is available educational mathematical materials that meet the requirements of the time	12.6	12.5
5. ELC provides an individual approach in the educational process	8.2	10.5
6. ELC of mathematical subjects effectively contributes to the formation of mathematical competence	12.3	12.7
7. ELC enriches the educational process with the most advanced digital technologies	8.0	8.9
8. ELC provides students with equal opportunities to study mathematical subjects	16.1	18.9
9. ELC does not limit self-expression of students and contributes to the development of their creativity	8.3	8.7
10. ELC creates favorable conditions for studying (ELC allows students to feel comfortable when checking knowledge; eliminates subjective attitude on the part of teachers)	8.9	12.3

The statistics for the task are taken from the official website of the State Statistics Service of Ukraine [24]. The problem will be solved with the help of general-purpose application software MS Excel.

The first stage for constructing and researching of an econometric model is the identification of variables. According to the results of identification we get:

Y – level of employment of the population of Ukraine;

X_1 – share of employees with higher education in Ukraine;

X_2 – growth rate of labor productivity in Ukraine;

X_3 – growth rate of average wages in Ukraine;

X_4 – index of capital investments in Ukraine;

X_5 – export-import coverage ratio in Ukraine.

The specification of the model is the second stage of construction, it provides the choice of the form of f communication between the factor and the resultant variable. We will carry out the construction of the correlation field depending on the level of employment of the population from each of the factors using a scatter chart in MS Excel (Fig. 3). To determine the best type of relationship between the factor and the result, we will use the trend line. Using the trend line format dialog box, we will display the coefficient of determination and the equations of the model on the chart (Fig. 4). Comparing the determination coefficients for each type of corresponding dependencies R^2, we can conclude that the most optimal were the dependencies for which the value R^2 takes the maximum value of possible ones. As a result, on the basis of the above research, it was established the existence of a linear relationship between the relevant factors of the econometric model.

Hence, the theoretical multiple regression equation will take the form

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + u, \quad (1)$$

where u – probabilistic component that is not directly determined from the equation.

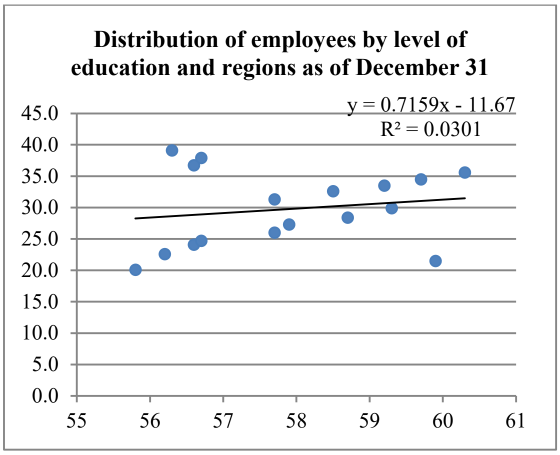

Fig. 3. Scatter chart

The next stage of the model construction is the parameterization stage: finding of parameter estimate $\hat{a}_i$ $(i = \overline{0,5})$ and constructing of the corresponding regression equation. This step can be implemented in MS Excel in several ways. The first method is purely mathematical, and consists in determination of the estimates of parameters using the least squares method using numerical calculations. To do this, we write down the vector-column of observations of the dependent (productive) variable Y and the matrix of observations of independent (factor) variables X_i and we apply to calculate estimates of regression coefficients by the formula

$$\hat{A} = (X^TX)^{-1}X^TY, \quad (2)$$

where $\widehat{A}$ - the vector is a column of estimates of the equation coefficients, X^T – the transposed matrix to the matrix $X, (X^T X)^{-1}$ – inverse matrix to the product of two $X^T X$. To implement this method, students will be able to multiply matrices, find transposed and inverse matrices in MS Excel using the mathematical functions MMULT, TRANSPOSE, MINVERSE.

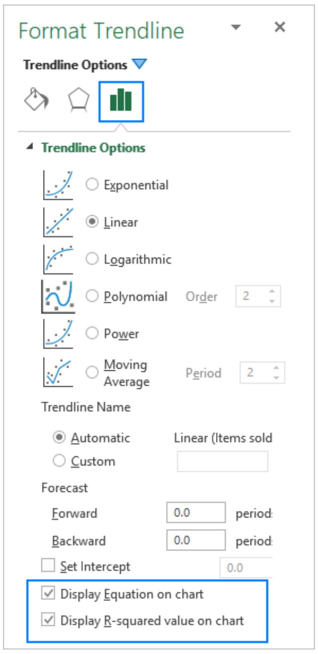

Fig. 4. The parameters of the trend line

The second method of finding parameter estimates is implemented through “Analysis package” add-in and “Regression” tool. After entering a range containing a set of statistics of the dependent variable (employment rate of the population of Ukraine) – Y and X_i a set of observations of independent (factor) variables MS Excel displays the results, which reflect the estimates of the coefficients (Fig. 5).

The third way to find parameter estimates is to use LINEST statistical function, which after entering the known values Y, X_i, constant and statistics, displays the result as a table of 5 rows and 6 columns by pressing the combination of Ctrl+Shift+Enter (table 2).

Table 2. The result of applying of LINEST statistical function

-0.8864	0.0157	-0.0017	0.00002	0.5061	45.7234
1.0676	0.0231	0.0020	0.0002	0.3097	8.0111
0.2517	1.5171	#N/A	#N/A	#N/A	#N/A
0.7401	11.0000	#N/A	#N/A	#N/A	#N/A
8.5174	25.3179	#N/A	#N/A	#N/A	#N/A

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,501728543
R Square	0,25173153
Adjusted R Square	-0,088390501
Standard Error	1,517111003
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	8,517410372	1,703482074	0,740121213	0,609206985
Residual	11	25,31788375	2,301625795		
Total	16	33,83529412			

	Coefficients	*Standard Error*	*t- Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95%*	*Upper 95%*
Intercept	45,72338655	8,011134005	5,70747993	0,000136673	28,09099949	63,35577361	28,09099949	63,35577361
X Variable 1	0,506111339	0,309699046	1,634203741	0,130483068	-0,175531665	1,187754343	-0,175531665	1,187754343
X Variable 2	-2,25217E-05	0,00023614	-0,095374478	0,92573268	-0,000542263	0,000497219	-0,000542263	0,000497219
X Variable 3	-0,001661698	0,002012612	-0,825642346	0,426551123	-0,006091427	0,002768032	-0,006091427	0,002768032
X Variable 4	0,015661933	0,023063952	0,679065462	0,511131637	-0,035101482	0,066425348	-0,035101482	0,066425348
X Variable 5	-0,886383793	1,067607512	-0,830252488	0,424049221	-3,236172083	1,463404498	-3,236172083	1,463404498

Fig. 5. Finding of parameter estimates using "Regression" tool of "Analysis package" add-in

The first row of the table shows the value of parameter estimates. Thus, the resulting multiple regression equation will take the form:

$$\hat{Y} = 45.723 + 0.506X_1 - 0.00002X_2 - 0.002X_3 - 0.016X_4 + 0.886X_5. \quad (3)$$

Note that the last two methods of finding parameter estimates, in our opinion, is advisable to use only after familiarizing of students with the first method, which demonstrates the step-by-step application of the mathematical apparatus for finding parameter estimates.

The next stage is the research of the model – check for adequacy, which involves finding the average value of the relative errors of approximation A_i, which are measured as a percentage and determined by the formula:

$$A_i = \left|\frac{u_i}{y_i}\right| \cdot 100\%. \quad (4)$$

Hence,

$$\bar{A} = \frac{1}{n} \cdot \sum A_i. \quad (5)$$

Students are offered to make these calculations in the table 3 and finding the coefficient of determination by formula.

Table 3. Table for registration of calculations

Y	X_1	X_2	X_3	X_4	X_5	$\hat{Y}$	u	u^2	$\frac{u_i}{y_i}$	Y^2

So, having carried out calculations we will receive

$$\bar{A} \approx 1.7\%, \quad R^2 = 0.888207527 \approx 0.89.$$

We can say that the model is adequate, since the average value of the relative approximation errors is in the range of 8-10%. The coefficient of determination tends to 1, and the closer R^2 to 1, the more significant is the relationship between these variables, that is, the change in the resulting variable is largely due to the change in the factor variable and only a small part of the changes – other factors.

The last stage of the research of the model is the check of statistical significance. To check the statistical significance of the results, we offer students two criteria: Fisher criterion (F-criterion) and Student criterion (t-criterion).

Checking the statistical significance, we put forward two hypotheses – the null hypothesis H_0: $R^2 = 0$ and the alternative one to it H_1: $R^2 \neq 0$. Next, we calculate the experimental value according to the formulas of each criteria, find the tabular values of each of the criteria for a certain number of degrees of freedom and compare the experimental values. Make appropriate conclusions: if the experimental value exceeds the table one, the null hypothesis is rejected.

Students should note that the tabular values for F-criterion) and t-criterion shall be found using the statistical functions FINV and TINV.

According to the described calculations we find $F_1 = 17.479$ and $F_0 = 3.204$. Since $F_1 > F_0$, the null hypothesis is rejected, so the model is statistically significant.

Similar results are obtained by the t-criterion. Thus, $t_1 = 9.349$ and $t_0 = 2.593$. Since $t_1 > t_0$, the null hypothesis is rejected, so the model is statistically significant.

5 Conclusions

1. As a result of the analysis of scientific sources it is established that mathematical modelling with the maximum use of its potential makes it possible to identify and solve professional problems of different nature: to define clearly the purpose of the research, to quickly find possible ways to achieve it, to develop appropriate models of economic objects or phenomena and on the basis of these models to create effective algorithms and programs for optimal solutions to current issues. It is noted that in order to implement the task of obtaining high-quality training of future bachelors on study of build and research of economic and mathematical modelling within "Econometrics", "Economic and mathematical modelling" subjects it is to introduce digital technologies in two directions: for the organization of educational space and in the process of solving applied problems at the junction of economic sectors and mathematics.
2. It is established that for the organization of educational space it is advisable to use e-learning courses of "Econometrics", "Economic and mathematical modelling" subjects, which is a complex of teaching materials created for individual and group learning using digital technologies for teaching mathematical modelling to students. Based on the indicated possibilities of application of the electronic learning course, as well as its didactic functions, the structure of the electronic learning course of "Econometrics", "Economic and mathematical modelling" subjects on the basis of Moodle platform is developed and described.

3. The results of a pedagogical experiment regarding the study of attitude of students to the use of electronic learning courses are presented. It is established that students in general positively evaluate the use of ELC in the educational process. At the same time, the following indicators need to be improved: availability of educational mathematical materials that meet the requirements of the time; individual approach in teaching; self-expression of students and development of their creativity in the e-learning process.
4. Features of application of MS Excel on an example of a problem of dependence of employment level of the population of Ukraine on influence of the chosen factors are considered. Various stages of building and study of the econometric model are characterized, they are following ones: identification of variables, specification of the model, parameterization and verification of the statistical significance of the obtained results.

We see the prospect of further scientific inquiry in the research of implementing an interactive approach using electronic learning courses.

Gratitude. The research, the results of which are presented in the article, was carried out in the framework of the project "Partnership for teaching and teaching mathematics at the University" (PLATINUM) of EU Erasmus + KA203 – Strategic partnership for higher education, 2018-1-NO01-KA203-038887. This article reflects only the views of the author and the European Commission cannot be responsible for any usage of the information contained here.

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Cloud technologies for enhancing communication of IT-professionals

Svitlana V. Symonenko[1[0000-0003-0599-3999]], Viacheslav V. Osadchyi[2[0000-0001-5659-4774]], Svitlana O. Sysoieva[3[0000-0003-2499-732X]], Kateryna P. Osadcha[2[0000-0003-0653-6423]] and Albert A. Azaryan[4[0000-0003-0892-8332]]

[1] Dmytro Motornyi Tavria State Agrotechnological University,
18 Bogdan Khmelnitsky Ave., Melitopol, 72312, Ukraine
svitlana.symonenko@tsatu.edu.ua
[2] Bogdan Khmelnitsky Melitopol State Pedagogical University,
20 Hetmanska Str., Melitopol, 72300, Ukraine
poliform55@gmail.com, okp@mdpu.org.ua
[3] National Academy of Educational Sciences of Ukraine,
52a Sichovykh Striltsiv Str., Kyiv, 04053, Ukraine
s.sysoieva@kubg.edu.ua
[2] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
azaryan325@gmail.com

Abstract. The paper deals with the urgent problem of enabling better communication of IT-specialists in their business and interpersonal interaction using information and communication technologies, including cloud technologies. It is emphasized, that effective communication is an integral part of the successful professional work of IT-professionals, but in recent years it has undergone significant transformations, which have been expressed in new forms and means of communication, its content changes, its complications and volume increases, the need to improve its accuracy, and the level of understanding for a wide range of people. Certain peculiarities of communication in the IT-environment have been discussed. It is noted that typical forms of communication in the IT-environment are synchronous and asynchronous ones. The authors insist that during their professional career IT-specialists communicate in the professional community from a variety of positions and common types of task formulation can be expressed through verbal or symbolic communication means. Due to the specifics of their professional activities, IT-professionals often need to communicate using synchronous communication (chats, video chats, audio chats, instant messaging) and asynchronous communication (email, forums, comments) tools, hence there is a demand to teach corresponding communication skills at universities. Certain practical examples of teaching communication skills using modern technologies are given. Advantages of cloud technologies for better communication within a company or an educational institution are presented. Microsoft Office 365 services, which can be successfully used to enable better communication and collaboration within a company or an educational institution are analyzed.

Keywords: Communication, Synchronous Communication, Asynchronous Communication, Collaboration, IT-professionals, Cloud Technologies.

1 Introduction

Effective communication is an integral part of the successful professional work of IT-professionals [6; 18]. Recently, it has undergone significant transformations, which have been expressed in new forms and means of communication, its content changes, its complications and volume increases, certain needs to improve its accuracy, and the level of understanding for a wide range of people. Moreover, such transformations have long been objectified in the leading countries of the world and reflected in numerous guidelines, for example, in the European Qualifications Framework (EQF), the National Qualifications Framework of individual European countries (Austria, Bulgaria, Holland, Denmark, Spain, etc.), the National Qualifications Framework of Ukraine (NQFU), the Common European Framework of Reference for Languages (CEFR) and Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering, Information Technology and Computer Science. Communication competence in these documents is defined as the dominant characteristic of a specialist, this concept determines the possibility of high-quality multicultural communication without loss of meaningful content of messages and more comfortable and constructive interaction between the subjects of communication. The NQFU includes descriptors of communicative competence which are not presented in the EQF as independent ones. Level 6 descriptors define the communicative competence as the ability to reporting information, ideas, problems, decisions and own experience in a field of professional activity to specialists and non-specialists, the ability to form a communicative strategy effectively. Level 7 descriptors suppose comprehensive and univocal reporting own conclusions, knowledge and definitions which substantiate them to specialists and non-specialists, particularly to learning people, application of foreign languages in their professional activity. Level 8 descriptors presume communication in the dialogue mode with broad scientific community and public in a definite field of scientific and/or professional activity [15]. The analysis of the NQFU and EQF allows us to trace the increase in communication requirements from one level to another in the descriptors of communicative competence. Some NQFU communicative competence descriptors do not reflect the international context, including communication in European languages.

The analysis of the documents mentioned above and a number of other guidelines makes it possible to confirm that the communicative role of IT-professionals becomes extremely important in the time of unification of large multicultural and multiethnic societies, because these specialists can create conditions for more comfortable entry of millions of ordinary people into the world of information and communication technologies. For these obvious reasons, the scientific and pedagogical problem which has a very promising character emerges: enabling better communication of IT-specialists in their business and interpersonal interaction using information and communication technologies, including cloud technologies.

The objectives of the paper are to outline peculiarities of communication in the IT-environment, overview the process of teaching communication skills for future IT-professionals in the learning process, and analyze the application of cloud technologies for enhancing communication of IT-professionals.

2 Peculiarities of communication in the IT-environment

Communication is an integral part of the successful work of IT-professionals, as they have to communicate with clients, project managers, colleagues and team members verbally and in writing, face-to-face and remotely, with or without information and communication technologies. Different types of interaction between IT-professionals have been discussed in our papers [5; 19; 20; 22]. A typical professional activity of an IT-specialist is working in an international team, which can be formed for a specific project. The main conditions for candidate selection for such a project are not the location of all participants, but the correspondence of qualifications and knowledge of a particular specialist to the project objectives and their level of communication competence.

First and foremost, communication is the transmission of messages. Any information is structured as messages, transmitted, received, processed, and restructured as knowledge. It is a system that works both at the level of direct "human-to-human" communication and in the situation of indirect "human-digital device-human" communication.

Typical forms of communication in the IT-environment are synchronous and asynchronous ones. Synchronous communication includes all audio and video chats, staff meetings within one team and one room. The asynchronous form includes forums, any task and time control systems, chats, mail messages, comments, correspondence, all messages that an IT-specialist has written and someone has commented instantly or in an hour, day or other period of time. The reply to the message can also be delayed in time.

An approximate estimate of communication in the IT-environment shows that almost 90% of communication is indirect, that is, the asynchronous symbolic communication system as opposed to the verbal one is dominant. During their professional career, IT-specialists communicate in the professional community from a variety of positions: contractor-supervisor, contractor-partner, contractor-customer. In addition, the typical types of task formulation that correspond to the types of communication with expression means are:

- verbal communication – staff meetings, communication in the process of flexible software development, which is characterized by short-term iteration tasks and cooperation between multifunctional teams capable of self-organization (agile software development), when the ability to make quick decisions is formed. It should be noted that the verbal setting of tasks is often indirect (calls, online conferences, etc.), since it is typical for IT-professionals to make a team at the time of the project according not to the regional criteria, but to the tasks that are being implemented now;
- symbolic communication – when tasks are received visually through a messenger, a task management system, in the course of correspondence. In the process of such

indirect communication it is very important to be able to clearly define their own tasks, existing problems, to understand the terms of execution, etc.

There are specific levers in the verbal communication system as IT-professionals can see each other. However, taking into account the technology development, Skype, Viber, Telegram may act as the system of verbal communication, however, all these and other chats can be used for non-verbal, that is, symbolic communication. Non-verbal communication may take more time to formulate a message, however, it may be more effective to achieve a specific goal.

As the work of IT-specialists requires precision in understanding the task and its execution, IT-mediated communication is better than verbal communication. In a critical situation, the occurrence of a problem or the detection of an error or a software bug, expression of emotions will be superfluous and hinder quick problem-solving. In the case of indirect communication, an IT-specialist receives a formalized message that is consistent with corporate policy and ethics. That is, a specialist who has found a mistake, cannot write about their own emotions, use slang or profanity. The reply should be based on phrase patterns that allow specialists to describe the tasks or bugs clearly, get similar formalized answers, evaluate, troubleshoot or follow the instructions in the message they receive.

3 Teaching communication skills for future IT-professionals in the learning process

Due to the specifics of their professional activities, IT-specialists often need to communicate using synchronous communication (chats, video chats, audio chats, instant messaging) and asynchronous communication (email, forums, newsgroups, comments) tools. These have their own characteristics that students need to learn.

Using synchronous communication tools, it is possible to conduct project and team activities aimed at completing a software development task or part of it. Students communicate using these means with each other in a project team, which can have a different structure according to the task: for example, a project manager, a programmer, a tester. Simulating processes of their future professional activities, the members of the same project team can be located not only in different rooms or different floors of the office, but also in different cities and countries, they communicate with each other via text messages, video or audio chats.

It is advisable to compare the peculiarities of communication using different synchronous means, to identify obstacles in understanding the essence of messages and to develop skills for their elimination. Thanks to the chat record archiving, specialists can be encouraged to analyze their dialogues after the conversation in order to find and correct grammar, stylistics, vocabulary, punctuation mistakes and more. It is advisable for teachers to take advantage of the following types of pedagogical chats presented by Dafne Gonzalez: a free topic chat with its main purpose in practicing speaking, listening and writing; a collaborative task-oriented chat, which is aimed at solving a specific educational task by its participants; an academic seminar or presentation chat, which is used to present certain materials (software, research results, methodologies) for purposes other than informing but learning to identify ideas or research on a specific topic based on out-of-chat information; a practice chat aimed at practicing a skill or strategy with other participants and a chat moderator (teacher); an evaluation chat, the purpose of which is to control and evaluate the degree of material comprehension [4].

Integration of chats and instant messaging into the learning process allows teachers to more effectively solve a number of didactic tasks in the classroom: to develop and improve reading, writing, speaking and listening skills; to develop and improve the skills of dialogue speaking; to boost vocabulary (active and passive) with modern words, phrases and terms; to acquaint students with the socio-cultural realities of a language (linguistic etiquette, features of linguistic behaviour, cultural peculiarities, traditions of the language being taught) [17]; to form a strong motivation for students in foreign language activities.

The use of asynchronous communication in the learning process, according to Oksana O. Rohulska allows: to provide subject-subject relations between the student and the teacher, as well as a general atmosphere of cooperation in the process of communication, to create the possibility of immediate correlation of the received information and activity, its emotional content; to identify deficits of skills, gaps in knowledge, as well as the inadequacy of the available motives of the installations formed in the process of activity; to replace inefficient learning models with newer and more effective ones [17].

IT-professionals need to learn how to handle e-mail correspondence, communicate in professional forums and newsgroups, and respond to customer comments about developed software properly. For this purpose, we have developed the methodological recommendations for forming the communicative competence of IT-professionals, we have developed tips for writing business correspondence in English and Ukrainian. These tips can be used when studying the English or Ukrainian language, certain special disciplines to learn how to complete a job request for an employer, a letter to a project manager or a software tester, or a whole letter to clarify a technical task for developing specific software.

Students should be acquainted with the process of commenting on user complaints. To do this, it is recommended to use comments on Google Play which can be analyzed from the point of view of using the correct vocabulary and grammatical forms, and to study response patterns to comments.

In their work, IT-professionals are periodically confronted with complex tasks and some problems that can be found in professional English forums. The materials of these forums can be used in the process of learning a foreign language, the formation of vocabulary and patterns of communication.

Due to the fact that the forum is intended to discuss the topic, this tool is suitable for discussion in the process of foreign language learning. It really develops the language skills of students, activates the use of vocabulary in their speciality. In the course of working with the forum, teachers can create communicative circumstances and bring the acquired clichés into speech, compile different writing formats, form the ability to separate and process information from the text passages and prepare students for conducting discussions.

The teacher chooses a topic for organizing self-study in the forum, for example, "New Inventions in ICT", "Global digitalization: good or bad", "Ethical aspects of artificial intelligence" and others. Then the teacher sets a deadline for students to participate in the discussion of a given topic. The task is to write a response to a discussion that would not be repeated by other students, and to build a competent statement. The criteria for evaluation are clarity, literacy and completeness of the answer, as well as its relevance to the given topic. The essence of self-study is that students have the ability to prepare a response using the Internet, to check the structure and spelling of their statements, and the teacher can correct them or point to materials that will help students write messages or correct mistakes. In the course of the forum, future IT-specialists have a clear ability to write in English, to understand writing, and to use language patterns. After all, students use more sophisticated and complicated designs, which are later transferred to real-life developments.

When communicating in the forum, the psychological barrier is removed, hence students cease to be afraid of a foreign language. Thus, the forum is an asynchronous communication tool that allows participants to conduct a meaningful conversation, breaking the timeframe of the session. When working in the forum, students increase motivation to learn a foreign language, intercultural and interpersonal communication is formed, there is an incentive to use their vocabulary and develop foreign language skills actively.

Social networks, virtual communities and virtual environments can also be used to enhance communication during learning and working processes. Undoubtedly, virtual communities have a huge potential in student learning, because they attract students with ease of use, the ability to choose the pace and the content of learning, the ability to participate in the formation of the learning content, the feedback presence from community members.

The most up-to-date definition of a virtual learning community is the definition of René Wegener and Jan Marco Leimeister, who argues that a virtual learning community is a virtual social space that exists in an information technology platform where people with a common purpose come together to interact with each other to get and/or share knowledge [21]. Danah M. Boyd and Nicole B. Ellison define social networks as web services that allow users to 1) create a public or semi-public profile within a connected system; 2) create a list of people they have contact with; 3) view their lists and other users' lists in the system [3].

Active communication of members in the community, their regular participation in community events, high motivation and shared interests make virtual communities an indispensable tool for learning. For example, Kirsti Ala-Mutka [1] highlights the significant advantages of introducing virtual communities into learning: access to certain knowledge and development of new knowledge, personal growth and development through socialization, and teamwork. According to the author, the typical types of educational activities and their respective educational perspectives in virtual communities are: the access to resources that are created individually and in collaboration (obtaining certain knowledge, understanding them through common materials, discussing by members of a community a certain topic); the use of knowledge and development of new common knowledge (training to obtain and provide advice, familiarization with different perspectives, development of offerings skills, defense and acceptance of thoughts); observing and following members of the community (learning different ways of being, functioning, reflecting on one's life, personality, knowledge and skills compared to other members of the community); communication and socialization (finding relationships with people, building and maintaining relationships with them) sharing personal contributions (development of creativity on knowledge and expression); participation in collaborative production (learning to work together, review and review through commenting, developing new solutions and problems in a dynamic environment).

Virtual learning communities can operate within global educational projects, within educational institutions, and can be created to bring together people of different age groups from different countries for the purpose of communication, learning, sharing experiences and more.

It can be argued that in the learning of foreign languages, communication, motivation and joint activity are the leading factors for successful mastery of the language. So it is not surprising that there is currently a large number of virtual language learning communities, which are different in style, content and capabilities.

Virtual foreign language learning communities provide communication with native speakers, promote speaking, writing, reading and listening skills, attract participants with modern content and multimedia, and allow participants to work at the pace and in the mode they need. All these features of virtual communities support the process of learning a foreign language, whether within the educational process or when learning a foreign language outside the formal educational process.

Thus, virtual learning communities are effective means of building the communicative competence of IT-professionals, including those who study foreign languages, as they bring together people of different life experience, ages and social backgrounds located in different parts of the world, but united by common motives and interests (mastering a foreign language or improving their professional level). Students, as members of virtual communities, have access to a wide range of resources and distribute self-created materials. Interaction and communication within virtual communities help students develop all the necessary communication skills (reading, speaking, listening, writing) and professional skills, because community members use knowledge and participate in the formation of new knowledge and new products. Successful functioning of virtual communities requires constant increase of interest and motivation of participants, modern content and active interaction of participants.

4 Cloud technologies for enhancing communication of IT-professionals

Basically, all tools of verbal and symbolic communication are moving to cloud technologies. Cloud computing, as it is stated, is the delivery of applications, platforms, data storage, operating systems, and other computing resources over the Internet instead of over on-premise infrastructure [8]. Experts believe cloud computing can improve communication within an organization, a company or an educational institution. Allied

Telecom company specialists [2] give the following benefits of adopting the cloud for a company:

1. improvement of remote working which leads to effective collaboration with everyone in the company;
2. possibility of working from any device (tablets, smartphones or desktops) which "encourages higher quality work, more effective document sharing and better business communications";
3. less outsourcing and more decentralizing (using videoconference platforms);
4. more effective collaboration due to shifts, changes and improvements of the cloud;
5. business globalization.

Lisa Remo outlines the following ways of enabling better communication using cloud technologies: the rise of video conferencing which "can help foster the development of better relationships and more effective meetings and collaboration sessions"; document sharing and collaboration; connecting by way of messaging platforms [16].

The examples of cloud technologies for enhancing better communication in the IT-environment are:

- synchronous communication tools – iMessage, Facebook Messenger, Firebase Cloud Messaging, Google Cloud Messaging, etc.;
- asynchronous communication tools – Office 365, G Suite, Zoho Workplace;
- collaboration tools – ezTalks Cloud Meeting, Yammer, Evernote, Prezi, Office 365.

Let us consider Microsoft Office 365, the line of subscription services, which can be successfully used to enable better communication and collaboration within a company or an educational institution. The main aspects that influence the choice of a particular tool are the specific communication needs, the size of the team, the specifics of the project, as well as the preferences of employees [7]. The line includes OneDrive for Business, SharePoint Online, Microsoft Teams, Yammer, Skype for Business, Outlook Online boards.

OneDrive for Business [10] is the Microsoft cloud service that allows users to store files, share them with others, and get the access to them from any devices. As it is an online repository for an organization or educational establishment, the organization manages user's OneDrive for Business library, and users can share and work on documents with other employees. Site administrators in the organization determine what users can do in the OneDrive library.

SharePoint Online [11] serves as a platform for corporate intranets and portals. It enhances collaboration through dynamic team sites for each project team, department and division. Team members can share files, data, news and resources using personal computers or mobile devices. Pages, lists, and libraries give all users access to required resources stored in Office 365 and other services. Participants can manage files, collect and track data, and keep up to date with news, job announcements, and deadlines. Recommendations and tips to help team members to find the right contacts, sites, and files can also be found easily.

Using the services mentioned above at a university, students can carry out a joint project, manage this project, work on set tasks, discuss arising problems, thus improving their written communication skills.

Microsoft Teams [9] can be used for public or private communication, as well as voice and video conferences. The service is suitable for online meetings, including audio, video, and web conferencing with anyone in the organization or outside it. Participants can get help with meeting planning, it is possible to take notes, open access to the desktop to any team member, download files, and chat. The service is also suitable for meeting broadcasting. Webinars, general meetings, and presentations for up to 10,000 participants from the organization and beyond it can be held. Audio conferencing allows participants to join a meeting from their phones or connect directly with Microsoft Teams. This function is possible even in the absence of the Internet.

The most noticeable function of Microsoft Teams is instant messaging, which is the most common activity in communication within a team of IT-professionals. It allows participants to communicate in group or private chats, join video calls and demonstrate their screens to their partners. Team members can add some emotions to their messages with personalized GIFs, stickers, and likes.

Yammer [13] is a platform for internal social networks, the participants of which are employees of a certain company. The possibilities of Yammer are creation of channels with useful information, development of knowledge bases, message exchange, file sharing, quick search of people inside the company and access to them directly, news sharing, and conducting surveys. In contrast to SharePoint Online, which is a platform for intranets suitable for formal communication within a company, Yammer is aimed at uniting team members, enhancing their informal communication and developing professional environment.

Skype for Business [12] is an application which includes numerous features, including instant messaging, audio and video calls, informing about team member presence. It is possible to record meetings, display the screen contents, and create PowerPoint annotations in real time. Up to 250 people can participate in the meeting. The distinguishing features of Skype for Business are boards, polls, voting, and built-in messaging.

Outlook Online [14] allows team members to send, receive, and organize e-mail messages, schedule and organize meetings using the calendar, prioritize tasks with Microsoft To-Do.

As it can be seen from the descriptions of the services, their application can facilitate personal and public interaction, foster both formal and informal communication, and improve team work activities.

The main features of the services mentioned above which can be used for enhancing better communication within a company or an educational institution are presented in table 1.

All the subscription services mentioned above can be successfully used within a company to enable better collaboration between team members. Moreover, introduction of these services into the learning process at higher education institutions can enhance better communication and collaboration between students and teachers while studying general and professional disciplines, working on the project, developing a software product etc. The possible disadvantages of cloud technologies for communication are the decrease of personal contact because of prevailed non-verbal interaction, the loss of meaning or simply misunderstanding between interlocutors, the slow choice of better decisions because of large number of different opinions on the topic which is being discussed etc.

Table 1. Features of Microsoft Office 365 services

	File storage	**File sharing**	**Joint work**	**Private communication**	**Public communication**	**Videoconferencing**	**Conducting surveys, polls, voting**
One Drive for Business	+	+	+				
SharePoint Online	+	+	+				
Microsoft Teams	+	+	+	+	+	+	+
Yammer	+	+		+	+		+
Skype for Business				+	+	+	+
Outlook		+		+	+	+	

5 Conclusions

Cloud technologies are definitely recent innovations which can significantly improve communication and collaboration within a company or a team. Numerous cloud developments can foster better relationships within a team, they change the way people communicate, making it possible to hold meetings and sessions, share documents and files, and connect using messaging platforms. Introduction of cloud technologies into the learning process at universities can enhance better communication and collaboration between students and teachers while studying general and professional disciplines, working on the project, and developing a software product. The prospects for future research can be the following ones: development of the methodology of cloud computing application for improving communication of IT-professionals at higher educational institutions and experimental examination of the methodology effectiveness.

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Modeling the training system of masters of public service using Web 2.0

Yevhen M. Khrykov1[0000-0002-5496-2753], Alla A. Kharkivska2[0000-0003-4782-1079], Halyna F. Ponomarova2[0000-0001-7658-9833] and Aleksandr D. Uchitel3[0000-0002-9969-0149]

[1] Luhansk Taras Shevchenko National University, 1 Gogol Sq., Starobilsk, 92703, Ukraine
[2] Kharkiv Humanitarian-Pedagogical Academy, 7 Rustaveli Ln., Kharkiv, 61001, Ukraine
enxr@ukr.net, kharkivska_hgpa@ukr.net, rector-hgpa@kharkov.com
[3] State University of Economics and Technology,
5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
o.d.uchitel@i.ua

Abstract. The article concerns grounding the technology of training masters of public service with the use of Web 2.0. This technology is based on the concept of sign-contextual learning, the positions of the laboratory-brigade method, the concept of Web 2.0, case technology, project method, problem learning. The main features of this technology are changes in the correlation between theoretical and practical training, in-class and individual studying; changing teachers' functions; extensive use of information technology capabilities in learning.

Keywords: Training technology, Masters of public service, Use of Web 2.0.

1 Introduction

The relevance of the problem of modeling the innovative technology for the organization of the educational process in a higher educational institution is determined by several factors. The first factor is the need to ensure the system of professional training of public servants is in line with the realities of today. These realities are the grandiose digitization of all spheres of public life, the country's full-scale entry into the global information space. First and foremost, it concerns production, management, public administration and education. Digitization caused not only the emergence of fundamentally new mechanisms of administration, new content of management activity, but also changed the very essence of public management.

The second factor is the emergence of new means of organizing students' learning activities. Among them, technology-based Web 2.0 is at the forefront [17; 32], and now Web 3.0 is about to appear.

The third factor is the fundamental changes that occur in the formation and development of the modern personality, who is ready to use information technologies in all spheres of human life. In the context of creating even "state in a smartphone", the level of information culture, information competence of a public servant should correspond to the existing requirements.

These factors determine the need for more complete implementation of information technology potential in the process of training masters of public service. It will contribute to the development of their information and communication competencies and increase the efficiency of public administration.

2 Methodology of the research

The research was conducted over five years in several stages. The first stage was devoted to singling out the factors that influenced the organization of the educational process for master's degree program "Public Service". It was carried out by analyzing the state requirements for public servants, the scientific literature on the organization of the educational process in higher education, and distinctive features of graduate students. The obtained results allowed us to substantiate the requirements for the technology of the educational process for master's degree program at the second stage of the research.

The third and the main stage of the research was aimed at modeling the training system of masters of public service using Web 2.0. This model envisaged modernization of the structure of masters of public service training, determining the target component of training – masters' competences and their indicators, singling out theoretical grounds on which the learning process should be based (concept of sign-contextual learning, laboratory-brigade method, Web 2.0 ideas, case technology, project method, theory of problem learning, ideas of student-centered approach, which provides for the realization of students' information needs).

The fourth stage of the research involved implementing a valid model in the educational process at Luhansk National University for three consecutive enrollments of graduate students over 4.5 years. At this stage, the results were diagnosed by interviewing graduate students, employers, and analyzing the volume of recruitment to the graduate program.

At the fifth stage, the results were summarized, conclusions were drawn and suggestions were made for further research.

3 Literature review

The theoretical foundations of informatization of modern society were studied by Syed A. Ahson [1] (cloud computing and software services), Alex Amies [2] (developing and hosting applications on the cloud), Rajkumar Buyya [6] (cloud computing), Richard N. Katz [16] (higher education in the age of cloud computing), Wolfgang Lehner [22] (web-scale data management for the cloud), Dan Marinescu [23] (cloud computing), Vladyslav Ye. Velychko [8] (informatization of education as a pledge of the existence and development of a modern higher education). The problems of using information technologies in education were investigated by Kees Blokland [4] (testing cloud services), Olga V. Bondarenko [5] (didactic potential of virtual information educational environment), Olena O. Lavrentieva [21] (virtual reality in the system of vocational training), Wolfgang Lehner [22] (web-scale data management for the cloud), Yevhenii O. Modlo [25] (methods of using mobile Internet devices), Pavlo P. Nechypurenko [28] (augmented reality in education), Liubov F. Panchenko [29] (methodology of using structural equation modeling in educational research), Serhiy O. Semerikov [26] (ICT-based competence approach), Myroslav I. Zhaldak [38] (computer-based learning systems), Hua Zheng [39] (using Web 2.0) and others. Andrey A. Verbitsky [37] and other researchers devoted their studies to theoretical backgrounds for the technology of educational process organization in the system of training masters of public service in higher educational institutions.

In the scientific discourse there are numerous works focused on the information problems in educational sphere. However, insufficient attention has been paid to the analysis of Web 2.0 technology usage in the system of masters of public service training. A striking example is the work by James I. Gow and Sharon L. Sutherland [9], which analyzes the missions, curricula, and peculiar features of about 200 public administration master's programs, but does not focus on the use of information technology in the learning process.

Thus, educational theory and practice substantiate a large number of approaches, concepts, tools for using Web 2.0 in vocational training, but it does not eliminate the need to model the original training system in each case. Such models cannot be the same and should take into account the characteristics of students, their future professional activities, content of education, available facilities and human resources.

4 Justification of the training system model for masters of public service

Nowadays modeling educational process on the basis of information technology is complicated by the division into separate scientific specialties of the theory and methods of vocational education and information and communication technologies in education.

The aim of our article is to model the system of training masters in specialty "Public Service", which is relatively new for Ukraine and its educational standards are in constant development.

To justify this technology, it is necessary to single out the factors that influence the organization of the educational process for master's degree program "Public Service". Among them, the most significant are the following:

- constant improvement and updating of requirements for training specialists in this specialty;
- development of a large number of technologies for the organization of vocational training;
- a high level of students' self-awareness, self-esteem, democracy, insistence on high standards, orientation towards the use of information technologies in all spheres of their life;
- students' combining studying for the degree and practical activities in the field of

public service, their life experience, focus on the position of the subject of the educational process, subject-subject relations with teachers, other students, management staff.

Taking into account the following factors allows determining the requirements for the technology of the educational process for the master's degree program:

- the technology should ensure that competences relevant to public officials are formed;
- the technology should anticipate a high level of student activity, covering all spheres of their life in educational institution;
- the technology should overcome the excessive level of theorizing of the educational process and provide a high level of not only theoretical but also practical training;
- the technology should involve participation of teachers, students, department laboratory assistants, dean's offices or directorates staff in its realization;
- the technology should provide for certain changes in the functions of the teacher, who can no longer be the main source of information for students. The teacher should become the organizer of students' educational, research, project, practical activity. It is what his position should be so that to correspond to students' peculiar qualities, increasing the amount of accumulated information, the potential of modern technologies of the educational process, the goals of vocational training in modern conditions;
- the technology should involve the integration of traditional and innovative learning forms and methods. Implementation of the principles of mixed learning, which allows for the flexibility and convenience of information technology and the benefits of traditional organization of the educational process. For a long time of its existence pedagogical science has developed a significant number of technologies and approaches to the organization of professional education, some of which are fundamental, and some require their updating in the light of the realities of today;
- the technology should be modeled taking into account the current level of the development of information technologies, their use in the civil service and local government. These technologies allow finding, accumulating, classifying, analyzing, transmitting, creating information, providing social interaction, communication, joint activity. Realization of available potentials can enrich the educational process, increase its efficiency, make it more relevant to our time, students' characteristics;
- the technology should be based on a specific distance learning platform, teachers' training blogs, cloud facilities, classroom activities, individual and group students' activity.

The realization of the abovementioned requirements calls for the modernization of the structure of training masters of public service. Its main components should include: learning sessions; performing tasks on the distance learning platform; implementation of the case- study; implementation of projects, development of plans, consideration of problematic issues; writing master's thesis; processing information on the sites of institutions, departments, social networks and messengers. These components of the training system can become more effective by implementing some innovations and extensive use of Web 2.0.

Even learning sessions should create opportunities for graduates to express their opinion, to share their experience and have it evaluated, to get acquainted with the experience of others, to ask questions.

A key role in building a training system belongs to the target component, which characterizes the competencies that this system should focus on. We can determine the core competencies of a public servant on the grounds of the competent approach and taking into account digital competence framework the DigComp 2.0 and 2.1 [7].

The resent research allowed us to determine the following competencies and their indicators: *ability to ensure effective work* (a clear understanding of the purpose and current tasks of their activity; perseverance, energy, efficiency; self-organization; resistance to difficulties; orientation to external and internal clients; availability of knowledge and skills required for effective activity); *ethical behavior* (positive attitude towards others, to oneself, to work, to the state; moral knowledge; decency, sincerity; adherence to the general rules of public servants' conduct; preventing conflict of interests); *ability for self-development* (the desire to improve their activities; awareness of own strengths and weaknesses; objectivity of self-esteem; active self-education and professional development); *analytical thinking* (ability to connect past, present and future; critical thinking; having a well-founded personal position; ability to analyze documents; ability to develop programs of development; vision of department development possibilities); *ability to work in a team* (respect for colleagues; ability to negotiate; focus on cooperation and assistance; ability to perform various functions in the team; contribution to the overall results of the work; ability to share results); *ability to communicate effectively* (culture of communication; proficiency in the state language; mastering the basics of conflictology; mastering the basics of information technology); *ability to use information technologies* (ability to find necessary information, analyze and generalize it; ability to use network services for creating databases, conducting surveys; providing information security; ability to create necessary documents, presentations) [18].

Most of the abovementioned factors and requirements for the training system are taken into account by the concept of sign-contextual learning [37]. Elaine B. Johnson states in the monograph "Contextual Teaching and Learning" that "contextual teaching and learning contributes to the effective adaptation of students to future professional activities and determines the relationship of academic knowledge with life situations" [14]. This concept is based on the theory of activity, according to which the acquisition of social experience is the result of activity of the subject. The organization of training according to this concept is based on the following principles: activity of the individual; problem-centered approach; unity of education and upbringing; sequential modeling by means of forms of students' educational activities and conditions of specialists' professional activity.

It is well known that sign-contextual learning is a form of active learning, modeled for using in higher education, which is focused on students' vocational training. This form is realized through the systematic use of professional context, the gradual saturation of the educational process with the elements of professional activity. Any theoretical question should be examined in relation to production. This concept offers two ways of integrating practical and theoretical training:

- the curriculum of any academic discipline must include such theoretical material that is as close as possible to the practical problems of a particular professional activity;
- taking into account the practical needs of professional activity, it is necessary to determine the content of the theoretical disciplines of the professional cycle.

If the first way involves the advancement from theory to practice, the second goes from profession to theory.

Sign-contextual learning implies that all knowledge is provided and learned only in the context of future professional activity. A common basis for different techniques is the professional context, the need for cross-subject and interdisciplinary relations.

In the process of modeling the system of masters training we rely on the laboratory-brigade method, which was created in the 1920s [12]. As it is known, this method is characterized by the following features:

- overcoming the shortcomings of the subject matter principle of teaching;
- priority of empirical knowledge over theoretical, focus on the study of society, production, nature;
- reorientation of the teacher from information delivery to the organization of educational activity;
- prevalence of group work in the educational process.

The current system of the educational process in higher educational institutions does not allow implementing the laboratory-brigade method in full, but its key ideas have retained their value and can be applied.

It is advisable to use the ideas of Web 2.0 as the next conceptual basis for the process of modeling the masters training system [10]. The introduction of Web 2.0 into education involves using new information and communication technologies to improve the quality of vocational training by facilitating access to resources and services, as well as through the remote exchange and collaboration of online community members.

Web 2.0 technology is based on social networking services that support the involuntary development of communities consisting of people interested in sharing information, developing specific problems, and communicating.

Web 2.0 is a social service platform that allows any user, in our case, a master, a teacher, a manager, to get, create or be a co-author of information, perform synchronous and asynchronous network communication.

The use of network services creates the conditions for meaningful and instrumental enrichment of the activities of masters, teachers, management staff. Knowledge sharing services [13], textbook creation services [3], online communication services [36], services for storing documents, photo, audio and video materials [20], geoinformation systems [27], bookmarking services can assist in the completion of vocational training tasks.

The realization of Web 2.0 potential involves masters' using spreadsheets [33], tools for control and self-control of educational achievements [34], tools for creating multimedia presentations [35], general-purpose search systems, training support systems, text editors [24], distance learning platforms [30], cloud-oriented learning support activities [31]; testing and completing online questionnaires in the course of monitoring procedures; analyzing survey results by MS Excel; creating interactive posters, presentations in Prezi, smart cards, infographics; participation in web conferences, webinars, forums, chats, creation of e-portfolio.

Modeling innovative technology it is advisable to rely on case technology [19]. At the heart of this technology is the idea of a case-study, which emerged at the beginning of the last century in the process of training management specialists, and remains the key one in training masters of business administration in all the leading business schools in the world. This technology allows structuring the content of education, educational tasks, masters' educational activities, their control tasks and report forms. Cases should be mainly complex, cover the content of vocational training, meet the optimum amount of self work and provide for the participation of all members of the training group in solving educational tasks. The basis for the development of the case structure may be the structure of competencies, practical tasks of public servants, and disciplines of the curriculum.

It is advisable to use the case-technology ideas in the light of all the other methodological foundations of the new technology, and first of all Web 2.0.

An example of a case study is "Overcoming Corruption". This case envisages attending classes on "Public Service", "Legal Bases of Public Service", "Ethics of Public Service", "Quality Management System of Administrative Services"; studying laws, scientific literature as well as having experience in solving corruption problems. Depending on the number of classes attended, each graduate student performs the tasks assigned by the disciplines on the distance learning platform.

The next step is to accomplish an interdisciplinary collective task: to identify the task of rooting out the corruption at the state, regional and public service levels. On the weblog created, students together fill in a spreadsheet (Table 1).

Table 1. Tasks for Overcoming and Preventing Corruption

Tasks at the state level	Tasks at the regional level	Tasks at the level of institution

The training blog creates an opportunity to take into account the contribution of everyone to the collective activity and to coordinate the participation of the teachers and the students themselves.

The case involves developing individual projects – anti-corruption programs of institutions or creating micro-groups for this purpose, if employees of one institution are simultaneously trained. This project involves identifying corruption threats to the organization, analyzing procedures for providing administrative services, developing tools for questioning citizens to assess the level of corruption, studying the experience of other institutions and countries, organizing the evaluation of the developed program by citizens, its agreement. The development of an anti-corruption program should be based on the previous work on identifying three groups of tasks to tackle and prevent corruption.

Another methodological basis of the new teaching technology, which is advisable to use, is the project method. It allows arranging graduate students' educational activities, to formulate their results and organize their assessment [15]. The projects should be of complex character, covering different disciplines, and be implemented by micro-groups of masters (teams).

We can provide a following example of such a complex task: create a database of codes of conduct for public servants (using Internet technologies and visiting public service institutions); analyze common and different features in these codes of ethics; to which extent their content corresponds to the legislative and regulatory documents; analyze the practices of public service institutions and find out whether they comply with regulatory, legislative documents; when visiting public service institutions, conversations with employees, citizens, analyze the activities of the institution and find out the reasons for the violation of certain ethical standards and suggest ways to optimize civil servants' activities.

Another methodological basis for modeling the master's training system is theory of problem learning [11], when the teacher does not deliver information, but organizes students' activity on obtaining new information. Here are the examples of problematic issues and practical tasks on "Public Service Ethics", which fundamentally change the role of the teacher, transform masters into subjects of the educational process, shift the focus of students' attention to the issues that are important for public service practice.

- Can a person, who did not study hard for a master's degree program, work effectively in public service?
- Can the level of ethical culture of the manager be lower than the ethical culture of the subordinates?
- Compare ethics of public servants in different countries.
- Find in the Internet and compare codes of conduct for different professions. What do they have in common and what do they differ in?
- Analyze the ethical principles of public servants' behavior to you in a particular situation.
- Describe the instances of misconduct by public officials that you have witnessed.
- Analyze the ethical principles of behavior at Ogurtsov's meeting in "Carnival Night".
- Develop criteria for assessing the ethics of a public servant's behavior.
- Suggest a system of methods for assessing the ethics of a public servant's behavior.
- Model a conversation with a citizen to study the level of ethics of a public servant's behavior.
- Develop rules of communication for a public servant with citizens.
- Develop rules of communication for a public servant with colleagues.
- Suggest ethical requirements for communicating the manager with public officials.
- Make a self-improvement plan for your ethics.
- After observing the behavior of public servants, describe the typical situations in which ethics are violated.
- Ask the public about cases of interaction with public officials and analyze the ethical foundations of their behavior.

- Analyze citizens’ attitudes towards local governments.
- Design the behavior of a public servant in a conflict situation with a citizen who came to solve their problems.
- Analyze the causes of ethical misconduct by public officials.
- Analyze the causes that lead to violations of ethical conduct by the manager.
- Suggest a plan for a manager to implement the Code of Conduct for Public Officials.
- Suggest criteria for assessing a public servant’s ethical conduct during certification.

It is advisable to organize teams that will look for arguments to support opposing positions when addressing problem issues.

An important part in masters training is a master’s thesis. Its quality now depends on the systematic use of information technologies. Nowadays, they allow discussing and approving the topic of the research promptly, ensuring continuity in the development of certain problems, finding scientific information, information about the activity of public service institutions, legislative and regulatory information, information about the experience of other countries, conducting surveys, establishing communication with employees of different institutions, promptly communicating with the scientific advisor, presenting the results of the research in various forms, checking whether the principle of academic integrity is implemented.

A crucial peculiarity of modern education is its orientation to the student-centered approach. In the context of our research this approach means that the effectiveness of the master’s training system depends on the extent to which the learning process allows them to fulfill their diverse information needs. There are two logics behind the construction of the master’s training system: to satisfy the existing needs of students, or to realize the potential of modern information technologies. The first logic is not fully effective because the information needs of the learners may lag behind the potential of modern technologies, which necessitates the formation of these needs according to the potential capabilities of information technologies.

Taking into account the peculiarities of the learners allows structuring their information needs. The first group consists of the information that provides the educational process (scientific, legislative, educational, about the activities of public service institutions). The second group consists of the personal information about teachers, students, graduates of previous years, employees of administrative structures, important events in the process of masters’ collective life. The third group consists of the organizational information about the schedule of the educational process, the schedule of classes, conferences, social events, the results of the educational process, conducting a survey of graduates, providing proposals for improving the training system.

To fulfill these information needs, it is necessary to create and maintain websites of dean’s offices, departments, functioning of distant learning platforms, repository, profiles in social networks, educational blogs. The guarantor of the master’s degree program can coordinate the realization of these tasks, as well as integrate the activities of all interested parties: graduate students, teachers, laboratory assistants. Particular attention should be paid to creating pages of departments in social networks. Such pages encourage students’ interest to studying, student life, provide opportunities to create the history of graduate school, certain traditions, to establish connections with graduates.

5 The results of the research

The results of the research were obtained on the grounds of the analysis of changes in the educational process, a survey of graduate students and the management staff in the executive and local government bodies.

During the annual survey graduate students were asked to assess the following factors: the level of complexity of problems that they had faced working on disciplines in the intersession period at the university's educational portal http://do.luguniv.edu.ua/ in the Moodle system, the optimality of the combination of traditional and information technologies in the educational process, sources of obtaining the information on the organization of the educational process, the quality of information and reference materials on the site of the department https://sites.google.com/site/kafedradsunsz, sources of information used for preparation for seminars and practical lessons, changes in the level of information and communication competences during the training, the level of the available information and methodological support of the educational process. The results presented in the diagrams (Fig. 1, 2, 3) thus indicate that graduate students positively assessed the changes in the educational process after implementing Web 2.0 technologies.

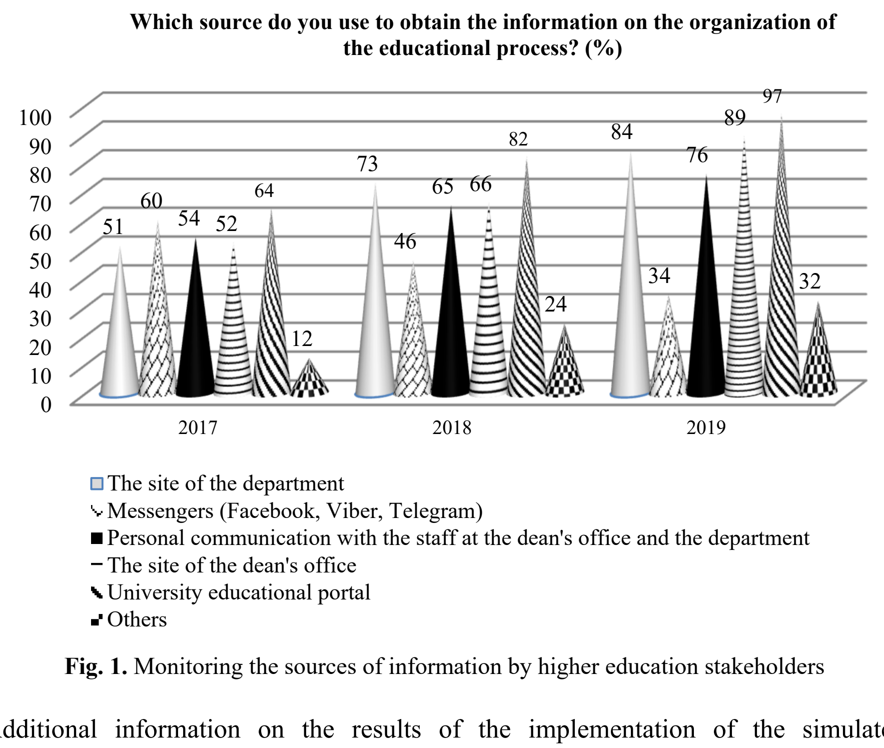

Fig. 1. Monitoring the sources of information by higher education stakeholders

Additional information on the results of the implementation of the simulated technology was obtained by surveying the employers' of the graduate students in the executive authorities and local government. It shows stable positive assessment of the graduates' work. A survey of this category of stakeholders identified a problem that arose in the course of their employees training. It appeared that the employers did not always have an opportunity to provide an educational leave for graduate students. So, it was the information technologies that made it possible to flexibly combine in-class learning with distant education using the Internet services.

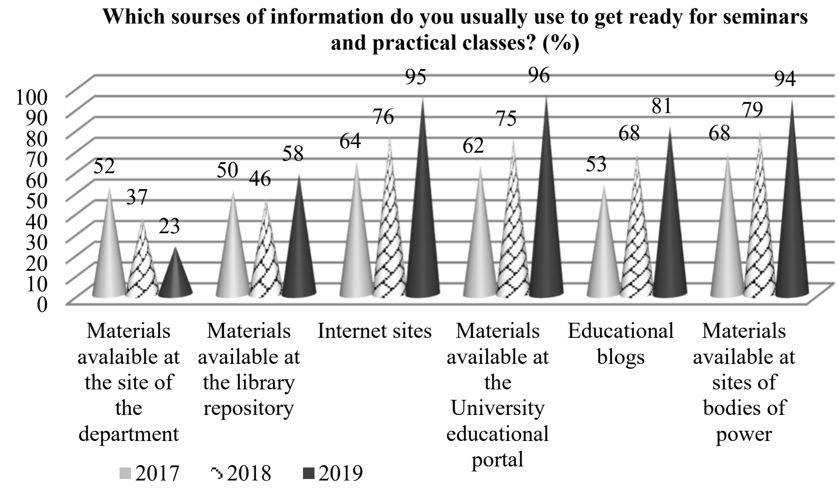

Fig. 2. Sources of information used to get ready for seminars and practical classes

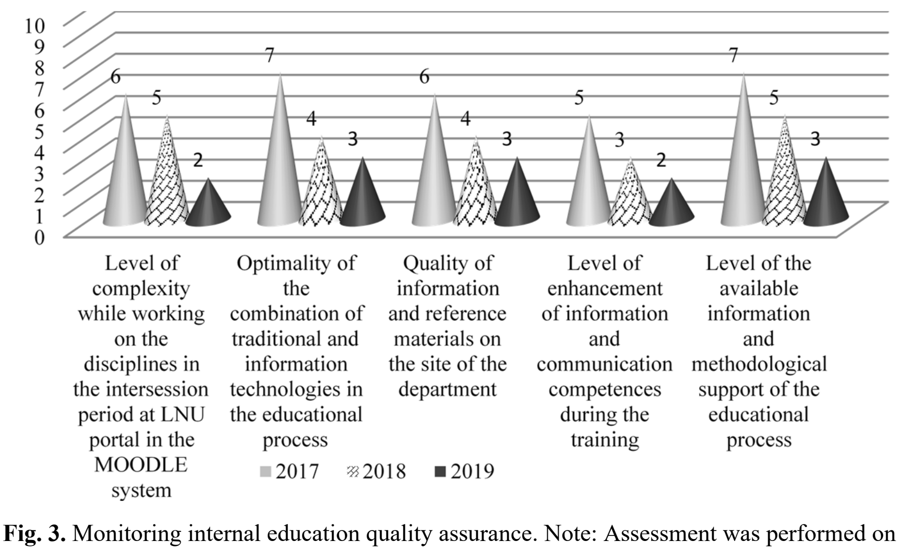

Fig. 3. Monitoring internal education quality assurance. Note: Assessment was performed on a 10-point scale from 1 (1 – optimal) to 10 (10 – not optimal)

Another evidence of a positive change in the educational process is the consistently high recruitment results for the master's program, which is 70–80 graduates a year. Compared to the fact that other graduate schools in the region recruit 10–12 students, it can be concluded that the master's program is highly appreciated by entrants, public servants management and it is competitive. The conducted research allows us to conclude that the main role in obtaining this result is played by the introduced model of the training system of masters of public service using Web 2.0. The main components of this model are presented in Fig. 4.

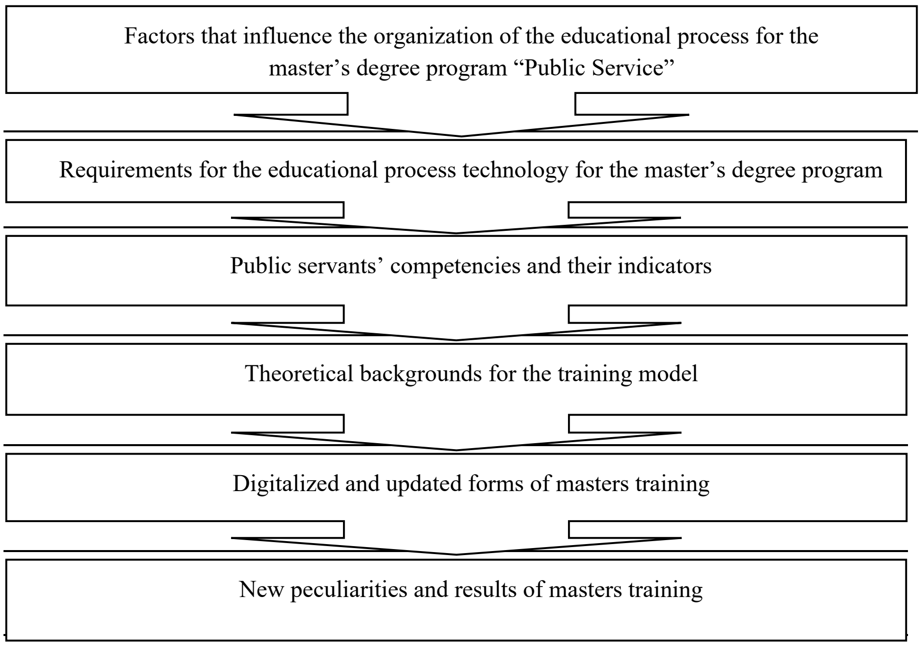

Fig. 4. Structural components of the model for training masters of public service with the use of Web 2.0

Generalizing the obtained results allowed singling out the key peculiarities of the simulated system of vocational training:

- change of functions and number of lectures, which should bear preparatory, overview character;
- development of a system of complex interdisciplinary tasks, forms of information fixation;
- use of Web 2.0 to obtain, capture, transform and produce information;
- vocational training has to be based on studying the practice of public service institutions, its modeling, students' group and individual work with information;
- introduction of students' group activities under the guidance of teachers;
- completion of educational tasks using electronic lectures, the information obtained during the study of public service institutions, the information obtained using Web

2.0 technologies, the information obtained during group project activities;
- organization of control and evaluation of learning activities in different form: defense of the developed components of educational content, complex tasks, projects, tests.

Implementation of the simulated training system may be prevented by: insufficient level of openness of the public service institutions, which makes the task of studying their activities more complicated; restrictions on the organization of interdisciplinary, collective forms of the educational process according to the traditional curriculum; complexity of taking into account the results of interdisciplinary, collective cases in the evaluation of masters' individual activity. That is why the problem of finding ways to overcome possible complications in the process of wider introduction of the new technology calls for its solution nowadays.

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Using Twitter in Ukrainian sociology majors training

Liubov F. Panchenko[1[0000-0002-9979-0625]], Andrii O. Khomiak[1[0000-0002-6661-4510]] and Andrey V. Pikilnyak[2[0000-0003-0898-4756]]

[1] National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", 37 Peremohy Ave., Kyiv, 03056, Ukraine
lubov.felixovna@gmail.com, andrii.khomiak@gmail.com
[2] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
pikilnyak@gmail.com

Abstract. The article deals with the problem of using cloud technologies in the training of sociology students in Ukraine. The popularity of Twitter in Ukraine is analyzed. The possibilities of using Twitter as a learning tool in classroom are discussed. List of recommended tweeters, including Ukrainian resources as well as resources related to population censuses is proposed. The article offers examples of student activities for Social Statistics and Demographics courses. The article demonstrates that new forms of student's activity related to data analysis introduced by academics and practitioners (building art objects and storytelling based on data; shared data collection by citizens through mobile devices, "play with data" modern data visualization services) can be realized with Twitter resources and can help overcome the barriers that arise while studying quantitative methods.

Keywords: cloud technologies, data visualization, social statistics, demographics, training of sociology majors, Twitter.

1 Introduction

1.1 Problem statement

In the modern digital globalized world, it is becoming more and more important to train sociology students in the field of social and demographic statistics based not only on social and demographic theories, but also on the practical application of the new computer tools and technologies, databases and Internet services [10; 12].

In recent years, educators from various disciplines have investigated ways to incorporate learning materials with a range of different technologies, especially the use of social media in courses. The accessibility of the various forms of social media provide educators with great opportunities and valuable platforms to interact and engage with students, to develop their critical thinking.

A promising area in the field of social media in education is Twitter. This service remains one of the most popular network for researchers and educators in the field of education as well as social and political sciences [1; 2; 6; 7; 8; 15].

The popularity of Twitter in Ukraine is shown in Fig. 1-2.

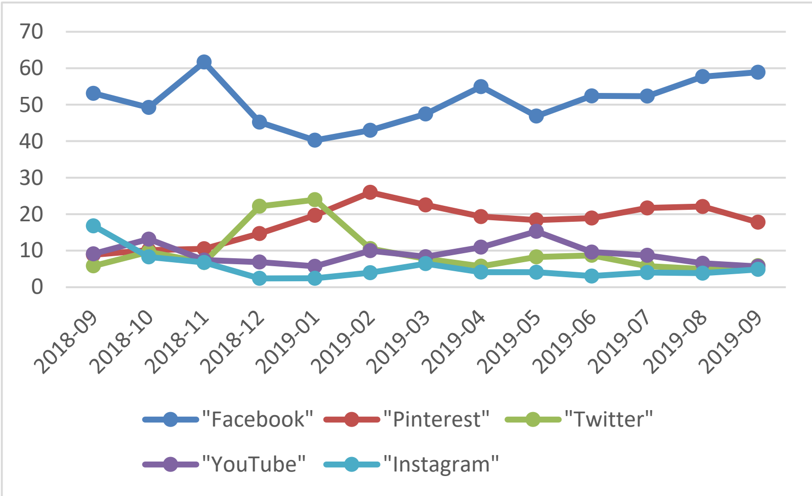

Fig. 1. Social media in Ukraine over the last year, % of users (according to [16])

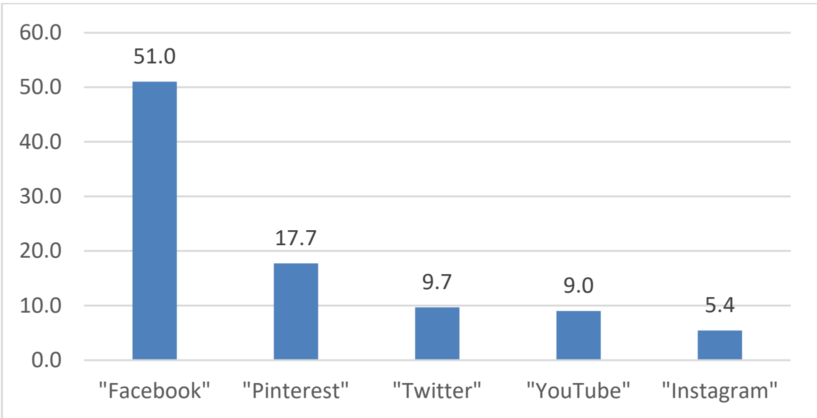

Fig. 2. Social network users in Ukraine, on average from September 2018 to September 2019, % (according to [7])

Consequently, we consider Twitter a very interesting and important tool to use it together with other cloud technologies in the training of sociology majors.

While solving the scientific problem of using cloud technologies in the training of sociology majors in the field of social statistics the following main results were obtained in past author works.

Our paper [9] analyzes the didactic capabilities of one of the cloud data visualization tools – Tableau; suggests a mixed form of data visualization training for sociology majors in the field of social and demographic statistics, based on combining the online course "Social Statistics and Demographics" and fragments of massive online open courses, in particular, specialization “Data Visualization with Tableau”, offered on the Coursera platform. The possibilities of interactive panels (dashboards) for presenting the results of course work in the field of social statistics and demographics are discussed.

Our article [13] analyzes the capabilities of modern computer tools for the analysis of demographic processes and structures in training sociology students; substantiates the use of the R environment as a tool for analysis and graphical representation of demographic data; presents the idea of teaching students to perform computer analysis of demographic data using a combination of Excel spreadsheets, SPSS statistical package, R environment. In addition, the article presented the didactic capabilities of the free Gapminder service that includes the list of the tools titled ‘Play with Data’, bubble chart, maps, ranking, trends, age pyramids, that provide colorful and dynamic data visualization for chosen demographic criteria by countries and continents in time that stimulates the students to perform additional scientific research.

In preparing specialists in the field of social statistics an important point is to select or obtain the real data sets that are modern and actual to engage the students. The Twitter as an educational tool gave such opportunities [2; 3; 6]. In addition, custom packages of R environment allow to extract information from a tweet (for example, from the Twitter of the US President) and analyze the data using various methods.

The aim of the article, based on the scientific sources is to propose different kinds of student activities for Social Statistics and Demographics courses with the help of Twitter.

1.2 Analysis of recent research and publications

The methodology of using social media in education, in particular Twitter, has received wide recognition in the global community.

George Siemens proposed connectivism as a learning theory for the digital age [15]. Dhiraj Murthy has analyzed the theoretical aspects of sociological understanding of Twitter as a social media [8].

A guide for academics and researchers about using Twitter in university research, teaching and impact activities is presented in [7].

Authors of work [6] develop an accurate and reliable data processing approach for social science researchers interested in using Twitter data to examine behaviors, attitudes, the demographic characteristics of the populations expressing or engaging in them; they discuss also how social media data may benefit demographic researchers.

The possibilities of using Twitter as a learning tool in classroom are discussed in [1].

Mark Ferris and Sherri Cheng [2] explored how Twitter could be used in the introductory business statistics course to achieve goals including improved student learning experiences, more interaction and engagement, stronger connection with the real world applications, and enhanced statistical literacy, reasoning and thinking skills among students.

Unfortunately, in Ukraine, Twitter is not sufficiently used in educational and social studies in general, and in the training of sociology majors at universities, in particular.

2 Results of the study

Twitter is a microblogging platform that allows users to record their thoughts in 140 characters or less. Here is a summary of global Twitter statistics for 2019 [5].

- There are 330 million monthly active users and 134 million daily active users on Twitter.
- 63% of all Twitter users worldwide are between 35 and 65.
- The ratio of female to male Twitter users is roughly one to two: 34 % female and 66% male.
- The average session on Twitter is 3.39 minutes.
- There were 11,7 million downloads of Twitter on the App Store in the first quarter of 2019.
- 75% of B2B businesses market their products and/or services on Twitter.
- 500 million tweets are sent out per day.
- 40% of Twitter users carried out a purchase after seeing it on Twitter.

In our work [11] we discussed the issues related to the formation of student's data literacy. Concept of adult's data literacy develops over time. Currently, it is not enough to prepare only critical consumers of statistical information, the emphasis is on the effective approach, the ability to produce data, as well as understand the properties of big data, algorithms for processing and presentation to consumers, ethical implications and data privacy issues. In this context training of teachers who teach mathematics related disciplines for higher educational institutions becomes crucial. The problems of such training are discussed by Ukrainian scientists in [14; 18; 19; 20; 21; 22; 23]. We discussed new forms of student's activity related to data analysis introduced by academics and practitioners: building art objects and storytelling based on data; shared data collection by citizens through mobile devices, "play with data" modern data visualization services [11]. In our opinion, Twitter is a powerful tool for creating these new activities and overcoming the barriers that arise during studying quantitative methods.

Analysis of scientific works [1; 2; 7] shows that if we want to use Twitter in university research and teaching every student need to take the following steps.

1. Set up their own Twitter account.
2. Start following other users.
3. Learn useful Twitter terminology (followers, following, unfollow, block, retweet, reply, first part of every twitter user name, mentions, hashtag, direct message, shortened URLs etc.)
4. Understand Tweeting styles.

Twitter researchers from LSE Public Policy Group identify three styles of tweets [7]. Substantive tweets are written in full sentences, are easy to understand, and the author is usually famous. They follow a formal or corporate style and are used by formal organizations, news outlets etc. Tweets written in this style can be used to educate students. Conversational style is more informal, the content of tweets can cover personal and professional interests, it is suitable for younger scientists and teachers. The compromise style takes everything best from substantive and conversational, is suitable for small groups, departments, research groups. In our view, the scientists have successfully described the characteristics of the styles, their advantages and disadvantages in Table 1 [7].

Table 1. Features Twitting styles [7, p. 5]

Features	Pros	Cons
Substantive style		
– Tweet is always in full sentences – Few abbreviations are used, except for shortened URLs – Must be independently understandable – Normally each tweet is the headline or 'taster' for a blog, post, web article or other longer piece of text – Focus is consistent and solely professional or single topic – The team producing tweets often remains invisible	– Always make sense to all readers – Especially accessible when viewed in a combined stream of many tweets from different authors – Attracts well-defined interests	– No conversational element, so can appear corporate and impersonal – Hence may turn off some potential followers – Takes a professional skill to always write crisply and substantively
Conversational style		
– Most or many tweets are fragments from an ongoing conversation with followers or thoughts from many different aspects of tweeter's experiences – Content is eclectic, drawing on professional interests but also on personal life, commenting on current events, etc. and so covers diverse topics – Includes author photograph	– Conveys personality well for individuals, or organizational culture for collective accounts – Attracts people who like this personality or culture – Good at building 'community' and strengthening followers' identification with site	– Some tweets only make sense to those who are involved in their conversation – Very hard to follow in a Twitter feed from many different authors – With eclectic contents many followers may not value many of the tweets – Hence incentives for some folk to unfollow over time
Middle ground style		
– Most tweets are substantive as above but some are short and conversational – Goes beyond a 'corporate' focus without being too eclectic – Uses retweets to diversify/liven up the tweet stream – Uses team photos, and the blog site or website identifies team members well	– Injects more personality or organizational culture into a basically professional approach – Most tweets are independently understandable	– Some conversational tweets will not make sense when read in combined tweet streams

Mark Ferris and Sherri Cheng [2] explored how Twitter could be used in the introductory statistics course. Scientists identified principles for learning statistics that are applicable to evaluating the efficacy of Twitter usage in such statistics class. Some of the principles are listed here:

- Students learn by constructing knowledge and active involvement in learning activities.
- Students learn to do well only what they practice.
- Technological tools should be used to help students visualize data.
- Students learn better if they receive helpful feedback.

In their course teachers suggested students to follow the more popular Twitter accounts: The Wall Street Journal, The Economist, The New York Times, The Guardian, Nature, Five Thirty Eight, Hans Rosling, Pew Research because these accounts offer real and sound data and statistics related topics on a frequent basis.

Scientists gave a series of weekly assignments on Twitter: students needed to find and retweet 6 statistical tweets in various assigned categories, identify 10 new statistical producing entities to follow, and build their individual Twitter "channel." Also, in final of course they chose one tweet and write two sentences summarizing the tweet; two sentences analyzing the credibility and biases of the article and its sources; propose two thoughtful questions about the article.

Note that the R programming environment has the appropriate package "The fivethirtyeight R", which facilitates the use of Twitter resources FiveThirtyEight in data science courses [4].

We added some tweeters to the recommendation list, including Ukrainian resources as well as resources related to population censuses. A fragment of comparative table with statistics for these twitter accounts is given below (Table 2).

Table 2. Twitters for using in the data analysis courses

Tweeter name	Content	Follow	Followed
FiveThirtyEight	Statistician N. Silver: politics, economics, science, life and sports.	288	1,1M
HansRosling	Remember Hans Rosling. Data and visualizations with Gapminder created Hans Rosling	170	350,2K
Pew Research	Pew Research Center. Public-opinion polling, demographic research, content analysis and other data-driven social science research.	94	404,6K
GFK	Data and science as a leading global market intelligence company for the tech and durable goods industry	3056	18,8K
VOX Ukraine	VOX Ukraine	581	6703
TEXTY.Org.Ua	Official Twitter account of the TEXTY site	972	4013
Stop Faking News	Stop Faking News of Mohyla School of Journalism	638	30,8K
IOM – UN Migration	Official Account of IOM	3442	119,1K
U.S. Census Bureau	USA Census Bureau	916	98,3K

The Impact of Social Sciences is a project (by the London School of Economics and Political Science, Imperial College London, and the University of Leeds) that aims to investigate the impact of academic work in the social sciences on government and policymaking, business and civil society [25]. In this project scientists compiled lists of academics on Twitter and curated it since 2011. The lists cover social sciences, humanities and arts, STEM subjects, media and journalism, higher education resources. We have compiled a comparison table and the bar plot with statistics for these Twitter lists in October, 2019 (Table 3, Figure 3).

Analysis of Table 3 and Figure 3 shows that Soc Sci Academic Tweeters are the most representative.

Table 3. Academic lists in Twitter

List name	Content	Members	Subscribers
HE Academic Tweeters	Higher education and educational technology	99	491
Media Academic Twitters	Media projects	60	313
Soc Sci Academic Tweeters	Anthropology, economics, geography, law, political science and sociology	305	1287
Art academic Tweeters	Art, history, languages, literature, philosophy, music	176	598

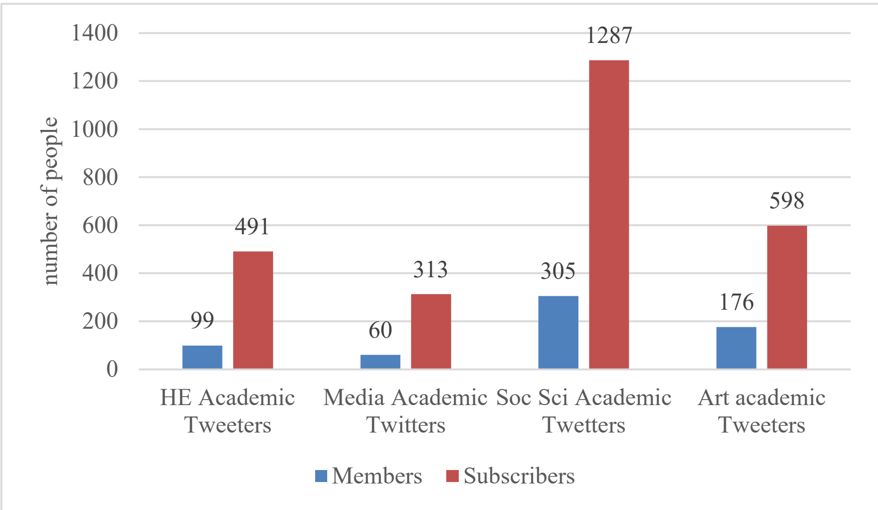

Fig. 3. Academic lists in Twitter: members and subscribes

We can collect tweets using different R packages. An analysis of the capabilities of the twitteR package showed that it has a large set of functions for analyzing Twitter data:

— Sending a Twitter DM after completion of a task
— Viewing Twitter timelines
— Retrieving the most recent tweet ID from a database
— Saving the tweets found to a database
— Viewing Twitter trends
— Setting up a database backend for twitteR

- Class “directMessage”: A class to represent Twitter Direct Messages
- Management of Twitter users
- Converting twitteR lists to data or charts
- Getting the favorite tweets
- Retrieving current rate limit information
- Setting up the OAuth credentials for a twitteR session
- Detailing relationship between yourself & other users
- Removal of retweets
- Searching Twitter
- Importing twitteR objects from various sources
- Manipulating Twitter status
- Loading twitteR data to a database
- Manipulating Twitter direct messages
- Return of statuses
- A container object to model Twitter users
- Decoding shortened URLs
- Class to contain a Twitter status
- Registering OAuth credentials to twitter R session
- Setting up the OAuth credentials for a twitteR session from an existing Token object.

Another new R package that deserves attention in the context of training sociologists is *saotd* package. It is focused on utilizing Twitter data (cran.r-project.org/web/packages/saotd/vignettes/saotd.htm). Authors of this package says that collecting data and analyzing it for sentiment can provide a powerful tool for the organization to better understand their target population. This package allows users to acquire data from tweets using the Public Twitter Application Programming Interface. The package is broken down into five different phases: 1) acquirement; 2) research; 3) topic analysis; 4) sentiment calculation; 5) visualization.

We can use different types of analysis for the collected data. Content analysis allows to define the most popular topics. Sentiment analysis helps define what opinions, views and emotions users have about the subject. Network analysis shows who is connected with whom. Geospatial analysis presents where users or tweets come from.

We propose such student’s activities using Twitter.

- Create a table explaining the basic concepts of tweeter (followers, following, unfollow, block, retweet, reply, hashtag, direct message, shortened URLs).
- Suggest two examples illustrating different styles of tweeting.
- Compare Tweeter accounts of the presidents Zelensky and Trump [17]. (Note that at the time of article writing, President Zelensky did not follow anyone on Twitter).
- Write a report about Ukrainian government organizations on Twitter [3].
- Find relevant accounts of organizations related to Census 2020 and follow them.
- Create infographics about Twitter world statistics and Ukrainian Twitter statistics [5].
- Tell a story about fake news checking with the help of the Twitter Stop Fake of Mohyla School of Journalism.
- Discus ethical framework for publishing Twitter data in social research [24].

- Take part in the survey the future of immigration in Europe and some potential migration scenarios; find twitter feeds of Ukrainian migrants in Poland.
- Find relevant accounts of famous Ukrainian social scientists and compile a list.

3 Conclusions and perspectives of further research

Twitter is one of the popular social media in the world. Presidents of many countries as well as political parties, parliaments, research agencies, scientists, teachers use Twitter. Twitter allows to study the behavior and attitudes of people, to understand more deeply those who they follow, contributes to democratization and transparency, helps to develop innovation, systemic and critical thinking, data literacy.

An important point in using Twitter in educational course is to select popular and relevant Twitter accounts that students can follow. We offer our students to follow such Twitter accounts: The Guardian, Five Thirty Eight, Hans Rosling, Pew Research, VoxUkraine, TEXTY.Org.Ua, Rob J Hyndman, GFK, AmstatNews (American Statistical Association), RoyalStatSoc (Royal Statistical Society), UN Migration, U.S. Census Bureau and other.

The main criteria for choosing are: this accounts give real and sound data and links to access the relative research; the list includes organizations, research agencies, well-known statisticians and sociologists; the list includes international organizations, national research centers, Ukrainian organization resources; the list should be considered as the starting point from which the student will build and develop his channel.

You can highlight such students activities using Twitter: register a new account for the course, find relevant accounts of organizations related to social statistics and demographics and follow them; find relevant accounts of famous personalities in this area, find and retweet tweets corresponding to the current topic of the course; write an essay based on one of the found tweets; evaluate and analyze classmates' tweets; create your own list of recommended twitters for a specific topic or field of knowledge; create infographics of global Twitter statistics and Ukrainian Twitter statistics; create data visualization on a basic Twitter data; discuss twitting styles, check fake news and other.

Further development of work in this direction is the creation of teaching and methodological support for using Twitter in Social Statistics and Demographics course in Ukrainian universities.

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Technology of poetry presentation via Emoji Maker platform: pedagogical function of graphic mimesis

Rusudan K. Makhachashvili[1[0000-0002-4806-6434]], Svetlana I. Kovpik[2[0000-0001-6455-5572]], Anna O. Bakhtina[1[0000-0003-3337-6648]] and Ekaterina O. Shmeltser[3]

[1] Borys Grinchenko Kyiv University, 18/2 Bulvarno-Kudriavska Str., Kyiv, 04053, Ukraine
r.makhachashvili@kubg.edu.ua, a.bakhtina@kubg.edu.ua

[2] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
kovpiks@ukr.net

[3] State University of Economics and Technology,
5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
shmelka0402@gmail.com

Abstract. The article deals with the technology of visualizing fictional text (poetry) with the help of emoji symbols in the Emoji Maker platform that not only activates students' thinking, but also develops creative attention, makes it possible to reproduce the meaning of poetry in a succinct way. The application of this technology has yielded the significance of introducing a computer being emoji in the study and mastering of literature is absolutely logical: an emoji, phenomenologically, logically and eidologically installed in the digital continuum, is separated from the natural language provided by (ethno)logy, and is implicitly embedded into (cosmo)logy. The technology application object is the text of the twentieth century Cuban poet José Ángel Buesa. The choice of poetry was dictated by the appeal to the most important function of emoji – the expression of feelings, emotions, and mood. It has been discovered that sensuality can reconstructed with the help of this type of meta-linguistic digital continuum. It is noted that during the emoji design in the Emoji Maker program, due to the technical limitations of the platform, it is possible to phenomenologize one's own essential-empirical reconstruction of the lyrical image. Creating the image of the lyrical protagonist sign, it was sensible to apply knowledge in linguistics, philosophy of language, psychology, psycholinguistics, literary criticism. By constructing the sign, a special emphasis was placed on the facial emogram, which also plays an essential role in the transmission of a wide range of emotions, moods, feelings of the lyrical protagonist. Consequently, the Emoji Maker digital platform allowed to create a new model of digital presentation of fiction, especially considering the psychophysiological characteristics of the lyrical protagonist. Thus, the interpreting reader, using a specific digital toolkit – a visual iconic sign (smile) – reproduces the polylaterial metalinguistic multimodality of the sign meaning in fiction. The effectiveness of this approach is verified by the poly-functional emoji ousia, tested on texts of fiction.

Keywords: technology, lyrical protagonist, emoji, Emoji Maker, multimodality, computer being (CB), graphic mimesis.

1 Introduction

Problem statement. Emoji signs are specific Unicode-based ideograms. Nowadays emotions and impressions of the written and read text can be conveyed in the form of punctiograms, pictograms and ideograms. Emoji is a multifunctional ideogram that not only saves one space in correspondence when communicating through social media, but also conveys shades of emotions, moods, feelings based on what one sees, hears, or reads. No wonder emoji in the modern world is considered a hieroglyph of the 21st century.

As modern literary criticism undergoes a process of depressurization, the allure of digital capabilities of the Emoji Maker platform as a metalinguistic phenomenon to the study of literary works will increase the interest of students of philology in works of fiction, developing creative thinking [18]. The specificity of applying emoji to the analysis of a fictional text is to condense and synergize the result. This is primarily due to the fact that emoji modeling takes into account only the most basic and key senses. This avoids the recipient's own context when interpreting the text and grasps the main point. That is why the transmission of the content of major genres (stories, novels, trilogies) is possible by modeling one or more emoji. All this also develops the ability and skill to create visual texts that will convey the full range of feelings from a read piece of fiction. This type of visual texts conveys the content of the reading as briefly as possible, activate memory, critical assessment, attention of students. It is through emoji that you can translate fiction, film, and other fictional media.

The objective of the article. Development and testing of information and communication technology application of presentation of different genres of fiction via the Emojidom Smiley & Emoji Maker [19].

Information and communication technology (ICT), where technology is understood as a set of methods, tools and implementation by a person of a complex process by dividing it into a system of sequential interconnected procedures and operations that are performed more or less uniquely and aim at achieving high efficiency of a certain activity ([12]), in our study emphasized the role of unified technologies, namely, software (Emoji Maker). This allowed students to create a model of visual interpretation of artistic (poetic) text during the experiment. With a limited set of tools in the program set, students rely on their own essential empirical experience and on a sensory typology that corresponds to three main types – visual, audio and kinesthetic [8]. In addition to aforementioned, students, using the color scheme, rely on general information about the person's physiognomic characteristics [8], which allows them to accomplish the task: to model the features of the faces of lyric characters in Emoji Maker according to contextual events, feelings, phenomena.

Analysis of recent research and publications. According to Svitlana V. Pidopryhora, "... the invasion of new technologies (computer, Internet) into the sphere of literature - changes the nature of authorship, the structure of text, the essence of reading and the form of interaction between the reader and the text, the level of communication interaction author – reader – text" [18]. Thus, emoji literature technology enhances the ability of philological students to convey the content of literature in the most appropriate characters or symbols.

Emoji researchers are convinced that these characters have great hypertext potential. For example, there have been attempts to translate the text of Herman Melville's novel "Moby Dick" via the appropriate emoji, called "Emoji Dick" [2].

Today, emoji is not only a linguistic tool, but also a psycho-physicalist one. By modeling this or that facial expression of an emoji, the author gives it the emotional touch that corresponds to the level of sensuality. The emoji face performs an informative function, that is, communicates to the interlocutor the emoji author's response to a text, which greatly diversifies written communication.

Consequently, by making sense of poetry with the help of a self-designed emoji corps in Emoji Maker platform, philological students have the opportunity to expand the range of emotions, moods and experiences that arise in the process of reading poetry and especially its interpretation. Emoji face expression is a student's creative approach to understanding the essence of prose and poetry. After all, all human feelings are expressed not so much in words as in facial expressions. So, we offer emoji modeling technique that reproduces the artistic meaning of poetry.

2 Methods

The following methods were used to solve the established problems: *empirical* – in the course of conducting an experimental study of emoji modeling in class with students; applying a systematic approach to consider an object as a system model; functional approach – to determine the functions performed by the model; *pedagogical modeling* [16] – for the study of pedagogical objects (phenomena) by means of modeling of conceptual, procedural, structural-content and conceptual characteristics and individual "sides" of the educational process within the defined socio-cultural space at the general educational level; *aspect analysis of the artistic text* – for the separation of stanzas and content clusters; *deductive* – for sign assembly.

3 Results

Natural language in its ousia is that macrocosm that is reproduced in the continuum of the world of things (Plato [20]). As we know, the efficacy of this subordination to a pragmatic world gives natural language the evolutionary status – capable of expansion, and most importantly capable of simplification. The latter, in turn, has an ontogenetic function of preserving and extending the human race: "*We must simplify grammar until grammar has simplified us*" [4]. It concerns the codification of human consciousness through language, and more precisely, through its unilateral structure (US) and polylateral ousia (PO). We emphasize the term ousia, since the term has passed the stage of modification and in the Greek language the denotation of this concept is absent. In modern Greek, the term is interpreted to mean the essence and nature of a thing. However, the "Dictionary of Untranslatables: A Philosophical Lexicon" [3] presents differences in understanding of concepts by different scholars and in different epochs. The dictionary emphasizes that the meaning of the word has undergone a radical transformation between Plato and Aristotle, since the former understood everything in the modern sense of "property" and in the philosophical sense of the essence of things, while the latter added other meanings, identifying ousia with ὑποκείμενον/theme (causes it to lable εἶδος through ousia sometimes, a type or feature, sometimes the unity of matter and eidos, and sometimes matter itself). Through the subsequent history of philosophy, the situation was increasingly complicated, since the Stoics regarded everything as an indeterminate substrate, thinkers of middle Platonism and Neo-Platonism returned to the meaning of "essence", and Christian Christology approximated υπόστασις with ousia giving the latter more enriched meanings, nonexistent in modern Greek [3]. It is because of differences in translations and interpretations that all modern Greek translators have decided to leave the word untranslatable, taking into account the entire range of interpretations available. The latter gives us the possibility to use the term "ousia" in the study.

It is worth noting that the unilateralism of the structure is not universal to all speakers, but is identical to the distinctive thinking (DT) of a person, which, in turn, is an explanatory factor for the evolution of language. Let us describe this process with the following formula:

$$\frac{\mathrm{US+DT}}{\mathrm{PO}}$$

where PO is a substantiated exponent, in fact, the material expression of a linguistic sign.

In the context of language simplification, the work of Ludwig Wittgenstein "Tractatus Logico-Philosophicus" plays a key role [22]. According to the concept of the scholar, called "language game", which correlates, and at the same time contradicts, the role of natural language in the reflection of the world, it is believed that natural language is most capable of world reproduction, but the peculiarity of language games is that there are specific rules that each player can understand differently. However, this is precisely the reason for the multilateral character of the ousia of a sign. After all, we are already dealing with the arbitrariness of his understanding (Wilhelm Wundt [23]).

The only field, where a sign synthesizes all its meanings, is exclusively a metalinguistic environment – one where any linguistic unit is reproduced as a linguistic-communicative (Ferdinand de Saussure [6], Charles Bally [1], Wilhelm von Humboldt [10], etc.), and logical and philosophical essence (Ludwig Wittgenstein [22], Gottlob Frege [9], Charles Sanders Peirce [17] and others). Such a field is computer being (CB) – a complex, multidimensional sphere of synthesis of reality, human experience and activity, mediated by digital and information technologies [13]. The linguistic aspect of CB research is determined by objective historical and geopolitical prerequisites: cybernetization, globalization, informatization of world society [14, p. 1]. It is in the continuum of CB, where the language game is the symbolic and semiotic foundation of Web 2.0 platform testing, that game rules acquire metal-linguistic characteristics and require special content analysis.

Essential-empirical analysis of computer being as a linguistic universal continuum uninstalls the following ethno-barriers: folk-mythological arsenal, cultural paradigms, socio-political discourses, etc. The key to this uninstallation is the phenomenon of "emoji" – "ideograms or emoticons used in emails and web pages" [7]. The digital emoji corps is a technogenetic mimesis of pictographic writing. The function of emoji, as pictography, is to identify the meaning, the content of which a priori eliminates its own invariance, transgressively appealing to the logical-eidological plane (Aleksandr A. Reformatskii [21]). Emoji in CB is a universe, its visualization is exploited by the macrostructure of technogenesis, which is indicated by the internal unity of its components at the micro- and macro-levels and in the plane of the sign substrate (formal and semantic elements and structures) and the synthesis of features of ontological, cognitive and anthropological substance [14, p. 2].

Thus, the importance of implementing CB emoji in the study and interpretation of literature is absolutely natural: emoji, phenomenologically, logically and eidologically installed in the digital continuum, is separated from the natural language predicated by (ethno)logy, and implicitly embedded in (cosmo)logy. Understanding emoji is not subordinated to the nationality of the speakers. Another interpretation is that each speaker interprets the linguistic field in terms of its empirically-essential foundation, but this premise does not preclude the understanding of emoji.

Emphasizing the iconicity of the emoji corps, we appeal to the concept of modality and multimodality. Charles Bally noted that modality is the soul of the proposal; like thought, it is formed predominantly as a result of the active operation of the speaker who speaks [1]. The scholar distinguished the main content (dictum) and its modal part (modus), which formulates emotions and intellect of reasoning regarding dictum. And therefore, modality is expressed in two types: objective and subjective. (Inter)synthesis of these types also involves multimodality as a way of constructing and reconstructing concepts and meanings with their integration into a metalinguistic semantic field, in which, in fact, the hypertext semiotic code is established. Thus, with emoji we get to a multilevel structure of language – from the phonetic level to the textual level.

Before proceeding to the empirical analysis of poetry modelling, let’s define the algorithm by which, with the application of the Emoji Maker program, emoji is constructed taking into account formal and informative factors of a fictional text.

1. At the first stage, students are offered poetry for analysis. Emphasizing that poetry is imagery, and therefore its analysis must be accompanied by imaginative and critical thinking.
2. At the second stage, we propose to analyze the text using the Emoji Maker digital program, having outlined the purpose and tasks before. The program provides students with a limited list of options for creating emoji, and thus the students’ creative and creative skills, as well as the essential empirical experience that will allow them to explain and substantiate the color choices of the emoji and its components, play a special role in the task.
3. At the third stage, we must emphasize to the students: emoji models should correlate with the content of the poetry, as well as formally reflect the mood and feelings of both the lyrical hero and the reader.

We shall proceed with the example of the poetry of a twentieth century Cuban poet José Ángel Buesa. The selection of poetry in this case is to appeal to the most important function of emoji – the expression of feelings. In his lifetime, Jose Buesa acquired the status of “enamored poet”, that is, a poet whose poetry is distinguished by sensuality in his own metaphor. Therefore, we believe that it is appropriate to reconstruct this sensibility with the help of the aforementioned metalinguistic digital continuum. We apply the Emoji Maker digital platform [19]. The program has technical limitations, which, however, seal the phenomenology of the presentation. These limitations are specifically available repertoire of tools that cannot be traversed during image rendering. Emoji Maker contains the following skins: *face shape, more shape, eye, eye brow, mouth, hair, sunglasses, hands, hats, others, background*.

We shall further disclose the completion of the sample study task: to recreate the *meaning of the following poem by José Ángel Buesa [11] using self-designed emoji in Emoji Maker tool*.

ACUÉRDATE DE MÍ	REMEMBER ME	НЕ ЗАБУВАЙ МЕНЕ
I. Cuando vengan las sombras del olvido a borrar de mi alma el sentimiento, no dejes, por Dios, borrar el nido donde siempre durmió mi pensamiento.	I. When shadows of oblivion advance expunging feeling from my very soul, for God's sake don't erase the case where dwell the thoughts to you I owe.	I. Коли прибудуть тіні забуття, Щоб почуттів в душі спинити існування, Благаю Богом, збережи буття, В котрім завжди жило моє кохання.
II. Si sabes que mi amor jamás olvida que no puedo vivir lejos de ti dime que en el sendero de la vida alguna vez te acordarás de mí.	II. Should you so know my love fails not, that I can't live afar from thee, Do tell me, on thy earthly trot you will remember me.	II. Як знаєш, що любов моя нетлінна, Що жить без тебе – зá бік узбереж, Скажи, що на путі життєво цінній Одного разу мене ти впом'янеш.
III. Cuando al pasar inclines la cabeza y yo no pueda recoger tu llanto, en esa soledad de la tristeza te acordarás de aquel que te amó tanto.	III. When you bow your head passing by, me unable to dampen your tears, in that loneliness gone awry You'll remember my love perseveres.	III. Коли в путі чоло огорне сум, І я не зможу сліз твоїх спинити, В цій одинокості печальних дум Упом'янеш того, хто вмів любити.
IV. No podrás olvidar que te he adorado con ciego y delirante frenesí y en las confusas sombras del pasado, luz de mis ojos, te acordarás de mí.	IV. You cannot forget I've adored thee with blind and delirious frenzy In the shadows of past gone hazy, delight of my eyes, you'll recall me.	IV. Ти не забудеш мого боготворіння, Безумного й сліпого до безтями В прожитому, що заплелося тінню, Мене згадаєш за очей свічáми.

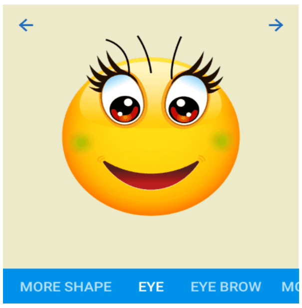
V. El tiempo corre con denso vuelo ya se va adelantando entre los dos no me olvides jamás. ¡Dame un recuerdo! y no me digas para siempre adiós. (José Ángel Buesa)	V. Time flies with thick might, Far ahead separating us two, Don't forget me. Deliver a token! and don't fare me well anigh. (Translation by Rusudan K. Makhachashvili)	V. Час тяжко простягається по колу І вже випурхує між нас у це буття. Не забувай! Не забувай мене ніколи. Не говори мені «Прощай без вороття!» (Translation by Anna O. Bakhtina)

The reconstruction of the poem should begin with its division. The poem contains of 20 lines, divided into 5 quatrains. We take each quatrain individually, so as a result we have to create 5 emoji characters. We reduce the compilation of the sign to deduction, that is, for each quatrain we define the universal qualities of emotion (UQE).

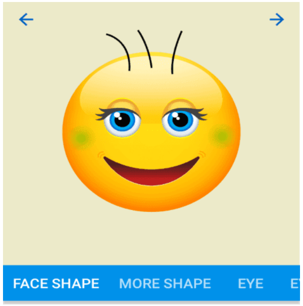
I. When shadows of oblivion advance,
expunging feeling from my very soul,
for God's sake don't erase the case
where dwell the thoughts
to you I owe.

Lyrical Hero = Love + Memory. So, we create the image of a character – a lyrical hero who pleads to be remembered be his love. UQE: anxiety, sadness, fear, hope. The main feature (hereinafter referred to as the "MF") is the PRAYER.

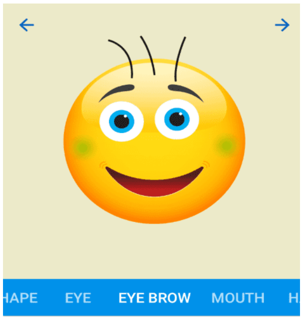
1. We take the yellow circle as the basis. Yellow in this case – as a symbol of hope, but at the same time – the sadness of separation.



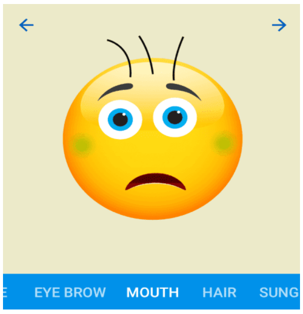
2. The choice of eyes is justified by the pleading expressed by the lyric hero. The main feature – mirrored dilated pupils, reminiscent of tears.



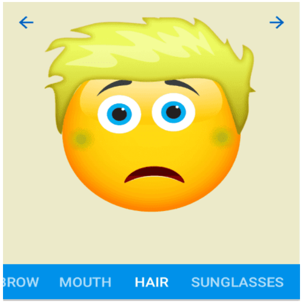
3. The main expression of emotions rests in the eyebrows, because the quatrain expresses a plea. Therefore, the eyebrows rise to the central frontal part of the eye.



4. The corners of his lips are slightly down, which also testifies to the sadness of the lyrical hero.



5. The choice of the lyrical hero's hairstyle correlates with his essence – romantic nature. Therefore, the hair is blond, not too short, disinfected.



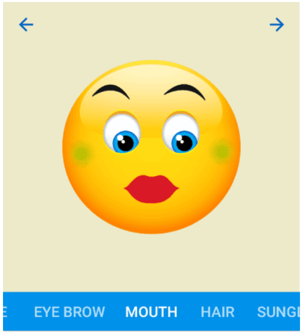
6. In this quatrain supplications can also be defined by gesture: palms are opened, the geometry of which involves the coverage of the object of love.

7. In addition, pleading can be emphasized with conditional tears, which gives the lyrical character the desired effect.

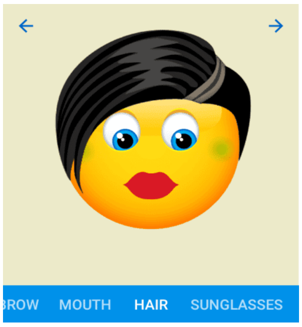
II. Should you so know my love
fails not,
that I can't live afar from thee,
Do tell me, on thy earthly
trot
you will remember me

Lyrical Hero = love + memory + incorruption. MF – ETERNITY. For the sake of this quatrain, in order to avoid repetition of images, one can portray a potential fiancée of a lyrical hero who mentions love. UQE: thoughtfulness, memories.

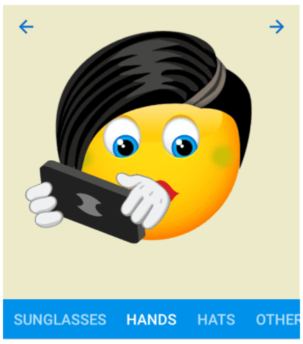
1. Let us pay attention to the lips of the alleged girl: it ought to be a red, full mouth, closed, which will indicate the reflections of the heroine, her memories. The pupils of the eyes will look sideways and downwards, which will again indicate the girl's reflections.



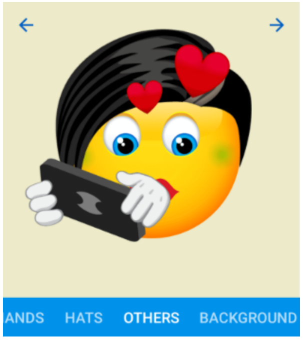
2. Hairstyle is also important because the length of hair, color, style correlates with the character of the woman. So, based on the limited selection offered by Emoji Maker, we choose medium length, black hair. With this choice, we visualize a girl as a young person, ages 23-25.



3. In digital age, communication cannot be imagined without gadgets. With that in mind, let's portray a girl with a mobile phone: so we can be interpretatively assumed that the girl's memories are symbolically stored on the device (photos, videos, etc.) – which is easier for students to relate to.



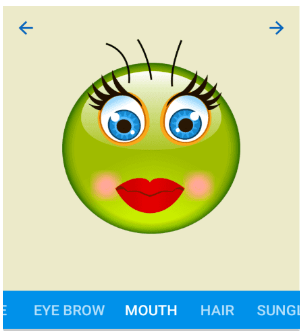
4. We can complete the image with a universal denotation of love – a heart.



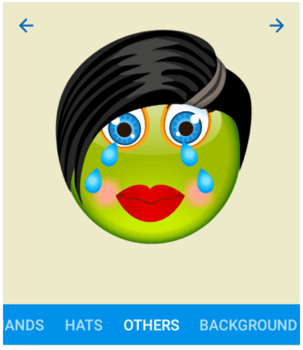
III. When you bow your head
passing by,
me unable to dampen your tears,
in that loneliness
gone awry
You'll remember my love
perseveres.

Lyrical Hero = Love + Sadness + Memory + Thoughts. MF is loneliness. UQE: sadness, memories, longing, despair.

1. It is worth noting that in Spanish speaking cultures, green is the color of hope in love [5, p. 15], and therefore, an emoji experiment with a green smiley is advisable. Because the hope of memories rests on the subject addressed in the poem by the lyrical hero, so here we portray the girl.



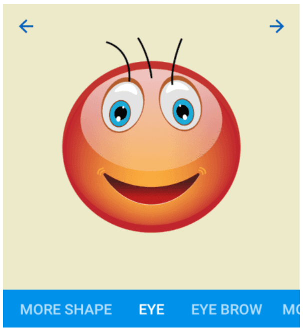
2. We leave the physiognomic characteristics the same as those in the second quatrain. And to visualize of the UQE we add the denotation of sorrow – tears.



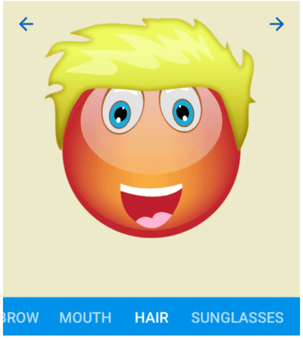
IV. You cannot forget I've adored thee
with blind and delirious frenzy
In the shadows of past
gone hazy,
delight of my eyes, you'll
recall me.

Lyrical Hero = Love + Memory + Time. OR is a passion. UQE: madness, passion.

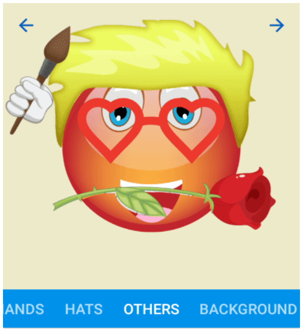
1. Universal characteristic of red color – love, passion; anger. Given the context of the quatrains, we construct a smiley face of red color, which will symbolize the love of the lyrical hero, his passionate feelings.



2. The hairstyle of the lyrical hero remains unchanged, as in the previous image, symbolizing the romantic nature. Lips play a key role in this image. Let us portray them as half-open, which shows the interest of the lyric hero, his admiration for the woman.



3. However, the most fundamental function of the UQE described in this quatrain is the attribute of love and romance. So let’s depict the lyrical hero in heart-shaped glasses, a rose, and a brush that characterizes the hero as a dreamer, an artist who, in his own reminiscence, abstractly depicts the image of a beloved woman.

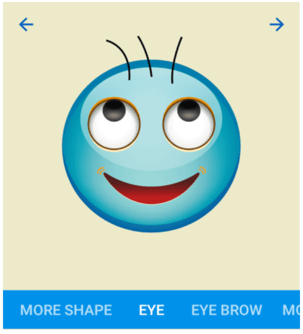


V. Time flies with thick
might,
Far ahead separating us
two,
Don’t forget me. Deliver a token!
and don’t fare me well
anigh.

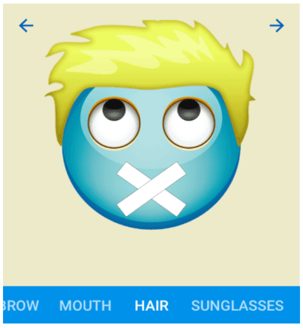
Lyrical Hero = Love + Time + Inevitability + Farewell + Memory. MF – timelessness. UQE: hope, memories, supplications, hopelessness.

1. The last quatrain demonstrates in the most detail the purpose of the lyrical hero as a kind of prayer to a woman: the feeling of not returning, the inevitability of time makes the hero appreciate his feelings. He also brings this up with a woman, pleading with her to remember his feelings as well. The poetic motif is that love will persevere as long as it is remembered.

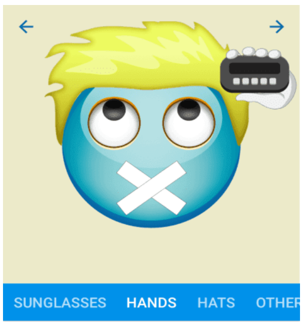
Let's finish the visualization of poetry in the blue color of the emoticon, where blue is the universal symbol of hope, the fulfillment of a memory dream in time.



2. A plea not to say "Farewell!" we can depict through another universal sign - muted lips.

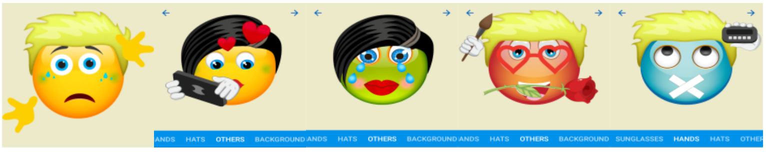


3. We complete the digital reconstruction with symbolic attributes: the pager (obsolete technology) reproduces the semantic nature of the image of time, the equivalents of which are being-timelessness-eternity-Cosmos-Eidos.



So, with the help of the Emoji Maker computer program, we introduce a visual reconstruction of J. A. Buesa's poem "Remember Me". This approach simplifies the isolation of the fundamental factors underlying poetry. First, considering the person's physiology, we tried to single out meanings that suggest the presence of the following feelings: love, anxiety, sadness, fear, hope, memories, supplication, hopelessness. Visual affirmation of the senses contributes to a profound awareness of the fundamental concept of the poem – time, which can be correlated by the micro- and macro-cosmic elements of being (and in our case, computer being): being-timelessness-eternity-Cosmos-Eidos.

By recreating poetry through an ICT semiotic tool, students can potentially reproduce the meaning, imagery and content of the text only through the chain of emoji created:



Applying the Emoji Maker multimedia program when analyzing a work of art (poetry) in the classroom, one should adhere to the following guidelines:

1. Before moving on to modeling emoji, it is necessary to outline the main idea of the text, because it depends on the further characteristics of poetry and its visualization.
2. Describe the lyrical hero, outline his role and function in the text. Describe his mood, feelings, emotions.
3. It is worth remembering that the reception of the reader can be validated only by the feeling and emotions of the lyrical hero, but not by the content of poetry.
4. Visualize the appearance of the lyrical hero without departing from the context of poetry. Imagine the emotions of the hero, hypothetically outlining the physiognomistic characteristics relevant to the mood and feelings of the lyrical hero. You can now move to image modeling in Emoji Maker.
5. It should be noted that the choice of options in the program is limited, and therefore, their use should be qualitative and contextual.
6. Each option used must be defendable – only under this condition the correlation of ICT tools potential with the content of poetry can be traced.

4 Conclusions and prospects of further research

A multidisciplinary approach to various disciplines (linguistics, literary studies, philosophy of language, psychophysionics, eye-tracking and text-mining technologies, etc.) in synthesis with structures of computer being, namely, with an emoji-body on the Emoji Maker platform allows to create a model of digital semiotic presentation of fiction. Thus, the reader-interpreter, using a specific technological toolkit, a visual iconic sign (smiley/emoji) reproduces the multilateral metalinguistic functionality of the meaning of a sign based on the artistic word. This approach significantly expands the subject of the study and can be applied in classes of linguistic and literary disciplines, as well as in classes in critical and analytical reading. Due to the powerful hyper-cybernetization in the world, research on the topic will acquire more and more interpretative layers, the study of which is impossible without a multidisciplinary approach.

The study outlined the multifunctionality of the computer being emoji corps based on fiction. The Emoji Maker platform attempts to compile the image of a lyrical hero. The created images, hieroglyphs of the 21st century, reproduce the multimodal concept of the metalinguistic field. The sign is both an icon, a symbol and a text. On the verbal language level emoji convey the meaning (dictum) of the signified, on the non-verbal level – the meaning (modus) of the signified. Objective and subjective in a sign are synthesized, and the reproduced image is read through the psycho-physiologist prism, which reconstructs the essence of graphic mimesis in the pedagogical sphere. The technical limitations of the Emoji Maker web platform have made it possible to phenomenologize one's own essential-empirical reconstruction of the image of a lyric hero, which allows one to appeal to the cognitive modeling of content and the development of skills in poetry. The basis of modeling is the theory of similarity, in which absolute similarity is possible only by replacing one object with another, identical to the first in form and content. However, as noted above, poetry is an imagery which understanding depends to a great extent on the recipient's essential empirical experience and on its sensory typology, which corresponds to three main types – visual, audio and kinesthetic [8]. Therefore, simulation of exactly the same results is impossible, because only under the condition of individual approach of students to visualized analysis of poetry is it possible to adequately reflect all aspects of functioning of the studied object with the help of a simulated emoji sign.

Acknowledgements. The study was performed within the framework project of the Department of Romance Languages and Typology (Borys Grinchenko Kyiv University, Kyiv) "European Languages and Literatures Development in the Framework of Intercultural Communication" (registration code 0116U00660) and the framework project of the Department of Ukrainian and World Literature (Kryvyi Rih State Pedagogical University, Kryvyi Rih) "Poetics of the Fictional Text".

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Model of using cloud-based environment in training databases of future IT specialists

Olha V. Korotun[1[0000-0003-2240-7891]], Tetiana A. Vakaliuk[1[0000-0001-6825-4697]] and Vladimir N. Soloviev[2[0000-0002-4945-202X]]

[1] Zhytomyr Polytechnic State University, 103 Chudnivska Str., Zhytomyr, 10005, Ukraine
olgavl.korotun@gmail.com, tetianavakaliuk@gmail.com
[2] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
vnsoloviev2016@gmail.com

Abstract. The authors substantiates and develops the model of using cloud-based environment (CBE) in the training of databases of future information technology (IT) specialists, which consists of interrelated units: target (purpose, task of using CBE), conceptual (pedagogical approaches, didactic principles), organizational and semantic (characteristics of CBE, basic requirements for CBE, subjects of training, CBE of the teacher, CBE of the student, curricula of institution of higher education, educational-methodical complex of discipline "Databases", installation and configuration of database management system, development of educational material from the database in electronic form, selection of cloud-based systems of distance learning, introduction of cloud-based systems of distance learning in the training of students' databases, selection of CBE in database training (databases, forms, methods, tools), evaluative (criteria, indicators, levels of professional and practical competence of future IT specialists on the use of CBE in database training), effective (increased formation of the information and communication technologies of future IT specialists on the use of CBE in database training).

Keywords: model, usage, cloud-based environment, database training, future IT specialists.

1 Introduction

1.1 Formulation of the problem

The process of training future IT specialists involves the obligatory study of databases, in which the teacher emphasizes on the features of database technologies so that students understand the basic trends of development of modern databases, advantages, and disadvantages in their use, specifics of work in database management systems data, etc. The acquired knowledge, skills from databases are necessary for future IT specialists in their professional activity.

To increase the efficiency of the educational process in training databases and improve the professional training of future IT specialists, teachers use a cloud-based environment (CBE). The use of such an environment in the educational process is currently a pressing issue in the theory and methodology of using ICT in education.

The use of CBE in the training of databases of future IT specialists enables the teacher to organize various forms of students' education (full-time, distance, distance, mixed, electronic), to provide the student with educational materials for the discipline, to test theoretical knowledge and practice, student learning outcomes, analyze student learning outcomes, organize an archive of study materials, and more.

1.2 Analysis of recent research and publications

Creating educational environments of domestic educational institutions in their works described Olga V. Bondarenko [1], Olga P. Pinchuk [12], Halyna V. Popova [22], Yevhenii B. Shapovalov [14], Mariia P. Shyshkina [17], Nataliia V. Soroko [18], Oleksandr V. Spivakovskiy [19], Snizhana O. Zelinska [23] and others; the use of a CBE was investigated by Dmytro S. Antoniuk [20], Olena G. Glazunova [5], Oleksandr H. Kolgatin [6], Larysa M. Petrenko [11], Mariya P. Shyshkina [15], and others.

We agree with the opinion of Svitlana H. Lytvynova [8], that the purpose of creating a CBE is to achieve certain didactic goals, to fulfill pedagogical tasks, to unite the subjects of the educational process for effective cooperation, focused on improving the educational results of students by tools of cloud services.

We share the opinion of Mariya P. Shyshkina [8] and Maiia V. Marienko [10], who state that cloud services are used to provide the user with electronic educational resources that make up a meaningful content of a CBE, as well as to provide creative and delivery processes educational services.

The learning environment, as noted by Valerii Yu. Bykov is an artificially constructed system whose structure and components contribute to the achievement of the goals of the educational process [2]. Vitalii V. Lapinskyi states that it is the set of material objects and the links between them that form a system designed to support the learning activities of the subjects of learning [7].

Valerii Yu. Bykov also considers such a concept as a cloud-based educational and scientific environment, in which he understands the ICT environment of a higher education institution, in which certain didactic functions, as well as some fundamentally important functions of scientific research, provide for the appropriate coordinated and integrated use and cloud computing technologies [4].

Based on the analysis of the source database, the cloud-based environment in training database at higher education institutions (HEI), we understand the HEI learning environment, which envisages the use of cloud computing technology to ensure a level playing field, educational interaction, and cooperation between subjects (teacher and students) database training activities.

The development of cloud computing has led to the emergence of new cloud-based ICT and has influenced the training tools of future IT teachers. The use of cloud-based tools facilitates the formation of CBE in higher education institutions and opens the way to individualization of learning, interactive interaction and active collaboration between participants in the educational process, and allows the use of the CBE in training databases.

Using training, we mean a set of objects, ideas, phenomena, and methods of action that ensure the implementation of the educational process.

As for cloud-based tools, we mean such training tools implemented by cloud technologies [21].

The **purpose** of the article is to develop a model of using CBE in training databases of future IT specialists.

2 Methods of the study

Methods of research:

- analysis, classification, summarization psycho-educational, specialized and technical literature on creating a model of cloud-based environment training of higher education institution to isolate the priority areas of research, defining the essence of basic concepts of research;
- method of specifying and systematization of theoretical knowledge for the development objectives of the study;
- modeling – to develop and represent a theoretical model: models of using CBE in training databases of future IT specialists.

3 Results

Simulation is an indispensable part of pedagogical research, which is used to describe and study various processes, including information, innovations, properties, as well as patterns of development of the educational system, educational environments, etc. [13].

We agree with Valerii Yu. Bykov's opinion [3] that a model is a representation (analog, image) of a system that is designed and reflects the features and properties of this system that ensure the achievement of the goals of model construction and use.

Adherence to the system approach allowed us to develop a model of using the CBE in the training of databases of future IT specialists, which consists of the following units: target, conceptual, technological, organizational-meaningful, evaluative, and effective (Fig. 1). Let us consider separately each unit of the presented model.

The target unit identified a goal, namely, to increase the level of professional and practical competence of future IT specialists to use the CBE in the training of databases. The tasks of using a CBE in training databases of future IT specialists are to use a CBE in training databases; improving the educational and methodological complex of the discipline “Databases”.

The training of students in the discipline of “Databases” using a CBE is based on several didactic principles and methodological approaches presented in the conceptual unit.

Learning in a CBE relies on methodological approaches:

System – defines the process of formation of the CBE in training databases as a coherent system;

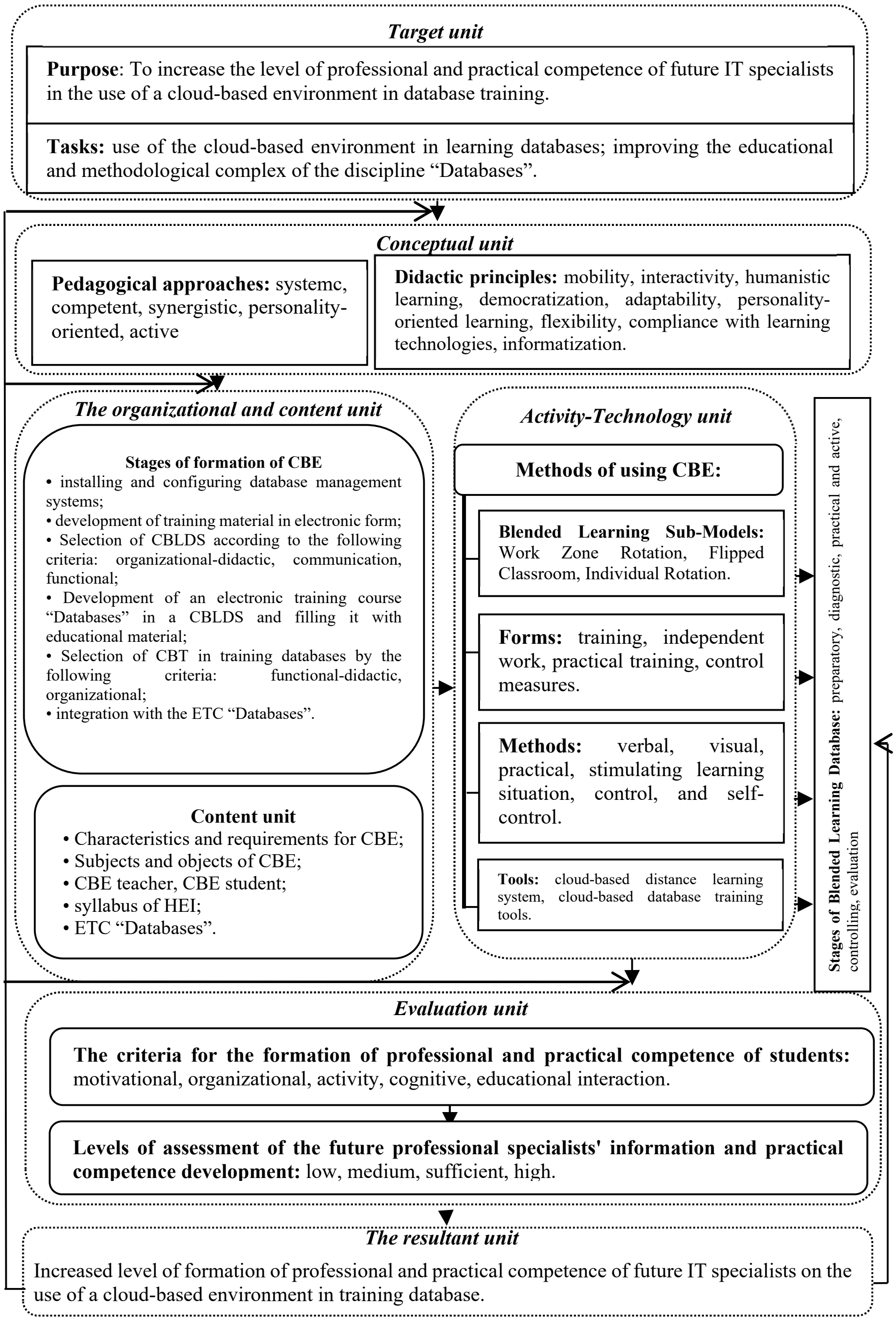

Fig. 1. Model of using CBE in training databases of future IT specialists

Competent – involves increasing the level of professional and practical competence of future IT specialists in the course “Databases”, which is manifested in the following features: understanding of the principles of construction and operation of different databases models, the procedure for creating databases using databases management systems, principles ensuring the security and demarcation of databases access rights in Databases Management Systems (DBMS); able to develop relational databases, create tables, forms, reports, queries in DBMS; ability to make rational use of cloud-based distance training systems to solve personal and professional problems;

Synergistic – orient the student to self-organization and self-development;

Personality-oriented – takes into account individual features defines each student as his/her main subject of study to create favorable learning conditions for him/her;

Activity – determines the focus on the organization of active educational, cognitive, independent, and communicative activities for the formation of professional and practical competence of a future IT specialist.

Consider the didactic principles of using a CBE, aimed at meeting the personal educational needs of future IT specialists as a subject of study and suggest the use of cloud-based learning tools:

- Mobility – providing the student with access to communication and collaboration tools regardless of time and place of residence;
- Interactivity – reflects the communicative interaction in a CBE of teachers with students in synchronous and asynchronous modes;
- Humanistic education – creation for the student in a CBE of the most favorable and convenient conditions for obtaining a chosen profession, reorientation of the educational process to his personality;
- Democratization – tools the distribution of rights, powers, and responsibilities among participants in the educational process in a CBE;
- Adaptability – involves the adaptation of the educational process in a CBE to the cognitive characteristics of each student;
- Person-centered learning – the realization that a student in a CBE is a person with his or her own experience and stock of knowledge and skills, the use of which leads to the best results in learning and the educational needs of each student;
- The principle of the flexibility of learning – a student in a CBE can absorb the learning material at a convenient time and place, at the right pace;
- Conformity to learning technologies – use of forms, methods, learning tools that are implemented only in a CBE;
- Informatization is the access of students and teachers to the tools of modern ICT.

The organizational and content units of using a CBE are the stages of the formation of such an environment and its content component. The stages of formation include the installation and configuration of DBMS, the development of educational material with databases in electronic form, the selection of cloud-based systems of distance learning, the introduction of cloud-based systems of distance learning in the training of student databases, the selection of cloud-based databases, integration into the e-learning complex “Databases”. Content component – characteristics and requirements for CBE, subjects, and objects of the CBE, cloud-based teacher environment (Fig. 3) and CBE of the future IT specialist (Fig. 2), educational plans education, an educational-methodical complex of discipline "Databases", electronic training complex (ETC) "Databases".

The technology unit reflects the use of the CBE in the educational process of the discipline "Databases", organized in a blended form, so it consists of sub-models of blended learning. Also in this unit, the teacher selects traditional forms of organization, methods, and learning tools that can only be implemented in a CBE to achieve didactic goals. The evaluation unit contains criteria for assessing the level of professional competence of future IT specialists regarding the use of the CBE in Database training. Assessment of the level of formation of the specified competence of future IT specialists is performed according to certain criteria, indicators, and levels.

Resulting unit – the result of the model implementation is to increase the level of professional and practical competence of future IT specialists on the use of the CBE in Database training.

Therefore, the CBE model in Databases training consists of the six units described above and is a prerequisite for its effective implementation into the educational process of future IT specialists.

The use of CBE in training databases provides support for new modern trends in the educational process; openness and accessibility of training for all subjects; confidentiality; efficiency, the flexibility of learning; determining the level of academic achievement of students; communicative interaction and effective cooperation between the subjects of study; rapid dissemination of educational material; formation of an individual trajectory of learning, as well as, encourages students to independent and active educational and cognitive activity, promotes self-development and increase interest in learning using modern ICT.

Formation, implementation, and use of the CBE in the training of databases of future IT specialists in higher education institutions should be carried out to achieve the didactic goals and meet the educational needs of all subjects, according to the following characteristics:

- Individualization of learning. The teacher, taking into account the individual characteristics of each student during the study of databases, uses the possibilities of a CBE to increase the motivation for learning, the level of educational training (some students in the school course of computer science did not study databases, some had difficulties in learning this topic, and some successfully studied it and participated in school competitions and competitions in which it was necessary to use knowledge of databases), the speed of perception of educational material, the implementation of group activities hone in carrying out group projects, etc.;
- Optimizing learning in a CBE. The teacher provides an appropriate set of modern methods and training tools for databases in a CBE for best results. Optimization of study of the specified discipline implies an increase of efficiency of training and success of results of students at the minimum expenditure of time and forces of subjects of study, and the results of education of students correspond to program results of training of discipline "Databases";

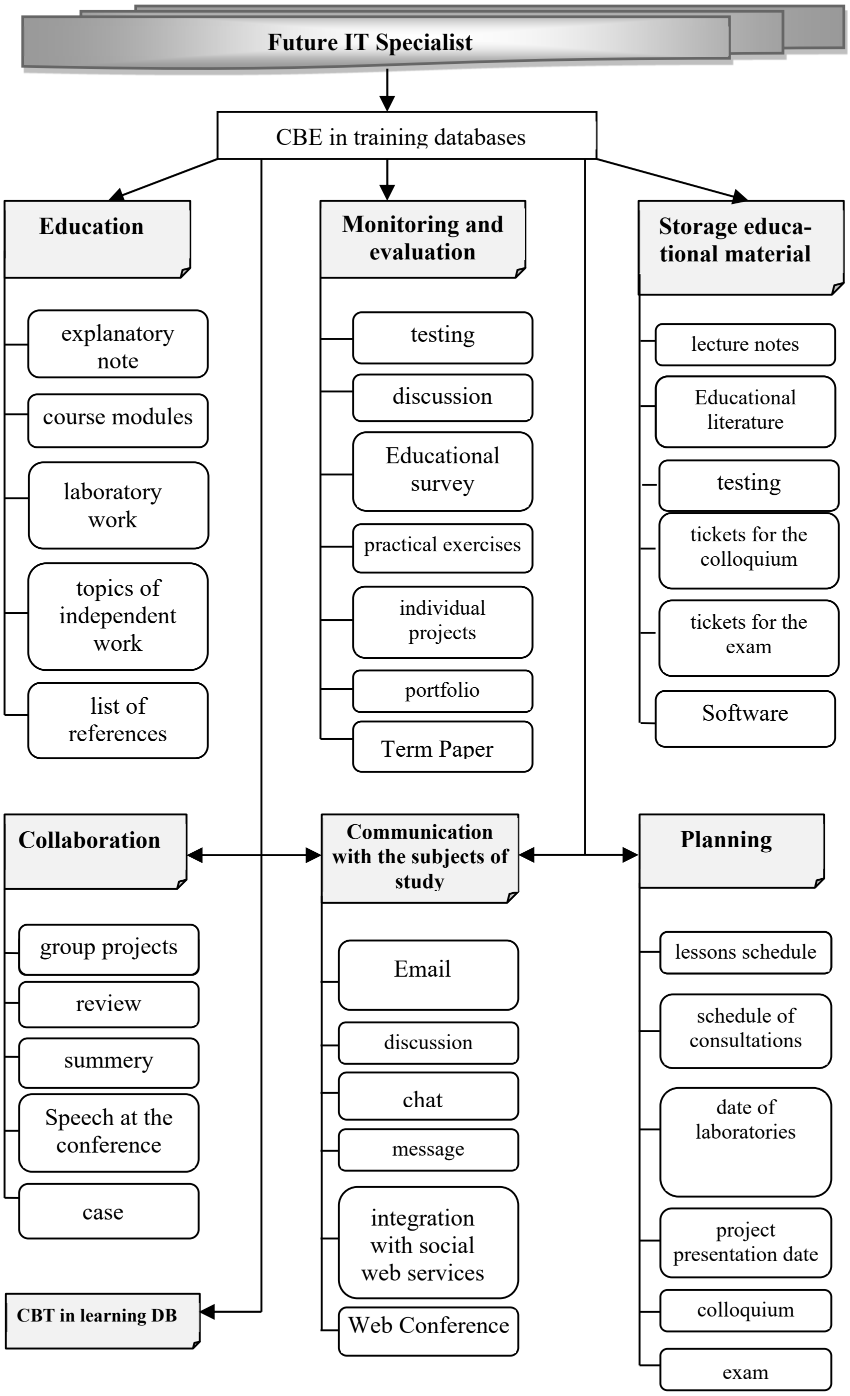

Fig. 2. Structure of the CBE of the future information technology specialist in database training

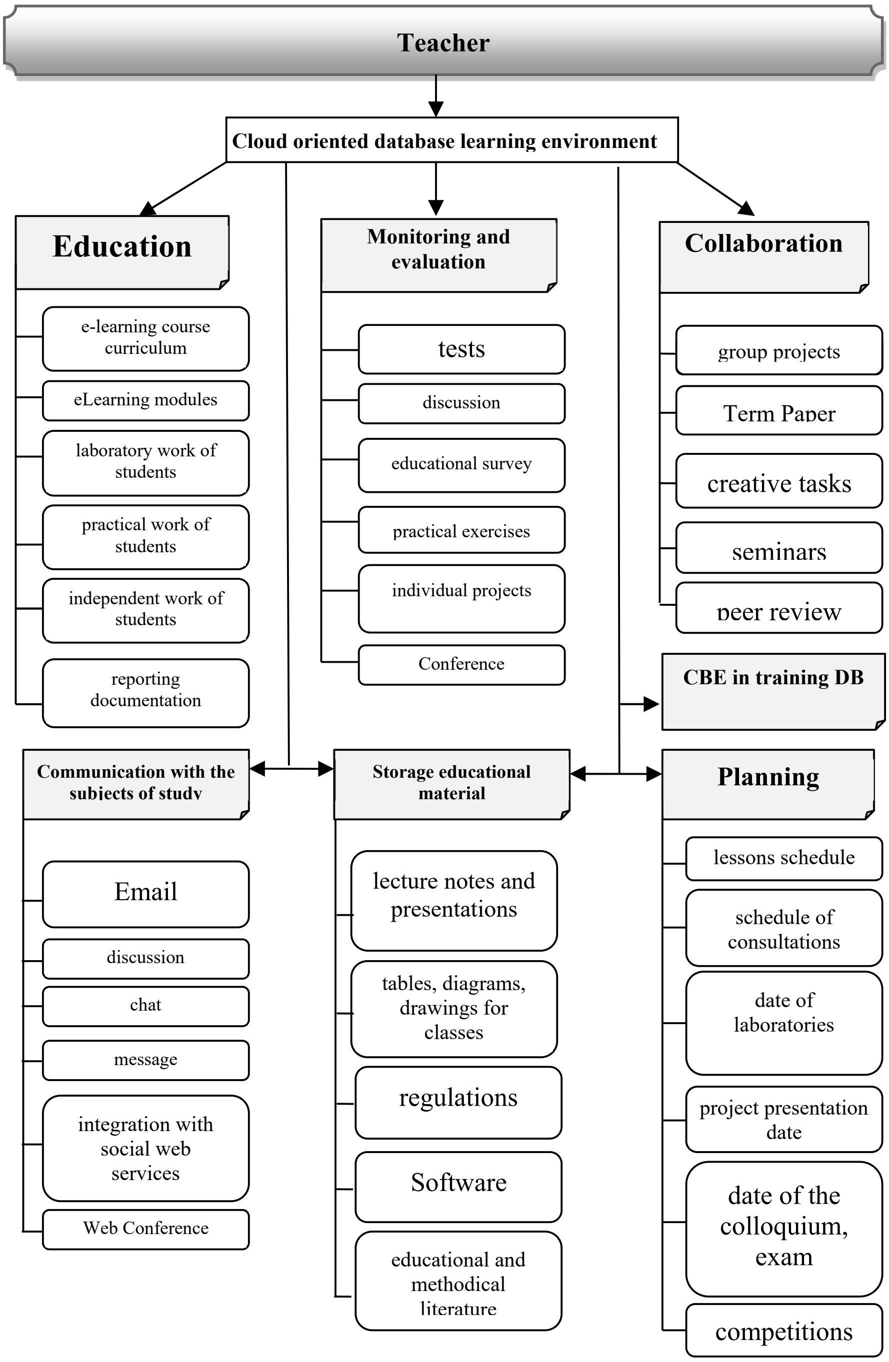

Fig. 3. Structure of cloud-based teacher environment in training databases

- creation and placement by the teacher of their course on databases in a CBE, which includes the author's development of lectures, practical and laboratory works, control works, etc.;
- rapid dissemination of educational material from databases in electronic format in various formats through cloud repositories, prompt notification of this to students and their access to materials regardless of location, time of stay from any computer-oriented medium;
- self-assessment of students' knowledge in a CBE to check their current learning outcomes from databases based on tests, practical exercises after studying a specific content module;
- convenient communication of the teacher with the future IT specialists: remote consultations in synchronous and asynchronous modes (both from the teacher and classmates) on the issues arising during the study of training material from databases;
- conducting group research in a CBE, when students perform such research in real-time, evaluate the performance of each group member. The teacher completely controls the process of such work, if necessary, may express comments, wishes, etc.;
- convenient cloud-based tools for learning databases.

4 Conclusions

The use of the CBE in the training of databases of future IT specialists s is advisable to implement based on a specially developed model consisting of the following units: target, conceptual, organizational-content, activity-technological, evaluative, and effective. The result of the application of the proposed model is to increase the level of professional and practical competence of future IT specialists in the use of CBE in databases training, which tools the confirmed ability of the future IT specialist to implement the professional activity in the field of databases practical skills, attitudes, personal qualities and experience that he has acquired while learning databases in a cloud-based environment.

The performed research does not claim to be a definitive solution to the problem of using a CBE in training databases of future IT specialists. The analysis of its results outlined the following areas of further research: the use of cloud services for the formation and development of professional competencies of future IT specialists.

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Using Learning Content Management System Moodle in Kryvyi Rih State Pedagogical University educational process

Iryna S. Mintii[0000-0003-3586-4311]

Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
irina.mintiy@kdpu.edu.ua

Abstract. The article analyzes the results of the survey of 75 lecturers on using learning content management system (LCMS) Moodle in the educational process. It is defined that more than 75% of the respondents use LCMS Moodle. The lecturers up to 30 or over 60 years old, with up to 3-year-work experience in Universities need methodic assistance. Textual e-learning resources are widely used in developed courses while video and audio are not used enough. LCMS Moodle is mostly used during exams or tests and student work, and using LCMS Moodle should be intensified in lectures, laboratory and practical classes. Among the most demanded resources are label, page, file, URL, book, assignment, attendance, glossary, quiz. Thus, the popularization of other resources is identified as one of the most important. An action plan how to improve LCMS Moodle usage: increasing the IT competencies of both teachers and students – planned long-term courses “IT in full-time (blended) learning”; seminars, consultations, (group and individual forms) both on general issues, and according to the specificity of the specialties; methodic handouts and recommendations; improving logistics; improving logistical support – ensuring constant access to the Internet, updating and equipping computer classrooms; creating of transparent, predictable and attractive for authors content of the regulatory framework.

Keywords: learning content management system Moodle, LCMS Moodle, survey.

1 Introduction

According to EDUCAUSE Horizon Report 2019, “key short-term (one to two years) trends of accelerating higher education technology adoption are redesigning learning spaces and blended learning designs” [2]. Teachers prove that blended education gives the possibility to combine advantages of traditional and innovational types of learning. Andrii M. Striuk defines blended learning as “the way of realizing the content of learning that integrates classroom and online learning activities with pedagogically balanced combination of traditional, electronic, distance and mobile learning technologies with the aim to achieve learning goals most efficiently” [32, p. 19]. Yurii

V. Tryus and Inna V. Herasymenko refine the given definition, saying that blended education is "the process aimed at obtaining knowledge, skills and habits, assimilating ways of cognitive activity and the development, as well as the creative abilities of those who are participants of education system, on the base of the complex and system usage of traditional and innovational pedagogical technologies and rules to achieve the improvement of the educational quality" [36, p. 304].

According to the European University Association report, 91% of universities use blended learning [8]. The organization of blended learning was investigated in the researches of Volodymyr M. Kukharenko [16], Olga V. Bondarenko, Svitlana V. Mantulenko and Andrey V. Pikilnyak [5], Iryna S. Mintii, Natalia A. Kharadzjan and Svitlana V. Shokaliuk [21], Nadiya O. Holiver, Tetiana V. Kurbatova and Iryna H. Bondar [10], Natalya V. Rashevska, Serhiy O. Semerikov, Kateryna I. Slovak, Andrii M. Striuk [27; 29] and etc.

To implement blended learning, the great part of the Ukrainian pedagogical universities use learning content management system (LCMS) Moodle [3; 4; 6; 7; 9; 11; 12; 13; 14; 15; 17; 18; 19; 23; 24; 26; 28; 33; 34; 38; 39; 40; 41; 42], which is considered to be the mostly widely-spread LCMS all over the world – in 2019 it is used in 242 countries [22]. The reason of LCMS Moodle popularity is in its functionality, free prom money, open admission (Open Source), wide set of instruments and interface with many languages.

Among Ukrainian scholars the use of LCMS Moodle in educational process is investigated by Hanna M. Shalatska, Olena Yu. Zotova-Sadylo and Ivan O. Muzyka [30], Andrii I. Abdula, Halyna A. Baluta, Nadiia P. Kozachenko and Darja A. Kassim [1], Pavlo P. Nechypurenko and Serhiy O. Semerikov [25], Svitlana V. Shokaliuk, Iryna S. Mintii [20; 37], Yevheniia M. Smyrnova-Trybulska [31], Yurii V. Tryus, Inna V. Herasymenko, Vasyl M. Franchuk [35] and others.

Some teachers of Kryvyi Rih State Pedagogical University were among the first in Ukraine who started working on LCMS Moodle. Finally, it caused the affirmation of Concept of Development of E-learning Environment in Kryvyi Rih State Pedagogical University. According to it, there are three stages in Kryvyi Rih State Pedagogical University.

The first stage involves developing the infrastructure and providing the conditions for the construction of e-learning environment: training of scientific-pedagogical and pedagogical staff for implementation of e-learning technologies; a primary fund formation of electronic didactic and methodological materials and placing them within LCMS; creation of a control system and evaluation of the quality of e-learning resources.

During the second stage, according to the Concept, the elements of e-learning system were implemented: testing the developed e-learning resources while students' training; improving existing e-learning resources and filling the database with new ones; creating and developing electronic evaluation system of students' achievements; analysis of changes in the quality of students' learning as a result of the introduction of e-learning elements.

The third stage deals with the full-scale deployment of the e-learning environment (2019-2020): completing the formation of information, methodological, technological and organizational components of e-learning environment; constant monitoring of the quality of e-learning resources and the performance of students' educational activities; formation of open e-learning resources, providing citizens' access in order to create conditions for lifelong learning; establishing cooperation with Universities (both home and foreign) in the field of e-learning; exchange of experience.

2 Methodology

The purpose of this article is to systematize the information relating to using LCMS Moodle in Kryvyi Rih State Pedagogical University educational process, formulate the conclusions, and determine the prospects for development. The survey method was used to obtain the data. A Google form (https://forms.gle/s8DZ7qYcDENUikZE7) "Using LCMS Moodle in Kryvyi Rih State Pedagogical University Educational Process" was prepared, containing 14 questions, one of which is optional (surname, name, middle name). The lecturers were able to access the survey via email.

The interview term lasted from 12.03.2020 to 18.03.2020. Seventy-five (75) lecturers participated in the survey (quantitative data of the lecturers in the chairs is shown in Table 1).

Table 1. Quantitative data of the lecturers in the departments

No	Department	The number of survey participants
1	Department of the Ukrainian Language	10
2	Department of Chemistry and Methods of its Teaching	8
3	Department of Sociology and Economics	7
4	Department of Mathematics and Methods of its Teaching	7
5	Department of Computer Science and Applied Mathematics	7
6	Department of Pedagogy and Methods of Technological Education	6
7	Department of Pre-School Education	6
8	Department of Physical Geography, Regional Studies and Tourism	4
9	Department of Fine Arts	4
10	Department of Physics and Methods of its Teaching	3
11	Department of Pedagogy	3
12	Department of the English Language with Methods of Teaching	3
13	Department of Ukrainian and World Literature	2
14	Department of History of Ukraine and Law Studies	2
15	Department of Applied and Decorative Arts and Design	1
16	Department of Botany and Ecology	1
17	Department of English Philology	1

The percentage distribution of respondents to the question "Do you use LCMS Moodle?" is given in Fig. 1.

It should also be determined what percentage of respondents has experience in course development. The distribution of respondents to the question "Do you have experience in developing courses in Moodle?" is given in Fig. 2. As can be seen in Fig. 2, more than 20% of those who use Moodle have no experience in designing courses. Therefore, they need methodological assistance to increase their IT competencies.

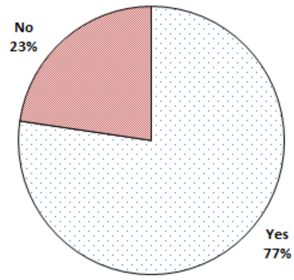

Fig. 1. The distribution of respondents in response to the question "Do you use LCMS Moodle?"

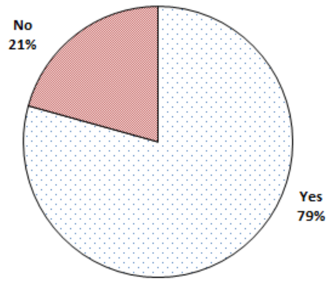

Fig. 2. The distribution of respondents in response to the question "Do you have experience in developing courses in Moodle?"

In addition to mentioning to a particular department, one of the questions was "Specify your age". The purpose of this question was to identify the correlation between respondents' age and using LCMS Moodle (the obtained distribution is shown in Fig. 3). Analyzing the results, we can conclude that lecturers who are up to 30 or over 60 years old use LCMS Moodle the least. When planning seminars or courses how to use LCMS Moodle, special attention should be given to lecturers of these age categories.

The next step was to define the relationship between work experience in a higher educational establishment and using LCMS Moodle. The results are presented in Fig. 4.

Fig. 4 makes us conclude that it is necessary to provide methodological assistance to lecturers with the least work experience in universities.

The Concept was adopted in 2017, although some lecturers used LCMS Moodle long before that. That is why one of the questions was "When did you start using LCMS Moodle?" From this issue on, only responses of the lecturers who use LCMS Moodle have been analyzed. Therefore, the survey shows that only 12% of the respondents already used LCMS Moodle during 2004-2012. The number of lecturers who started using LCMS Moodle has increased sharply since 2014 (Fig. 5).

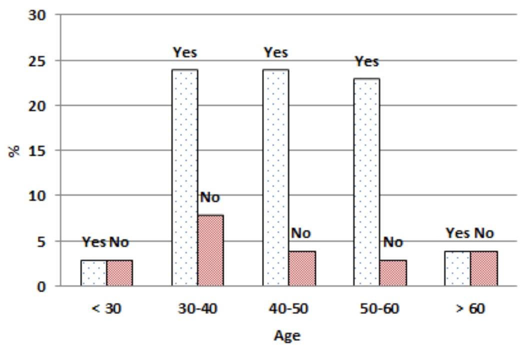

Fig. 3. Distribution of respondents by age and using LCMS Moodle

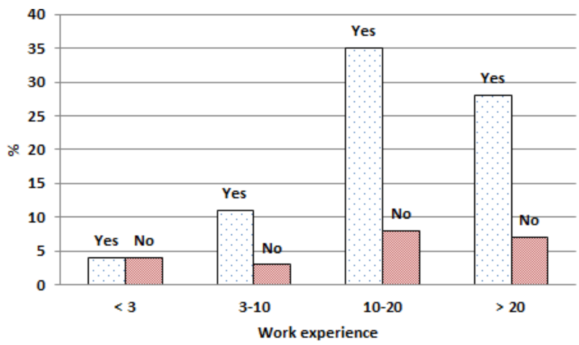

Fig. 4. The distribution of respondents according to their work experience in universities and using LCMS Moodle

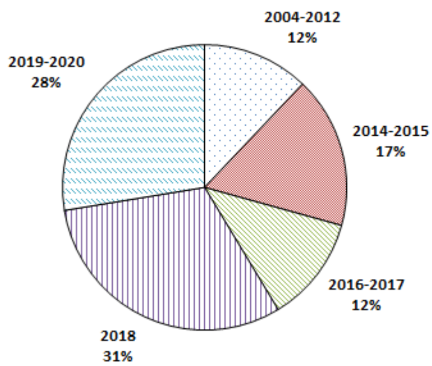

Fig. 5. The distribution of respondents according to starting using LCMS Moodle

Researching the intensification of using Moodle the reasons for this should be identified. That is why, the courses of advanced training of teachers of “IT in Full-Distance (Blended) Training” were held in Kryvyi Rih State Pedagogical University in 2014 for the first time.

So, in response to the question “How do you increase your competencies in using Moodle?” the following answers have been proposed: 1) self-education; 2) communication with colleagues; 3) webinars, workshops, seminars; 4) the courses of advanced training of teachers of “IT in Full-Distance (Blended) Training”; 4) your option. The distribution of respondents to this question is shown in Fig. 6.

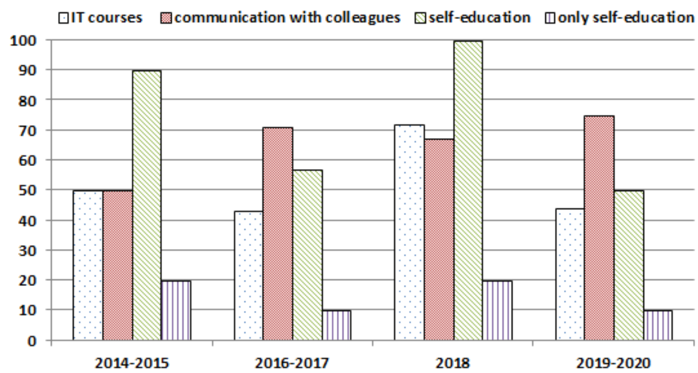

Fig. 6. Ways to improve Moodle competencies

The great majority of lecturers have indicated several ways – mostly self-education, communication with colleagues, and courses. Only 20% (2014-2015, 2018) and 10% (2016-2017 and 2019-2020) have indicated that they increase their level of competencies only due to self-education. Thus, we conclude that the implementation of courses plays a significant role in enhancing the use of LCMS Moodle.

According to the Concept, the university is implementing a full-scale Moodle deployment now. Therefore, it is worth researching the e-learning resource types lecturers use in their courses.

Options for answering the question “What types of e-learning resources do you use in LCMS Moodle courses?”: 1) text (*.doc, *.docx, *.pdf and etc.); 2) graphics (*.bmp, *.png, *.jpg and etc.); 3) tables (*.xls, *.xlsx and etc.); 4) sound (*.mp3, *.wav and etc.); 5) video (*.avi, *.mp4, *.mpg and etc.); 6) multimedia (*.ppt and etc.). The distribution of respondents to this question is shown in Fig. 7.

Analyzing the data, we conclude that lecturers more often use text files in the Moodle courses (this is the only type of e-learning resources that received values “periodically” and “mostly” 80%, and multimedia – 50%). Communication with the respondents shows that the most common materials in the courses are programs, texts of lectures, literature, etc., and presentations to lectures, which correspond to the obtained results completely. However, at the same time, audio and video resources are not widely used. Therefore, using e-learning resources audio and video courses should be popularized.

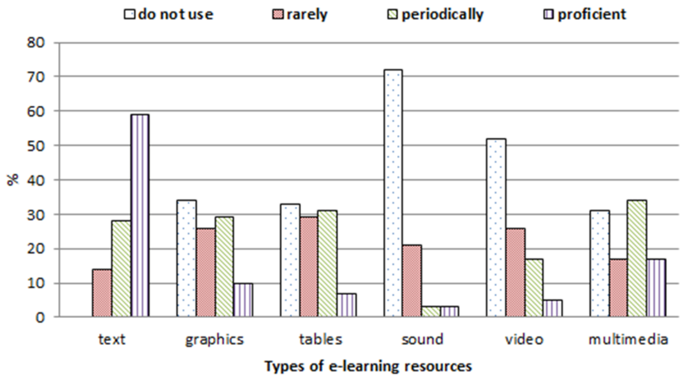

Fig. 7. Distribution of respondents regarding using different types of e-learning resources

Classes in Universities are held in various forms – lectures, laboratory classes, practical classes, exams, tests. Do lecturers use LCMS Moodle in all classes to the same extent? The distribution of respondents to this question is shown in Fig. 8.

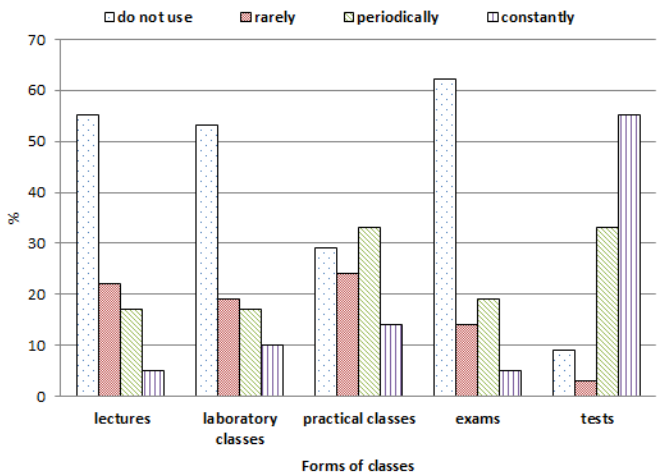

Fig. 8. Using LCMS Moodle according to the forms of classes

Only 3 lecturers (5%) use LCMS Moodle in the lectures regularly, 6 (11%) use LCMS Moodle in laboratory classes, 8 (14%) use LCMS Moodle in practical classes, 3 (5%) use LCMS Moodle in exams, 26 (46%) use LCMS Moodle in tests. Lecturers should be encouraged to use LCMS Moodle, because it will intensify the educational process, regardless of the form of the class. For example, LCMS Moodle provides students with an opportunity to re-watch a presentation to a lecture or a video after the lecture if necessary. What is more, it makes possible to place the list of references, as well as links to the literature, the plan of the lecture, etc. Furthermore, it is available to develop a task as a resource “Assignment” and to choose an option “to submit” the answer online in laboratory or practical classes. Due to this, even skipping classes the students will know the tasks. They change the file only in their cloud storage to correct the answers, and lecturers link to the updated file immediately.

During tests the lecturers post questions for study, a list of recommended literature (as references to resources) with page indication, design tasks as a resource “Tasks”, and evaluate students’ works in the form of testing, etc.

Regardless of the form of class, only 3 teachers (5%) of those who use LCMS Moodle in the educational process follow this procedure in all classes.

LCMS Moodle has a large set of tools. They can be conditionally divided into information resources (which only give access to certain information and do not provide any reporting) and activity resources (which provide some reporting on their implementation). Fig. 9-11 show estimating of the level of proficiency in using LCMS Moodle resources.

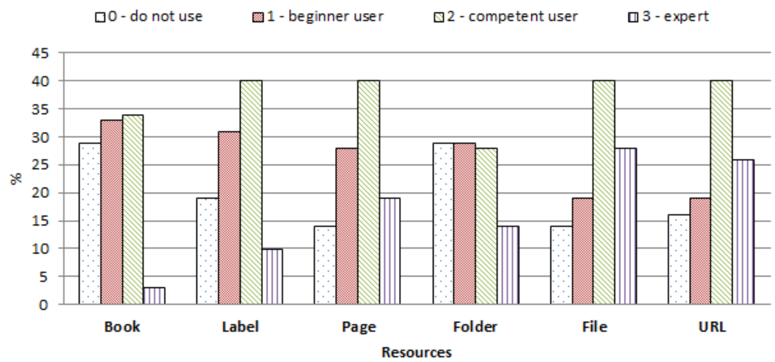

Fig. 9. Levels of proficiency in using LCMS Moodle information resources

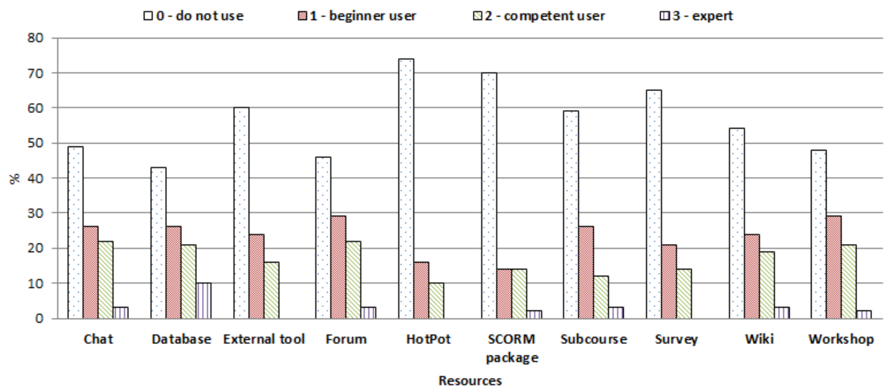

Fig. 10. Levels of proficiency in LCMS Moodle activity resources
(resources for which the sum of levels “2” and “3” < 50%)

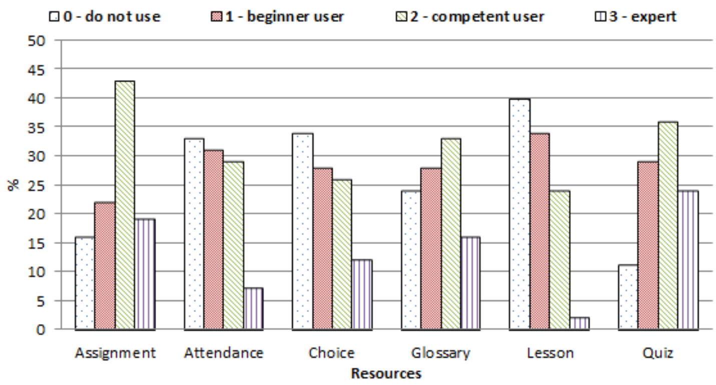

Fig. 11. Levels of proficiency in LCMS Moodle activity resources (resources for which the sum of levels "2" and "3" > 50%)

The obtained data help us conclude that most lecturers need methodical support for using a wide range of activity resources. The examples of them are instructions for using these resources, and demonstrations of these resources in existing courses, etc.

One of the most important questions answered by the interviewed lecturers is "What prevents you from using LCMS Moodle?" The response to this question was separately analyzed for lecturers using LCMS Moodle and for educators who do not (Fig. 12).

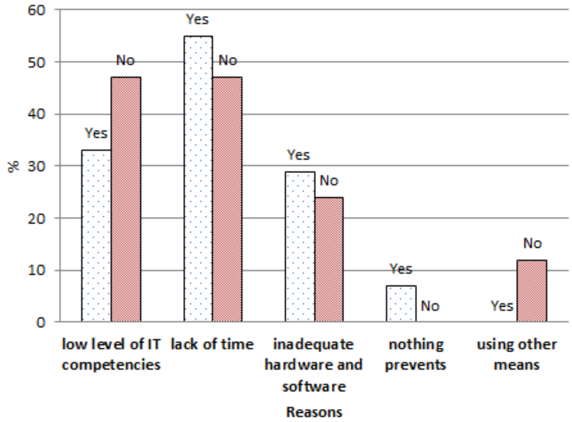

Fig. 12. Reasons preventing from using LCMS Moodle

Most of the respondents noted such reasons as "a lack of time", "a low level of IT competencies" and "the nonconformity of hardware and software". We can conclude that it is necessary to intensify the methodical assistance to lecturers because developing e-learning resources of the proper quality is time-consuming what restricts the use of LCMS Moodle. Many processes can be automated (for example, by importing tests, glossary entries, enrollment, etc.) with the right level of IT competencies.

The lecturers have stated their wishes how to use LCMS Moodle in the educational process efficiently, (parentheses indicate the number of persons who stated the same wish):

- providing computer classes of some University buildings with the necessary equipment (10);
- stability of the site (2);
- possibility of participating in webinars (e.g. via BigBlueButton (3));
- various forms of encouragement of lecturers (including bonuses);
- conducting seminars, consultations on LCMS Moodle features (for example, electronic booking an appointment with an expert for individual or group consultations) depending on the specificity of the specialty (12);
- conducting full-time IT courses (blended) training (3);
- developing methodological guidelines of using individual elements in the educational process (2);
- increasing the relative importance of the development of the e-learning resources as a form of methodical work of the lecturer (2);
- internal and external expert evaluation of the content and presentation quality of courses;
- creating transparent, predictable and attractive for authors content of the regulatory framework, including a clear sample course;
- developing methodological materials for the assessment of competencies acquired in the course;
- enhancing students' IT competencies in using LCMS Moodle;
- creating applications in Ukrainian that can reflect specificities of particular disciplines.

One of the ways how to improve LCMS Moodle in the educational process is providing a lot of opportunities to enhance your abilities and skills. The main problem is to learn using it. It is up to a person to use as many tools and capabilities of LCMS Moodle as possible.

3 Conclusions

The majority of respondents (75%) claim that using LCMS Moodle in Kryvyi Rih State Pedagogical University educational process is at an appropriate level now. However, the following steps to improve efficiency should be taken in such areas as:

- involving new educators in using LCMS Moodle;
- promoting using LCMS Moodle regardless of class types;
- facilitating using different types of e-learning resources and more LCMS Moodle resources by teachers.

The lecturers have defined the main steps to reach this purpose:

1. increasing the IT competencies of both teachers and students – planned long-term courses "IT in full-time (blended) learning"; seminars, consultations, (group and individual forms) both on general issues, and according to the specificity of the specialties; methodological developments, recommendations, etc.;
2. improving logistical support – ensuring constant access to the Internet, updating and equipping computer classrooms (it should be noted that at the time of writing the article several computer classrooms were completed at the university);
3. internal and external expert evaluating of the course quality, both in content and in submission; creating of transparent, predictable and attractive regulatory framework for authors' content.

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Peculiarities of using of the Moodle test tools in philosophy teaching

Andrii I. Abdula[1[0000-0001-5484-1639]], Halyna A. Baluta[1[0000-0002-4772-9240]], Nadiia P. Kozachenko[1[0000-0003-2358-9076]] and Darja A. Kassim[2[0000-0002-1750-1237]]

[1] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave, Kryvyi Rih, 50086, Ukraine
{standrewne2, moment71164, N.P.Kozachenko}@gmail.com
[2] State University of Economics and Technology,
5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
kasik_78@ukr.net

Abstract. The paper considers the role of philosophy and philosophical disciplines as the means of forming general cultural competences, in particular, in the development of critical thinking. The article emphasizes that the process of forming over-subject and soft skills, which, as a rule, include also critical thinking, gets much more complicated under the conditions of the reduction in the volume of philosophical courses. The paper grounds that one of the ways to "return" philosophy to educational programmes can be the implementation of training, using the e-learning environment, especially Moodle. In addition, authors point to the expediency of using this system and, in general, e-learning as an instrument for collaborating students to the world's educational community and for developing their lifelong learning skills. The article specifies the features of providing electronic support in philosophy teaching, to which the following belongs: the difficulty of parametrizing the learning outcomes; plurality of approaches; communicative philosophy. The paper highlights the types of activities that can be implemented by tools of Moodle. The use of the following Moodle test tasks is considered as an example: test control in the flipped class, control of work with primary sources, control of self-study, test implementation of interim thematic control. The authors conclude that the Moodle system can be used as a tools of online support for the philosophy course, but it is impossible to transfer to the virtual space all the study of this discipline, because it has a significant worldview load. Forms of training, directly related to communication, are integral part of the methodology of teaching philosophy as philosophy itself is discursive, dialogical, communicative and pluralistic. Nevertheless, taking into account features of the discipline, it is possible to provide not only the evaluation function of the test control, but also to realize a number of educational functions: updating the basic knowledge, memorization, activating the cognitive interest, developing the ability to reason and the simpler ones but not less important, – the skill of getting information and familiarization with it.

Keywords: Philosophy, Critical Thinking, Soft Skills, Reflexive Learning, Test Control, Moodle, E-Learning Environment.

1 Introduction

Reforming of the education system should be provided for in response to public demand and information standards of the world educational culture, which is focused on the formation of key competences of participants in education [30]. In education, the process of transformation requires revision and reassessment of the humanities, especially philosophy, as it should be regarded as a powerful methodological platform, which leads to successful solving of the tasks outlined in the national educational strategy.

1.1 Outlining the problem

The modern times are characterized by such peculiarities as the accelerated dynamics of socio-cultural development, the change of interpretative schemes of worldview, and broadening of information horizons. The processes mentioned above require understanding of the fact that Ukraine cannot collaborate with European countries as far as it concerns education and cannot expect for mutual evaluation of academic diplomas without the development philosophical disciplines as a methodological basis of critical thinking as mental attribute of key competences. For it is necessary to introduce e-learning tools in the educational process, the educators should take into consideration the specificity of their implementation that allow to master the strategy of teaching philosophy on the basis of the online learning environment. Thus, there is a need to outline the educational perspectives of philosophy teaching with the involvement of online learning environment and to identify the particularities of the use of test tools in this process.

1.2 Analysis of recent research and papers.

The issue of the placing philosophical disciplines in the educational space is considered by scholars all over the world. The research paradigm is represented by Alan Crawford [6], John Dewey [7], Diane F. Halpern [9], Jaakko Hintikka [12] Martha J. Kurtz [25], Matthew Lipman [18], and others. The national tradition includes the publications of Alina O. Karapetian [15], Igor M. Kopotun [16], Serhii O. Terno [32] etc. John Dewey was one of the first educators who prioritized critical thinking in education. He believed that the main drawback of traditional education was its focus on refined knowledge, devoid of analytical processing. John Dewey outlined a new “reflexive” style of education, as reflection makes it possible for a student to perceive the object from different viewpoints. The philosopher notes that “knowledge” does not mean understanding; certain information does not guarantee that the opinion can get the right direction. Jaakko Hintikka describes critical thinking as an opportunity to combine different perspectives, as a crucial resource, focused on the search for cognitive distortions. He thinks that to teach how to think and analyze is a huge challenge from education to philosophers [11]. The researcher substantiates the notion of Socratic epistemology as a special cognitive strategy, which has a dialogical form [12].

Standard educational programmes cannot achieve such progress in the development of cognitive skills, as the programmes, including the development of critical thinking. The author of an educational programme focused on reflective thinking Matthew Limpan admits that teaching thinking skills is different from the ordinary acquisition of academic knowledge. He substantiates the idea of higher order thinking, which synthesizes creative, moral, ethical and critical thinking. Matthew Lipman considers the ways of thinking as necessary modes of reflective educational practice [18]. Lipman's approach was developed by Gerald A. Matthews [27], Joanne R. Reid [26] and others. Therefore, the reflexive paradigm highlights reflective and dialogic strategies as a development of personal autonomy embedded in a special space of mutual open-mindedness for joint exploration and discovery.

The use of the potential of philosophy in the development of critical thinking and other important competences is complicated due to several reasons. Firstly, the place of philosophy in a number of general educational courses is uncertain. Secondly, it is complicated to transfer the content of philosophical disciplines to e-learning platforms.

The practical implementation of this project is based on one of the most promising online learning platforms, which is actively implemented in the educational process and facilitates its modernization – Moodle. In the current educational discourse, the potential of using e-learning platforms is considered in various aspects [2]. Serhii V. Petrenko [23], Yurii M. Pienkin and Nataliia M. Yatsenko [24] consider Moodle as an important component of the provision of distance education and blended learning. Elina Yu. Zhelezniakova and Iryna V. Zmiivska [36] treat it as prerequisite for realization of the students' self-management capacity. Anton V. Myshchyshen [19] considers Moodle as tools of information and communication support to the process of advanced training. Oleksandr V. Avdieiev [3] and Gabriela Carmen Oproiu [21] draw attention to the fact that Moodle is a way to optimize the educational process in higher educational establishments. For Serhii M. Nedilko, Olean O. Chumak, and Tetiana S. Plachynda Moodle is a key aspect of quality of professional training of future specialists [13]. Carmen Holotescu, Gabriela Grosseck, Vladimir Crețu, and Antoanela Naaji outline that e-learning platforms provide students' involvement in the global educational space and the development of lifelong learning skills [13]. The use of e-learning platforms is also considered in the context of globalization, changes in the institutional status of the education system [33]. Hanna A. Horshkova [14], Andrii V. Semenets [28], and Halyna A. Biletska [4] draw attention to the considerable practical experience of using Moodle in the process of teaching exact mathematical sciences and natural sciences. Yevhen V. Dolynskyi [8], Kateryna Yu. Akulenko [1], Hanna M. Shalatska, Olena Yu. Zotova-Sadylo and Ivan O. Muzyka [29], Viktoriia O. Ustinova, Svitlana V. Shokaliuk, Iryna S. Mintii and Andrey V. Pikilnyak [34] show that Moodle can be used by teaching social science and humanities.

1.3 Unsolved aspects of the problem

Unfortunately, there is a dangerous tendency in the national education to curtail the humanities, especially philosophy, ethics, aesthetics, cultural studies, etc. They are losing their positions, undermined by the tendencies of educational instrumentalism and vital pragmatism. The reasons of such situation are as follows: the relativization of the educational culture, the lack of definition of standards of quality of education, as well as rigidity, the firm rootedness of the "monopolized" post-Soviet educational tradition. After a few decades, philosophical subjects focused on Marxism lost their relevance, as they reproduced the structures of crowd psychology, the realized ideological function and function of identity formation. As a result, philosophy focused on Marxism created a false stereotype about its uncertainty or even its uselessness. Thus, a hidden paradox has emerged: the minimization of the humanities in education contradicts current educational strategies, outlined in the Law on Education.

Among the educational competences defined by the Law on Education, there are a number of extra-curricular competences, which, in our opinion, provide for an in-depth mastery of a philosophical resource. According to the Law on Education, "common for all competences are the following skills: reading with understanding, a skill to express one's opinion orally and in writing, critical and systemic thinking, ability to logically justify one's position, creativity, leadership, ability to manage emotions in a constructive way, assess risks, make decisions, solve problems, ability to cooperate with other people" [35]. Thorough analysis of the subject field, included in the scenario of achieving the stated goal, implies a direct mastery of the information product of philosophical genesis. Instrumental competence, which means performing technical procedures and operations, ways of determining information adequacy, criteria for trust in an information source, etc., is also particularly relevant.

Therefore, the main unsolved aspect of the problem is the question of whether the information, purified from philosophy, is sufficiently efficient in competitiveness of education if it is considered as a complex product, formed by long-term research selection by historical trial and error and as the result of successful, balanced, and projected educational programmes, focused on education and society, theory and practice. The implementation of electronic support in the teaching of philosophy is also important. However, the specific nature of philosophy as a subject should be taken into consideration. Using e-learning platforms is a definite challenge of the modern times, so the educators need to respond to it adequately. Nevertheless, the following question arises: how and to what extent can we trust e-learning, in training philosophy and other humanities?

Thus, the objective of the paper is to reveal the peculiarities of electronic support of teaching philosophy, highlighting its subject specificity on the basis of methodically substantiated forms of test control.

2 Theoretical basis of the research

If philosophy is considered as a source of critical thinking, the method of its formation appears as a combination of different models of learning. It is clear that "rigid models" are typically suitable for individual tasks, while "soft models" dominate when there are atypical problematic situations with uncertainty potential. Such models play a special role in the process of personality formation. "The development of critical thinking is just such a task that can be solved with the help of a soft learning model," says Serhii

O. Terno [32, p. 18]. Methods of the critical thinking development require a set of conditions that include problematic situations, knowledge of critical thinking strategies, creating choice situations, making a dialogue, giving students' opinions in writing, the right to correct mistakes, etc. This system of learning implies its openness, plasticity, the presence of variations and feedback. Individual-oriented project methods and dialogue play a special role, as they are focused on reconstructing the educational participants' individual experience. The methodology is based on the following principles: identifying and denying assumptions, verifying accuracy of facts and logical consistency, examining context and exploring alternatives [32, p. 18]. In our opinion, this is the way in which the monologic "banking" or fixed teaching is reoriented to qualitatively developing innovative model.

Such a guideline was taken into account by the community of lecturers of the Philosophy Department in Kryvyi Rih State Pedagogical University in the process of teaching the course "Philosophy" with its positive consequences. Firstly, the philosophical resource was preserved as a source of formation of different types, styles of thinking, a methodological platform for learning the variety of the best examples of world philosophical culture. Secondly, the structure of the course, the logic of its presentation, demonstrated the effective implementation of a number of tasks of informative and constructive content, as it successfully combined the traditional informative or lecture-seminar system of education and the modern pedagogical approaches, which necessarily include person-oriented techniques.

Thus, there was a need to combine the critical resource of philosophy and the tools, provided by the e-learning environment. Obviously, such a combination could not have been a perfunctory transfer of the course to an online learning platform. However, it also requires both the peculiarities of the course and the specifics of the chosen platform. We used Moodle as such e-learning platform.

In our opinion, we should consider the particularities of using Moodle, taking into account the global challenges, tasks and problems that cause the reform of the education system in Ukraine. Moreover, it is necessary to pay attention to features of use of the platform in comparison with similar systems. Thirdly, it is necessary to demonstrate the expediency of appealing to Moodle, in the context of teaching the social sciences and humanities, especially philosophy.

As for the first aspect, we should admit that the implementation of Moodle is increasingly correlated with the prospect of implementing the principles of blended and distance learning, taking into account that the latter is a relatively new phenomenon in the educational space of Ukraine [5]. Serhii V. Petrenko says: "The use of modern information and communication, electronic technologies in combination with pedagogical experience will allow to raise higher education in Ukraine to a higher level" [23, p. 140]. This problem is also considered in the context of globalization, changes in the institutional status of the education system and the integration of the national education system into the European educational space [20, p. 116]. In response to these challenges, the scholars draw attention to the following benefits of distance learning: the ability to save considerable amount of time while displaying significant amounts of information; focusing on the specific achievements of each student; ensuring the relative independence of the process of communication between the student and the teacher from the place and time, organization of control and planning of students' independent work in the conditions of reduction of class hours and transition to the credit-modular system, etc. [17, p. 102; 36, p. 34]. In general, these characteristics have economic, operational, informational and pedagogical dimensions [19, p. 98]. Unlike distance learning that requires using ICT, blended learning presupposes a combination of different forms of activities (traditional, distance, electronic, etc.), at the same time it takes advantage of distance learning and eliminates its disadvantages [23, p. 141]. An important tendency of recent years is the increasing level of integration of distance and traditional learning [3, p. 6].

As for the second aspect, we should mention that there are several groups of e-learning organization software: copyright software, learning management systems, content management systems, and educational content management systems [24, p. 105]. Among these tools, one of the most suitable for higher education institutions is the open source distance learning platforms, to which the Moodle belongs (in general, there are a great number of such systems: ATutor, Claroline, Dokeos, Sakai, Prometheus, etc.) [24, p. 106]. A considerable number of scholars think that Moodle has certain advantages over other similar systems. The evidence is the considerable number of users who have chosen this system (about 90 million people [23, p. 140]), as well as the fact that it is used by educational institutions in more than 100 countries [24, p. 106], demonstrating positive statistics of students' involvement [21, p. 428–430]. The basis for the functioning of this system is based on the principles of social constructivism, according to which, the teacher is regarded as an assistant and mentor; training is carried out in activity; self-presentation and self-realization of students are provided; the learning environment is flexible, able to adapt to specific needs; the student can observe and respond to the activity of participants in the educational process [31]. Accordingly, Moodle allows to organize distance learning in such a way that it meets the today's didactic requirements: regularity, systematic character, objectivity of control, individuality, economic efficiency, that is, it is fully capable of completing the tasks assigned to it [3, p. 7].

Other advantages include: openness of the system, ability to adapt to specific tasks and types of activities; providing ample opportunities for communication and data exchange; the availability of a flexible evaluation system and opportunities for statistical analysis of performance; versatility and simplicity in using [24, p. 106]. An important argument in favour of Moodle is that as an open source system, it can be freely distributed, applied and modified [23, p. 141].

Moodle is quite capable of providing the distance learning functions assigned to it, but it should be admitted that the use of a virtual learning environment has its peculiarities when it supports training courses in philosophical disciplines.

(1) The complication of parameterization of learning outcomes. This is due to the fact that all philosophical disciplines and, first of all, philosophy involve the teaching of thinking, and not just memorizing the biographies of a number of philosophers and difficult obscure terms. Obviously, this peculiarity is inherent in other courses, but the main difference is that the results of teaching philosophy are very difficult to calculate and quantify. This problem is typical, in general, for determining the level of competence formation, which does not reduce to specific knowledge, abilities and

skills. We have discussed above the competences, which include, inter alia, environmental competence and information and communication competence, lifelong learning, civic and social competences related to the ideas of democracy, justice, equality, human rights, well-being and a healthy lifestyle, with an awareness of equal rights and opportunities; cultural competence. For this type of competence there is a problem of verification, parameterization, quantification, the solution of which would make it possible to simply revision of the level of their formation by tools of e-learning, where testing is particularly convenient and widespread.

(2) The plurality of approaches. The second problem is related to the specificity of philosophy, namely its pluralistic nature. Philosophy cannot be represented as a single holistic entity, the conventional result of a study of the existing philosophic community. Philosophy is a constant development of thought, which consists in asking questions, finding answers and constantly rethinking them. Thus, any reference or educational material in philosophy bears a significant imprint of the philosophical position of its author, which cannot be considered universally acceptable to all participants in philosophical discourse.

(3) Communicative nature of philosophy. There was an experiment when the android Bina48 gave a lecture on philosophy [22]. Its results show the achievements of robotics, but they do not mean a breakthrough in the teaching of philosophy. The main results of the teaching of philosophy are formed in the course of communication; they are argumentative and critical skills, values and socio-cultural competences.

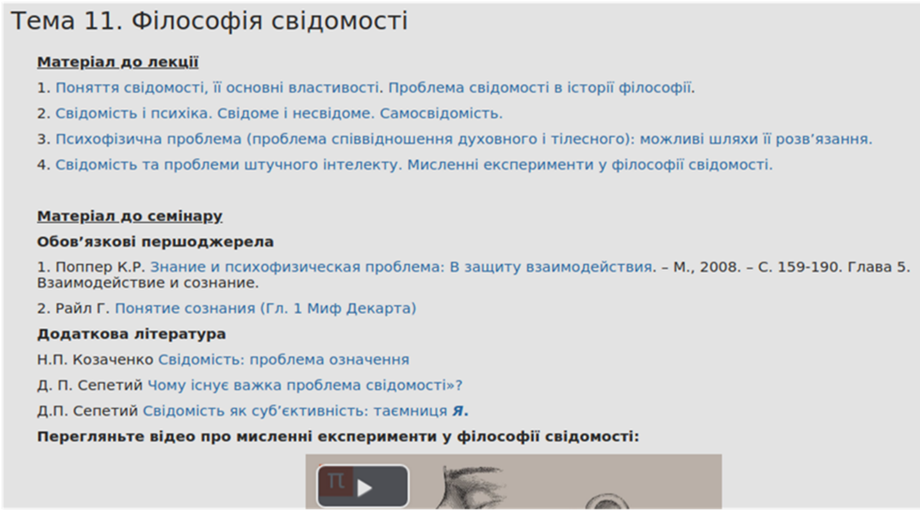
For the use of e-learning courses is an up-to-date challenge that can greatly enhance students' cognitive activity through interesting activities, the philosophy teacher must find ways to integrate these activities into the learning process and use them in a way that does not deteriorate, but rather improve the quality of philosophy teaching. Obviously, it is simply impossible to fully implement a philosophy course on an e-learning platform without communicating with a teacher. It is not only about teacher's support in forums, chats, ongoing consultations and other forms of feedback, but it is also about full-fledged group seminars, involving pluralism of thoughts, discussions, and critical, philosophic reasoning in real-time.

3 Results of the research

In teaching philosophy, not all activities are reduced to face-to-face communication. The student has to develop skills of individual work, be able to work with primary sources, to carry out relations and systematization, to draw conclusions, to reason the opinion and to express it and so on. Thus, in the process of philosophy teaching, it makes sense to use e-learning courses as a support of full-time study, which allows to cover other activities of the student and to evaluate his or her individual work. Let us consider some of the techniques of using a Moodle-based e-learning course and their peculiarities in philosophy teaching, using the Moodle controlling tools in the philosophy course.

3.1 Test control in the flipped classroom model

Firstly, the thing that makes Moodle convenient is to provide theoretical material. This approach makes it possible to use the flipped classroom model when students are introduced to the lecture material before the lecture begins. Then, the lecture itself is based on explaining the most interesting points of the topic, discussing problematic and incomprehensible parts of the material (Fig. 1).


Тема 11. Філософія свідомості

Матеріал до лекції

1. Поняття свідомості, її основні властивості. Проблема свідомості в історії філософії.
2. Свідомість і психіка. Свідоме і несвідоме. Самосвідомість.
3. Психофізична проблема (проблема співвідношення духовного і тілесного): можливі шляхи її розв'язання.
4. Свідомість та проблеми штучного інтелекту. Мисленні експерименти у філософії свідомості.

Матеріал до семінару

Обов'язкові першоджерела

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2. Райл Г. Понятие сознания (Гл. 1 Миф Декарта)

Додаткова література

Н.П. Козаченко Свідомість: проблема означення

Д. П. Сепетий Чому існує важка проблема свідомості»?

Д.П. Сепетий Свідомість як суб'єктивність: таємниця ***Я*.**

Перегляньте відео про мисленні експерименти у філософії свідомості:

Fig. 1. Test control in flipped classroom model

It is advisable to combine the flipped classroom model with the simplest test to check whether the students have read the material to the lecture. Test tasks most often involve the literal reproduction of text and they perform two functions: checking for content understanding and activating memorization.

We should admit that the test assessment of the quality of the philosophy study is quite complicated and, when provided formally, it usually has a negative result. Firstly, ordinary tests are mainly focused on checking the memorization of certain characteristics, terms and names, which is quite possible without understanding the essence of the philosophical concept. Secondly, tests without any material, given in advance, provide students with a choice of a textbook or other reference sources. In the case of philosophy, it cannot be guaranteed that the opinion of the author of the test coincides with the way the relevant material is presented in the textbook chosen by the student. Thus, it is advisable to limit the use of simple verification tests as a control measure in the virtual accompaniment of philosophy training to the following parameters:

(1) tests can only serve as a tool of the simplest control of familiarization with the material before the lecture;
(2) tests should be directly bound to, and limited to, the material provided.

It is necessary to mention some technical points. Moodle allows you to create various types of tests. For this purpose, it is quite convenient to use several test types: multiple choice tests, tasks with short answer, matching tasks, built-in answers, gap texts, true or false statements. The most problematic types of tasks are multiple choice tests and gap texts, where a student has to fill in the missing words. In Moodle multiple choice tests are implemented very well, if you do not take into account the following feature: if the student selects all the answers, he or she will be assessed as having chosen all the right answers. Therefore, while creating the test, it is advisable to use the penalty for incorrect answers, which is realized by negative indicators.

Missed word assignments or the gap texts differ from short answers in that regular "*" expressions to substitute any character sequence cannot be used. Missing words should be filled in, so there is a serious spelling problem. If we do not consider the cases of the students' illiteracy or carelessness, we deal with the instability of Ukrainian-speaking philosophical terminology and the lack of a stable tradition of Ukrainian transliteration of the philosophers' names. For example, "Leibniz" can be spelled in Ukrainian as 'Лейбніц' – 'Лейбниц' – 'Лейбніць' – 'Ляйбниць' – 'Ляйбніц' and etc. There are several ways out of the situation. For example, it is possible to provide students with accurate spelling, to familiarize them with the terms to be used in the tests, and to provide clear instructions for completing this type of assignment.

3.2 Test control of work with primary sources

The skill to work with primary sources, analyze them and correlate with the theoretical material described in the textbook is an important type of students' activity while studying philosophy. The primary sources are often discussed at the seminar, but this kind of work can be successfully implemented through the online support of the Moodle training course. In addition to widespread multiple-choice tasks and built-in answers, it is appropriate to use gap texts and true or false statements. Moreover, it is necessary to focus not on the literal reproduction of the text of the primary source, but on realizing the author's opinion and on correlating it with the philosophical direction or tradition to which the author of the text belongs. The re-writing tasks showed good results in "true or false statements", when the opinion presented in the source text is formulated in other words (Fig. 2).

3.3 Test control of independent (out-of-class) learning

The university course in philosophy provides much of the material that the student studies out of the classroom. It is necessary to state that making notes and writing assignments are irreversibly out-of-date, but this should not be considered as a negative trend. Rewriting and reproduction is rapidly inferior to speculating and evaluation, which should be reflected as a change in teaching methods, especially in philosophical courses that have a world-view forming task. Independent study in a philosophy course means that the student works on certain themes for which the student has been provided with the relevant list of references. However, no one can guarantee that the student will not use Google search engine as the primary source of answers instead of reading recommended textbooks and sources. In such situation, one can find some positive aspects, as independent work involves familiarity with fairly standard concepts, definitions and personalities. Thus, doing simple tests for choosing names, book titles, philosophical directions will not be superfluous, and it will allow the out-of-class study with the online learning environment should also include tasks that do not provide obvious answers that pop up in the first search engine rows. So, it is advisable to develop tasks that help the student to master the material submitted for self-study. It is appropriate give the student a task to analyze the text where the student is offered to choose a statement that most fully reflects the main idea of the text, or a statement that contradicts the text, a statement that may or may not a conclusion (Fig. 3).

Філософи науки П'єр Дюгем і Віллард Квайн звернули увагу на те, що науковому знанню притаманна зв'язність, цілісність і системність.

За словами П. Дюгема "Фізик ніколи не може піддати контролю досвіду одну якусь гіпотезу окремо, а завжди *тільки цілу групу гіпотез*". А за словами В. Квайна "Будь-яке твердження може розглядатися як істинне, якщо ми зробимо певні корективи в деякому іншому фрагменті системи".

Таким чином, система наукового знання дуже гнучка і може залишатися прийнятною, постійно пристосовуючись до нових фактів. Це положення отримало назву "теза Дюгема-Куайна" за іменами філософів, що його сформулювали.

Згідно тези Дюгема-Квайна оцініть правильне чи неправильне таке твердження:

"***Наукову теорію можна спростувати за рахунок спростування або підтвердження її окремих компонентів, оскільки спростування навіть одного компоненту теорії, фальсифікація хоча б одного її положення, відшукання хоча б декількох суперечливих фактів приводить до спростування наукової теорії в цілому***".

Виберіть одну відповідь:

- **Правильно**
- **Неправильно**

Fig. 2. Test control of work with primary sources

Юрген Хабермас обгрунтовує теорію комунікативної дії та засади комунікативної етики, використовуючи поняття **консенсусу**, що передбачає баланс інтересів на ґрунті порозуміння як спільної мети комунікації, на засадах комунікативної компетентності, толерантності, солідарності. Поняття комунікативної компетентності Ю. Хабермаса розуміється як ставлення до іншого як рівного у комунікації, незалежно від расової, статусної приналежності.

Оберіть твердження, яке суперечить ідеям, наведеним у тексті.

Виберіть одну відповідь:

- **a. Комунікація змінюється залежно від расової, гендерної чи статусної приналежності.**
- **b. Консенсус -- це баланс інтересів.**
- **c. Комунікативна компетентність може бути охарактеризована як неупередженість щодо учасників комунікації.**
- **d. Мета комунікації -- це порозуміння.**
- **e. Комунікація здійснюється на засадах рівності, толерантності, солідарності.**

Fig. 3. Test control of out-of-class study

The specificity of test verification of out-of-class study is the need to set a deadline clearly. This is due to the fact that most of these tasks are woven into the canvas of the classroom material and their untimely fulfillment breaks the logic of teaching. On the other hand, the student should understand that out-of-class study is as chronologically regulated as activities in the classroom, which are carried out on schedule. The method of self-study is not regulated. It is focused on checking the results; thus the student develops skills of self-study, self-control and planning.

3.4 Test implementation of interim thematic control

The possibility to make full use of test tasks for interim control is also limited. Firstly, it does not justify setting a high score for these types of control, so it stimulates some manifestations of students' plagiarism, because it exists in a form of distance learning. Secondly, thematic control does not imply the availability of ready-made material, as in the case of preparation for an "flipped classroom" or an activity for checking understanding of primary sources. Thirdly, thematic control should be designed not only to check what students have memorized, but also to presuppose tasks that require speculation and reasoning. Thus, it is appropriate to use such tasks as matching, multiple choice tests, but with a slightly more complicated formulations. The challenges of finding a mismatch, finding an error, or finding the wrong answer are considered to be fruitful. The task of matching statements with authors has also shown good results as well as the tasks for chronological ordering. In addition to testing knowledge, the matching tasks also have a cognitive load: it is convenient to offer students a number of characteristics of philosophical directions or doctrines, which are usually opposed, in order to relate them to these areas (here it is appropriate to create the task in such a way that the characteristics are distributed evenly and not more than three parameters, optimally two). It is appropriate to offer students assignments for reasons that involve establishing a pattern, continuing a logical chain, choosing the causes or effects of a particular position.

We should draw attention to the task of drawing conclusions in which students are asked to select all the correct conclusions (or one) from the text proposed. In the simpler version, it is a reformulation of the thought, in a more complex one, the logical or substantive consequences generated by the idea demonstrated in the text. Test for matching is convenient to use as an extension of the test for true or false statements, because it allows you to evaluate a number of statements at once by correlating them with the choice of true/false (Fig. 4).

The result of thematic control in this form is not only the score expressed in points, but also a certain broadening of the student's horizons. Obviously, in the development of in-class and out-of-class activities, the student does not focus on reading the works of the philosophers mentioned above, but focuses primarily on short theoretical information that can provide a clear answer to the questions of the seminar or the assignment for out-of-class study. Philosophy does not provide such answers. The teaching of philosophy involves the formation of the skills of contextual, discursive analysis, aimed at clarifying the course of reasoning of a particular philosopher, which leads him to certain conclusions. The mentioned test organization achieves at least two goals: firstly, it familiarizes students with the aphorisms and important quotations of the classics of philosophy, shows their depth, and secondly it develops the skills of philosophical analysis and intensifies educational interest. An indirect, but pleasant, consequence is that students remember the names of philosophers and basic philosophical terms.

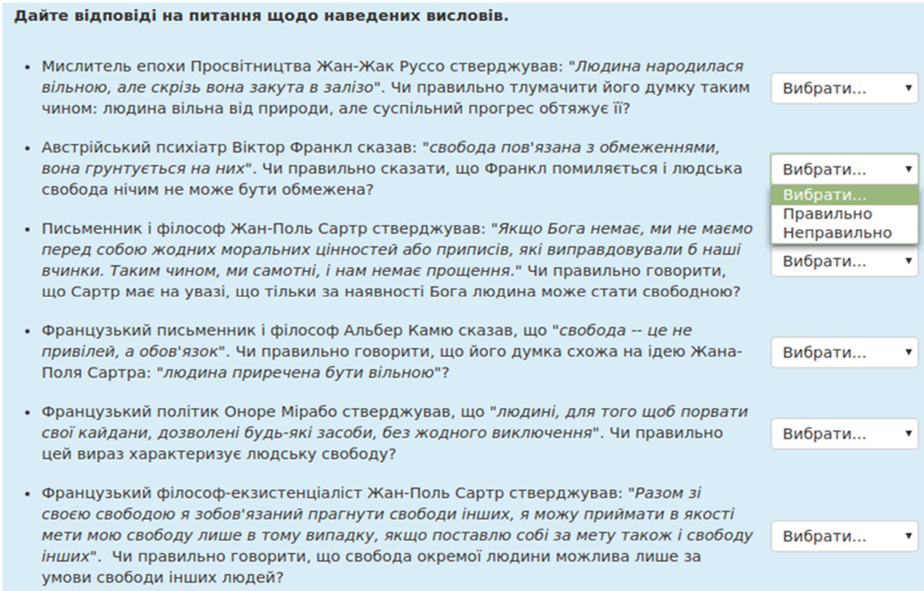

Fig. 4. Test implementation of interim thematic control

4 Conclusions and prospects of further research

Trends in modern education are linked, on the one hand, to the desire to develop cultural competences and, on the other, to take into account the informational influence, using its opportunities. The philosophical courses, especially philosophy, are directly meant for the formation of beliefs and convictions, values, systemic and scientific worldview. Therefore, the significant reduction or even the complete exclusion of philosophy from higher education in favour of majors jeopardizes the realization of the stated educational priorities. The creation an e-learning environment will help to simplify and universalize a significant number of types of activities dealt with memorizing information and providing control, so lectures have more time for other activities. First of all, these are activities directly related to communication, which is an integral part of the philosophy training. Moodle can be used as a tool of the online support of the philosophy course, but it is not possible to transfer a full amount of discipline into the virtual space, as this course has a considerable ideological load. This is due to the dialogic, discursive, communicative and pluralistic nature of philosophy. However, taking into account the peculiarities of the discipline, it is possible to provide not only the evaluative function of test control, but also to realize a number of educational functions: the updating of basic knowledge, memorization, activation of cognitive interest, the development of ability to reason and more simple, but not less important, – the skill to familiarize oneself with information.

We should note that the use of e-learning environment on the one hand imposes certain restrictions on the educators and creates a risk of "mechanical" passage of the course by the students. At the same time, it encourages the teacher to develop new and rethink existing forms of learning in order to fully implement them in e-learning support systems [10].

The peculiarities of the use of Moodle as a tool in the philosophy teaching can be extended to other courses, not just the humanities. They open the prospect of using test tools not only as a control but also as an effective learning tool. Moodle tools such as essays and seminars are promising to assess the level of idea formation, the ability to express and reason students' own opinions, but they also have their own implementation specifics, which we will highlight in future research.

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The technique of the use of Virtual Learning Environment in the process of organizing the future teachers' terminological work by specialty

Victoria V. Pererva[1[0000-0002-7086-3050]], Olena O. Lavrentieva[1[0000-0002-0609-5894]], Olena I. Lakomova[1[0000-0002-7798-2263]], Olena S. Zavalniuk[1[0000-0001-6093-732X]] and Stanislav T. Tolmachev[2[0000-0002-5513-9099]]

[1] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
helav68@gmail.com
[2] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
stan.tolm@gmail.com

Abstract. This paper studies the concept related to E-learning and the Virtual Learning Environment (VLE) and their role in organizing future teachers' terminological work by specialty. It is shown the creation and use of the VLE is a promising approach in qualitative restructuring of future specialists' vocation training, a suitable complement rather than a complete replacement of traditional learning. The concept of VLE has been disclosed; its structure has been presented as a set of components, such as: the Data-based component, the Communication-based, the Management-and-Guiding ones, and the virtual environments. Some VLE's potential contributions to the organization of terminological work of future biology teachers' throughout a traditional classroom teaching, an independent work, and during the field practices has been considered. The content of professionally oriented e-courses "Botany with Basis of Geobotany" and "Latin. Botany Terminology" has been revealed; the ways of working with online definer (guide), with UkrBIN National Biodiversity Information Network, with mobile apps for determining the plant species, with digital virtual herbarium, with free software have been shown. The content of students' activity in virtual biological laboratories and during virtual tours into natural environment has been demonstrated. The explanations about the potential of biological societies in social networks in view of students' terminology work have been given. According to the results of empirical research, the expediency of using VLEs in the study of professional terminology by future biology teachers has been confirmed.

Keywords: Virtual Learning Environment; E-learning; terminology competence, system of future science teachers' vocation preparation.

1 Introduction

The integration information and computer technologies (ICT) into the educational process sets up higher requirements for the future teacher's professional qualities. Thus, an updating the approaches to the organization of educational activities in higher school with an emphasis on self-development and self-study ones become more and more vital.

The intensity of the educational process increases, it also becomes more dynamic and continuous (we mean the principle of lifelong learning), and educational technologies are changing accordingly. Electronic learning (e-learning) emerges as innovative educational technology [2]. Ukrainian higher educational institutions (HEI) are actively implementing these technologies into the educational process. The integration of Ukraine toward European and world educational spaces challenges both pedagogics science and education system to search for effective approaches to quality-based restructuring of future specialists' vocation preparation. One of such aspects is the creation and use of the Virtual Learning Environment (VLE) which is a complement rather than a complete replacement of traditional classroom training.

At present, there are many tools for creating web-based learning experiences [30; 41] that becoming more powerful and easier to use, and Internet technologies advance at unexpected levels.

An important the feature teacher's occupational formation is the development of professional-and-terminological competencies being revealed by way of understanding of biological concepts and using discipline-related terminology. For that reason, innovative educational approaches that aimed at professional competence formation and based on future teacher's terminological competences become increasingly popular.

However, due to the fact permanent updating of e-learning concepts, it is necessary to develop new approaches to organizing the future biology teachers' terminological work by specialty into VLE that are professional significant to them.

This research *is aimed* at identification opportunities and a specificity use of E-learning and Virtual Learning Environment in organizing future teachers' terminological work by specialty.

2 Materials and methods

Issues related to professional-and-terminological competence formation have been investigated by scientists in various aspects. Especially, the communication competences were considered in the studies by Mikhail M. Bakhtin [3], forming of professional-and-terminological competence of future bachelors in economic area of expertize were highlighted by Iryna V. Vlasiuk [66]; Lesya V. Viktorova [62] proposed a method to perceive the veterinary terminology originating from Latin and Greek. These and others researches contributed a lot to the evolution of knowledge about professional-and-terminological competence formation.

Scientists are united in their viewpoint about fact that the terminological language fluency by the future science teachers is the key to their successful professional activity. Thanks to this fact they can selection of terms in accordance with the academic topic, distinguish of terms semantic as well as their Latin counterparts, use ones of according to their definition, terms and professional words differentiation.

Thus, the biology teachers' vocation preparation must involve the formation students' terminological competence by high level. And since biological terms are predominantly of Latin origin so it is quite important to understand their semantic meaning. It is the modern ICTs that greatly simplify process mastering of terminological competences.

Recently, scientific literature pays much attention to increasing the efficiency of the educational process with the use of ICT. The theory and practice of higher education have accumulated experience that can form the basis for students' training system upgrading with the help of ICT: the didactic principles and regularities of educational process informatization in higher education are determined by Olga V. Bondarenko [7], Valerii Yu. Bykov [8], Maiia V. Marienko [28], Serhiy O. Semerikov [49], Vladyslav Ye. Velychko [13], Myroslav I. Zhaldak [70] etc.; the peculiarities of ICT application in high school educational process are studied by Galyna O. Kozlakova [9], Olena O. Lavrentieva [23], Natalya V. Rashevska [44], Irena V. Robert [46], Lina M. Rybalko [24], Snizhana O. Zelinska [69] etc.; the computer-based learning tools are theoretically substantiated and developed by Oksana M. Markova [27], Serhiy A. Rakov [43], Kateryna I. Slovak [31], Vladimir N. Soloviev [34], Andrii M. Striuk [45], Tetiana A. Vakaliuk [60], Nataliia P. Volkova [42] etc.

We can observe a significant increase in the number of studies that have focused on ICT use in the educational process. In particular, these are the studies of Svitlana M. Amelina [57], Dmytro S. Antoniuk [61], Liudmyla I. Bilousova [6], Halyna I. Ivanova [18], Vasyl P. Oleksiuk [35], Liubov F. Panchenko [36], Olga P. Pinchuk [39], Volodymyr V. Proshkin [17], Ivan M. Tsidylo [54], Yurii V. Tryus [51] and others. In their work Nadiia R. Balyk [4], Dan Benta [5], Pierre Dillenbourg [10], Evgen O. Kozlovsky [20], Hennadiy M. Kravtsov [21], Oksana S. Lytvyn [50], Pavlo P. Nechypurenko [33], Kateryna P. Osadcha [56], Noawanit Songkram [53], Simhachalam Thamarana [58] are paid special attention to VLE.

3 Theoretical background

For the past few years, computer technologies for the support teaching have been developed including as assessment or communication tools. It is well known the modern technologies enable to be combined these tools into single products that called VLE. So, a VLE can be defined as a self-contained computer based online environment enabling interactions between instructor and learner [58].

A VLE handles information that directly related to students' study, for instance, they are lecture notes, online discussions and perhaps students' grades. Moreover, a VLE deals with the management of other information which can be directly not connected with teaching "in the classroom" [58].

According to Simhachalam Thamarana, a VLE is an online (web) environment where various tools are provided for teacher and student to facilitate the learning experience. VLEs generally operate across the World Wide Web, so one often only need an Internet connection to access a VLE. But even so the teacher has a chance to give access for only registered students.

VLEs can be identified by the following main features, namely [10]:

- A VLE is a designed information space.
- A VLE is a social space since educational interactions occur in the environment turning spaces into workplaces.
- A VLE is explicitly represented; this information / social space representation can vary from text to 3D immersive worlds.
- Students are not only active participants but they also actors. They co-construct the virtual space. In light of this viewpoint VLEs aren’t restricted to distance education, they also enrich classroom activities.
- The VLEs integrate heterogeneous technologies and multiple pedagogical approaches.
- Most virtual environments overlap with physical ones.

Let’s examine the advantages of using a VLE. The VLEs are used to support teaching and learning. They have potential in order to foster learning just like in a face-to-face teaching. We mean following things: information delivery; peer support; organizing a group work; self-assessment; formative / summative assessment; teacher-student communication; tutorials, and whatever. The fact that VLEs provide a range of tools to secure the same teaching and learning principles like traditional classroom are established. At the same time these tools are delivered online in a virtual environment [53].

Blended Learning is an educational concept envisaging knowledge acquiring by learning individual both on-line and under teacher’s supervision. This approach makes it possible to monitor time, pace and focus of study material, the integration of traditional methods and modern technologies. This model does not foresee complete abandonment of traditional education (B&M Education), since face-to-face education involves the formation and improvement of linguistic and socio-cultural skills. So Blended Learning is a mix of traditional B&M Education and E-learning.

VLEs aren’t restricted to distance education [58]. It can be applied in course of traditional classroom (Brick and Mortar Education) as well as in Blended Learning (on authors’ opinion [48]). Internet-based activities are generally added to enrich a presential of study ones. This process can be just an add-on (for instance, the teacher points to extra resources that the students should study by means VLEs) or have a stronger influence on the teacher’s pedagogical approaches. E.g., technology can become the enabling factor for functioning complex socio-constructivist study scenarios [48].

Consider the possible options for the forming and development of future biology teachers’ professional-and-terminological competence via the VLE.

4 The Virtual Learning Environments tools overview

For deliver certain types of information the modern IT services, such as mobile applications, cloud repositories, media hosting, social networks, are being used to. It should be noted that in the educational process, regardless of growing IT technologies relevance, the essential role belongs to the face-to-face teacher-and-student interaction. It is well known young people are familiar chiefly with gaming computers and mobile applications and use the technical devices mainly for entertainment purposes. In such a way there is a threat of the simplified perception of VLE-based educational technologies by young people. In this case it is teacher that contribute to the students' learning motivation creating and IT application promotion with widen the conditional framework of the educational environment and even provided an exit its bounds.

The active use of VLE technologies is intended not to substitute but to supplement the educational environment.

Let's review basic VLE tools that can be used in blended learning during the future biology teachers' vocational training process (see Fig. 1) in light of forming the professional-and-terminological competences.

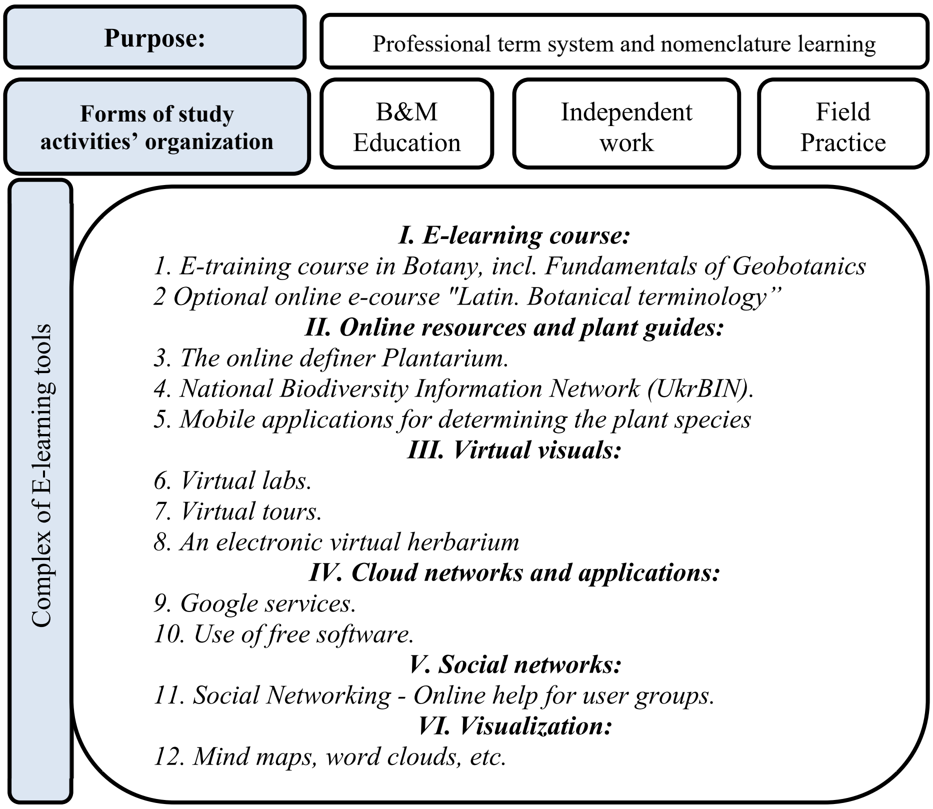

Fig. 1. Complex of E-learning tools used in the organization of students' self-studying process within learning professional biological and binary terms

The VLE structure can be represented by the following components:

- the Data-based component (HEI's website, e-textbooks, e-learning courses in LMS Moodle or other LMS);
- the Communication-based component (ensuring video conferences, webinars, chats, forums, e-mail, social networks);

- the management-and-guiding component (organization of individual or group work, current and final students' knowledge assessment, educational process monitoring),
- the virtual environments (laboratories, tours, electronic collections - herbariums, encyclopedias, etc.).

In our previous researches we have analyzed the properties and capabilities of a number of VLEs and tools applications in course of future biology teachers' terminological and classification education [25]. We advisable to use them both in course of lecturing and conducting laboratory-practical classes as well as during students' self-study process.

4.1 Survey of e-training courses for organizing future teachers' terminology work

The efficiency of future specialist's vocation preparation is greatly fostered thanks the use of online training courses making the educational process more individual.

Below the concept of several electronic courses designed to form the professional-and-terminological competences of future biology teachers will be introduced.

The courses are formed according to the well-known principles that underlie the organization of distance learning in synchronous and asynchronous modes. On top of all the specific character of the academic natural-science subjects embracing the need for microscopic, laboratory experiments and observations, the study of natural samples and fixed preparations, excursions into nature, and whatever, is also takes into account.

Such courses can be distributed on a variety of media, as well as on educational sites on the Internet, as well as sites when e-learning management systems LMS Moodle are installed. E-training course can be extended via variety of information carriers and published on educational sites in the Internet, including distant learning technology like MOOC. Online courses for the implementation of synchronous learning involve the use of teacher-student interaction tools in real time (chat, virtual class, general and special purpose browser environments, etc.).

E-learning management system of Kryvyi Rih State Pedagogical University (KSPU) is represented with LMS Moodle platform [29]. There is a spreading experience of introducing lecturers' personal educational sites where students' independent study activities are organized with use the blended learning technology. Blended learning resources presume shared use of both traditional and e-learning practices and tools. In this case the part of e-learning technologies in educational process can range from 30% to 80%. Currently in KSPU both fundamental academic courses of natural-science preparation and subject-science courses are being developed.

The main purpose of the e-learning course *"Botany with Basis of Geobotany"* is to teach future biology teachers to determinately and appropriately use biological terms, to construct new ones independently, including taxon names. The course contains information on the history of biological terminology and classification formation, the etymology of plant names, the specifics of plant groups' taxa word formation, as well as the meaning of word-building basic elements. Creating this course, we taken into account some general pedagogical regularity. It is considered the terminoelements recognition in definite cases determines the efficiency of professional terminology interpretation and memorization by future biology teachers and their proper practical usage in vocational communication process.

The optional e-learning online course “*Latin. Botany Terminology*” is destined to expand students’ knowledge in the field of biological terminology, to identify terminological Latin-Ukrainian correspondences, to promote the formation of future teachers’ professional terminology system.

Indeed, the Latin language course is not included both in the normative and variable parts of the specialty-based developed curriculum 014.05 Secondary education (Biology and human health) specialty. Therefore, this special course is optional; it is developed for first year students (1-2 semesters) of the Natural Sciences Faculty of KSPU. One of its major tasks is a preparation student for understanding the academic subjects as well as international scientific terminology and biological classification principles based on Latin terminology knowledge.

The “Latin. Botany Terminology” course is aimed at: preparing students to read Latin texts with the help of the dictionary; digesting of international Latin biological terminology; mastering of Greek-Latin terms elements semantic analysis methodology; compilation of an individual biological vocabulary; processing of general principles of floristic and physiognomic naming of various plant groups; working of binary biological classification rules.

The purpose of course “Latin. Botany Terminology” is to teach students elementary grammar (phonetics and morphology), a certain vocabulary that underlies inter-national terminology in the field of biology; to develop skills of elemental analyze of Greek-Latin-based terms and ability to read dedicated biological texts and phytonyms; to show methods how to work with Latin educational and supplementary literature; how to apply professional biological terminology in practice, and what’s more, to improve students’ linguistic culture and do wider their outlook.

The optional course “Latin. Botany Terminology” has been published in e-learning courses management system LMS Moodle of KSPU. This system is focused, first of all, on the arrangement teacher-student interaction under the conditions of self-timed online learning, and can also be effectively used to arrange both face-to-face and correspondence study as well as online learning [22].

4.2 Use of the online definer (guide) in the future biology teachers’ practical vocational preparation

The main purpose the field practice by botany is an evolution students’ ability to use the definer on thesis-antithesis principle. As generally accepted, that is quite tedious and time-consuming work. In such case the online resources and mobile applications have been proven themselves as quite helpful tools in terms of time optimization, students’ cognitive activity intensification and motivation.

The *Plantarium* [40] is a non-profitable project; it’s an atlas of species and an illustrated online plant identifier meaning for a wide range of users (amateur and botany professionals, geobotanists and environmentalists) (see Fig. 2).

The main purpose of this project is to help concerned persons with identification of wild plants and lichens into the Post-Soviet space. Last but not least this project is also aimed at collection of comprehensive photo gallery of all plant species. The indisputable advantage of the Plantarium plant determinant, in contrast the conventional plant determinant that based soft or hard copy, is the possibility to select an arbitrary number of key features of investigating object. That is, app does not use the dichotomous thesis-antithesis key. The search results in the app database generate a set of species that match the query. Researchers of different professional levels via Plantarium tools can easily identify a particular plant specimen by means of a photo.

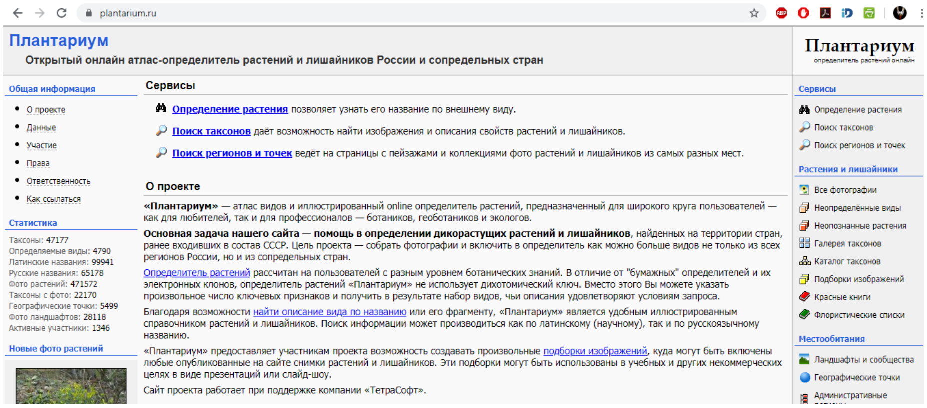

Fig. 2. Online plant identification guide “Plantarium”

In general the advantages of this resource are as follows: accessibility and usability; availability of an illustrative guide; possibility to search by key attributes; relevance of use during the laboratory-practical course in “Botany with Basis of Geobotany” and relevant educational vocation practice; a chance to create random sets of images (slideshows) for educational purposes.

However, we want to take emphasize the disadvantages this app. This is, in first, the high error probability identification of plant due to the specific features of the anatomical and morphological its structure levelling which can’t be recognized by the photo. Such studies require examination of the specimen under a binocular microscope. But even so, the use of Plantarium tools allows considerably intensify the students’ terminology work, rids of them routine retrieval of the information.

4.3 UkrBIN – National Biodiversity Information Network as an informational support

On Fig. 3 you can see screenshot one of pages an online search database Ukrainian Biodiversity Information Network [59] that use for study biological links between animals, plants and fungi (forage plant phytophagus, parasite host, and whatever).

The distinctive feature of this resource is considered the digital material has represented by a photobase of living objects (plants, animals, fungi) in a natural or anthropogenically transformed environment [40].

The material posted on the UkrBIN resource can be used to organize terminological work of future biology teachers, to improve the level of their terminological competence. Last but not least, providing relevant territorial information the UkrBIN resource helps to improve the quality of students' research work.

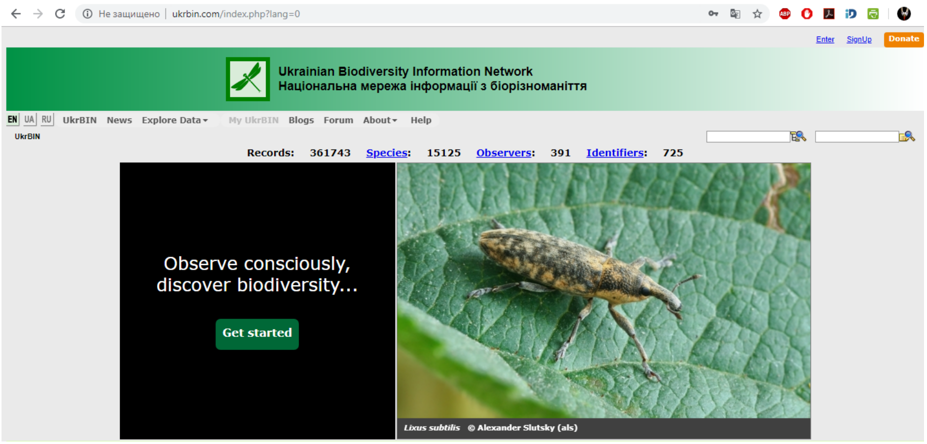

Fig. 3. The Ukrainian Biodiversity Information Network

4.4 Virtual labs in VLE

Should take into account a *virtual lab* is a VLE allowing the simulation of real-world objects in a computer among and helping students to gain new knowledge and skills. Such laboratory can serve as the mechanism for various natural phenomena studying with the possibility of their model's development [32].

Let's make review some virtual biological labs which we could capably introduced into future biology teachers' vocational training. Having analyzed free virtual labs on natural sciences disciplines we can state the predominance of English-language data-bases while accessibility of Russian-speaking and Ukrainian-speaking virtual labs is by far fewer.

Virtual Biology Lab [63] is a free online educational resource that simulates the natural environment considering living world feedback to changing conditions. The resource also contains interactive guides for study ecology, evolution and cell biology.

The *Online Education Program* [19] is designed to simulate a lab with the possibility to make one's own adjustments. So as to facilitate the organization of the research process in this environment the consistent guidance has been developed for users.

Connect Virtual Labs [67] is a kit of biological laboratories that students can access whenever and wherever.

LabBench Activities by Pearson is an interactive, free-access virtual biology lab [37].

VirtuLab [65] is Russian-language stand-alone that don't need any installation and has free platform. This is a project that can use for development of virtual laboratory works in physics, chemistry, biology, ecology.

The Global School Lab International Project is a portfolio of projects and researches, shaped as of pre-made templates. Virtual education laboratory (laboratory work) in biological courses includes: VirtuLab 6-7 (“Botany. Zoology”); VirtuLab 8 (“Human being and his health”), VirtuLab 9 (“General Biology, Grade 9”), VirtuLab 10-11 (“General Biology, Grades 10-11”), VirtuLab (“Ecology”) (it shows on fig. 4).

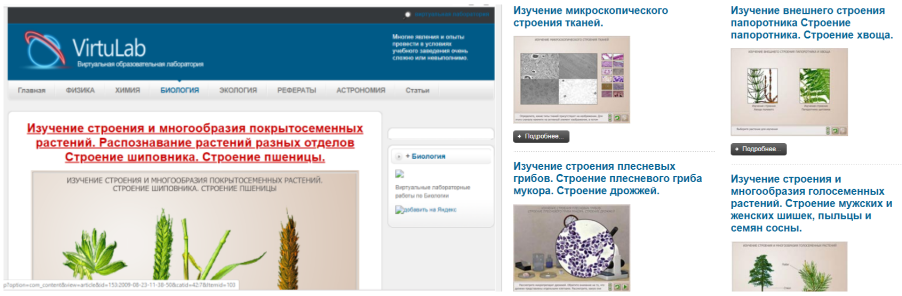

Fig. 4. Virtual laboratory (VirtuLab)

Biology with Olga [64] is a resource containing a video library, online tours, virtual labs, and notes about interesting biology. The virtual labs are introduced here in accordance with biology training courses for pupils by 6-11 grades.

SMIT Ukrainian-language Virtual Laboratory [52] is a series of pedagogical software or electronic textbooks that have received the Stamp of the Ministry of Education and Science of Ukraine. They are designed for schools and vocational education institutions and use multimedia technologies (animations, videos, sound) for showing of natural effects. The developer works on a series of professional tools for higher education. Unfortunately, now it is a paid business product.

Far and away the opportunities of virtual labs usage are quite wide. They can be use by teacher demonstrating experiments at a stage of study new information, while working out the methodologies of both chemical and biological researches based on virtual objects, by individually or in problem groups. Such tools are expedient during arranging individual search activities students on the all stages – from educational content securing to its digestion monitoring.

Thus, the use of virtual laboratory work as referred to the real ones can be of demonstrative, generalizing and experimental kind.

The main advantages of virtual laboratories (VLs) are:

1. Efficiency – time and resource saving. No need to buy expensive equipment and reagents. Furthermore, obsolete equipment, ware, reagents can distort the experiment outcomes and serve as a potential source of danger for people, involved in the educational process. The high cost of acquiring computer hardware and software is offset by their versatility of [15].
2. VLs be up ability to simulate processes that can’t occur under laboratory conditions and visualize them on a computer screen. Modern computer technologies allow to explore processes that difficult to observe in the real environment without use of additional equipment. They may be, for example, objects of the small size (microscopy) or groups of large size (populations, biomes, etc.).
3. By means of VLs everybody has ability to observe and investigate on a different

time scale processes occurring in fractions of a second (e.g., cell division) or, conversely, lasting for several years (succession, population fluctuations) [20].
4. Work into VLs is safety throughout using volatile and poisonous substances, alkalis and acids, electrical appliances, and whatever [24].
5. It is controllability and repeatability of experimental conditions. In this case we have in mind providing a series of experiments with different values of the set-up parameters, in the end - obtaining the expected and reliable outcome [68].
6. Perspective use in online learning, blended and brick and mortar ones or students' self-education process when there is no opportunity to work in real laboratories [20].

Over and above, VL is an example of an artificial learning environment that allows observation and detection of cause and effect links between of real-world objects with use computer models. VLs is essential when you study the microscopic anatomical structure of plant and animal organisms at the cellular and tissue levels, which is not always possible to do in real laboratory conditions for a number of reasons.

But the potential of VLs is not limited to the above-mentioned features, they are also quite relevant during investigation the living organisms, both at the organismal level (animal and plant morphology) and at the above-organismal one (trophic chains and interspecific interactions of organisms, the structure and functioning of populations, biocenoses, and biosphere in general).

4.5 A digital virtual herbarium

An electronic virtual herbarium is an information resource that provides fast and high-quality access to renewable and open databases, a higher level of accumulation, storage and dissemination of text and graphical biology information in contrast with usual herbarium. Taking into account the training of future biology teachers involves the formation of a knowledge system on the composition and functioning of flora and fauna, there is a need to expand opportunities for the use of biological collections and to transform herbarium funds into a virtual electronic format.

Advantages of digital herbarium are prevention of unique samples damage, economy, ergonomics, availability, and renewability of data. The development of modern technologies and computerization are being enabled exchange of huge scientific information through wide access to specialized databases [1; 63], including the herbarium collections (Fig. 5).

It was *IBD* [1] that became such an online directory for botanists. It is organized in the form of indexes and allows using the online version of available botanical information. This project was implemented by a team of herbarium composition specialists from Harvard University (Cambridge, the USA), Missouri Botanical Garden (St. Louis, the USA), a group of Canadian programmers, the Botanical Department of the Museum of Natural History and the University of Helsinki (Finland).

Computerization of the National Herbarium (*KW*) [16] database of the Botany Institute named after M.G. Kholodny (Kyiv, Ukraine) envisages the development of a software block that will be able to process information about species, covering all related search data displaying, namely: family name, species list, species status, distribution data, year and collector [1].

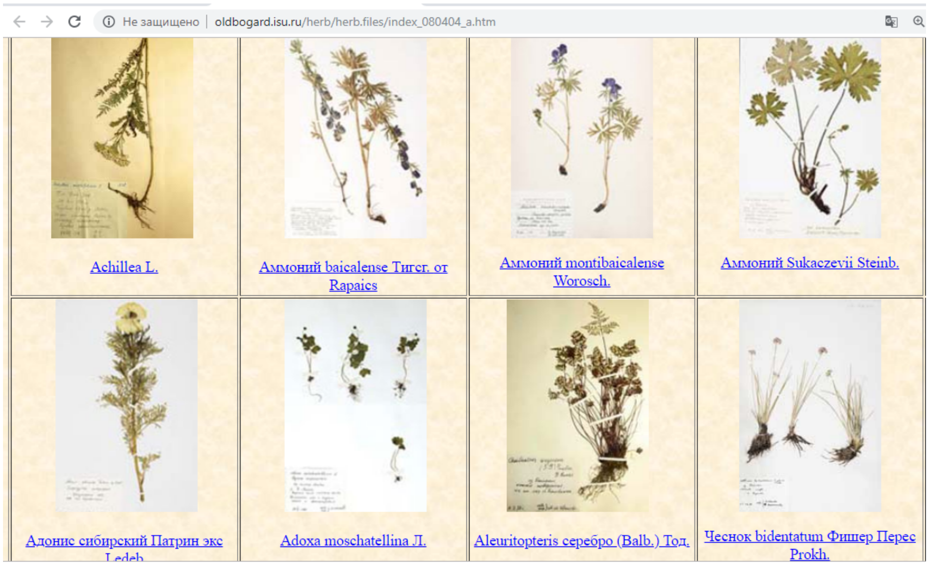

Fig. 5. Digital (virtual) Herbarium [26]

Definitely virtual herbarium has some disadvantage. It should be carrying to them follows:

- the possibility of biology specimen diagnostic features loss (which, for example, is visible only under a binocular microscope) and impossibility of sampling for other analysis making purposes like genetic, biochemical, etc.;
- the limitation herbarium's database by server capacity;
- the need for costly equipment and labor to digitize large amounts of herbarium funds.

But even so, if necessary, it always possible to address directly to digital herbarium specimens to redefinition, to do morphometric measurements or genetic analysis of plants, to make sampling for spectrometry.

5 Organization of future science teachers' terminological work among Virtual Learning Environments

5.1 Implementation mobile apps to definite the biology terms

There are a number of mobile apps gaining popularity among both lecturers and students can be useful for the biology teacher in organizing pupils' research activities. In particular, these are apps for identifying living objects in the wild environments by photo. They have a number of advantages including accessibility, simplicitability (even at an intuitive level), adaptability to different gadgets and operating systems, in the end they usually free of charge, have visibly attractive and smart interface.

All of the above things provide an increasing relevance of the mobile apps usage as a state-of-the-art modern supplementary to the traditional educational system. The mobile app is software developed for use on smartphones, tablets and other mobile devices [71]. It is well known the basic set-ups of mobile apps are provided and pre-installed on the device and can be downloaded from the online application stores like AppStore, Google Play and others, both free and for payment [11].

The apps' type that we investigate are introduced by a large group working on the principle of researched vegetative and generative organs plants by means of photo verification with a photo base. But some apps even offer the opportunity to consult with specialist or experts. Definitely, a using such kind of apps is relevant to realization the route's method of vegetation research during a botany field practice.

The mobile application system using in the vocational training process by specialty 014.05 Secondary education (Biology and human health) is represented by 5 main functional groups (see Fig. 6).

Fig. 6. Mobile apps for the future biology teachers' vocational training (based by [40]).

There are a 5 number of main type apps for these purposes.

1. Mobile apps using to determine the plants species.

2. Reference mobile software that can be helpful to conduct the morphological description of plants, to identify the features of their chemical composition and use in medicine, to realize of agricultural activities (crop, gardening, horticulture, etc.). Their use is justified in teaching such subjects as “Basis of Agriculture”, “Medicinal plants”, “Basis of Ecology” to study the morphology and bionomics of plants, their practical application in phytotherapy.
3. The mobile apps that efficient in mastering the biological terms of Latin origin. They can be also useful for study disciplines of vocational training process like “Botany with Basis of Geobotany”, “Zoology of invertebrates and vertebrates”, “Microbiology and Virology”, “Bases of Ecology” and “Human Anatomy”.
4. Special mobile apps helping to demonstrate certain features of biological systems’ structure or functioning.
5. Mobile apps in chemistry that can be useful in the studying and fastening of students’ knowledge about the cells’ chemical composition, metabolic process-es of aerobes and anaerobes, as well as in mastering the subjects of vocation training the future biology teachers like “Plant Physiology”, “Human Anatomy”, “Botany with Basis of Geobotany”, “Zoology”, “Microbiology and Virology” and others.

Significant advantages of mobile apps are follows: accessibility, cost-efficiency, usability, time saving kind. However, these facts should clarify. Unfortunately, such software tools do not always provide accuracy in the terminological definitions and require clarification of the studied living organism belonging by means of identification’s key. In general they are useful in determining the affiliation of an object to taxa of super-species rank (species, genus) [38].

Mobile apps for plant identification are of practical importance and can be used in the laboratory course like “Botany with Basis of Geobotany”, “Introduction to the Specialty”, “Phytodesign”, “Medicinal Plants” and other vocation oriented study subjects; in course of nature tours; while fulfilling by students individual research and qualification studies tasks, in self-educational process [38].

5.2 The virtual tours into natural environment

Virtual tour is one of the types of educational process arrangement in HEI, but, as practice shows, it rarely used. Pedagogical potential of educational tours is being able to impact students’ intellectual level, to develop their emotional sphere, to shape of conscious attitude to environment constituents, to do environmental awareness upbringing.

Virtual tours are one of the most effective ways to present cognitive information, these are a multimedia photo panorama where one can place video, graphics, text, links. But unlike a video or a regular series of photos, virtual tours are of interactive kind. It goes without saying that in course of the tour one can zoom in or out any object, check some details in more profound manner, zoom in the object under study [55].

Virtual tours are widely represented in the visual arts. In particular it may be museum video tours (see fig. 7). However, virtual tours into nature is seems to be quite perspective and can be used in future biology teachers’ vocational training.

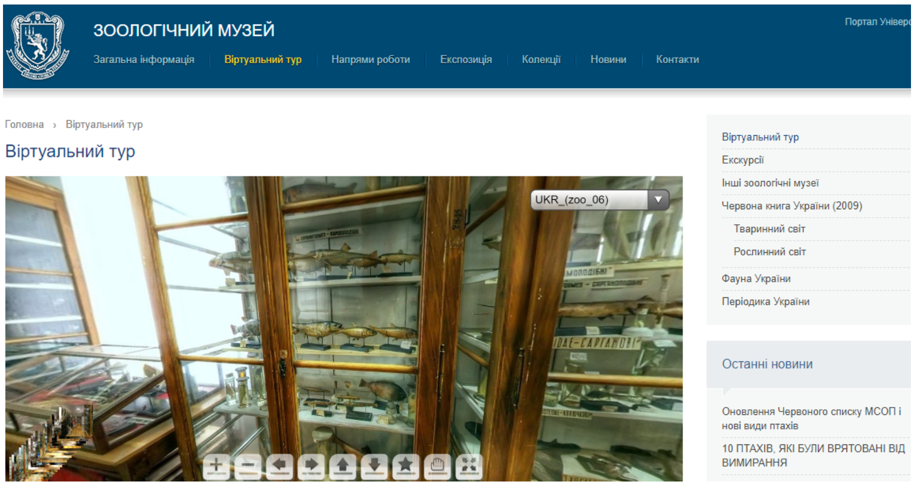

Fig. 7. Virtual excursion in KSPU Zoology museum [72]

As on date virtual tours into nature are available at the Zoological Museum of Lviv National University named after Ivan Franko [72], the Museum of the Human Body in the Netherlands, the State Darwin Museum, the London Museum of Natural History, the Chornobyl' National Museum, the Biological Museum named after K. A. Timiryazev, Nature museums in Yekaterinburg, Yalta Zoo, Virtual Carpathians, etc.

Analyzing the presented content, it should be noted that the above tours can't be described as virtual ones to the full extent, because they don't have interactivity component. They only allow you to view indirectly these museums exhibits collection or other objects.

But, in any case the development of virtual tours into nature or natural museums-based tours may be helpful for students to accelerate perception of learning material. Considering realities of present day, the elaboration of full-blown virtual tours into nature is only matter of time.

5.3 Use of free software for the organizing terminological work with students

Science teachers must be educated specialists who as good as they can incarnate the potential of modern natural sciences. For example, in study the subject "Basis of Agriculture" it is advisable to use such free software that facilitates processing of theoretical material on the principles and typology of crop rotation.

Let's do review a list of freeware and shareware programs and apps, likely can be used to consolidate some knowledge of fruit crop rotation and planning a school study-experimental lot. These programs include *GrowVeg, Garden Planner Online, Kitchen Garden Planner, Garden Puzzle, Sprout it, Garden Tracker* and *Edyn Sensors* (see Fig. 8).

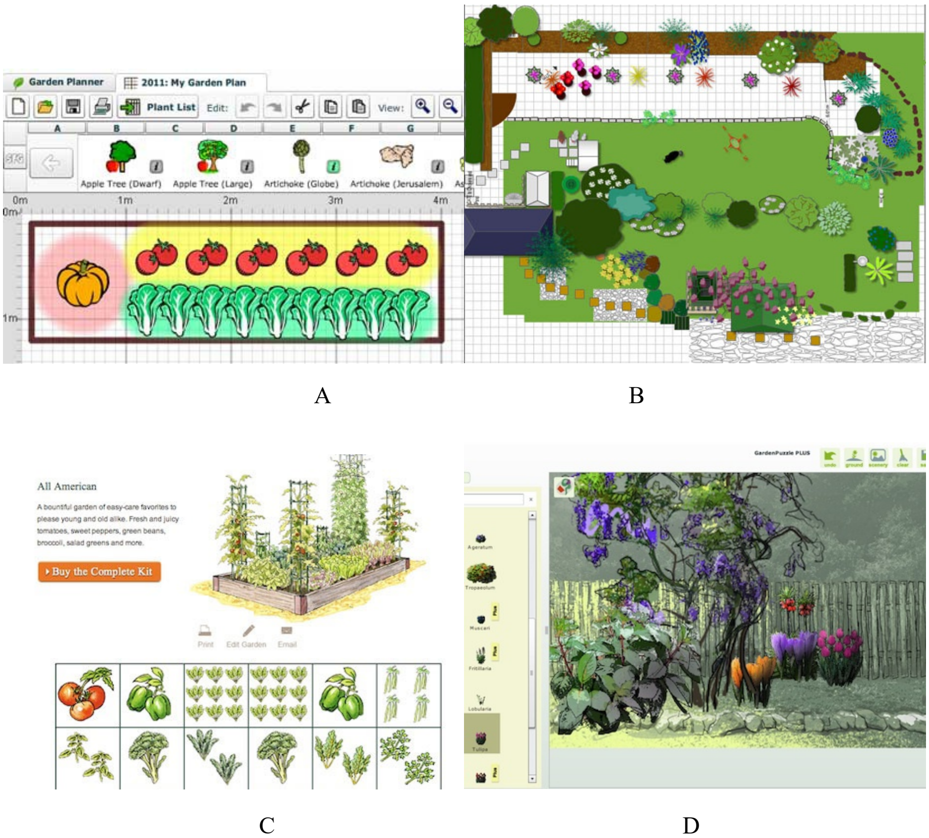

Fig. 8. Free software: *My Garden Plan* (A), *GrowVeg Garden Planner Online* (B), *Kitchen Garden Planner* (C), *Garden Puzzle* (D) [47]

One of the most popular apps is the *GrowVeg* landing planner [14] allowing to add objects, vegetable bed types, and rearrange objects for the perfect location. The program calculates the appropriateness of neighbouring plants. Based on data obtained from local weather stations, app depicts the sowing time for a particular area. Basing on the rational crop principles, the system offers the placement of the following crops, taking into account the predecessors. Via e-mail the app can send reminders about what and when to plant throughout the season.

The lot planner *Garden Planner Online* allows adjustment size, shape and location of lot. Available elements are reckoned shrubs, trees, flowers, and fences. It enables to place both vegetables and fruits. Knowing specific crops planting area, it is possible to calculate the amount of seed for planting via this app.

The *Kitchen Garden Planner's* is online planting planner covers nearly three dozen garden beds. It is designed for organic garden planning. There are 15 cells in each garden bed where vegetables can be placed. The app also offers the detailed planting guidance and does to give recommendations refer to the agrotechnics of each crop growing.

The *Garden Puzzle* provides maximum visualization planning of lot and drawing-up one. The range of available plants includes garden crops, garden, flower and ornamental plants.

The reminder app the *Sprout* fully customizes plant care and so it is very convenient for beginners. The database covers a fairly large list of plants and offers a timetable for land treatment, tunes them in line with a weather data and alerts user in case their changes.

The popular *Garden Tracker* app allows planting planning and monitoring at area up to 2500 m^2 in size. It also enables beds marking and selection a list of crops from a wide database. The program tracks the date of planting and includes many settings, namely: a monthly calendar, and an illustrated database of pests and organic remedies. This program is a fee-based one and allows processing of lot images by experts' help, providing specific guidelines for particular area planning.

Modern technologies using for the automation of organic farming are represented by the *Edyn sensors and software*. Planning crop rotations and crop locations can be conducted based on online monitoring outcomes. These sensors enable data obtainment on weather conditions directly from a location, to determine soil acidity and what's more – darkening of plants.

Really, the representatives of free software discussed above are easy to use, built on the principles of gamification; and are able to introduce novelty elements into the educational process. Working with such apps the future biology teachers can to carry out mental experiments to check virtually made predictions.

5.4 Social Networking – online help for user groups

The use of social networks for educational purposes provides the opportunity to expand the contacts circle in line with students' preferences or their professional interests. In particular, the Ukrainian Biodiversity Information Network (UkrBIN) community is represented on the social network. Amateurs and scientists help with identification of living organisms by photo as well as with filling in the UkrBIN database. Such profile social groups like Dendroflora of Ukraine and the World, Flora of Ukraine, Herbarium Management in Ukraine, Ukrainian Botanical Group, Mushrooms of Ukraine, Plants of Ukraine and others (see fig. 9) are being quite active.

Becoming the members of such a community, future biology teachers not only more deeply study specifically subject knowledges, they thus join a cohort of specialists who enhance knowledge of animate nature and contribute to its protection.

5.5 An empirical study of Virtual Learning Environments application effectiveness in course of future biology teachers' vocational training

In order to analyze the effectiveness of VLE and tools that have been used in students' terminological work in vocational preparation process throughout 2018-2019, the systematic surveys, observations and assessments have been conducted. The monitoring spectrum was included:

1. Students’ questioning about their motivation to study professional terminology.
2. Identifying the level of awareness and particular ICT tools ownership by students.
3. Analysis of students’ terminological awareness.

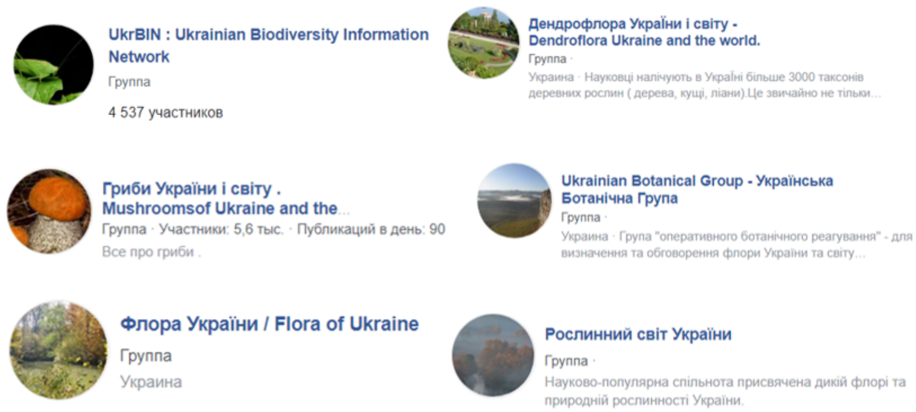

Fig. 9. Biology user groups [12]

Having analyzed the outcomes, eventually, we can be drawn following conclusions: if VLE and tools be actively introduces into the educational process, a tendency to be about increase of future biology teachers’ motivating level appears to studying professional terminology.

Comparison of professional terminological training self-analysis outcomes was conducted in the first and third semesters based on following key questions (it was suggested to be rated on a 10-point scale) (shown on Fig. 10).

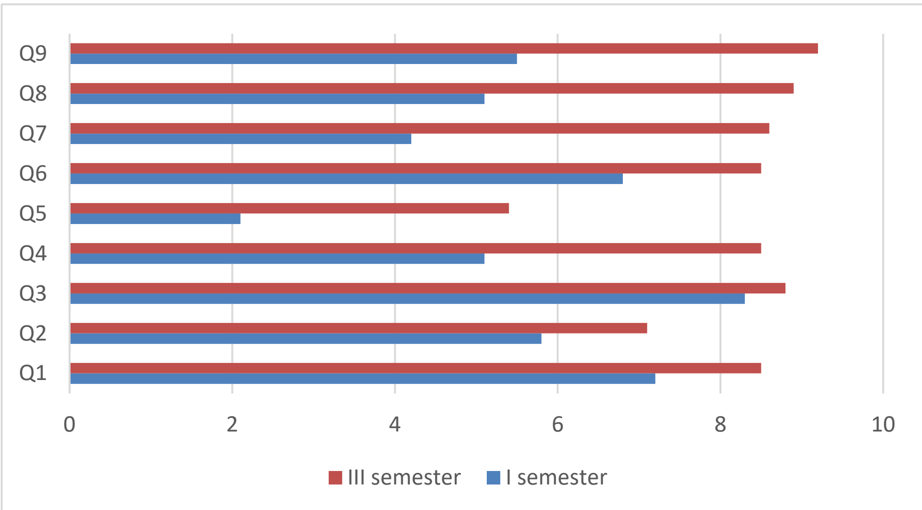

Fig. 10. Dynamics of students’ motivation to study and use professional terminology upon VLE-based vocational training completion (it prepared by authors)

1. What do you think about importance of biological terms application in your future professional activity?
2. Fix the level your willingness to speak in a professional way.
3. How do you value your speaking skills and ability that required for future professional work as a teacher?
4. How do you assess the capability of Latin biological terminology in your future professional activity?
5. How can you evaluate your experience of binomial nomenclature awareness?
6. How do you appraise your level of biology terminology preparedness?
7. Fix the level your readiness to use biological terminology and binary nomenclature in your future professional activity.
8. To what extend do you consider Latin as a mean to get new professional information?
9. In your opinion, how important is the ability to use Latin biological terminology and binary nomenclature in the teaching profession?

It has also been found that the use of VLE technologies has led to a significant growth of level of students' terminological competence (see Fig. 11).

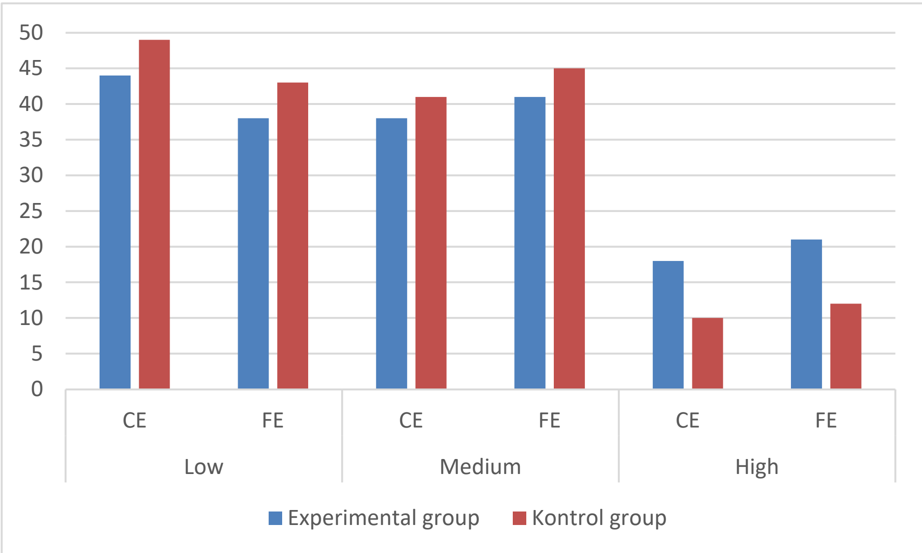

Fig. 11. Dynamics of levels of students' professional-and-terminological competence: CE – Control experiment, FE – Forming experiment (it prepared by authors)

These results are correlating with the growth of students' computer competence.

6 Conclusions

Peculiar feature of teacher's professional competence is the focus on practical skills formation, basic knowledge about the general principles of ICT application in biology, the formation of individual pedagogical approach. Definitely, application of E-learning systems and Virtual Learning Environments opportunities is consistent with the traditional values of HEIs and has the proven potential to enhance both the effectiveness and efficiency of meaningful learning experiences of students.

Virtual Learning Environment can be defined as a self-contained computer based online environment enabling interactions between instructor and learner. It can be presented as a set of components, such as: the Data-based component, the Communication-based, the Management-and-Guiding ones, and the virtual environments.

The system of Virtual Learning Environment is contributed to efficiency of handling with the students' real educational problem situations, which can be sorted out with digital devices and gadgets.

This study presents an analysis of only a few elements of the virtual educational environment those are appropriate in the terminological work of future biology teachers. Nevertheless, significant potential of professionally oriented e-courses, online definers (guides), UkrBIN National Biodiversity Information Network, mobile apps, digital virtual herbariums, virtual biological laboratories and virtual cognitive tours to shape of future biology teachers' terminological competence has been revealed.

However, it is determined the E-learning cons shouldn't be neglected since the application of ICT and tools cannot be referred to all training courses, not all lecturers and students are ready to use E-learning solely; ICT and tools' high dependence on technical infra-structure of HEI take into account also be considered.

Mastering in vocational training courses of future biology teachers' is distinguished by the need to carry out microscopic, laboratory studies and observations, examination of herbarium specimens and catalogue specimens, nature tours. Thus, integration rather than the complete replacement of traditional educational activity with E-learning is becoming the perspective trend of future biology teacher's professional training upgrade.

In view of that reason we have researched the ways organizing of educational process in Virtual Learning Environments as well as done theoretical substantiation and illustrated practical implementation of its methodology in blended learning. The effectiveness of shown above Virtual Learning Environment and tools that have used in students' terminological work has been confirmed by the pedagogical experiment's outcomes.

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The use of digital escape room in educational electronic environment of maritime higher education institutions

Serhii A. Voloshynov[1[0000-0001-7436-514X]], Halyna V. Popova[1[0000-0002-6402-6475]], Alona Y. Yurzhenko[1[0000-0002-6560-4601]] and Ekaterina O. Shmeltser[2]

[1] Kherson State Maritime Academy, 20 Ushakova Ave., Kherson, 73009, Ukraine
helen18@online.ua
[2] State University of Economics and Technology,
5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
shmelka0402@gmail.com

Abstract. The paper is tended to investigate the gamification activities use in educational electronic environment of maritime higher education institutions. Gamification methods with examples are described (gamification testing, QR Code quest, storytelling and escape room). Comparative characteristic of traditional learning and learning using gamification in educational electronic environment is given in the article according to different criteria: the place and role of teacher or students in the learning process; type of information communication; methods of training; equipment; level of freedom of the actions; presence of the problems in educational process; level of its control and learning outcomes. The paper also presents examples of gamification activities based on escape room quest to form communicative competency of future maritime professionals. Escape room activity presented in the article contains storytelling element, crossword and electronic testing questions of different types. Question types listed in the paper are Drag and drop to the text, Short answer and Multiple choice. Escape room activity was done by second year cadets of Kherson State Maritime Academy. According to the received results, knowledge quality increased by 10% and success by 20%. Further investigation of gamification activities can also be done for learning system of maritime higher education institutions using simulation technologies of virtual, augmented and mixed realities.

Keywords: Blended Learning, Educational Electronic Environment, Maritime Higher Education, Gamification, LMS Moodle, English For Specific Purposes.

1 Introduction

The constant and rapid development of professional information, the emergence of new technology, digital technology and navigation informatics require professional education to accelerate the updating of content, search, development and testing of new pedagogical technologies that guarantee the training of a specialist who has practical competences at the time of training completion.

Today it is impossible to separate professional competence from the knowledge of modern computer facilities, which are constantly updated and upgraded in shipping industry with the sole priority – to ensure the preservation of human life. It is precisely this emphasis on the importance of improving ship equipment to the IMO (International Maritime Organization) and put forward certain requirements for the professional competence of future marine professionals. A new problem arose before the maritime institutions of higher education – the search for new effective methods and technologies for training to build the professional competence of future marine professionals. For the placement of teaching materials and interactive content, modern educational establishments create and use an electronic information environment.

The scientists who studied the use of the electronic information environment in education are: Olga V. Bondarenko [4], Olena G. Glazunova [9], Oleksandr H. Kolgatin [13], Olha V. Korotun [14], Vitalii V. Lapinskyi [10], Svitlana H. Lytvynova [15], Maiia V. Marienko [16], Pavlo V. Merzlykin [18], Olena V. Pakhomova [25], Larysa M. Petrenko [21], Olga P. Pinchuk [22], Volodymyr V. Proshkin [26], Viktor B. Shapovalov [27], Mariya P. Shyshkina [29], Aleksandr V. Spivakovsky [31], Vladimir I. Zaselskiy [30], Snizhana O. Zelinska [35] and others. Researchers who considered the electronic information environment in the higher educational establishment are Gilly Salmon (E-Moderating) [24], Robert J. McClelland, Nick Hawkins (use and development of a broad range of e-books in higher education and their use in supporting virtual learning environments) [17], Hepu Deng (usage of Electronic Information Resources for academic research) [7], and others. The latest trend in learning, the Escape room (quest room), the number of tasks you need to do to get out of the room or get to a certain place, was explored by Olha V. Shykina (the development of quest-attractions) [28], Maximilian Pohle, Veit Haensch (chemistry escape room for students) [23], Ifan Jenkin, Natalie Fairhurst (escape rooms in medical teaching) [11], and others. However, the use of the proposed technology in the electronic information environment for the formation of professional communicative competence by future marine professionals remains unresolved.

The purpose of our study is to analyze the potential of using gamification as a pedagogical technology for forming a communicative competence of future marine professionals, for example, by organizing “escape room” game on Learning Management System (LMS) Moodle in the Kherson State Maritime Academy (KSMA) [32].

2 Methods

The participants of this research are a total of 120 cadets (male) aged 17–19 from Ukrainian maritime higher education establishment (KSMA). They are cadets of three departments: navigation, ship engineering and electrical engineering one.

The participants of the research were asked to study in an educational electronic environment including study on LMS Moodle and its activities (Quiz, Page, SCORM package). The materials to be used on LMS Moodle e-course are from “Seven Seas Ahead: coursebook” [3].

Stage one. The e-course “Maritime English” escape room activity was created in order to form communicative competency of future maritime professionals.

Stage two. This stage involved the collection and analysis of the results.

Stage three. The questionnaires were created in order to get feedback from the cadets who have done escape room activity.

Stage four. There was the circulation and collection of the survey questionnaires.

Stage five. Calculation and analysis of the received data took place.

3 Results

The main IMO regulatory documents that clearly regulate the standards of training of future marine professionals they include the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW-78/95) with Manila Amendments, which define the minimum requirements for the content, criteria and evaluation of professional competencies. According to the STCW, sufficient knowledge of English is a compulsory professional competence that allows the ship navigator to use maps and other navigational aids, to understand meteorological information, communications regarding safety and operation. As for a ship engineer this competence allows him to maintain the ship, use technical manuals and perform all the duties. According to the standard of higher education of Ukraine in specialty 271 “Marine and inland water transport” for the first (Bachelor) level of higher education, which was approved in 2018, communicative competence is defined by one of the general competences of a marine professional (see Fig. 1) [5].

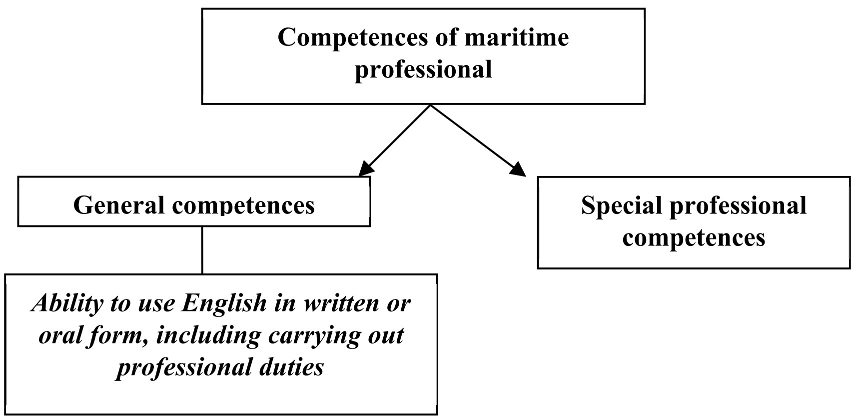

Fig. 1. Competences of maritime professional.

The knowledge quality of marine specialists depends on the extent to which the educational process is focused on future professional activities that are associated with solving various tasks of processing, transmission, transformation of information flows and processes, and involves solving various tasks of modern information production through the development of complex algorithms for modeling information processes.

The processes of digitalization and globalization have pushed for the search for the latest effective techniques, forms and technologies for training professional disciplines in higher education institutions. The system of education is in a state of irreversible changes under the influence of external (socio-economic, informational, cultural) and internal (professional) factors. A significant increase in competition in the maritime labor market requires an immediate increase in the level of training in higher education institutions, which will meet modern trends and time requirements.

One of the perspective areas of the educational process is the use of e-learning [2], which is based on the use of virtual environments [20] in the educational process, complemented by the reality of computer simulations [12], virtual 3D worlds with the effect of immersion [36; 19]. The need to attract students to virtual forms of interaction is a consequence of the redevelopment of educational space, which has been proclaimed as a modern educational trend in the Horizon reports [1].

In connection with this, there are new pedagogical technologies that are becoming widespread and implemented in the educational process. One such technology is gamification, which is a tool for using game thinking and game dynamics to engage the audience in solving professional problems [33; 34].

The use of a game without a professional context can not promote the development of professional competencies, and the setting of a certain goal is one of the most important conditions for the use of gamification in the educational process.

Since the fact that gamification has been used in educational processes of higher education not so long ago and is not a very common technology, it is indisputable that the scientific understanding and wide discussion among the representatives of the educational community about the involvement in the practice of teaching modern technology of gaming technology takes place.

Patrick Buckley and Elaine Doyle [6] theoretically and practically consider the possibilities to individualize gamification for the formation of students' interest. The use of the Escape room game was studied by Olha V. Shykina [28], Maximilian Pohle, Veit Haensch [23] and others. The analysis of scientific literature and personal pedagogical experience of authors in higher educational establishment allows us to highlight the peculiarities of the use of various types of gamification exercises in the electronic courses of LMS Moodle. While designing gamification content the first and most important is to distinct competencies that can be generated using this method (see Table 1).

There is no doubt that the skillful use of all gamification elements which we've described above can in many cases increase the efficiency of learning the material and develop the necessary competencies. Using the LMS Moodle mobile application allows you to implement virtual learning by accessing content from anywhere, at any time. The modern information materials representing the educational material produce qualitatively new properties of the content of education, which was not in the traditional methods. Virtual reality environments are the development of virtual simulators, workshops, games that are actively used in the educational process, and are tools that allow you to simulate real-world situations of professional activity for the more effective formation of professional competencies. Given the relevance of the implementation of the gamification approach, consider the characteristics of learning using gamification technologies.

Table 1. Gamification elements, their description and examples of use.

Name	Description	Examples of competencies, which can be formed using this method
Gamified testing	Online task system based on the game technique, the results of which can be judged on the level of knowledge and skills of the student.	to describe symptoms and recommend first aid for a specific disease/injury;
QR Code quest	The chain of tasks to do which you need to scan QR codes.	to list shipboard emergencies in terms of their causes, ways of preventing them and actions to be taken if emergency actually occurs;
Storytelling	The use of a plot line in the tasks.	to name Life Saving Appliances in terms of their stowage, construction and launching procedure;
Escape room tasks	The chain of activities you need to perform to win.	to list marine environment in terms of causes and consequences of marine pollution, MARPOL, sea garbage disposal regulations and actions in case of an oil spill [3];
Badges	Visual tokens of achievement sharable across the web.	to compare properties of conductors, semiconductors and insulators

Escape Room is a life-based game where the player finds hints, performs a chain of tasks for them at a certain time. This kind of educational games was based on the genre of computer games. The term “escape room” was first used in 2006 when creating the video game “Origin”. The chain of tasks and clues to them was taken from the works of Agatha Christie.

For the application of this technology in the educational process, we used the “Testing” activity of LMS Moodle. Being part of the “Maritime Security” module, the escape helps to form the key competence of the module – talk about maritime security in terms of the main guidelines of the International Ship and Port Facility Security (ISPS) Code [1]. The competence of this module, as well as other modules, is contained in the course competency framework and a separate file like the “Page” at the beginning of the module, which can be seen in Fig. 2.

When setting up a test, the required element is storytelling or adding a plot element to the task. An example is the escape room for the module “Maritime security” – Your ship was attacked by the pirates. You have 15 minutes to get to the panic room!

Exactly “Testing” activity allows adding one of the key elements of the escape room – the time when tasks are interrelated. When creating an escape room, it is mandatory to link it with the competence of the course, using the competency framework. The escape room tasks (different places on a ship) goes consecutively – each one is located on a separate page. In the escape room of the topic “Maritime security” the first task is to perform an author’s crossword, which was designed and located on learningapps.org website, the transition of it to LMS Moodle is possible by the link (see Fig. 3). After solving the crossword, the cadets must find the keyword. This keyword must be written under the picture of Engine room, next to the word “Answer”. Questions of this type are called Short answers and allow you to create tasks with a controlled response [8].

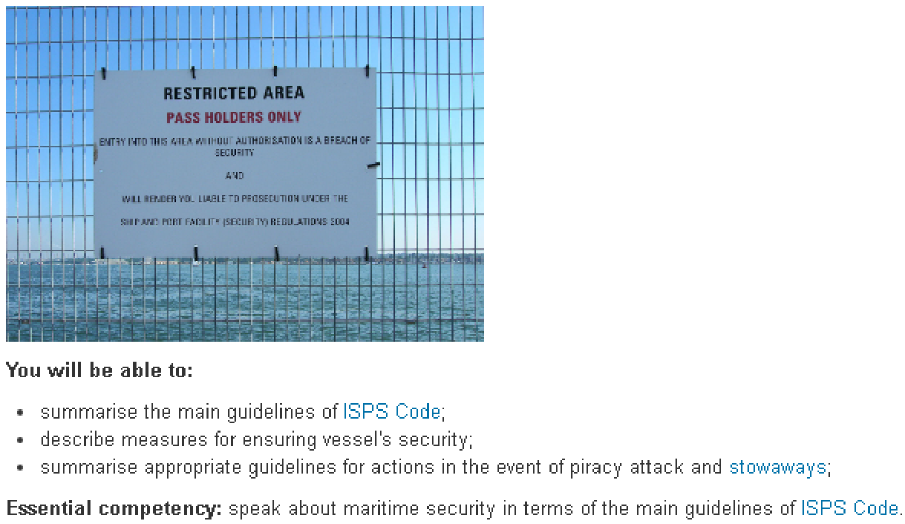

Fig. 2. List of competencies of “Maritime security” module from e-course «Maritime English» on LMS Moodle.

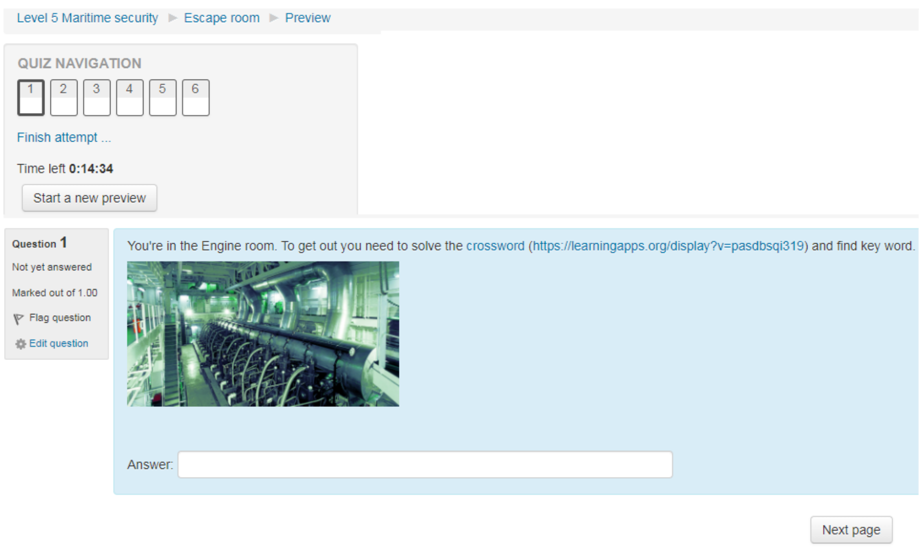

Fig. 3. The first task of the escape room of the topic “Maritime security” with a link to the crossword.

Each issue of the escape room contains images from the real ship, which allow you to create an effect of presence and reflect the places through which the player virtually moves to achieve the main goal of the quest room – reach the citadel to save himself from the pirates.

The next task of the escape room is "Drag and Drop to Text". This type of question allows you to fill in gaps in the text (the names of the pirates' tactics when attacking the ship) using the phrases provided after the image of the part of the ship (main deck) where the player is virtually in during this task.

Fig. 4. "Drag and Drop to Text" task of gamified testing.

After completing tasks about naming parts of a superstructure – the names of individual spaces with the help of the question type "Multiple choice" – the course users virtually reach the citadel, where they can escape from the pirates. Questions of the type "Multiple choice" allow to use an image (with the possibility of using gif), create a list of its possible names (see Fig. 5).

The next type of question is "Drag and Drop onto Image" (Fig. 6). This type of question allows you to drag images or text labels and drop them into defined drop zones on a background image.

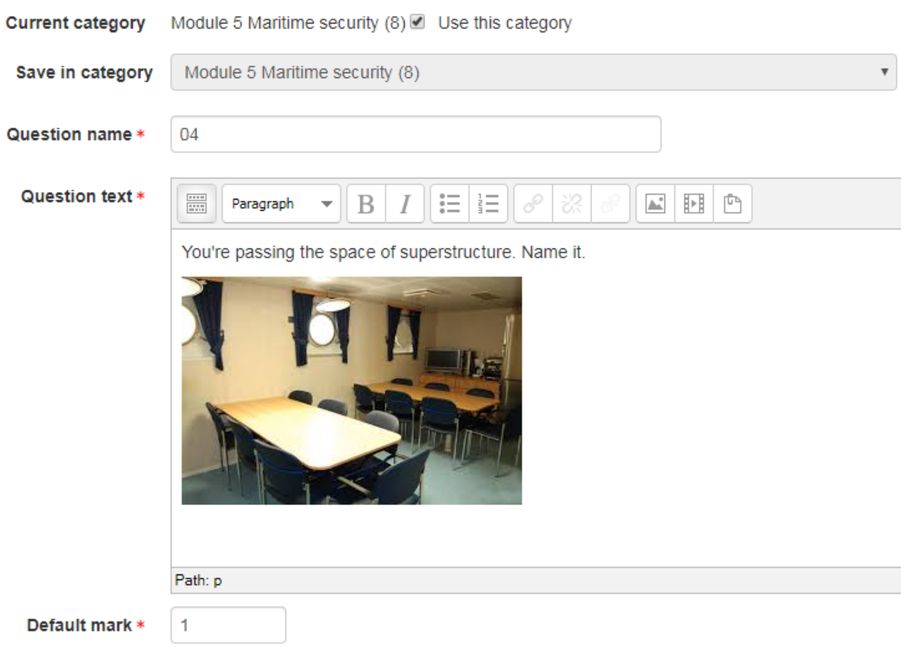

Fig. 5. Setting up a Multi-choice option.

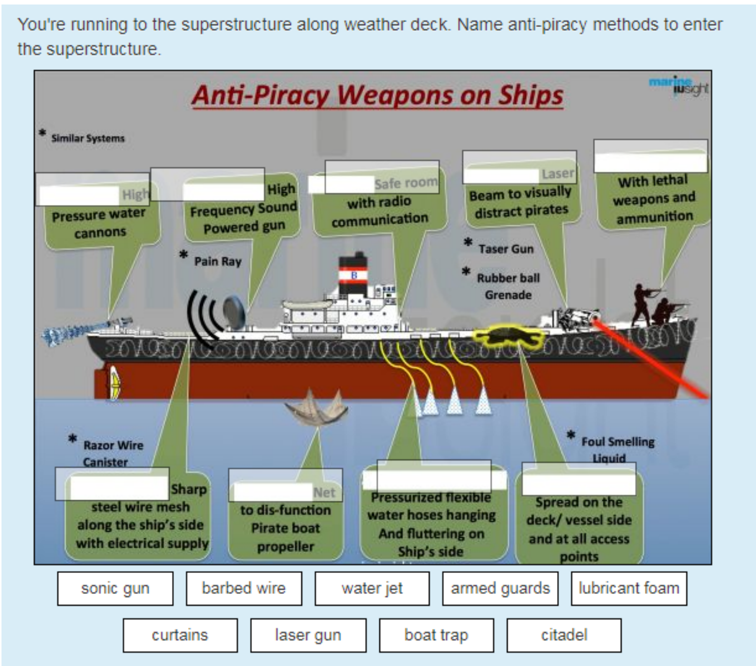

Fig. 6. Drag and Drop onto Image task of gamified testing.

4 Discussion

Thus, after completing all the tasks, the users of the course will achieve a single result (achievement of the goal – the citadel), this result depends on the level of preparedness of the player on a specific topic.

By analyzing the data of success after using the gamification exercises in the electronic course, one can observe that the current state of formation of the communicative competence of future ship engineers of the 2nd year 2018-2019 Maritime College of KSMA is better compared with 2015 year (Fig. 7). According to the results, we see an increase in the success, the marks 3-5/5 (by 20%) and knowledge quality, 4-5/5 (by 10%).

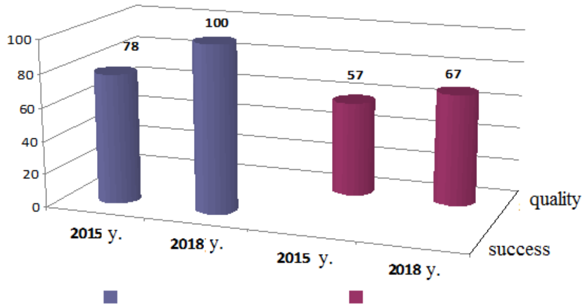

Fig. 7. Comparison of statistics for 2015 and 2018 years.

Informative is the survey of the cadets of KSMA in choosing the desired form for studying the topic or answering questions (Fig. 8). So, with the help of Google Forms, cadets noted that only 26.6% would like to do this traditionally in a notebook. 45.6% of cadets said that their testing tasks on LMS Moodle were desirable, and 13.9% of the cadets indicated that they would like to perform gamification exercises/questions on Moodle.

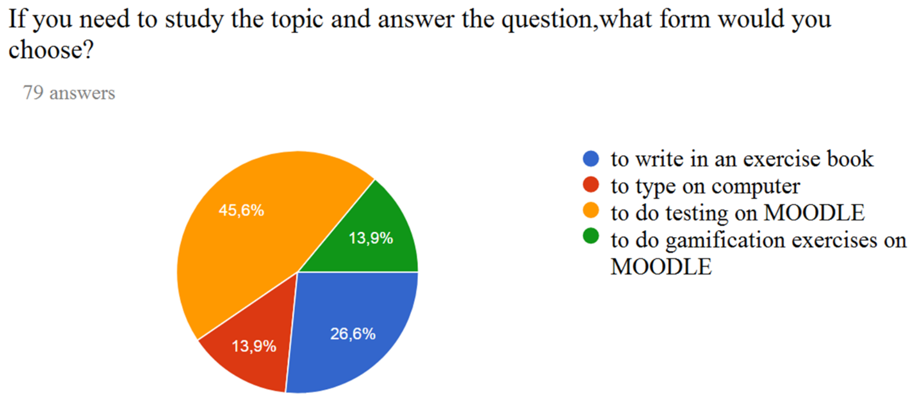

Fig. 8. Comparison of statistics for 2015 and 2018 years.

5 Conclusions

Gamification activities like the digital escape room increase interest in learning, motivate, implement learning through independent tasks, provide self-development of users of the electronic course.

We believe that the use of gamification exercises can not only form general and professional competencies, but also acquire practical experience of teamwork skills, responsibility and awareness of your belonging to one profession.

The prospects for further research, we see in the inclusion in the educational process of gamification scenarios using simulation technologies of virtual, augmented and mixed realities.

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Improving the content of training future translators in the aspect of studying modern CAT tools

Rostyslav O. Tarasenko[1[0000-0001-6258-2921]], Svitlana M. Amelina[1[0000-0002-6008-3122]] and Albert A. Azaryan[2[0000-0003-0892-8332]]

[1] National University of Life and Environmental Sciences of Ukraine,
15 Heroiv Oborony Str., Kyiv, 03041, Ukraine
r_tar@nubip.edu.ua, svetlanaamelina@ukr.net
[2] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
azaryan325@gmail.com

Abstract. The article deals with the search for improving the content of training for future translators, taking into account the expansion of the use of information technologies in the field of translation. The results of a study of curriculums for translators at the universities of Europe, America and Asia are presented. The use of CAT systems in the work of translation agencies is shown. The presentation of various CAT systems in training programs for translators and their use in the market of translation services is analyzed. It has been established that both university curricula and translation agencies are oriented, as a rule, not to one, but to several CAT systems. The results of a student survey based on their practice in translation agencies are presented. Recommendations have been developed regarding the inclusion of the most common CAT systems in the training program for translators. The expediency of studying not just one, but several CAT systems is substantiated. The necessity of studying both desktop and cloud CAT systems is indicated.

Keywords: Information Technology; CAT system; Translator.

1 Introduction

1.1 Statement of the problem

The powerful development of the modern translation industry is largely due to the use of the latest tools and technologies, which are mainly based on the use of information technologies. In particular, the development of a number of separate groups of specialized software made it possible, to significantly increase the efficiency and quality of work not only of translators, but also of translation agencies, which began to use them as the main toolkit. First, it became possible due to:

- optimization of technological processes that underlie the implementation of certain translation projects;

- effective use of terminological resources organized in such a special way that they not only affect the speed of the translation process, but also ensure its high quality;
- implementation of new approaches to organizing the work of the team of specialists involved in work on translation projects, based on the collective access of all participants to terminological resources, interactive interaction among themselves of managers, translators and editors to distribute the task, meeting the deadlines for its completion, quality of work, and the formation of the final product etc.

Achieving these advantages due to the use of modern tools in the process of carrying out translation activities is possible only through appropriate training of specialists for the effective use of these tools, which are directly involved at each technological stage of translation projects.

1.2 The purpose of the article

The purpose of the article is to consider the possibilities of improving the training of future translators, taking into account the use of modern information technologies, in particular CAT systems, in the translation activity; definition of those CAT systems, the study of which is advisable in the program of training translators at universities. For this purpose, an analysis of the study of CAT systems at universities and their use in the work of translation agencies is presented.

1.3 Literature review

Many authors are of the opinion that dealing with CAT applications is not always easy; it requires an increased concentration in learning.

Milan Pišl claims that commercial translation is no longer an individual contract awarded on the open market, but rather an extensive project with different project roles. In doing so, they are largely subject to the rules of project management - the computerized approach allows a detailed overview of detailed translation statistics, timelines, percentage of work distribution, etc. Based on this coherent information, the translators are financially rewarded by the clients [10]. In particular, as other authors describe, this is based on the development and application of terminological data processing [2; 3]. Silvia Cerrella Bauer emphasizes that any terminology management project typically pursues goals of a quantitative and qualitative nature, including: harmonizing the content (print, digital) in the source and target language, increasing translation quality, promoting the organization’s corporate language, strengthening a consistent and distinct organization image, reducing authoring and translation costs, reducing/avoiding customer complaints, shortening release deadlines (software, publications) [2].

Joss Moorkens, Sheila Castilho, Federico Gaspari and Stephen Doherty made an attempt to bring together research and practice from academic and industry settings and a combination of human and machine translation evaluation [9]. The article by Nicole Keller highlights the familiarization with a new system and the fast and uncomplicated handling of documents with corresponding translation-specific problems and thus helps to select the appropriate CAT system [6]. Dealing with marketable translation software should now be the basic knowledge of any well-trained entry-level translator [10].

In domestic science, scientists (Arnold E. Kiv [7], Serhiy O. Semerikov [8], Vladimir N. Soloviev [11]) are increasingly paying attention to the use of cloud technologies in the educational process, it is displayed on the training of specialists in various fields, and therefore is relevant for the training of translators.

However, specification that is more detailed is required regarding the selection and study by translators of those tools and technologies that are available on the market of translation services. In this case, it is advisable to direct a special focus on studying the question of which particular CA systems are studied in foreign universities and which are used by translation agencies, to conduct a comparative analysis and identify those that need to be studied at domestic universities.

2 Results and discussion

In order to effectively master future translators with modern translation tools, the content of their training should take into account not only an understanding of the development directions of these tools and the need for their application to increase translation efficiency, but also a change in the relationship between the customer and the translation service provider. In particular, more and more customers understand the main point of using modern tools by translation agencies.

Therefore, more and more often, in the process of agreeing on the conditions for fulfilling a translation order, issues of cost of work are discussed taking into account the following points: providing a translation memory base by customers, the presence of a large number of repetitions in the order text, transferring to the customer along with the translation the generated translation memory database based on the work done, providing the customer own terminology base to comply with a single terminology in the target text and the like. In these circumstances, the future translator should be prepared for flexible interaction with the customer to determine the optimal conditions for the execution of the order on mutually beneficial conditions. Such an interaction can be successful if the future translator is able, based on a deep understanding of both the technological processes of the execution of the translation order using modern tools, in particular automated translation systems, and the complexity of performing certain types of work, to comprehensively assess the wishes of the customer, identify possible reserves and advantages for yourself taking into account the resources provided by the customer and offer profitable solutions for the customer.

Taking into account the indicated trends in the market of translation services, the professional training of future translators at the present stage should be aimed at the formation of their respective competencies [5; 14] that will ensure successful professional activity in the conditions of the modern translation industry.

In the process of solving this problem, first, it is necessary to determine a number of key aspects of the organization of the educational process and the content of the training translators related to understanding the strategic directions of the development of translation tools and the prospects for their use in professional activities [1; 12]. In particular, it is extremely important:

- determination of the list of tools, the study of which should be included in the content of the training;
- distribution of the instruments chosen for study between the courses within which they will be studied;
- determining the relationship between the same type of alternative tools according to the criteria of availability, functionality, the need for installation, and the like;
- distribution of the volume of the training load, which is provided for the study of selected tools, between courses, modules and topics.

For the successful completion of the first task, one should turn to the international standard ISO 17100, one of the applications of which lists the groups of software products that can be used as basic tools for performing translation tasks, in particular [4]:

- content management systems (CMSs);
- authoring systems;
- desktop publishing;
- word processing software;
- translation management systems (TMSs);
- translation memory (TM) tools and computer aided translation (CAT);
- quality assurance tools;
- revision tools;
- localization tools;
- machine translation (MT);
- terminology management systems;
- project management software;
- speech-to-text recognition software.

Of course, the study of the above list of specialized software groups in full is impossible in the process of training a future translator. However, taking into account the indicated list and relying primarily on the need to study the tools that ensure the implementation of all technological operations in the implementation of translation projects, we should select the maximum possible number of software groups for study, as well as determine the basic software products, on an example of which is better to work out their functionality. Typical technological operations performed during translation projects include the following:

- preparation of source material for translation (scanning and text recognition, converting files of one format to another, etc.);
- creation and filling of terminological bases to ensure the uniformity of the translation of terms and quality control of translations;
- formation and editing of translation memory databases;
- translation with connection of terminological databases and translation memory databases, taking into account the possibility of collective work;

— verification of the quality of the translation;
— editing the translation.

In accordance with the above list of technological operations, a narrower list of software groups can be distinguished, which should be included in the training program for translators, in particular:

— optical character recognition (OCR) systems;
— terminology management systems (TMS);
— aligner systems;
— computer-aided translation system (CAT);
— quality assurance (QA) systems;
— word processors.

It should be noted that some software products included in one of the groups could provide, depending on their features, several technological operations.

In order to determine the recommended list of software products, on the example of which it is advisable to study their typical functions within a specific group, the following analysis was carried out:

— a list of tools that are included for study in training programs for translators at universities in Europe, North and South America, Australia;
— features of the work of translation agencies, which widely use modern tools in their activities;
— distribution conditions and characteristics of specialized programs from selected groups that are available on the software market.

To this end, we analyzed the translator training programs that were presented on the official websites of the universities for applicants in 2018 and 2019. In the process of analyzing training programs for translators at 69 universities in the world, it was revealed that the main focus on the study of translation tools is aimed at studying CAT systems. The list of CAT systems that are studied at universities in Europe, North and South America, Australia, are shown in table 1.

Table 1. The list of CAT-systems, the study of which is included in the training programs for translators at universities.

Universities	CAT systems
Europe	
Kaunas University of Technology	SDL Trados, memoQ, OmegaT, Déjà Vu, Wordfast Classic
University of Latvia	SDL Trados, memoQ, Memsource
Riga Graduate School of Law	SDL Trados
University of Malta	SDL Trados
University of Bologna	SDL Trados, memoQ, OmegaT
Università degli Studi di Bari Aldo Moro	SDL Trados, Déjà Vu
Università degli Studi di Torino	SDL Trados
Fachhochschule Köln	SDL Trados

Universities	CAT systems
Ruprecht-Karls-Universität Heidelberg	SDL Trados, Across, memoQ, Transit NXT, Déjà Vu, Wordfast Classic, Memsource
Sprachen & Dolmetscher Institut München	SDL Trados, Across
Universität des Saarlandes	SDL Trados, Wordbee
Hochschule Zittau/Görlitz	SDL Trados, OmegaT
Universität Leipzig	SDL Trados, memoQ, Déjà Vu, OmegaT, MemSource, MateCat
University of Antwerp	SDL Trados, Déjà Vu, memoQ, Memsource
The Katholieke Universiteit Leuven	SDL Trados, memoQ, Memsource
Université Libre de Bruxelles	SDL Trados, memoQ
Universiteit Gent	SDL Trados, memoQ
Université de Genève	SDL Trados, OmegaT, MateCat
Zürcher Fachhochschule	SDL Trados
Budapesti Muszaki és Gazdaságtudományi Egyetem	SDL Trados, memoQ
ELTE University Budapest	SDL Trados, memoQ, Memsource
Ionian University, Corfu	SDL Trados, Memsource, OmegaT
Aristotle University of Thessaloniki	SDL Trados, Wordfast Anywhere, Across, Déjà Vu
Universidade do Porto	SDL Trados, memoQ
Universidade de Coimbra	SDL Trados
Instituto Superior de Contabilidade e Administração do Porto	SDL Trados, memoQ, Transit NXT
Universidade Nova de Lisboa	SDL Trados, memoQ
Universitat Autònoma de Barcelona	SDL Trados, memoQ, OmegaT, Memsource
Universidad Alfonso X el Sabio	SDL Trados, memoQ, Memsource
Universidad de Alicante	SDL Trados, memoQ
Universidad Internacional de Valencia	SDL Trados, Wordfast Classic, OmegaT, MateCat, Memsource
Universidad de Sevilla	SDL Trados
Universidad de Cádiz	Wordfast Classic
University of Turku	SDL Trados, Memsource
Aston University	SDL Trados
University of Bath	SDL Trados
University of Birmingham	SDL Trados
University of Durham	SDL Trados, Wordfast Classic
University of Central Lancashire	Memsource
University of East Anglia	SDL Trados, memoQ
University of Bristol	SDL Trados, memoQ, Memsource
University of Edinburgh	SDL Trados, Déjà Vu, Wordfast Anywhere
University of Essex	SDL Trados, memoQ
University of Leeds	SDL Trados, memoQ, Memsource, OmegaT, MateCat
University of Leicester	SDL Trados
University of Roehampton (London)	SDL Trados, Memsource
Dublin City University	SDL Trados, Memsource
National University of Ireland, Galway	SDL Trados
The University of Stirling	SDL Trados
Univerzita Karlova v Praze	Memsource

Universities	CAT systems
Adam Mickiewicz University	SDL Trados
Sofia University "St. Kliment Ohridski"	SDL Trados, WordFast Anywhere, Memsource
Université de Bretagne Occidentale	SDL Trados, Memsource, memoQ
Université Charles-de-Gaulle Lille	SDL Trados, memoQ, Wordbee, Memsource
Université de Toulouse Jean Jaurès	SDL Trados
Middlebury Institute of International Studies Monterey	SDL Trados
North America	
Glendon College, York University (Toronto)	SDL Trados, LogiTerm
University of Massachusetts	SDL Trados
University of Illinois	SDL Trados
South America	
Universidad Latinoamericana de Ciencia y Tecnología	SDL Trados
Universidad de Buenos Aires	SDL Trados
Universidad de Belgrano	SDL Trados, memoQ
The Federal University of Santa Catarina	SDL Trados, MetaTexis, Déjà Vu, Wordfast Classic, Transit NXT, XTM
Pontificia Universidad Católica de Chile	SDL Trados, Wordbee
Universidad de Antigua	SDL Trados, OmegaT
Australia	
Macquarie University	SDL Trados, Memsource
The University of New South Wales	Memsource, OmegaT, memoQ, XTM
Monash University	SDL Trados, Wordfast Anywhere

According to research results, the list of CAT systems selected for study by the aforementioned universities is quite wide and includes 14 different software products. It is important that in most universities, students study not one, but several such systems (see Figure 1).

The diagram shows that only 22 universities that were examined in our study are limited to studying only one CAT system. Two CAT systems are studied at 24 universities, three at 12 universities, four at 5 universities, five at 3 universities, six are studied at Universität Leipzig, and seven are studied at The Federal University of Santa Catarina and Ruprecht-Karls-Universität Heidelberg.

It is worth noting that in general, more than 30 CAT systems of various developers are presented on the software market. Despite the significant prevalence and popularity of desktop CAT systems, the above list contains three belonging to the cloud systems, in particular, Memsource, Wordfast Anywhere, MateCat. Such CAT systems have relatively recently appeared on the market for software products, but they are quickly gaining popularity among freelance translators as well as among translation agencies. Summarized data on the representation of various CAT systems in university programs for training translators is shown in Figure 2.

Despite the proprietary license and its rather high cost, SDL Trados is present in 94% of universities (65 out of 69) among the CAT systems chosen for studying. This situation is due, in our opinion, to the high popularity of this system among translators and its wide use as the main tool for implementing translation projects with the ability to ensure all standardized stages of the translation process. In addition, according to representatives of the translation industry, the successful mastery of SDL Trados provides further free adaptation to the study and use of other CAT systems [15].

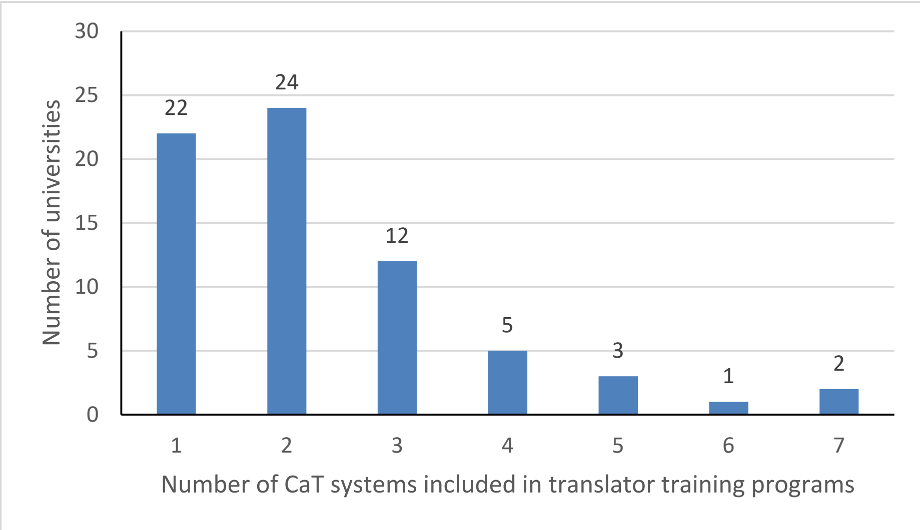

Fig. 1. Quantitative Representation of CAT Systems in University Translation Programs

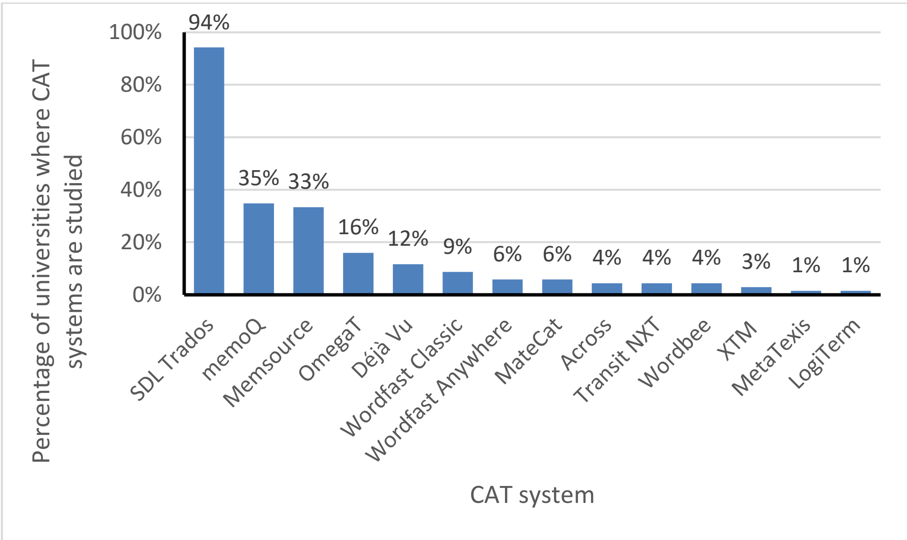

Fig. 2. Representation of CAT systems in translator training programs of universities

A high level of representation in translator training programs belongs to the Memsource cloud-based CAT system, which is studied at 23 universities (33%). In popularity, it is second only to SDL Trados and memoQ. This is a testament to the fact that universities direct their efforts to training competitive specialists and take into account the development trends of the basic tools of a translator. The widespread implementation of the study of cloud CAT systems is largely due to the relatively high functionality of these systems for the implementation of translation projects, relatively low cost, the ability to use via a web browser without the need to install on your computer, the availability of free versions on an ongoing or temporary basis, etc. [13].

It is worth noting that despite the low popularity of such a CAT system as OmegaT among translators, almost every seventh university took it for study. A feature of this system is that it has a free license, and this greatly simplifies its receipt and use in the educational process. Most likely, this explains its fourth position among the CAT systems included in the curriculum of universities covered by our study.

In order to determine in our study a list of tools, the study of which should be included in the content of the training of translators, it is necessary to understand not only the development trends on this issue in the university environment, but also in the field of translation. For this purpose, data were analyzed from more than 400 translation agencies, whose offices are located in Europe, America and Asia. For analysis, translation agencies were selected, on the web pages of which information was provided on the names of the CAT systems used by them for the provision of translation services. As an example, some of these translation agencies are shown in Table 2.

Table 2. The list of CAT systems used by translation agencies for the provision of translation services.

Translation agencies	Country	CAT systems
	Europe	
Intercontact GmbH Schälike	Germany	SDL Trados, memoQ
KERN AG	Germany	SDL Trados, Across
Connect-Sprachenservice Regensburg GmbH	Germany	SDL Trados, memoQ, Across
EVS Translations	Germany	SDL Trados, memoQ, Transit NXT, Across
Translate.Pro	Germany	SDL Trados, memoQ, Transit NXT, Across
Oneword	Germany	SDL Trados, Accross
Text&form GmbH	Germany	SDL Trados, memoQ, Across, Memsource, SDL Passolo
Lingo24 (UK)	Great Britain	Memsource
Gengo	Great Britain	SDL Trados
RWS Translation services	Great Britain	SDL Trados
Wolfestone	Great Britain	Synergy X
Capita Translation and Interpreting	Great Britain	SmartMATE
MORNINGSIDE TRANSLATIONS	Great Britain	SDL Trados, memoQ, Memsource
ATLAS TRANSLATIONS LTD	Great Britain	SDL Trados, memoQ
STAR UK	Great Britain	Transit NXT
Technolex	Ukraine	SDL Trados, memoQ, Across

Translation agencies	Country	CAT systems
Translatel	Ukraine	SDL Trados, memoQ, Transit NXT, Across, Wordfast, SDLX, Déjà Vu, Idiom, SDL Passolo, Alchemy CATALYST
МоваСвіт	Ukraine	SDL Trados, memoQ, Accross, SDL Passolo, RC-WinTrans
Традос	Ukraine	SDL Trados
Polilingua	Poland	SDL Trados, Wordfast, memoQ, Déjà Vu, Across
VEROLING Translation Agency	Poland	SDL Trados, memoQ, Memsource, Across, Déjà Vu, Wordfast
Eurolingo	Poland	SDL Trados, SDLX, Wordfast, Transit NXT, Across, Idiom, SDL Passolo, Alchemy CATALYST
iTrans Translations	Poland	SDL Trados
KMC GLOBAL SOLUTIONS	Poland	SDL Trados, memoQ, Wordfast, Transit NXT, SDLX, Idiom, Memsource, SDL Passolo
Biuro tłumaczeń Versus	Poland	SDL Trados, Idiom, Déjà Vu
	America	
Excel Translations	USA	SDL Trados, XLCATS, WorldServer, Transit NXT, Déjà Vu
U.S. Translation Company	USA	memoQ, Workbench
APlus Translations Company	Canada	SDL Trados, Wordfast
BG Communications International Inc.	Canada	At the request of our clients, we can perform translations utilizing their preferred translation software
	Asia	
Jerome Translations	China	SDL Trados. We also use other CAT tools from time to time.
CCJK Technologies Co., Ltd.	China	SDL Trados, SDLX, memoQ, Wordfast, Transit NXT, Alchemy CATALYST
Beijing E-C Translation Ltd. (BEC)	China	SDL Trados

Summarized data on the representation of various CAT systems in translation agencies are shown in Figure 3.

The analysis of the use of CAT systems by translation agencies showed that the leader among translation tools of this class is SDL Trados, which is used by more than 80% of agencies. Although by a significant margin from SDL Trados, such systems as memoQ and Across are still very popular. A fairly high percentage of the prevalence (16%) of the Memsource cloud CAT system confirms the tendency for translation agencies to deploy next to desktop systems – the cloud systems.

It is also worth noting that the vast majority of translation agencies use more than one CAT system, and some of them even up to eight. Some agencies are even ready to fulfill an order on the terms of the customer for the use of a particular CAT system, which indicates a high level of staff training and a wide range of available software products of this class.

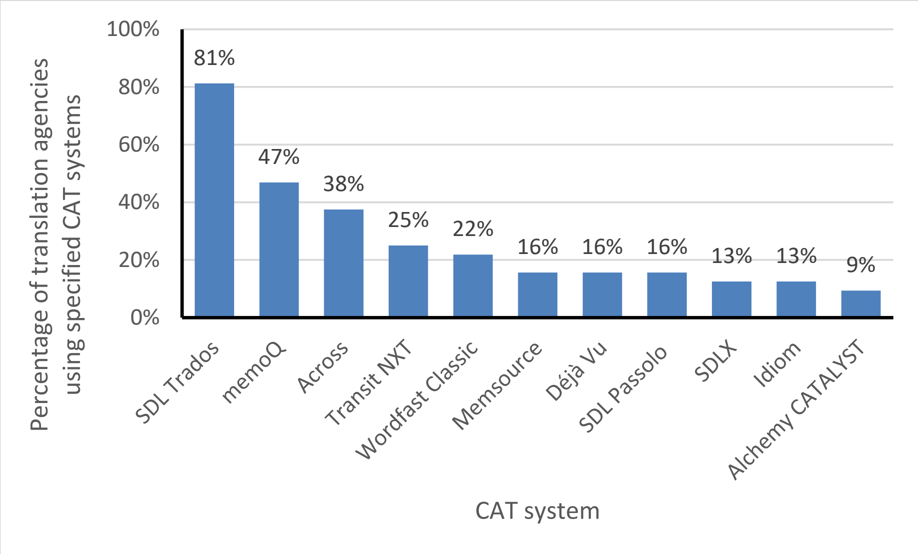

Fig. 3. Representation of CAT systems in translation agencies

Considering the fact that recently many translation agencies have begun offering services for the localization of software products and websites, it is natural to have appropriate tools in their arsenal. In particular, this is SDL Passolo, the prevalence of which among the surveyed offices is 16% and Alchemy CATALYST with a lower representation (9%).

An important indicator of the compliance of the training content of future translators in the aspect of their training for the use of modern tools in the professional activity is the analysis of practical training. After studying the course «Information Technologies in Translation Activities», the content of which included the study of the main stages of working with CAT systems SDL Trados and Memsurce, future translators at the National University of Life and Environmental Sciences of Ukraine can consolidate their knowledge and skills within the framework of translation and technological practice. The duration of such practice is 2 weeks. During this time, students had to complete tasks involving acquaintance with the technology of implementing translation projects using modern tools, participating in the formation of terminological databases and translation memory databases, checking the quality of translations, and the like. Upon completion of the practice, students were offered a questionnaire that contained 5 questions and was aimed at identifying their assessment of the conformity of knowledge and skills in using CAT systems in translating, acquired in the educational process of the university, to the real conditions of the translator’s activity in a translation agency. 47 students participated in the survey, answered the following questions:

1. What CAT systems are used in translation agencies that have been identified as the basis of practice?
2. What CAT systems that are used in translation agencies to provide translation services did you first meet during your practice?
3. What are the functions of CAT systems that you have mastered in the studying process, are used in the practical work of translation agencies?
4. What functions of the CAT systems that you mastered during the training process are not used in the practical work of the translators of the agencies where the practice was carried out?
5. The study of which CAT systems is necessary in your opinion, first of all, to be included in the content of the translator's training in order to maximize his readiness for professional activity?

Student's survey results on their assessment of the conformity of knowledge and skills in the application of CAT systems when performing a translation are shown in table 3.

Table 3. Student's survey results on their assessment of the conformity of knowledge and skills in the application of CAT systems when performing a translation.

Question	Answer options	Answers given	
		number	%
Question 1	SDL Trados	44	93,6
	memoQ	17	36,2
	Across	6	12,8
	Memsource	10	21,3
	Wordfast	12	25,5
	Déjà Vu	5	10,6
	SDL Passolo	2	4,3
Question 2	Wordfast	7	14,9
	memoQ	4	8,5
	Déjà Vu	2	4,3
Question 3	Translation of texts using CAT systems	47	100,0
	Creation and filling of terminology databases	45	91,5
	Parallel text alignment	8	17,0
	Creating translation memory databases	22	46,8
	Editing translation memory databases	14	29,8
	Checking the quality of translations using QA	42	80,9
Question 4	Creation of terminology databases	2	4,3
	Converting terminology databases from one format to another	36	76,6
	Filling terminology databases by extracting dates in texts with extractor programs	45	100,0
	Parallel text alignment	39	83,0
	Creating translation memory databases	25	53,2
	Editing translation memory databases	33	70,2
Question 5	SDL Trados	47	100,0
	Wordfast	9	19,1
	memoQ	15	31,9
	Memsource	32	68,1

Answers to question 1 of the questionnaire found predicted results on the prevalence of various CAT systems in the activities of translation agencies. The leading positions, as in the case of previous research on studying them in foreign universities and use in translation agencies, are occupied by the SDL Trados CAT systems (93.6%) and memoQ (36.2%). Among the most common CAT systems, students also noted the cloud-based Memsource, the application of which amounted to 21.3%, despite the relatively limited list of translation agencies that were involved as practice bases. This indicates a rather rapid advance in the market for translation services of cloud CAT systems. It is important to note that in practice, students were able to see the use of CAT systems for a relatively specific type of translation activity related to the localization of software products. Therefore, 4.3% of the answers regarding the SDL Passolo program is not a high indicator, but it is an important evidence of the need to study the tools of this group for future career prospects.

A positive feature of the practice was the familiarity of some students with the new CAT systems that were not studied in the framework of the course "Information Technologies in Translation Activities". The largest number of students (14.3%) noted in the answers to question 2 about getting to know the Wordfast system, which indicates its rather high prevalence. Overall, acquaintance of students with the noted new CAT systems is a positive step, since they could compare them with already known CAT systems and evaluate the general similarity of the various CAT systems. Such experience can help to overcome psychological barriers before mastering new tools, even if necessary independent learning.

Formulating questions 3 and 4 of the questionnaire, we intended to identify the extent to which the content of the course "Information Technologies in Translation Activities" covers modern aspects of using CAT systems in the provision of translation services. It was pleasant to note the high percentage of students' answers, where they indicated that the vast majority of the functions of CAT systems studied in the course used in the activities of translation bureaus studied in the course. In particular, the use of CAT systems in translation was noted by students in 100% of the answers; 91.5% of responses indicated that students performed operations related to the creation and filling of terminological databases; verification of translated texts by QA tools became part of the list of work performed during practice for 80.9% of students.

But a fairly small percentage of students (8%) were able to assess the need to master such an operation as alignment of parallel texts. This is mainly due to the fact that translation agencies primarily work either with translation memory databases provided by the customer, which are based on aligned parallel texts, or these databases are formed directly in the translation process without alignment operations. These operations are carried out in those agencies where, at the stages of their activity without the use of CAT systems, significant volumes of translated texts were accumulated in certain industries within which they continue to work. Despite this, the functions of CAT systems that allow alignment of parallel texts are present as separate modules in almost all powerful desktop systems and embedded in the tools of cloud systems, which are quite new. This was the reason for the inclusion of the study of the indicated function of CAT systems in the content of the course.

Unfortunately, 100% of students noted that in the translation agencies where the practice took place, they did not take part in filling the terminology databases by extracting the terms in the texts with extractor programs, although they mastered this operation in the educational process using the SDL MultiTerm Extract software module. Despite the rather specific nature and low prevalence of such a method of forming terminological bases among translators, we believe that the availability of specialized tools and the rather high efficiency of such an operation determine the feasibility of studying it as an element of an entire training system for translators to use CAT systems. But in order to optimize the priority study of more applicable operations with the use of CAT systems, it is better to make studies on filling terminological databases by extracting terms in texts in independent work.

An additional confirmation of the correctness or incorrectness of the choice of a strategy for studying one desktop and one cloud-based CAT system, in particular SDL Trados and Memsource, as part of the course “Information Technologies in Translation Activities”, should have been students' answers to questions 5 of the questionnaire.

It is important to note that 100% of the answers showed the need to include in the training of the translator the study of the desktop SDL Trados system. The interest in the mandatory study of the Memsource system is confirmed by 68.1% of the answers, which, as in the previous case, coincides with our vision of the prospects of these software products as the main tools. The fact that students highly appreciated the importance of studying systems such as memoQ (31.9%) and Wordfast (19.1%), encourages the search for ways to improve the content and organization of translator training, which will expand the range of capabilities of future specialists when translating from using various CAT systems.

3 Conclusions

Studies aimed at identifying the development trends of translation technologies and tools should ensure that the professional training of translators is consistent with industry trends, and the process of its design should contribute to a flexible response to modern challenges. Considering that one of the main tools of a translator in modern conditions of technical translation is CAT systems, the content and organization of training of future translators should ensure their quality training in the aspect of its study.

Based on the analysis of translator training programs at universities around the world, research on the activities of translation agencies for the provision of translation services and our own experience in the development of the content of translator training in the aspect of studying modern CAT systems, it is advisable to take into account the following features:

- to offer for study the most popular in the industry and the most technologically efficient CAT systems, in particular SDL Trados, memoQ, Memsource and others, among which should be both desktop and cloud.
- to apply various forms and methods of organizing the educational process in order to include at least three leading CAT systems in the training content, since the

development trends of the activities of translation agencies lie in the plane of expanding the range of automated translation systems in the provision of services in order to maximize customer satisfaction.

- to improve the content of teaching curriculum courses by orienting the implementation of practical tasks related to translation, structuring terminological data, aligning parallel texts using the functions of specialized software, primarily CAT systems.

Further research can be aimed at identifying the features of the study of other translator tools in the process of their professional training.

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Integrated testing system of information competence components of future translators

Rostyslav O. Tarasenko[1[0000-0001-6258-2921]], Svitlana M. Amelina[1[0000-0002-6008-3122]] and Albert A. Azaryan[2[0000-0003-0892-8332]]

[1] National University of Life and Environmental Sciences of Ukraine, 15 Heroiv Oborony Str., Kyiv, 03041, Ukraine
r_tar@nubip.edu.ua, svetlanaamelina@ukr.net
[2] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
azaryan325@gmail.com

Abstract. The article deals with the diagnosis of the formation of the information competence components of translators through testing. The use of testing to determine the level of formation of the information-thematic component of the information competence of translators is demonstrated. It has been established that one of the ways to form the information-thematic component of information competence in the aspect of studying terminology can be the use of thematic networks. The development of a thematic network is shown on the example of the thematic network “Electrical equipment”. The stages of test control, which are consistent with the logic of the organization of the educational process and the process of forming the information competence of the future translator according to the scheme of the developed thematic network, have been determined. These stages are the current, thematic, modular, final testing. The main types of test tasks are defined, the combination of which allows diagnosing the level of formation of the information-thematic component of students’ information competence. Criteria and principles for the selection of test tasks for each of the testing stages are proposed. The ratio of test tasks of different types and complexity at the determined testing stages has been developed. The results of an experimental study on the diagnosis of the formation of the information-thematic component of the information competence of future translators by applying the developed integrative testing system using the Moodle platform are presented.

Keywords: Information Competence, Integrated Testing System, Information Technology.

1 Introduction

1.1 Statement of the problem

At the stage of the formation and development of the information society, the main goal of training a specialist is not his traditional mastery of a certain qualification, but the formation and development of a set of competencies that should enable him to adapt to the dynamic development of the modern world. Information competence refers to the key competencies that must be formed in the process of professional training future specialists, including translators. Therefore, it is relevant to study the characteristics of the formation of components of information competence and the search for effective ways to diagnose their formation. One of such ways is testing. The main task of testing is to ensure high informativeness of test results, monitoring the dynamics of learning, accumulation of data for the formation of a pedagogical forecast. It becomes an increasingly important component of the pedagogical diagnostics system, especially, with the use of appropriate tools that are part of distance learning systems.

1.2 The purpose of the article

The purpose of the article is to consider an integrated system of testing the formation of the information-thematic component of the information competence of future translators, to determine the stages of testing and types of test tasks for each of the stages. The developed testing system is presented on the example of studying specialized terminology and monitoring students' knowledge.

1.3 Literature review

Issues of development, use and effectiveness of test control in the educational process of higher educational institutions investigated both domestic and foreign scientists. Theoretical analysis showed that their studies are devoted, in particular, to cloud technologies transforming educational process (Arnold E. Kiv, Vladimir N. Soloviev, Serhiy O. Semerikov) [9]. In their opinion, there is urgent general need for principled changes in education elicited by current e-learning tools, services and IT communication.

The substantiation of the theoretical and methodological foundations of designing a computer-oriented system for pedagogical diagnostics of future teachers of natural and mathematical specialties was made by Oleksandr H. Kolgatin [10]. The author states that pedagogical diagnostics in the educational process is based on modern methods of pedagogical measurements using testing technologies. However, it is necessary to improve pedagogical measurements in the aspect of adaptive strategies for automated testing, to develop new approaches to assessing deviations of test results in conditions of individual test formation for each student.

Oleksandr S. Burlakov, Iryna M. Mushenyk [7] considered the assessment of the quality of test tasks for diagnosing students' knowledge of economic specialties by means of the Moodle distance-learning environment. They emphasize that the process of streamlining the control and evaluation of the quality of educational achievement has initiated the widespread use of test technologies at all stages of the learning process. In particular, the authors paid attention to complex issues (system) approach to solving the problems of examination of the quality of test problems using modern information and communication technologies.

Liudmyla I. Bilousova, Oleksandr H. Kolgatin, Larysa S. Kolgatina developed the principles of building an automated pedagogical diagnostic system. They have designed methods of the pedagogical diagnostics, which satisfy following demands: different forms of the intellectual activities of an examinee are attracted in process of testing; the automated system of the pedagogical diagnostics ensures its diagnostic abilities at wide differences of the examinees mastering; processing of the test results provides maximum information for an examinee and a teacher to correct the educational process [6]. Olha V. Avramenko et al. [5] studied the adaptation of educational measurements, including testing, to EU standards.

Foreign researchers (Lambrini Loumbourdi [11]) note that over the past few years there has been a real renaissance of testing as a measure of the level of knowledge acquired by students. This method of assessment is increasingly used in the daily practice of European and especially American universities. Frank Adamson, Linda Darling-Hammond justify the new assessment: tests based on open-ended questions [1]. Scholars believe that it is important to focus on strategic resources that promote equitable access to quality teaching for all students and the evaluation of their learning outcomes.

1.4 Research methods

To achieve the purpose of the article, a number of methods were used. The purpose of the theoretical analysis a theoretical analysis of the scientific literature on the problem of testing the knowledge and skills of students in the educational process was to determine the degree of investigation of the problem under study. We used the descriptive method to expose our informational competency testing system. Empirical research methods were aimed at determining the effectiveness of the proposed integrated testing system.

2 Results and discussion

Exploring the possibility of testing to determine the level of formation of information competence components of translators [13], we will discuss in more detail the example of one of them, namely the information-thematic. The information-thematic component of information competence is directly related to the mastering terminology. This is because of the correct use of terminology is crucial for the quality of the translation, regardless of the content of the translated text. This ensures consistency between the source and target languages, the efficiency and adequacy of the translation.

After all, discrepancies in the translation of terminology may adversely affect the translation and, consequently, cause difficulties in the work of those specialists for whom the translation of documentation was carried out. Incorrect translation of specialized terminology can cause difficulties in work based on the use of translated materials and even cause production problems. Considering this, we think, that the study of effective ways of working with terminology is a necessary and important aspect of the training future translators.

It should be noted that the essence of the information-thematic component of information competence is to acquire linguistic, thematic and background knowledge, the ability to form electronic databases of reference terminological materials for translation using automated translation systems, in particular, cloud-based [12]. It implies the ability to search for relevant information to better understand the thematic aspects of the document; expanding one's own knowledge in the field of specialization (owning a system of concepts, argumentation methods, presentation techniques, language control, terminology, etc.). The saturation of specialized texts with terms especially actualizes the question of the orientation of the professional training future translators towards the formation of a terminological base both in the aspect of studying and controlling the mastery of terminology.

One of the ways to form the information-thematic component of information competence in the aspect of studying terminology can be the use of thematic networks. Such an innovative approach was declared, in particular, in the "Framework for the German language for professional communication for higher educational institutions of Ukraine" [4] created in the framework of an international project. The participants of the project are Bosnia and Herzegovina, Italy. Along with the development of communicative competence and professional orientation, the program provides the design of thematic networks for determining the content of training, which can be carried out through joint discussion by teachers and students. The concept of the aforementioned Framework Program provides for the possibility of choosing terminology that will be studied by future translators depending on the specifics of their training at a particular university.

The areas of communication specified in the Common European Framework of Reference for Languages [8] should be taken into account when choosing themes and situations, have interdisciplinary correlation, that is, to establish links between foreign language terminological training and the courses of the student's curriculum. Thematic networks and the authenticity of educational materials are the main criteria for the selection of specialized texts. When forming the content of practical classes can be used: detailed lists of types of texts for different specialties; language actions with a strong focus on professional language; schematic plans for specific themes; suggestions on the main thematic aspects of terminology.

When creating such networks, the choice of thematic content is carried out in the direction from the general thematic sphere by detailing to specific themes depending on the coordination of students' interests and the goals of applying the gained knowledge in professional activities. We will demonstrate the formation of a thematic network in German using the example of the thematic area "Electrical equipment" (see Fig. 1). The given network provides eight possible directions of specialization for forming the terminological base of the future translator.

Since the document "Common European Framework of Reference for Languages: Learning, teaching, assessment" is a practical mechanism for determining clear standards of language competence, communication skills and knowledge that are recognized throughout Europe, we are guided by these standards in the development of training courses and control tasks, including tests. The test refers to tasks that have a specific organization, which allows all students to work simultaneously in the same conditions and record the execution with symbols. The test is defined as a system of tasks of a specific form, a certain content, and increasing complexity, which allows us to objectively evaluate the structure and qualitatively measure the level of language competence of students, and in our study, the level of the information-thematic component of information competence.

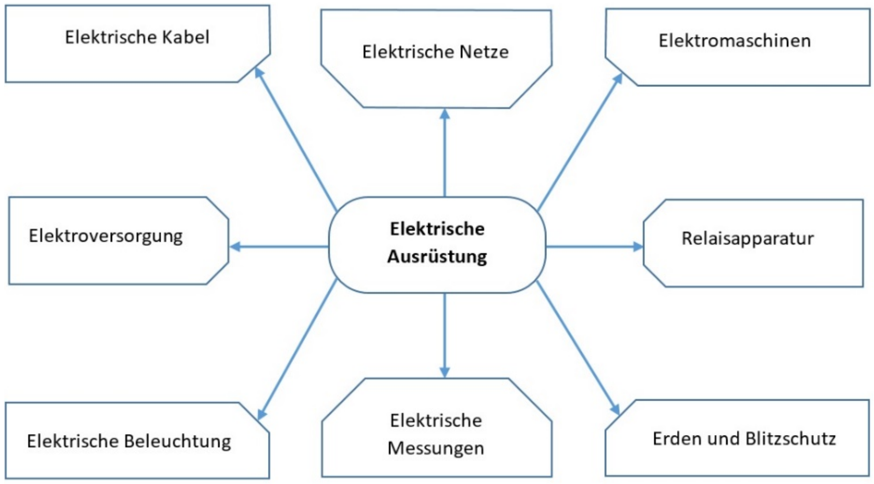

Fig. 1. The scheme of formation of the thematic network in German in the example of the thematic sphere "Electrical equipment"

Designing a testing system, based on one of the distance learning systems, for example, Moodle, it is necessary to develop a mechanism that will allow determining the level of information-thematic component of information competence, taking into account the following criteria:

- mastering the meaning of terminological units and their understanding;
- knowledge of the semantic valences of words and structures of a foreign language, the ability to choose adequate terms and use them;
- knowledge of uniqueness and polysemy;
- skills of differentiation of forms and means of language;
- ability to translate in a specific subject area based on the vocabulary of this area.

It is also worth to note that testing, unlike traditional forms of control, causes students greater interest and reduces stress levels, increases their cognitive activity and contributes to positive motivation to further studying foreign languages and developing the information-thematic component of information competence.

Testing the level of information-thematic component of information competence using the tools of the Moodle distance learning system has several advantages over traditional forms of control, namely:

- allows allocating time more efficiently, increasing its share of the study elements of the thematic network and reducing the time for the control procedure;

- allows covering the terminological material of the thematic network in test questions more fully;
- simplifies the procedure for determining the level mastering the terminology;
- provides the opportunity for regular monitoring at all stages of the learning process;
- provides an objective assessment by eliminating the teacher's subjective influence on the assessment of student's knowledge;
- diversifies the form of presentation of terminological material in test questions and answer options, including visualization.

However, it should be noted that the test control for these purposes also has certain limitations and disadvantages, in particular:

- tasks allow testing only knowledge of terminological units without their application in a broad context;
- the inability to automatically check the answer when using open questions that are effective in checking the peculiarities of understanding terminology in technical translation;
- the absence of an effective mechanism for analyzing the mistakes made, which may be systemic in nature and contain the probability of their further manifestation at a higher level of making translation decisions.

Therefore, to determine the level of development of the information-thematic component of information competence, tests must be developed based on a careful selection of material, various types of test tasks that will most fully ensure the implementation of this function. On the basis of this, the structure of the test is also formed, the time allotted for the test is determined, the scale of evaluation of test questions is developed depending on their level of complexity and the test as a whole.

Considering the above, the quality control process of training future translators in the information-thematic aspect should be carried out, in our opinion, using an integrated testing system. This system involves the use of various stages of test control, which are consistent with the logic of the organization of the educational process and the process of forming the information competence of the future translator based on the scheme of the developed thematic network. In particular, these are the following stages of testing: current, thematic, modular, final [3].

We will consider the use of an integrated testing system to determine the level of formation of the information-thematic component of information competence in the process of studying the course "Semantic and stylistic features of the translation of specialized texts" at certain stages. The content of this course provides the choice of modules with the further formation of terminological bases of agrarian terminology based on thematic networks [2]. In particular, in our example, there are such modules:

- electrical equipment;
- machines for harvesting grain crops;
- plant protection products;
- fruit and berry cultures.

We will consider the details of studying the content of these modules and test control of their acquisition using the example of the "Electrical Equipment" module, which includes one of the areas of the thematic network "Electric Lighting". A schematic structure of an integrated testing system is presented in Figure 2.

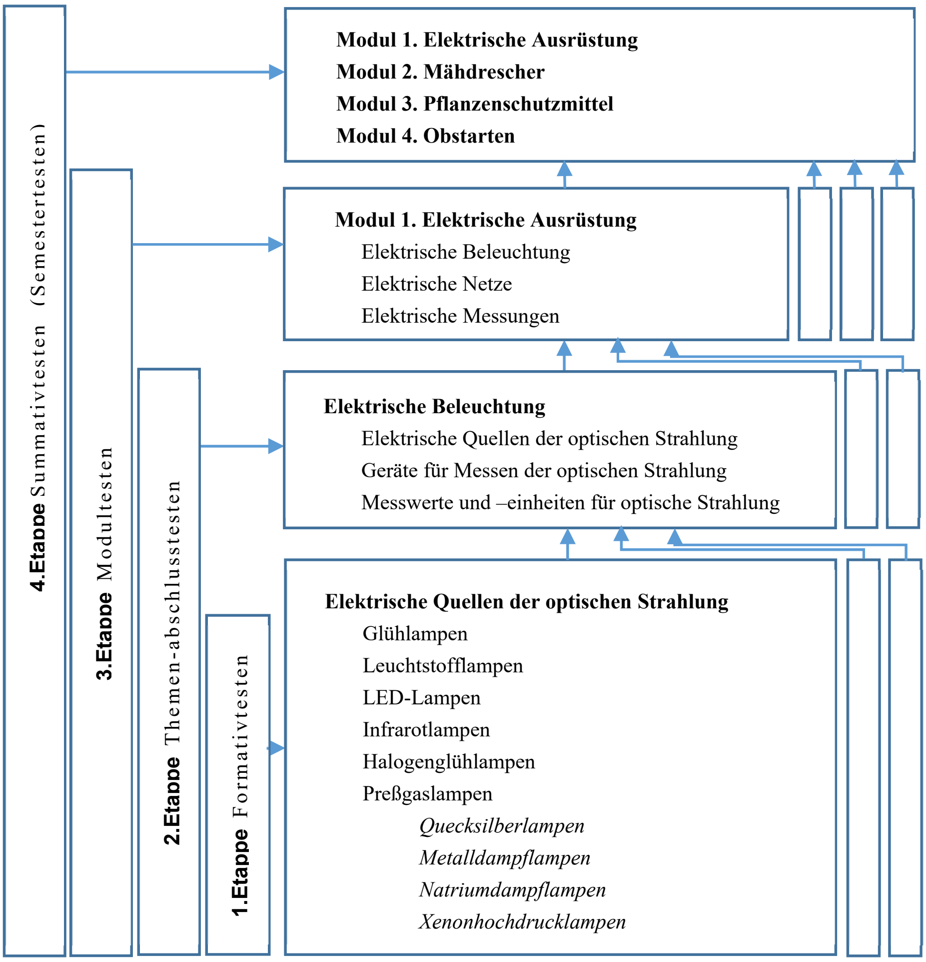

Fig. 2. Schematic structure of an integrated testing system

The first stage of testing (the current testing) involves monitoring the study of terms and the formation of the terminological base on the structure, characteristics and application of one of the types of electric lamp. The current test control is carried out systematically in the learning process. The goal is to get information about the acquisition of language material by students and the formation of their relevant knowledge.

The second stage of testing (the thematic testing) is a generalizing about thematic terminology on electric lighting (electric radiation sources, measuring devices, units of measure, etc.). Thematic test control is carried out after the completion of work on all the themes that are defined by the thematic network in the “Electric Lighting” section. The main testing functions at this stage are controlling and evaluating. This type of knowledge and skills control helps to improve the quality of the educational process, because this determines the gaps in student’s knowledge and carries out targeted adjustments of training to fill them.

The third stage of testing (the modular testing) is aimed at evaluating terminological knowledge within the framework of the “Electric Equipment” module, which will later be used to create electronic terminological databases of technical terminology.

The fourth stage of testing (the final (semester) testing) summarizes the measurement of the results of the formation of the information-thematic component of information competence to ensure professional translation of specialized texts.

When preparing tests for these stages of testing, it is advisable to use different types of test tasks, which allows us to achieve greater efficiency in the measurement of training results. As we know, test tasks are divided into two broad categories: closed and open type. Closed-end tasks contain questions and give answers to them. In this case, there may be tasks with one or several variants of correct answers. Test tasks with multiple choices allow determining a higher level of acquired knowledge due to the possibility of the student identifying the complex of correct ideas about the object, phenomenon, process, etc. with the simultaneous rejection of false options. In this case, the task offers a list of 4-6 answers to choose from.

In addition to the tasks of choice, assignment and correlation tasks should also be applied. In particular, questions that needed to be correlated as a response: a term in one language with its counterpart to another, a term with its image, a term with its definition, a multivalued term with context, were particularly effective in the context of diagnosing the formation of the information-thematic component of information competence.

The effective type of test tasks was open type tasks requiring independent recording of the answer, including in expanded form. In the case when the answer required writing in the form of one or two words, such tasks allowed their automated control during the test using distance-learning platforms. The inclusion in the tests of tasks that required a detailed response, although it made impossible their control in automatic mode, but allowed to reveal the ability of students to analyze language actions focused on the use of professional terminology.

The Moodle system as one of the possible variants of the program shell, in which there are tools for organizing and implementing test control, allows using a significant number of types of test tasks that are more or less appropriate for forming questions for testing knowledge at each level of the proposed integrated testing system. Among them, there is a sufficient set of types of test tasks of both closed and open type.

Based on experience, we believe that to form a base of test tasks for the proposed testing system the most successful are:

- in a closed form (“yes/no”, “conformity in the figure”, “multiple choice (in different versions – with the possibility of choosing one or several correct answers)”, “overtightening the answers”, “matching”);

— in open form (“short answer”, “essay”).

When creating a comprehensive testing system, we made sure that we should rely on the following methodological principles, taking into account the following features:

— from simple to complex (for example, from the usual choice of the term from the proposed list to the reproduction of the term with the correct spelling);
— from concrete to abstract (for example, from visualization of the term to reproduction without visual support);
— from general science to narrow-sector orientation (for example, from the reproduction of the term in the commonly used version to the correct use in a particular context).

Because of these principles, we determined the most effective types of test tasks for monitoring the results of the formation of the information-thematic component of information competence at each of the testing stages. Based on certain types of test tasks, for each stage, a test task bank was created that contained such a number that ensured compliance with the basic requirements for the test (reliability, validity, discriminativeness).

In particular, at the first stage (the current testing) it is advisable to check the terminology acquisition with the maximum involvement of visualization and the simplest answers to the question. Such criteria correspond, in particular, to questions like “yes/no” and “conformity in the figure”. Examples of tasks for the following types are presented in Figures 3, 4.

Fig. 3. An example of a test task for the first testing stage (“yes/no”)

The second stage (the thematic testing) should summarize the formation of a terminological stock within a certain completed themes. This requires some complication of both tasks and answers, but with the use of visual support. Questions like “multiple choice (one correct answer)” and “overtightening an answer” are best suited for this purpose. Samples of such questions in the Moodle system are shown in Figures 5, 6.

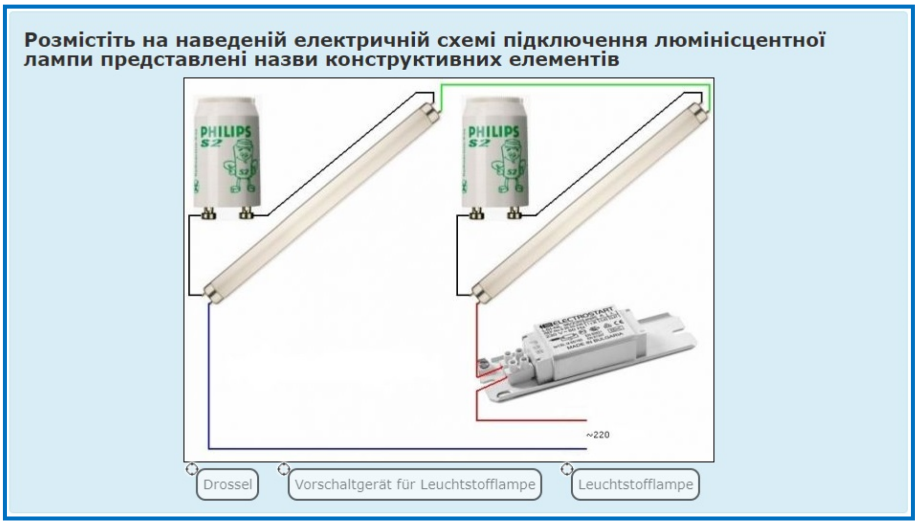

Fig. 4. An example of a test task for the first testing stage (“conformity in the figure”)

Fig. 5. An example of a test task for the second testing stage (“multiple choice with one correct answer”)

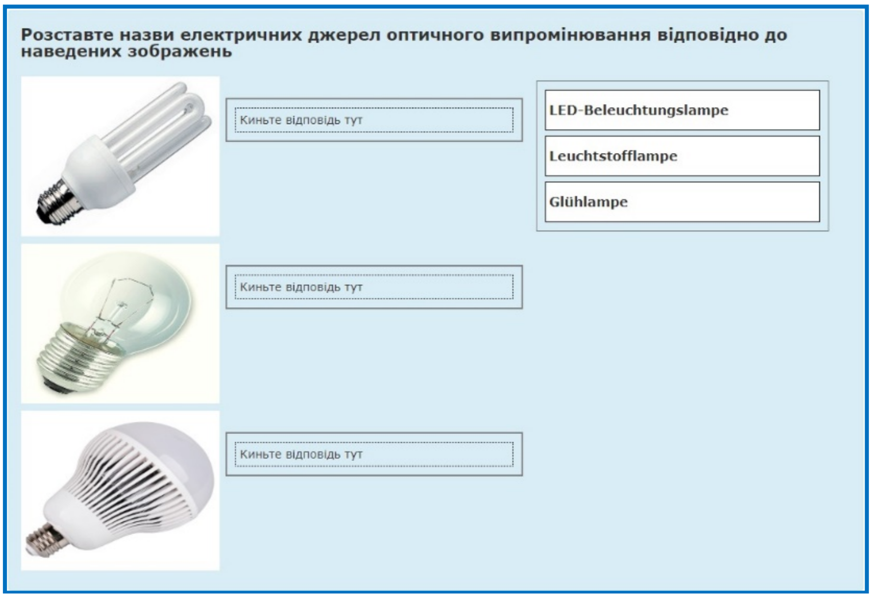

Fig. 6. An example of a test task for the second testing stage (“overtightening an answer”)

Modular control is a milestone stage of the level control of formation of the information-thematic component of information competence. This implies a fairly higher degree of generalization of the study material, which is tested in test tasks for this level. In this case, they are complicated in such a way that besides the partially visualized, abstract forms of tasks are used. These requirements are satisfied, for example, with tasks like “multiple choice (one or several correct answers)” and “matching”. Examples of tasks for the third stage of testing are shown in Figures 7, 8.

However, the final assessment of the levels of formation of the information-thematic component of information competence, which contribute to the development of the ability to translate scientific and technical texts, is possible only at the final testing stage. We have identified the following levels of its formation: reproductive; technologized; constructive; productive [5].

During the compilation of test tasks that will complement the test for this stage of control, it is necessary to provide the ability to control both the reproduction of the term with the correctness of its spelling and the adequacy of its use in accordance with the context. Such types of questions as “short answer” and “essay” are the most suitable for this. The possibilities of their use are shown in Figures 9, 10.

The control of the formation of the information-thematic component of information competence at each stage is carried out using tests, the basis of questions for which are the above types of test tasks. However, the combination of these types of tasks in tests was carried out not arbitrarily, but by a certain proportion. At the same time, the test tasks of the previous stages were part of the tests at the next stages. However, the number of evaluation points for the questions of the previous stage was twice lower than for the questions of the next stage.

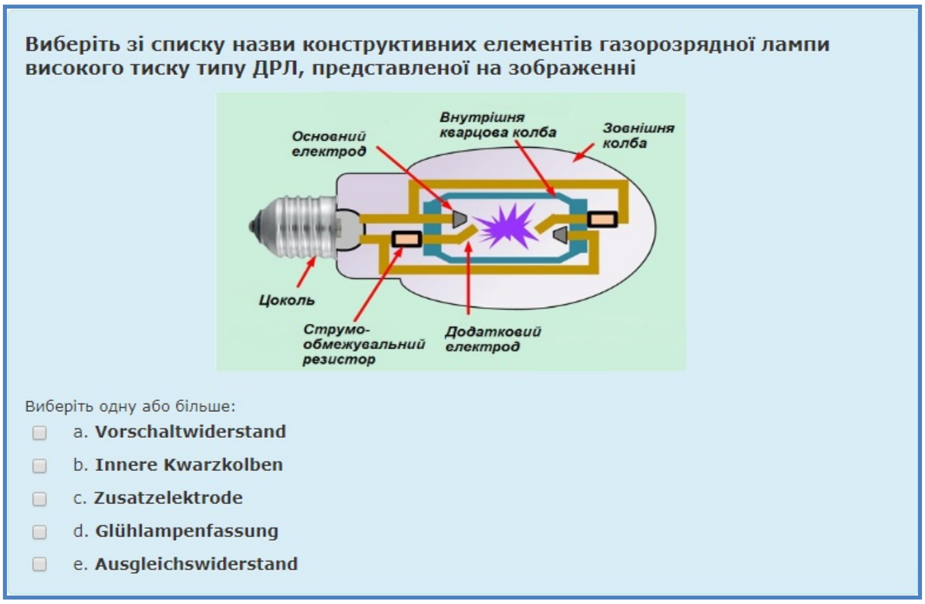

Fig. 7. An example of a test task for the third testing stage ("multiple choice with one or several correct answers")

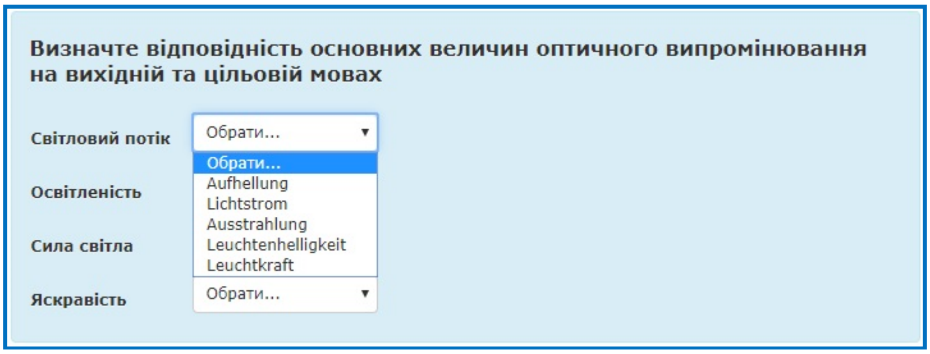

Fig. 8. An example of a test task for the third testing stage ("matching")

The percentage of test tasks selected from the task bank of each stage, in the tests for the corresponding stage, we determined in such a proportion:

- the first testing stage: 100% of tasks from the bank of the first testing stage;
- the second testing stage: 50% of tasks from the bank of the first stage and 50% of tasks from the bank of the second stage;
- the third testing stage: 30% of tasks from the bank of the first stage, 30% of tasks from the bank of the second stage and 40% of tasks from the bank of the third stage of testing;
- the fourth testing stage: accordingly 20% – 30% – 35% – 15%.

Fig. 9. An example of a test task for the fourth testing stage (“short answer”)

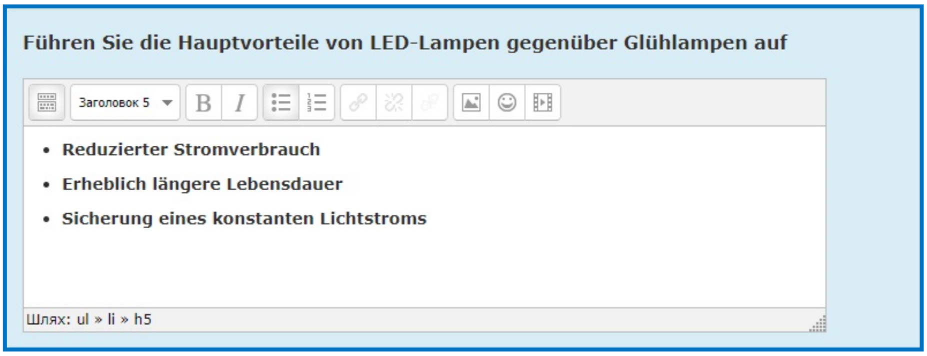

Fig. 10. An example of a test task for the fourth testing stage (“essay”)

This ratio of tasks in the tests at each stage due to the following considerations:

- a combination of questions from different banks in the test, that is, different types and different complexity, improves the accuracy of determining the level of formation of the information-thematic component of information competence due to their diverse evaluation;
- the testing stages outlined by us allow us to determine the level of formation of the information-thematic component of information competence as a whole. The presence of 100% correct answers at each stage indicates that the student has reached a certain level of formation of the information-thematic component of information competence;
- the set of tasks at the fourth stage of testing is defined so that it corresponds with the possible percentage of correct answers. This allows the diagnosing of the information-thematic component of information competence by level (20% – reproductive, 50% – constructive; 85% – technologized, 100% – productive).

An empirical study was conducted to determine the effectiveness of the proposed testing system. Diagnosing the development of the information-thematic component of the information competence of future translators was carried out by applying the developed integrated testing system using the Moodle system. 46 students of the fourth year of the bachelor program “Philology” were involved in the testing. The entry testing was carried out at the beginning of the study of the course “Semantic and stylistic features of the translation of specialized texts”, and the final one after studying it. The obtained test results are presented in table 1.

Table 1. The results of testing to assess the level of formation of information and thematic component of information competence.

Levels	At the beginning of the course, %	At the end of the course, %
Reproductive	82,6	10,9
Technologized	15,2	21,7
Constructive	2,2	52,2
Productive	0,0	15,2

The use of the proposed testing system for entry testing allowed us to diagnose effectively the existing levels of formation of the information-thematic component of information competence. The data of this testing showed the prevalence of reproductive level among students, which was 82.6%. The technologized level was 15.2%, the constructive level was 2.2%, and the productive level was diagnosed in one of the students.

During the final testing, a high (productive) level of formation of the information-thematic component of information competence in 15.2% of students was diagnosed. 52.2% of students showed a constructive level, while 21.7% showed a technologized level. The use of this testing system made it possible to establish that the reproductive level of the quality studied remained at 10.9% of students.

3 Conclusions

Analysis of the test results gives grounds to assert that it is possible to identify changes in the formation of certain components of information competence, and, accordingly, the feasibility of implementing an integrated testing system in the process of training future translators. The integrated testing system developed by us, which provides for the monitoring of students’ terminological training, is based on thematic network resources on the chosen specialization of the thematic field, determining test stages and types of test tasks in accordance with these stages. This system allows you to determine the level of formation of information and thematic component of the information competence of future translators.

Ensuring the accuracy of determining the level of formation of the information-thematic component of information competence can be achieved by combining questions from different banks, that is, of different types and complexity. The study showed that the combination of different types of tasks in the tests should not be arbitrary, but formed in a certain proportion. Moreover, the test tasks of the previous stages make up the corresponding part of the tests in the next stages. When developing a testing system, the ratio of test tasks, selected from the bank of tasks of the preliminary stage, and new tasks in the tests of the next stage was determined. It is also advisable to use visualization, which diversifies the presentation of terminological material in test questions and answer options.

It is proposed to take into account the following skills in a testing system using the Moodle system: mastering the meaning of terminological units and their understanding; knowledge of the semantic valences of words and structures of a foreign language; ability to choose adequate terms and use them; knowledge of uniqueness and polysemy; skills of differentiation of forms and means of language; ability to translate in a specific subject area based on the vocabulary of this area.

Further studies may be related to the study of the features of using an integrated testing system for diagnosing the formation of other components of the information competence of future translators.

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The use of mobile applications and Web 2.0 interactive tools for students' German-language lexical competence improvement

Yuliya M. Kazhan[1[0000-0002-4248-4248]], Vita A. Hamaniuk[2[0000-0002-3522-7673]], Svitlana M. Amelina[3[0000-0002-6008-3122]], Rostyslav O. Tarasenko[3[0000-0001-6258-2921]] and Stanislav T. Tolmachev[4[0000-0002-5513-9099]]

[1] Mariupol State University, 129a Budivelnykiv Ave., Mariupol, 87500, Ukraine
ukazhan@gmail.com
[2] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
vitana65@gmail.com
[3] National University of Life and Environmental Sciences of Ukraine, 15 Heroiv Oborony Str., Kyiv, 03041, Ukraine
svetlanaamelina@ukr.net, r_tar@nubip.edu.ua
[4] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
stan.tolm@gmail.com

Abstract. The article focuses on the use of mobile applications and Web 2.0 interactive tools to improve students' German-language lexical competence. The composition and structure of lexical competence are described, the order of exercises for lexical competence formation is given, the didactic possibilities of using mobile applications, blogging technologies and other interactive tools to improve lexical skills are found out, examples of using mobile applications and Web 2.0 interactive tools in the learning process that prove their effectiveness are given. It is proved that the use of mobile applications and Web 2.0 interactive tools helps to organize students' work in and outside classrooms effectively for the formation and improvement of their lexical competence.

Keywords: mobile applications, interactive tools, Web.2 technology, communicative competence, lexical competence, foreign language, blog.

1 Introduction

1.1 The problem statement

The Internet offers a wide range of modern online tools and applications for learning a foreign language. Of course, everything is changing and updating very quickly in this area, so you should always be alert to avoid missing important information. But this does not mean that all teachers should be media experts as the principle of most applications' action is intuitive.

Using mobile applications and Web 2.0 interactive tools in the learning process, foreign language teachers face some challenges, such as not having enough hours for classroom work or the use of mobile devices by students not for educational purposes, but for entertainment or communication. Therefore, heated discussions are taking place around the topic of using mobile devices in foreign language learning. Taking into account that there are few hours for classroom work, it becomes understandable that these hours are needed to form language skills and speech skills in the process of doing classical exercises and tasks without the involvement of mobile devices or computers. But on the other hand, mobile devices have become so entrenched in our lives that it is simply impossible to give up the learning opportunities they offer for learning a foreign language.

As to the use of Web 2.0 interactive tools, an important feature of which is engaging students in filling and using services, as well as accessibility, openness, interactivity and connectivism [31, pp. 9–10], they play an important role in learning foreign languages. The formation and improvement of students' lexical competence in German also happens faster and more efficiently with the use of mobile applications and Web 2.0 interactive tools as additional learning tools, so they need to take a valid place in the German language learning process.

1.2 Analysis of recent research and publications

Analyzing the work of native and foreign scientists on the problems of using mobile applications and Web 2.0 interactive tools in the educational process in order to form lexical competence, we have concluded that there has been an increasing interest in this topic in recent years. Scientists point out that the use of mobile applications and interactive tools not only contributes to the formation of foreign language communicative competence, but also to the improving students' media competence, the formation of research skills, increasing motivation to learn a foreign language.

The use of mobile devices, applications and Web 2.0 interactive tools in a foreign language learning process was studied by Ukrainian researchers Hanna M. Alekseeva [13], Oksana Ye. Bondar [32], Olga O. Gnedkova [18], Larysa V. Gorbatiuk [13], Darja A. Kassim [32], Nataliia V. Kravchenko [13], Hennadiy M. Kravtsov [18], Kateryna P. Osadcha [37], Viacheslav V. Osadchyi [37], Olena O. Pavlenko [32], Alona M. Prykhodko [34], Oksana O. Rezvan [34], Tetiana S. Rozumna [13], Ekaterina O. Shmeltser [37], Svitlana V. Symonenko [37], Stanislav T. Tolmachev [34], Nataliia S. Tymchenko-Mikhailidi [32], Olga M. Ustimenko [42], Nataliia P. Volkova [34], Nataliia V. Zaitseva [37], foreign scientists Nils Bahlo [2], Gunhild Berg [4], Johanna Chardaloupa [9], Albert L. Harris [15], Aimi Jõesalu [9], Choi Kwangoon [32], Alan Rea [15], Sarah Torres Cajo [2], Bae Gi Yon [32] and others. The works of Karin Aguado [1], Natalia F. Borisko [6], Rainer Bohn [5], Birgit Henriksen [16], Aleksandra Łyp-Bielecka [20], I. S. P. Nation [28], Jonathan Newton [29], Mattheus Wollert [43] and others are devoted to the problems of teaching vocabulary.

The use of smartphones in the educational process, the possibilities and prospects of such use for the creation of a mobile learning environment as well as their method of use were studied by both domestic (Mariia A. Kislova [39], Yevhenii O. Modlo [25], Pavlo P. Nechypurenko [24], Olga G. Pronina [33], Serhiy O. Semerikov [23], Ekaterina O. Shmeltser [17], Kateryna I. Slovak [26], Vladimir N. Soloviev [38], Andrii M. Striuk [35], Viktoriia V. Tkachuk [40], Tetiana I. Zhylenko [44]) and foreign researchers (Earle Castledine [7], Max Wheeler [7], Myles Eftos [7], Philip Karsch [12], Henrike Friedrichs-Liesenkötter [12]).

Although the topic is covered in a large number of papers, the emergence of new applications and tools requires new approaches to teaching German [10; 41], testing them in the learning process and examining their impact on learning outcomes. In view of this, the purpose of this article is to analyze the possibilities of using modern mobile applications and Web 2.0 interactive tools in the educational German language process in order to improve students' lexical competence and to describe examples of integrating individual tools into the German language learning process.

2 Importance of lexical competence formation

Lexical competence is one of the main components of a foreign language communicative competence, as no information can be reported or perceived without it. Foreign language communicative competence (FCC) is seen as a unity consisting of certain components (competences) in the modern method of teaching foreign languages. The authors of the Common European Framework of Reference for Languages [10, p. 108] distinguish the following components of FCC:

- linguistic competence, which includes lexical, grammatical, semantic, phonological, orthographic, orthoepic competences;
- sociolinguistic competence;
- pragmatic competence which consists of discursive (knowledge of the principles by which statements are organized, structured and concluded), functional (knowledge of the principles by which utterances are used to carry out communicative functions) and speech programming competencies.

Considering the fact that the listed components are unequal in importance and that the modern achievements in the methodology of teaching foreign languages and related sciences are not fully taken into account during the process of their determination, Sofiia Yu. Nikolaeva proposes to include in the structure of foreign language communicative competence the following competences: speech, language, linguosociocultural and strategic training [30, p. 12].

All components of the foreign language communicative competence are formed at each level of the university degrees, but the formation of one or another competence occupies a more or less important place in the educational process. Initially, for example, more attention is paid to the formation of linguistic (lexical, grammatical, phonetic, spelling and orthoepic) and speech (reading, listening, speaking and writing) competences, as well as mastering strategies of learning and using language, that is the formation of strategic training competence.

Lexical competence is defined in the Common European Framework of Reference for Languages as the knowledge of lexical units and the ability to use a vocabulary composed of lexical and grammatical elements. Lexical elements include persistent expressions (colloquial formulae, phrasal idioms, fixed frames, phrasal verbs, fixed collocations) and single words forms. The grammatical elements belong to the closed classes of words (articles, pronouns, prepositions, auxiliary words, conjunctions, particles) [10, p. 110–111]. Nevertheless, this definition does not fully reflect the composition and structure of lexical competence, so let us analyze the point of view of methodologists on this problem.

Questions about the components of lexical competence are being considered differently in the methodological literature. For example, Carol A. Chapelle proposes to distinguish three components of lexical competence, namely: 1) knowledge of the context (linguistic, cultural, situational) use of a word; 2) knowledge of mental vocabulary organization and word processing processes in memory; 3) metacognitive strategies for using words [8, p. 160–161].

According to Sergei F. Shatilov, the formation of lexical competence involves the formation of students' skills of intuitively correct derivation, use and understanding of a foreign language vocabulary on the basis of speech lexical connections between auditory speech-motor and graphic forms of the word and its meaning, as well as connections between words of a foreign language [36, p. 129].

In addition, the so-called "language awareness" should be included in the lexical competence, namely, a conscious reflexive approach to the phenomena of language and speech, as well as to one's own processes of learning and mastering of a foreign language communicative competence and its components. Language awareness in the field of vocabulary acquisition can be defined as lexical awareness, that is, a person's ability who masters a foreign language:

- to recognize foreign language lexical units, their peculiarities and patterns of their formation and use;
- to be aware of the socio-cultural stipulation of foreign language lexical units, especially non-equivalent vocabulary of a country, common phrases, phraseologisms, proverbs, sayings, etc.;
- to think over the processes of formation of one's own lexical competence, to ponder over the organization of mental vocabulary, the processes of processing of lexical information in memory, the peculiarities of memorizing lexical units;
- to analyze the lexical side of texts for reading and listening: to guess the meanings of international words, cognates, compound words, to pay attention to a context and means of interphrase communication, etc.

Therefore, summarizing all the above-mentioned, we can identify lexical skills, lexical knowledge and lexical awareness as the main components of lexical competence, which is shown in figure 1.

Lexical competence is traditionally divided into productive and receptive. The basis of productive lexical competence is active vocabulary – the lexical material that a student should use to express his / her thoughts orally or in writing, as well as understand other people's thoughts during listening and reading.

Receptive lexical competence is based on active and passive vocabulary, these are layers of vocabulary that a student must understand perceiving others' thoughts in oral form (during listening) and in writing (during reading). It is obvious that productive vocabulary is always part of receptive vocabulary and the capacity of passive vocabulary is greater than active vocabulary. Batia Laufer proved in her experiments that the capacity of passive vocabulary is ten times bigger than the capacity of active vocabulary during the process of learning a foreign language. In addition, there are processes of regrouping, restructuring in lexical competence's composition, lexical units change their status over time, but the relation between active and passive vocabulary changes in favor of passive [19, p. 265]. Karin Aguado also notes that understanding a word does not necessarily provide its active use in speech, and vice versa, a word that belongs to learner's active vocabulary may not always be understandable during reading or listening [1]. In general, we agree with Birgit Henriksen's point of view, which defines the difference between productive and receptive lexical competence gradually but not as dichotomy "passive vocabulary–active vocabulary" [16, p. 309], that is, the learners' vocabulary is not divided into two parts that exist separately from each other, during the foreign language learning process lexical units pass from passive vocabulary to active and vice versa.

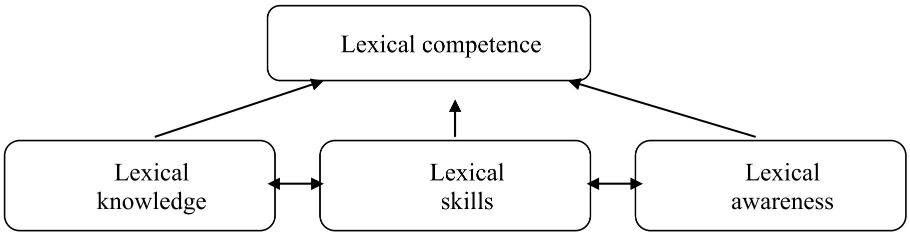

Fig. 1. The structure and composition of the foreign language lexical competence

Organizing an exercise phase for memorizing and further active use of vocabulary, the fact should be taken into account that lexical units are better remembered when they are processed using various channels of perception and information processing, among which visual perception takes an important place according to scientific researches, as it is proved that the parts of the brain, that are responsible for processing and storage of verbal and visual information, are very closely related [21, p. 16]. Therefore, the use of mobile applications and Web 2.0 interactive tools, most of which rely on visual perception of information, promotes faster and better memory of lexical material.

There is a classic order of types of exercises that are performed at the stage of automation of students' actions with lexical units, namely:

1. exercises on the recognizing of lexical units;
2. exercises on the choice of lexical units;
3. exercises on the ordering of lexical units;
4. exercises on the classification of lexical units;
5. exercises on the productive use of lexical units [21, p. 20–23].

You can improve your vocabulary skills with the help of tested classic techniques on the one hand and on the other with online tools and applications. In the following examples we will show how the vocabulary learning process is enriched with the use of digital technologies.

3 Mobile applications and Web 2.0 interactive tools for building and improving lexical competence in German

3.1 Mobile applications

The popularity of mobile apps for learning foreign languages has grown a lot lately. The mobile application is a standalone software product specifically designed for mobile devices to optimize a solution to a problem or a task in a user's life. It is necessary to distinguish between native and network web applications [7, p. 26]. The network application is available online through the device browser, in other words, it is a website that offers similar functionality to the application. In addition, the so-called native applications are developed specifically for a given platform (Android or iOS, for example) and is installed in the device. Native mobile applications that are of great interest in the context of foreign language learning are distributed through app stores: Apple App Store, Google Play and others.

We consider that the use of Bring Your Own Device (BYOD) model is the most effective way to learn foreign languages when students bring their own mobile devices to an educational establishment. In such a case, there is no need for an educational establishment to buy devices and that allows overcoming one of the main barriers to the introduction of information technology in the educational process – the issue of logistics. Many teachers and lecturers also point out the fact that teenagers prefer to use personal devices, even when an educational institution may offer an alternative because they feel psychologically more comfortable.

Let us consider the following network applications Memrise (https://www.memrise.com) and Quizlet (https://quizlet.com), that allow training lexical units during the phase of automation.

As we can see from the Table 1, the selected applications allow creating word groups, sharing them, and selecting existing ones. They offer a wide range of exercises: recognition, selection, ordering, sorting lexical units; translation exercises and reproductive exercises that can be used at the situational phase of the formation of lexical skills in order to automate them.

As we can see from the Table 1, both Memrise and Quizlet have many advantages, but the existence of the paid content indicates a limitation of features in the free version. For example, the function "keeping statistics" is not available in the free version.

The advantage of Memrise is that it offers to use memes for associative memorizing. These can be images, videos, voice recordings, examples of sentences that have been added on one's own or borrowed from other users. The disadvantage is the fact that Memrise users can only learn a foreign language using a clear, non-infringing algorithm. As for a mobile app, it can only be used with an Internet connection.

Table 1. Comparison of mobile web applications

Criteria	Memrise	Quizlet
Possibility to create word groups yourself	+	+
Possibility to share created word groups	+	+
Possibility to select already created word groups	+	+
Possibility to add a voice recording	+ (it is possible to add audio files or to record a sound image of a lexical unit using a microphone)	+ (it is possible to add one's own sound recording in the paid version and there is an automatic sound system in the free version)
Possibility to add images	+ (the program offers memes for better memorization of words, it is also possible to create them yourself, a meme can be not only a picture but also a video, a word, a sentence)	+ (it is possible to add one's own images in the paid version and to can select images from an application library in the free version)
Keeping statistics	+ (in the paid version)	+ (in the paid version)
Paid content possibility	+	+
Lexical exercises	– exercise on word order; – exercises on writing the word independently; – multiple-choice tests	– Flashcards (card view mode); – Spell (printing the heard word); – Learn (fitting into the translation of a word in a foreign language and choosing one of the four proposed); – Write (insert word translation); – Test (4 types of tests); – Match (a combination of words); – Gravity (a speed game, it is necessary to have time to type a word in the appropriate place before a meteorite falls); – Live (a team play in a classroom is based on training card sets)

As for the advantages of the Quizlet resource, it has the function of an automatic sound system of lexical units; it is possible to select images from the Quizlet database. Like Memrise, this educational resource contains the paid content, that allows you to add your own images and voice words yourself, and it allows creating an unlimited number of classes, that is convenient for teachers, as they have the ability to monitor students' activity and their results. Teachers can create not more than 8 classes in the free version. With the help of this educational resource, a teacher can track the lists of words created by students (Fig. 2), using them during vocabulary dictations' preparation, as well as make various types of control. Quizlet makes it possible to print a list of lexical units (Fig. 3), that is also quite convenient. Unlike Memrise, the Quizlet mobile application can be used without an Internet connection. The possibility to learn words not according to the algorithm is also a hallmark of Quizlet.

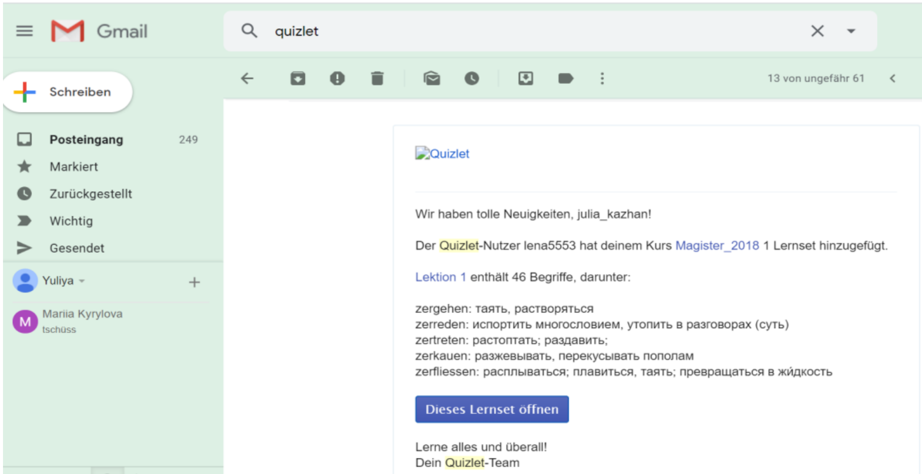

Fig. 2. Email message to a teacher of the creation and development of a new module by students

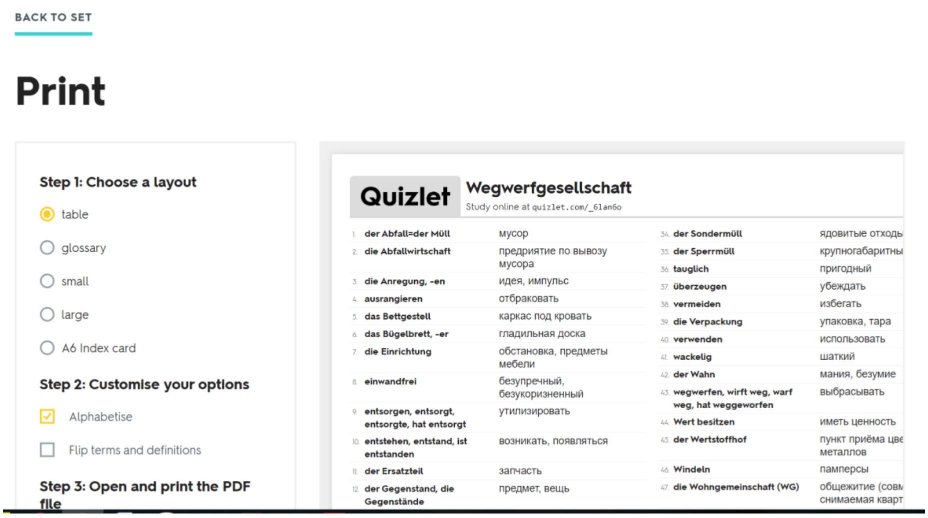

Fig. 3. List of lexical units prepared for printing

Our experience of Memrise and Quizlet mobile applications' using has been quite successful. Quizlet is the most understandable and easy to use according to student feedback (some of them are given below in the table), and therefore the process of working with Quizlet is worth describing in more details.

A separate class was created for each academic group which included all students of the group who initially had to sign up for Quizlet. The main idea of using the resource was to systematize the lexical material in order to improve students' foreign language communicative competence. Due to the fact that the free version does not have keeping statistics function, a teacher is not able to check the students' activity and their doing of interactive exercises offered by the resource. But our idea of using the free version was to compile common lists of lexical units on the topics being studied. All students of the group were involved in the compilation of the lists; all of them had the right to edit the modules. In the classroom, we highlight those lexical units that make up the lexical minimum of a topic during the process of word processing. The students had to put the selected words into a common list of lexical units, distributing them among themselves (Fig. 4, 5, 6).

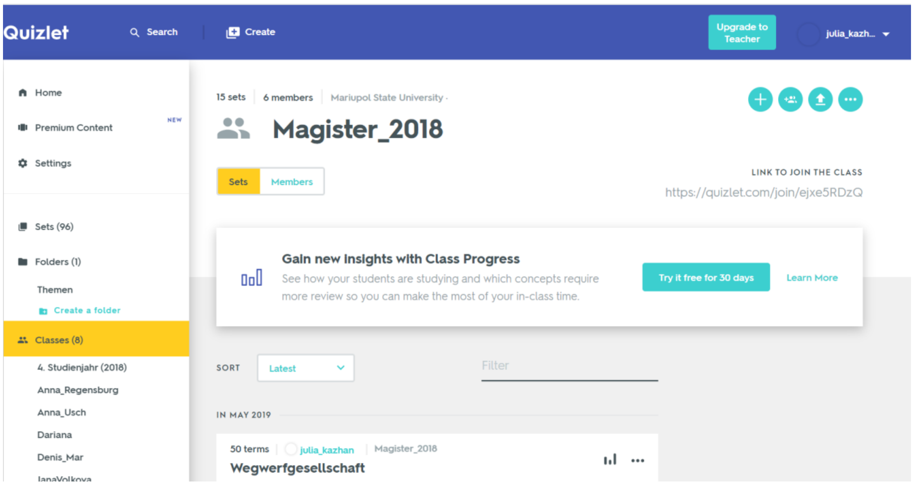

Fig. 4. A created class for masters in the speciality "Philology. Language and Literature (German)"

So, as we can see from the figures above, the students' teamwork was quite successful, they were actively involved in creating word lists and developing them. The teacher could not control the students' implementation of the interactive exercises, this was a facultative option that students were introduced to at the beginning of the resource. From our observations, we can say that most students did the exercises at the beginning of using Quizlet, but later this function was used only occasionally. Most students saw the main advantage in ability to practice vocabulary using flashcards at any convenient time for them and anywhere, as they always have a mobile phone at hand. We provide students' feedback on the use of the Memrise and Quizlet applications next (Table 2).

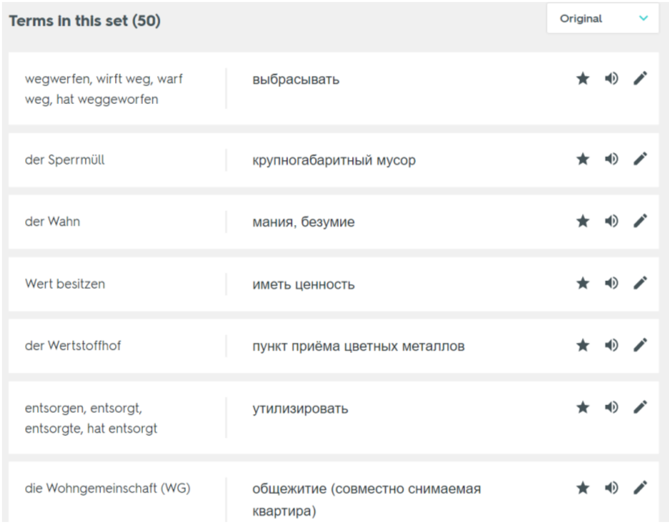

Fig. 5. List of lexical items on the topic "Consumer society"

Fig. 6. Module "Consumer society"

Table 2. Memrise та Quizlet Students' feedback on the use of Memrise and Quizlet

Positive feedback	Negative feedback
1. It is possible to expand vocabulary significantly. 2. Scoring and gamification of the learning process motivate further language learning. 3. The free version has enough features to use the application successfully.	1. After a while, the user's success of memorizing decreases. 2. The word can often be guessed without knowing it (by the method of exclusion). 3. Assessing of a user's level of knowledge is often not true, users think that they have a large vocabulary, but in reality, they cannot formulate elementary sentences. 4. Applications can only be used as an additional language-learning tool; you cannot learn to use words only with them.

So, as we can see from the students' feedback, mobile apps can be used to memorize vocabulary and receptive having of vocabulary. In order to formulate a productive vocabulary, it is necessary to offer conventionally speech and speech exercises for students that would encourage them to express their own opinions about certain facts. These can be both classic exercises performed in a classroom or exercises developed by means of Web 2.0 resources, which are discussed below.

3.2 Interactive Web 2.0 tools

There are different points of view on how Web 2.0 can be used in the learning process, but it is undeniable that they allow students and teachers to collaborate, and students can individualize their own learning style using them. These interactive tools have the potential to transform learning into a fun process through the use of innovative learning tools that support a person-centered approach and offer interactive forms of work that contribute to learning motivation.

Olga G. Pronina outlines four main benefits of implementing Web 2.0 technologies into the educational process (Table 3), noting that the right column of the table reflects the cognitive aspects of learning and the left reflects social and interpersonal aspects [33, p. 96–97].

Table 3. Advantages of introducing Web 2.0 technologies into the educational process

Cognitive aspects of learning	Social and interpersonal aspects of learning
Organization of research	Organization of cooperation
Language literacy	Ability to publish information

From the point of view of our article's problem, we are interested in the aspect of language literacy, and we really agree that the use of Web 2.0 technologies can significantly improve students' language competence and lexical in particular. Due to the fact that during the process of working with interactive technologies, students do not passively absorb knowledge, but are engaged in collaborative work to obtain knowledge and have the opportunity to publish their own texts, videos, audio, they pay special attention to their own formulations, thus productive lexical competence is formed and improved.

If we talk about how web technologies can improve the learning process in general and students' lexical competence in particular, we should first consider the criteria by which foreign language classes can be attributed to high-quality classes. Hilbert Meyer proposes to distinguish 10 features of qualitatively conducted lessons in a foreign language:

1. a high percentage of real study time in a class;
2. a prepared classroom and materials;
3. clear structuring of a lesson;
4. atmosphere in a classroom which promotes learning;
5. meaningful clarity;
6. organization of the communication process;

7. an individual approach;
8. a variety of teaching methods and techniques;
9. transparency of control;
10. conscious management [22].

If we correlate these features with the characteristics of Web 2.0 technologies (Fig. 7), we can see that they allow to organize and conduct high-quality foreign language lessons.

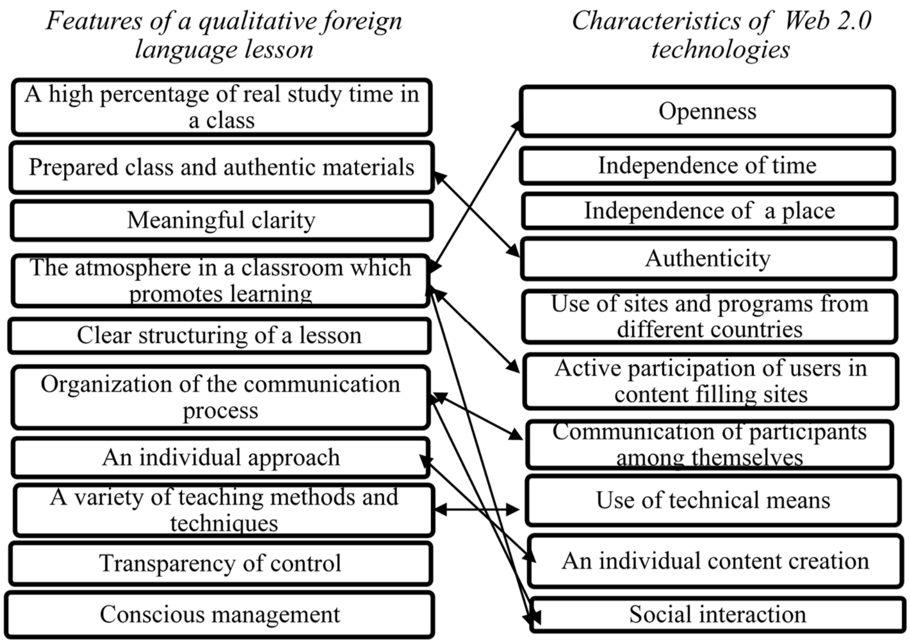

Fig. 7. Correlation between the features of a qualitative foreign language lesson and the characteristics of Web 2.0 technologies

So, as we can see from Fig. 7, the use of Web 2.0 technologies improves the quality of foreign language teaching and organizes students' work both in a class and in their own work.

Based on the classification of Elena I. Goroshko [14, pp. 557–558], we distinguish Web 2.0 technologies that are appropriate to use in the foreign languages learning process (Table 4).

Here are some examples of Web 2.0 technologies that can be used for the purpose of formation and improvement of students' lexical competence in German.

A teacher's (lecturer's) blog as a type of blog is created and moderated by a teacher, it may contain information about the course or subject (course syllabus, homework, information on the study material, links to additional sources, reading and listening materials, links to tests on the topics studied or topics are being studied, etc.). Let us describe the technology for creating a teacher's blog on Wordpress platform:

Table 4. Web technologies in the foreign languages learning process

Categories	Internet addresses
Blogs and microblogging	www.edublogs.com www.blogger.com de.wordpress.com
Social networks	www.facebook.com www.linkedin.com
Wikiprojects	www.mediawiki.com www.wikidot.com
Social bookmarks	www.bibsonomy.com www.google.com/bookmarks
Information dissemination multimedia systems	www.youtube.com www.apple.com/itunes de.slideshare.net
Joint editorial office systems	www.google.com/intl/de/docs docs.google.com/spreadsheets
Podcasts	www.podcastpeople.com www.podomatic.com
Platforms for the development of educational materials	learningapps.org de.padlet.com

Step 1. A teacher needs to determine whether the Wordpress online resource suits him or her, or whether the interface is easy to use and post the educational material. It is necessary to consider the structure of the site beforehand because it is considered inappropriate to offer students a content on one page or in one section in the practice of creating an educational blog. In addition, it should be considered that the content must be diverse: links to foreign resources, references, links for downloading materials, interactive tasks, tests, questionnaires, communication situations, information about events in German, contacts or widgets of other social networks, Web 2.0 resources (Padlet, Instagram, Facebook, etc.). A teacher is invited to do several sections for creating a site that will be used for educational purposes. The basic idea of the educational platform is placed in the first section and the content for the purpose of the use is in the others. As an example, here is a teacher's blog created as part of a master's project on the topic of "Blogging in the German language learning process" (by M. O. Yashkova, academic adviser Yu. M. Kazhan):

(1) Hauptseite (home page);
(2) Über uns (about us);
(3) Kontakte (contacts);
(4) Interessante Tatsachen (interesting facts);
(5) Übungen und Tests (exercises and tests).

Step 2. Each section should be filled in with the following content:

1. Hauptseite (see Fig. 8, 9)
2. Über uns and Kontakte – sections that will help students to learn more about a teacher, an educational institution, see information about the learning process, etc.

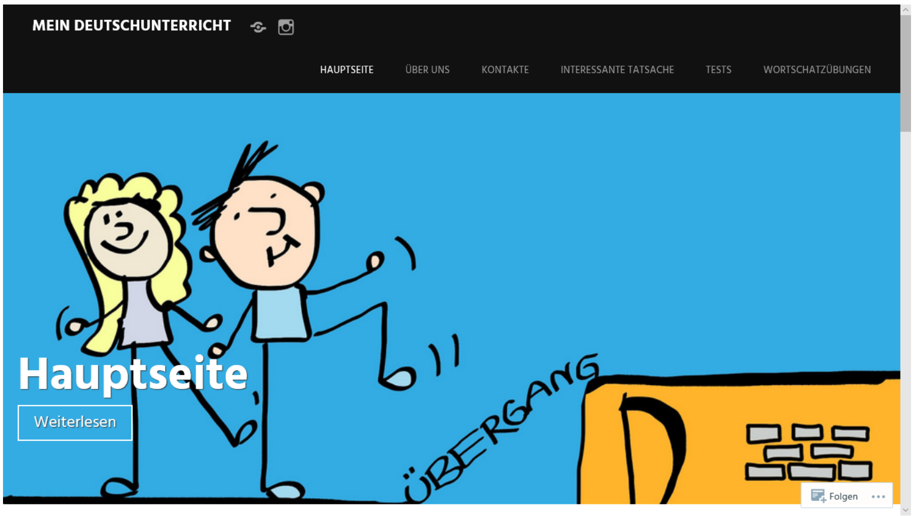

Fig. 8. Blog homepage “Mein Deutschunterricht”

Fig. 9. The main tasks of the educational blog

3. The main section – Interessante Tatsachen – includes interesting communication situations, problems that are constantly updated by a teacher. One of the tasks for students is to write comments on posts, which can be one of the tasks for organizing students’ independent work in the discipline (Fig. 10, mistakes in student comments are saved).

When commenting on posts, of course, students make mistakes in their statements commenting on posts. The teacher’s task is to correct mistakes or respond during a lesson or in comments expressing a personal opinion.

3 Gedanken zu "Europa ist bunt!"

Europa gefällt mir sehr. Dort gibt es sehr schöne Plätze für Leben, z.B die Ukraine. Aber für europäischen Leben fehlt uns Toleranz, Höfflichkeit und Geduld.

★ Gefällt mir

Ja, ich stimme dazu. Die Ukraine kann in Europäischen Union sein, aber dafür sollen wir fertig sein. D.h. unsere Lebensweise ein bisschen zu verändern.

★ Gefällt dir

Europa ist wirklich sehr schön und bunt. Das Leben in Europa ist unterschiedlich. Sie hat viele bekannten Sehenswürdigkeiten und keine Gränze zwischen Ländern. Der zweite Punkt ist natürlich der wichtigste Vorteil. Fast alle Länder sehen so ausgezeichnet aus. Die meisten Europäer leben wohl uns sind mit alles Nötiges versorgen.Sie sind auch ein Naturfreunde und bereit eine Hälfte das Gelds für Naturschutz auszugeben.

★ Gefällt mir

Fig. 10. Students' comments

4. Students report their results to a teacher using the commenting function while performing exercises and tests in the tab (by links). In our example, we offer students a quiz on the topic "Europe" (see Fig. 11).

Du bist gut! Bist du etwa ein Reisefan wie wir, leicht verknallt in deine/n Geografie-Lehrer/in und wolltest sie/ihn mit Wissen beeindrucken oder bist du einfach gerne auf dem Laufenden? Wir freuen uns, wenn du unseren Roadtrip durch alle Länder Europas auf http://comewithus2.com verfolgst und vielleicht hast du ja sogar den einen oder anderen Reisetipp für uns?

Sie haben 11 von 15 Aufgaben richtig beantwortet.

★ Gefällt mir

Fig. 11. Quiz results

The peculiarities of the offered exercises are that they are related to the use of blogging technology, so it is advisable to develop notes that will help students and teachers better navigate and create the following exercises:

Recommendations to students on completing blog assignments

- Leave comments! This will help you to become a member of a real discussion.
- Do short but clear notes.

- Keep a close eye on the topic of a future message.
- Examples and cliches will help you with the task.
- Attach pictures or audio/video files! This will make your message vivid and individual.

Blogging recommendations for teachers

Creating and maintaining a blog, you should pay attention to:

- content (filling with educational material);
- original design;
- convenient blog navigation;
- interactivity, feedback, students' evaluation of the blog.

Another type of blog is a collective blog created to inform others about certain events. According to the results of an American study [27, p. 225], the main motives for creating a blog are the following:

- to inform others about activities and what is happening around;
- to express one's own opinion and influence the opinion of others;
- to find like-minded people and to get feedback;
- to structure one's own thought by its verbalization on principle think when I write ("think by writing");
- to reduce emotional tension.

As for the use of blogs in the foreign language learning process, it is advisable to maintain them in order to improve writing skills, in such a case they become a tool for organizing real communication using a studied foreign language.

The idea of the blog, which we will describe below, was to develop students' communication skills of Mariupol State University, who participated in the study trip to the University of Göttingen in Germany from German Academic Exchange Service. The idea of creating a blog was, firstly, to make students, who participated in the trip, record their impressions in small texts, express their opinions about their stay at the University of Göttingen, attending lectures and seminars, communicating with students, etc. The purpose of this activity was to create a travel information page and to improve students' writing skills in German. Secondly, the blog was created in such a way that non-travelling students would also be able to get acquainted with interesting facts and cultural sites in Germany.

It is important to note that blogging was a new activity for all students, so we decided that structuring thinking could be achieved through daily group reflection. At the end of each day, we discussed the events that occurred and reflected on certain issues, such as the organization of seminars at the University of Göttingen and differences from our system, topics discussed by students in the classroom (hostility to foreigners, problems of migrants, etc.); about museums, we visited, etc. These reflection phases provided the basis for writing the blog texts. In addition, during the discussion, we trained new lexical units that students wrote themselves during attending lectures and seminars, that is, there was an improvement of their lexical competence in oral speech. Thus, the preparatory work for writing blog texts contributed to the improvement of students' lexical skills.

We used Blogger tool (Google service) for this blog. You must create a Google account to use this service. Creating a blog takes little time; the process of creation is intuitive. In the window "Create a new blog", it was necessary to enter a blog name and come up with an address (Fig. 12).

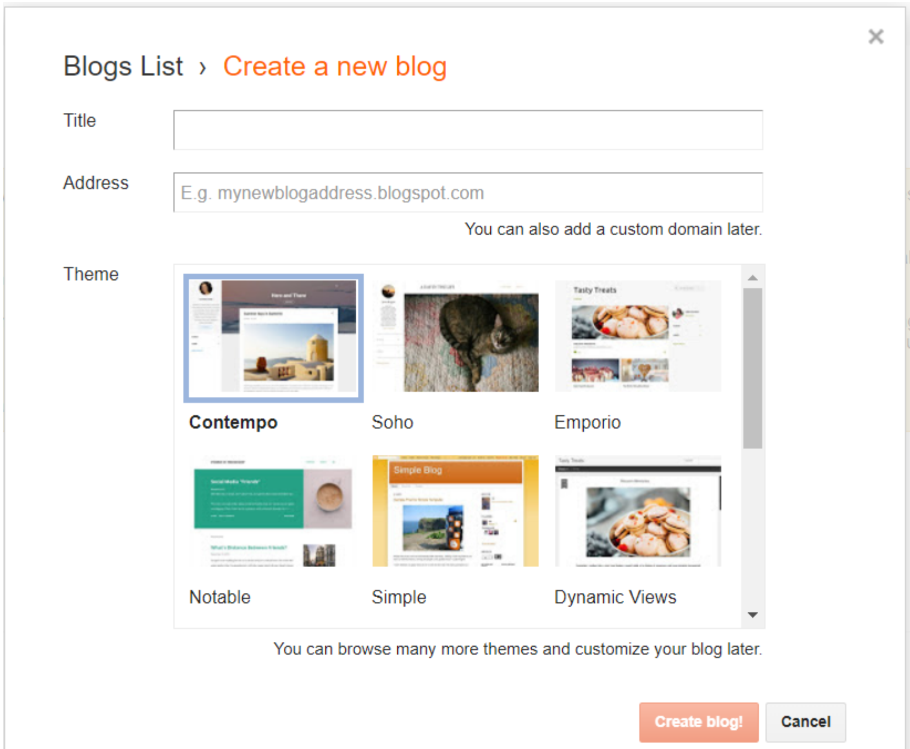

Fig. 12. Creating a blog using the service Blogger

Students called our blog "Göttingen: Traum und Wirklichkeit" (Göttingen: from dream to its realization) and set an address for the blog https://endlichingoettingen.blogspot.com/, chose a template "simple" and could already publish the first post (Fig. 13). Of course, we did not forget to customize the look of the blog by selecting the background, colors, the template, etc.

The study trip lasted 10 days, the group consisted of 12 students, so we established the order of writing posts; we have discussed also the structure and the form of writing blog texts. On the one hand, our goal was to fix impressions of the trip's and to inform the students who were not travelling; on the other hand, our goal was to improve students' competency in writing, which included such aspects as improving language skills and teaching students how to write blog texts according to the requirements for this type of text. Therefore, we started by discussing the features of blog texts with students and looking at examples of such texts. We have also included some tips for organizing a blog [https://www.selbststaendig.de/10-tipps-gute-blogtexte]. When writing a text, it is necessary to take into account the fact that the reader's attention is drawn to a title and an introduction, as they are of primary interest to readers and cause desire to read a text further. The sentences should be clear and understandable they should be interconnected by means of interphase communication.

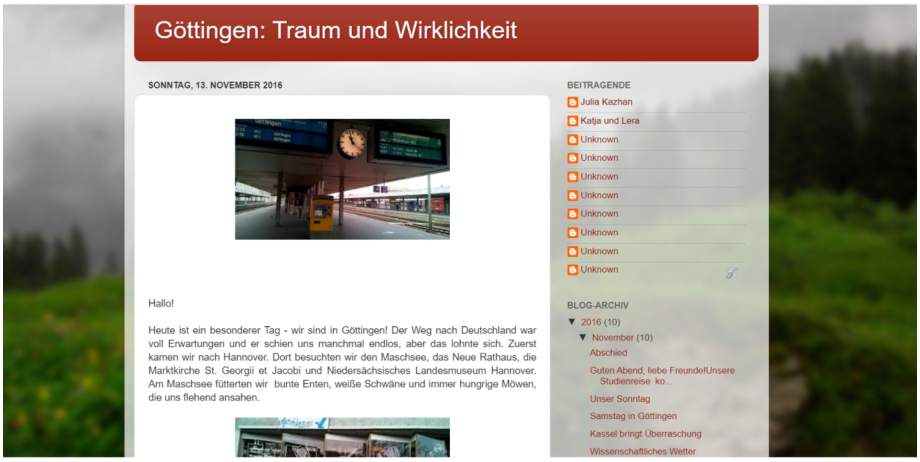

Fig. 13. The blog "Göttingen: Traum und Wirklichkeit"

Another feature of a blog is its multimedia – the simultaneous use of several semiotic systems in the communication process, such as visual and audio channel. Multimedia is also manifested as a combination of verbal text with non-verbal components such as graphics, photos, videos and more.

Multimedia content is increasingly making its way to blogs and there are currently 4 options for presenting text and multimedia information:

1. only text information is provided;
2. textual information prevails, but there is an interspersion of multimedia information (audio, video, graphics);
3. text and multimedia information are presented equally;
4. multimedia information prevails [3, p. 128]

We used the third version of information presentation in our blog: every published text was necessarily accompanied with photographs taken by students during a day. Here is an example from a student's text who, in our opinion, took into account the above requirements for writing a blog text (the text is saved in the author's version, the mistakes were not corrected) https://endlichingoettingen.blogspot.com/2016/11/das-wetter-spielt-keine-rolle.html

Das Wetter spielt keine Rolle

Der Morgen. Grau. Regnerisch. Man will in die Uni nicht gehen, aber es geht nicht um uns. Wir sind in Göttingen – die Stadt für Studenten, hier leben und studieren 32 Tausend Studenten.

Wir haben uns gefreut über die Möglichkeit mit der Professorin Middeke noch einmal zu treffen, bei ihr waren wir schon am Montag im Seminar für Grundlagen der Sprachachvermittlung. Aber heute war es der Besuch der FaDaF-Geschäftsstelle (der Fachverband Deutsch als Fremd- und Zweitsprache). Aber was macht der FaDaF? Im Großen und Ganzen der FaDaf fördert Initiativen zur Integration und Mehrsprachigkeit und unterstützt die berufs- und arbeitsplatzbezogene Aus- und Weiterbildung DaF. Wenn Sie Lust haben mehr darüber zu wissen, könnten Sie die Website besuchen www.fadaf.de.

Das Mittagessen. Endlich! Mmm, was soll man auswählen? Suppe? Würstchen? Alles sieht so lecker aus! Und danach kommt der Besuch des Internationales Schreibzentrums. Es ist das erste Schreibzentrum in Deutschland, wo gibt es verschiedene Worskshops zu verschiedenen Themen, bei denen es um akademisches Schreiben geht.

Und die letzte Doppelstunde für heute – Projektseminar mit Professorin Meißner. Es war angenehem die bekannten Gesichter der Studenten zu sehen. Wir haben ziemlich produktiv in den Gruppen gearbeitet und es war spannend einander besser kennen zu lernen. Es spielt keine Rolle, dass wir aus verschiedenen Ländern sind, weil Witze die Leute näher machen.

Schließlich kommt der Ukrainische Abend – alles was man über die Ukraine wissen möchte: Lieder, Tanzen, Live Musik und Präsentationen über die Ukraine, Mariupol, unsere Uni. Und danach beim Büffet haben wir uns mut den Gästen wunderbar unterhalten. Ein ereignisreicher Tag!

This example also takes into account such a blog parameter as hypertextuality, that is, the use of hyperlinks that connect separate elements of a blog structure. In this example, the link www.fadaf.de is given to an association of German teachers and lectures which students were able to get acquainted with during their study tour.

4 Conclusions

Use of mobile applications and Web 2.0 interactive tools through such features as: accessibility (ability to work remotely, regardless of location), openness (ability to express your views, comment), interactivity (get comments on your own publications in real time, or asynchronous) and collectivism (teamwork, team responsibility, team spirit) have become an integral part of the foreign language learning process. Especially effective is the use of Internet services in the development of lexical competence, which is confirmed by the practice of using mobile applications and interactive Web 2.0 tools in learning German.

Given that lexical competence consists of lexical knowledge, lexical skills and lexical awareness, we believe that its development is due primarily to the rich lexical stock and the ability to recognize lexical units and their structural components through linguistic awareness. Because of this, the task is to maximize the vocabulary of learners. We consider the use of mobile applications and Web 2.0 interactive tools that combine the use of different channels of information perception (visual and auditory) as an effective means of developing lexical competence.

Mobile devices have several advantages in the learning process: each student has a smartphone, as well as the mobile Internet; mobile applications can be downloaded in their free version. Even in the free version, Memrise and Quizlet mobile applications are effective in the automation of lexical units. They offer different types of exercises: recognition, selection, ordering and translation, allow creating your own instructional content that can be used by the teacher to complete the test tasks. Both applications are effective at memorizing and automating the vocabulary.

Web 2.0 technologies allow you to individualize the learning process, to transfer it from passive mastering of vocabulary into the format of its active use. In addition, these technologies allow you to produce your own texts, videos and audio materials, which diversify the learning process, make it interesting, encourage students to be creative. This improves the quality of teaching in the classroom and allows you to optimize your work. Teacher blogs or community blogs have proven effective in practice. Teacher blogs aim to organize the work of a group or class, while collective blogs are created specifically to organize real communication in a foreign language that promotes foreign language competence. Blogs make it possible to train vocabulary but through context, to combine text and multimedia information that attracts students, thus creating a virtual learning environment.

The possibilities of using mobile applications and Web 2.0 technologies are not limited to the above. The next step in the study is to explore other resources for developing communicative competence.

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Moodle course in teaching English language for specific purposes for masters in mechanical engineering

Hanna M. Shalatska[0000-0002-1231-8847], Olena Yu. Zotova-Sadylo[0000-0002-9474-016X] and Ivan O. Muzyka[0000-0002-9202-2973]

Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
shalatska@i.ua, hjzotova74@ukr.net, musicvano@gmail.com

Abstract. The central thesis of this paper is that e-learning courses can have a significant impact on English language for specific purposes (ESP) proficiency of mining mechanical engineering students. The purpose of this study is to assess the effectiveness of ESP Moodle-based course "English for Mining Mechanical Engineers" and to reveal the results of its experimental approbation. In order to identify the lectures' and learners' needs we have applied the survey research. The survey confirmed the greatest demand for Moodle courses that include all the elements of a coherent training manual to provide self-development of engineering students. The interview results contributed to design of author's ESP course syllabus. The importance and originality of this study are that to approbate the course materials' effectiveness two approaches have been adopted simultaneously. The first is blended learning method based on e-learning platform applied in the experimental group and the second one is classic in-class instructor-led studying used in a control group. Students' progress in ESP proficiency has been assessed using the cross assessment method. The experiment has validated the initial hypothesis that the special online courses focused on honing foreign language skills and integrated in the domain of specific professional knowledge have a beneficial effect on students' communicative competencies in general. There were identified the advantages of self-tuition based on Moodle platform. The Moodle course lets the teachers save considerable in-class time to focus more on communicative assignments. The findings of this study have a number of practical implications in ESP online courses development.

Keywords: Online Learning, Moodle Platform, Blended Learning, ESP Course, Masters in Mechanical Engineering.

1 Introduction

The tendency to move from traditional education to blended [5; 11] and virtual [6; 22] learning applies to Ukrainian higher education, and an increasing number of courses appear for teaching at a distance. E-assessments have become a major component of student's independent work [14; 16; 31]. Information and communication technology (ICT) skills play a major role in today's technology world and led to an increasing use of web-based systems like Moodle [1; 19; 21]. Researchers have not treated Moodle in studying English for specific purposes (ESP) for master's students in much detail so far. This study seeks to consider the ways of using different assignments of Moodle-based ESP course for organizing student's independent work according to the curriculum.

Analysis of recent research and publications. Latest studies describe the use of Moodle as a suitable platform to support distance learning courses, assess its functionality and potential. Al Nadabi's study focuses on the use of technology in assessment, contributes some guidelines that can be useful for creating, developing, implementing, and researching large-scale high-stakes tests on Moodle. According to his research, "Moodle activities are used in a blended learning approach either as practice materials or as informal assessment tools for some course components" [3, p. 6]. Jing Liu investigates the factors influencing ESL college students' acceptance and use of Moodle in their English classes [17]. Wajeha Thabit Al-Ani identifies factors behind the usage of a blended learning approach that could have an effect on students' achievement, motivation, collaboration and communication as perceived by students, analyzes obstacles faced by students in using Moodle in blended learning [4]. Kateryna V. Rudnitska and Veronika V. Drozdova analyze the problem of first-year students' of economic specialties self-study organization by means of Moodle system in the process of foreign language learning [24]. Aliona Yu. Yurzhenko describes and analyses the work of the future maritime specialists in the e-course [32]. Hicham Zyad examines tertiary education students' acceptance of and engagement in a Moodle-hosted writing course, measures time spent in activities, number of downloads from the platform and number of online feedback comments [34]. Group of scientists analyses the main tools available on the online platform, and concludes that Moodle is mainly used as a repository for materials [33]. Maria del Mar Camacho i Martí's doctoral thesis provides an online instructional model to train English Language Teachers in the use of ICT, a general vision on the new instructional modalities from blended learning to distance learning, and deals with the difficulties of including ICT into educational management, such as need to catch-up and update their equipment and training programs for their teachers and students [7].

Despite these existing studies, the level of research related to using of Moodle platform in modern ESP teaching and learning is still constrained and limited. Recent investigations analyze the benefits of Moodle, different areas of the system like resources, users and ways of learning management system (LMS) integration as online support throughout a semester course; however, long-term academic studies are also requested for obtaining a clearer picture of applying online platform in teaching and learning of ESP.

The purpose of the article is to explore ESP e-based courses as an effective method of improving the level of English language proficiency within the framework of Concept of English Language Development at Universities established by the Ministry of Education and Science of Ukraine; and to represent the curriculum of ESP course "English for Mining Mechanical Engineers" based on Moodle platform for students of mining mechanical engineering and reveal the results of its approbation.

It is hoped that this research will contribute to a deeper understanding of significance of blended learning approach to improving the level of English language proficiency of engineering students. Taking into account the objectives we have determined the tasks of our study. They are:

- to analyze the relevant scientific literature;
- to conduct a survey;
- to design the special course "English for Mining Mechanical Engineers" and identify the most appropriate tasks and assignments for e-learning;
- to assess the efficiency of this course through its contribution to enhance ESP proficiency of mining mechanical engineering students.

2 The theoretical backgrounds

We have analyzed and consolidated existing experience and practices at the initial stage of the study. Tom Hutchinson and Alan Waters claim that ESP must be seen as an approach not as a product [12]. It is approach to language learning, which is based on learner needs. The foundation of all ESP is the simple question: Why does this learner need to learn a foreign language? Peter Strevens defines characteristics of ESP as English language teaching which is designed to meet specified needs of the learner; it is related in content to particular disciplines, occupations and activities, and it is centered on the language appropriate to those activities in syntax, lexis, discourse, semantics, etc. [29, pp. 1–2].

Anthony Laurence in his book "Introducing English for Specific Purposes" investigates four pillars of ESP. Based on the works of the scholars who played the role of torch-bearers for innovative ESP approach to education, the 1st pillar is considered to be *needs analysis*. It is also significant that interests of all the stakeholders are also taking into account. The second pillar is *learning objectives* which mean how language is used in different contexts. The third one is *methods and materials*. The fourth is *evaluation* which includes reliability, validity, and practicality. In our research we have used Anthony Laurence's treatise as a basis, and have developed practical materials on the above-mentioned principles [15].

Weaving subsequent scholarly works as a thread through ESP is an approach to language teaching which aims to meet the needs of particular learners [2; 13]. Tony Dudley-Evans and Maggie Jo St John define ESP as a teaching method which emphasizes specific learner needs and a set of teaching patterns that recognize the learner's subject-matter expertise [9]. Hence, it may be concluded that the benchmarking of students' needs provides the basis for further practical guidance for implementing ESP courses. They have specified age of ESP students and the level of their language proficiency. They conclude that ESP is likely to be designed for adult learners, either at a tertiary level institution or in a professional work situation. ESP is designed for intermediate or advanced students. Most ESP courses assume some basic knowledge of the language systems.

From the perspective of that, Olga M. Demidova has drawn up the textbook "Engineering Mechanics (ESP)". Each module consists of an authentic professional oriented text, vocabulary and system of exercises. The author selected materials according to the criteria of authenticity, professional relevancy, and informative value [8]. This therefore corresponds fully with four pillars of ESP and the core recommendations of British Council.

K. Sasirekha, K. Rathiga, M. Sarpparaje and G. S. Suresh make a point that teaching materials for ESP have evolved several changes in recent years as a consequence of access to the relevant teaching materials via the Internet. It makes able-to-get all sorts of texts and all kinds of domain specific materials; whereas the role of a teacher is to make the information comprehensible for a student [25].

With regard to ESP teacher's tasks they are similar to any language teacher's the main one is to encourage the student to attend the classes, be active, to make students interested in writing by involving them in real-world and interesting activities, provide them with the opportunity to interact in groups, to share their ideas, and to help each other deal with specific problems. Besides, group work usually brings personal satisfaction, self-confidence, gives students a chance to be creative and imaginative through assignments such as revising a story or changing its ending and their motivation and enthusiasm also increase when they make their contribution and ideas in the written product [27].

Moodle LMS is a one of the most popular existing educational platforms available for providing a flipped classroom [10], conducting learning activity at flexible times and places through the Internet. Jing Liu gives explanation to the term "flipped classroom" that means the teaching method flips, or reverses from the traditional method. In a flipped classroom, the instruction is delivered online, which provides students with more opportunity to gain practical skills, preview lessons via video or audio and then accomplish various activities and exercises [17].

Aliona Yu. Yurzhenko [32, p. 71], Oksana V. Tynkaliuk and Iryna Z. Semeriak [30] emphasizes that using the e-course makes English training more effective, enhances the possibilities for obtaining knowledge, stimulates self-education, and the most efficient tools for increasing the learning motivation include: Forum, elements of the gamification (Game-based Exercises, Easter eggs, Leaderboards, Points, QR Code Quest), Glossary, Presentations, Test Tasks (Quizzes), Grade books.

Wajeha Thabit Al-Ani indicates that Moodle has more impact on context of learning, implements knowledge-centered learning techniques and develops students' self-regulated skills [4]. Furthermore, Hicham Zyad notices that Moodle is "a learning management system with several useful features that can transform the learning environment into a site for interactivity, connectivity and great amounts of extensive learning" [34, p. 314].

However, some researchers argue that "the successful use of e-learning platforms in the teaching and learning context critically depends on the teachers having knowledge about the tools, being aware of how they should be used and being capable of organizing all the communication process" [33, p. 289]. The results of Dr. M. Marti's research provide evidence of ICT in teaching English as a foreign language applied as a tool to work, to search for the information and to manage administrative tasks. Teachers have more skills in the use of e-mail and word processors, the different reference tools such as the online dictionaries, encyclopedias, virtual resource centers, educational portals, whereas they demonstrate the lack of instruction and knowledge in the usage of forums and chats [7].

In view of all that has been mentioned so far, we may suppose that ESP course based on electronic platform is a science-relevant subject to investigate and develop.

3 Methods

To investigate teachers' expectations, needs and difficulties we have applied a method of survey. The total number of respondents was 62 teachers from 6 departments.

The majority of those who responded reported that they used Moodle platform and special courses particularly in their teaching practice. Only a small number of respondents 3% indicated that they had not used Moodle yet. One of the reasons they mentioned was lack of experience in ICT applying. Interestingly, 42% of the lecturers observed the important role of Moodle courses in self-paced training of students.

More than half of those surveyed have agreed with the statement that applying of Moodle courses contributes to improvement of their classes' efficiency (62%), motivation of their students (59%) and quality of teaching (25%), individualization and differentiation of learning process (84%). 95% of the respondents have uploaded the author courses on Moodle platform at least once that contrasted somewhat with the low intensity of Moodle use (according to the questionnaire results it is on average twice a month). In this regard a question occurs: what are the reasons of lecturers' underactivity? We tried to seek the answers initiating the snap poll for the lecturers. The identified hindering factors towards Moodle platform usage can be summarized into: lack of personal computers in the class, restricted Internet access or speed, insufficiency of technical support (software), and inadequate knowledge needed to provide teaching via the Moodle platform. Taken together, these results suggest that there is poor flexibility of technology which includes poor flexibility in functioning, use and modification. Dave E. Marcial explains that poor flexibility of technology is an obstruction to innovative teaching and learning. Likewise, poor structural and process flexibility significantly influences the high adoption of technology in the classroom [18].

Let us turn to the learners' interview. In total 134 students of Mining and Metallurgical, Mechanical and Machine Engineering Faculties and Faculty of Geology and Ecology have been interviewed. The learners note they prefer working online to learning in class (89%). One of the reasons for this is global digitalization of different life areas, and young generation tends to be engaged to. The students explain their choice that IT makes training interesting, individual and varied in form. Some of them (37%) mention ability to manage the learning process themselves like a great advantage of online learning.

To find out the topics that the prospective participants of the experiment are interested in; we have offered them the list of themes selected from vocational disciplines curriculum and they should choose the most important ones to be learned properly in English. Some interviewees argue they will not deal with any foreign language in their future career (17%), while others 83% realize and support the need to have sufficient foreign language skills. The respondents have not selected only from offered but added several topics which they would have to cope with in their future career. The results of students' interview have become really meaningful to design our ESP course syllabus.

Taken together, these results suggest that there is a demand on special ESP courses and students are interested in improving the language proficiency, on the one hand. On the other hand, there are not enough courses which are narrowly focused on specifications of technical majors.

4 Findings

Accordingly, based on the results of the survey, students' and tutors' interviews we have designed the special course "English for Mining Mechanical Engineers" [26]. It is intended for advanced students specializing in mining engineering, geodesy, mining machine building engineering, mechanical engineering and other related specialisms. The purposes of the course have been established in accordance with to the criteria of authenticity, purposiveness of the language, and professional appropriateness of the content. This therefore corresponds fully with four pillars of ESP and the Concept of English Language Development at Universities [20]. The program of the course is targeted at the wide range of students of engineering specialisms of the 4th and 5th years of studying. It stems from their willingness and readiness to adopt learning material and to understand its applicability in their career context. We have in mind the proper level of professional knowledge and also their level of language proficiency. Besides, the ESP course demands motivation, dedication and responsiveness from the students. The graduate students, we are convinced, are in conformity with these criteria. The main objective of the special course is to improve students' reading, listening, writing and speaking skills within professional engineering context. The course is structured at different levels of proficiency and our program integrates the skills in professional area into foreign language proficiency.

Let us detail the learning outcomes according to language domains. By the end of the course students will be able to:

- reveal subject-specific language from a range of authentic sources;
- communicate about technical topics;
- read and comprehend specific engineering texts, tables and graphs, course brochures and job advertisements;
- differentiate and exploit various sources of information (written, spoken and video);
- be aware of principles of writing study- and work-related letters;

The special course "English for Mining Mechanical Engineers" consists of ten topical units, which are summarized in Table 1.

The special course has been used as an element of an educational experiment which we started in September of 2018 in Kryvyi Rih National University. The *objective of the experiment* is to test the designed special course "English for Mining Mechanical Engineers" on the Moodle platform basis and evaluate its effectiveness.

Table 1. Syllabus of special course "English for Mining Mechanical Engineers"

No	Topical Unit	**Learning Outcomes** ***By the end of this unit you will be able to:***
1	Organisational Structure	• understand topical vocabulary and learn to use it in an appropriate context; • identify the key sentence (topic sentence) in a paragraph; • develop critical thinking abilities and cultivate work ethics; • analyse graphs and digammas in terms of organisational structure;
2	Career	• select and analyse the contents of job advertisements; • write appropriate CV; • write a covering letter in response to the advertisement on the company's website.
3	Minerals	• acquire fundamental skills of speaking about of basic properties of minerals; • develop an understanding of authentic topical video; • identify some minerals by their basic physical, chemical and mechanical properties and describe their properties.
4	Four States of Matter	• master the information of the topical text "Four States of Matter: Solid, Liquid, Gas, Plasma"; • make up a plan using the keywords and phrases; • annotate the texts.
5	Mining Machining	• identify the giant mining machines and their importance in mining (video); • improve listening skills; • select and summarize the important information.
6	Autonomous Mine	• develop skills of summing up the video information about autonomous trucks; • summarize the information about their functions and applications in the autonomous mine.
7	Iron Mining and Geology	• be aware of exploiting iron in the modern world, creation and excavation of iron ore deposits; • adopt the information from video; • draft the report of the survey.
8	Iron Ore Processing	• analyse the information of the video; • speak confidently about the key terms connected with concentration, palletisation and alloying; • plan a presentation on the topical video.
9	Surface Mining Demonstration	• identify important functions of surface mining procedure (based on the video); • analyse a written text in terms of layout, genre, functional types; • write an informational e-mail with regard to repairing of some mining machines.
10	Impacts of Mining	• understand a range of processes involved in mines affect the environment and investigate ways of reducing the impact; • establish clear aims for practices at mine sites that reduce environmental impacts of mining; • find out how scientific understandings influence mining practices; • design strategy plan in terms of land rehabilitation measures.

To provide the educational experiment properly we have selected a control (58 students) and an experimental (61 students) group as well as 11 lecturers from the amount of participants who have taken part in the ascertaining experiment. Total number of students there are 119 who are studying at the Mechanical and Machine Engineering, Mining Faculties, Faculty of Geology and Ecology. The group of 11 lecturers has taken initiative in promoting the experimental activity too. According to the experiment procedure the students have to master the learning material within the syllabus of the discipline “Business Foreign Language” (BFL) as approved by the University curriculum. The course “English for Mining Mechanical Engineers” has become the major component of experimental group’s educational activity. BFL program includes 32 academic hours of in-class activity and 58 extracurricular hours. The special course has been a meaningful component of self-directed students’ training. The top page of newly architected course is presented on Figure 1. It contains its short description, the goals of the special course and structure navigation.

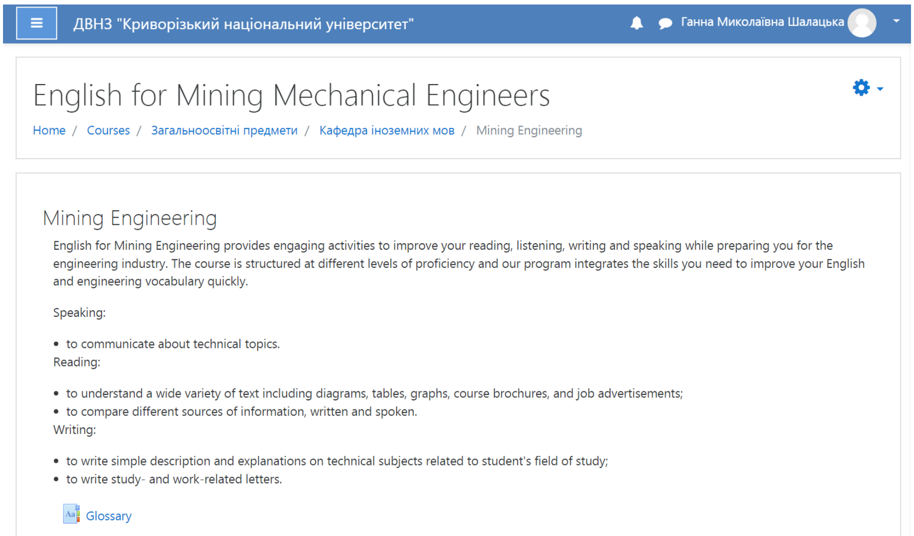

Fig. 1. Top page of the course “English for Mining Mechanical Engineers”

It should be noted that only enrolled students had access to the course materials during the experiment (2018-2019 academic year). The materials and activities of the course are meant to be used in class and distantly since it was available online on the Moodle platform. The students of the control group used the materials of the course in class only. The self-training of the control group based on the exercises from the traditional study guide arranged and published in 2011. The experimental (Moodle) group spends most of the class time doing communicative exercises and discusses project, completing all homework assignments on Moodle, while the control group (CG) does homework assignments in a conventional way – on paper.

The learners in the Moodle group (MG) have access to the Glossary loaded onto

Moodle course “English for Mining Mechanical Engineers”, which can be updated and edited, while the learners in the CG have printed word lists that can not be updated after they have received them. Furthermore, the glossary on Moodle provides the opportunity of including sound clips, i.e. students can hear the pronunciation of the words, and upload images. The learners are able to contribute to the glossary, which provides collaborative learning opportunities, for example definition creation help them to learn new words and concepts such as “bucket wheel”, “conveyor belt”, “crawler tracks”, “pressure”, “property” etc.

By using of Moodle audio and video authentic materials provided with the help of online platform recreate the kind of real-life atmosphere that is close to real working situation. To improve listening skills and pronunciation some audio materials and video clips have been included in the course content. For example, the learners should answer the questions by watching a video from YouTube “Mining Technology Product Demo – MINExpo 2016” in Topical Unit “Autonomous Mine” and “A Monster of Mining” in Topical Unit “Mining Machining”. The students can access to the listening and video material without limitation, they can control the mode of playback – pause, stop, or use rewinds the video. The students in CG watch the same videos only in the class, as a rule, twice.

Different forms of learning, remembering and recalling are at teacher’s and student’s disposal due to applying of Moodle. For example, in the process of studying Topical Unit “Career” there are two job offers of European and Canadian companies under internship programs (Figure 2).

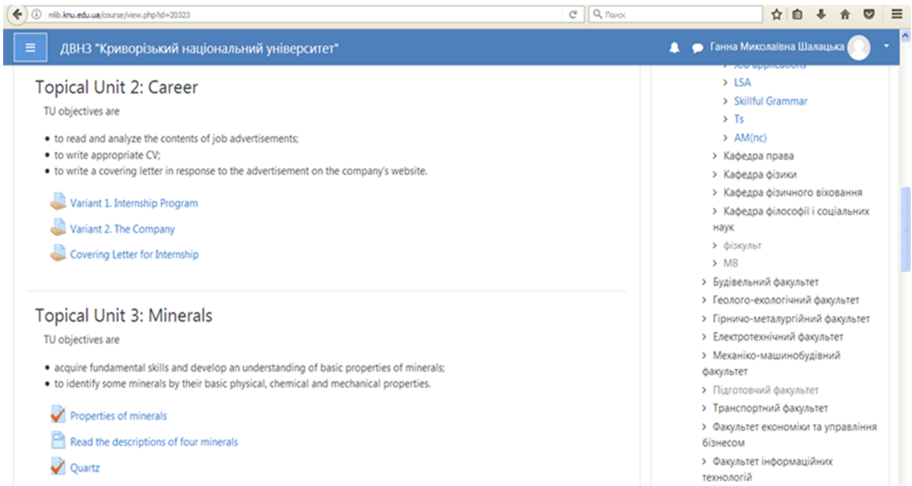

Fig. 2. Design of Topical Unit “Career” and “Minerals”

Besides the information included in the special course further details on the vacancy are available on the website of the company, and students can click the link and apply for a post. It is worth noting that about half of the participants (48%) of the experimental group did not confine themselves to complete the course’s assignments and submitted their CV and covering letters to the real companies via the Internet, and as a consequence they had got feedback from both a university teacher and a real employer. Such form of work that implied linking between new information/skills and real life experience is really helpful, since it enables to identify learners' own strengths and weaknesses and draw the necessary conclusions.

In addition, there are other options of online learning run on the Moodle platform. We have developed assignments, quizzes and exercises for the Moodle course, which are available to the students online, and can be accessed from anywhere. The participants of the experiment have completed the same tasks during blended and traditional classes that have shown the difference between paper and computerized tests. When completing a quiz or assignment on Moodle platform, the students receive immediate feedback on their answers, re-attempt quizzes (pass the test once more time) or resubmit the assignment. On the contrary, the learners in the CG have to wait to receive their graded assignments or tests from the teacher. In the MG, the questions and answers in quizzes are shuffled and the learners all receive different questions. The learners in the CG get the similar content and the same sequence of questions per group. Online course quizzes have the titles and descriptions that reflect the content and the type of questions. Multiple choices, matching, essay type, short answers and true or false questions have been used on the time-limited basis. The students are allowed two attempts and the quizzes are set to use the highest grade of all attempts. In addition, they have been allowed to review past attempts of the quiz. This enables them to learn from their own mistakes. For essay type questions, the learners' grade is updated after the educator has marked the question. It is absolutely objective assessment and greatly facilitates the teacher's routine activity (Figure 3).

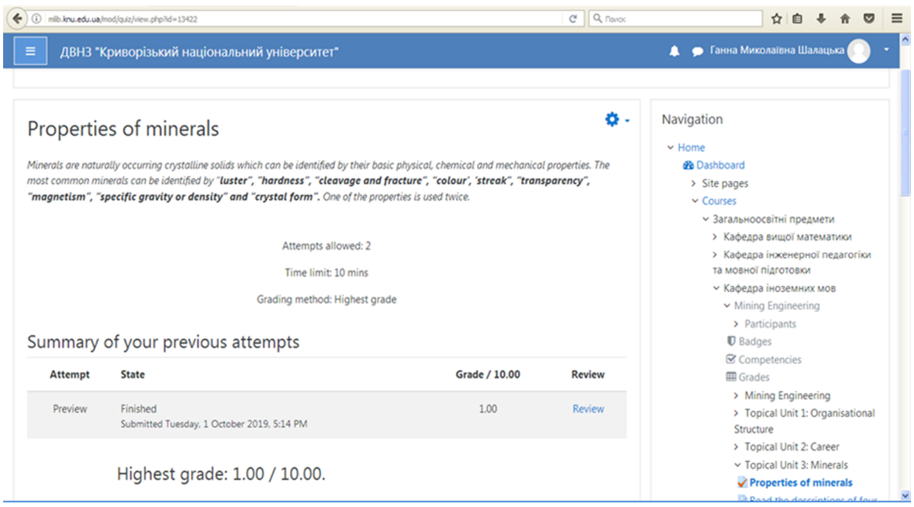

Fig. 3. Evaluation options of student's activity (using the example of Topical Unit "Properties of Minerals")

The special course includes a great variety of activities. The exercises have been categorized according to Bloom's taxonomy cognitive domains from basic ones – knowing, understanding to the top domains like evaluating and creating [28]. The assignments correspond to the categories of the cognitive domains and expected outcomes as well. At the stages of knowing and understanding, for example, these are multiple choice answers, matching the words and their definitions or choosing the synonyms and antonyms and so on (Figure 4).

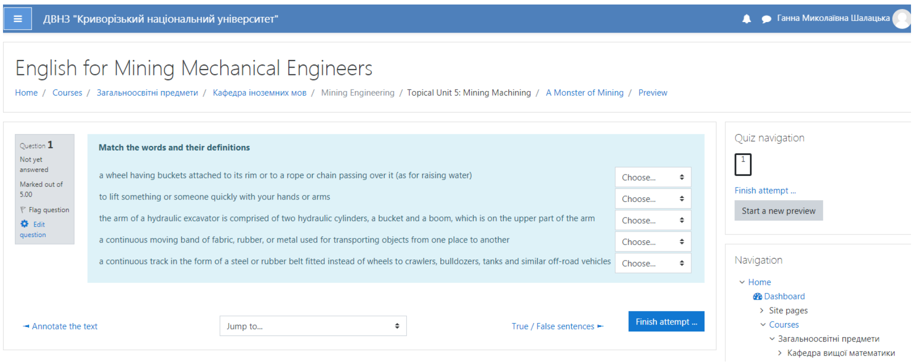

Fig. 4. Example of exercise based on multiple choice options

As we can see on the screenshot the Moodle software gives an opportunity to complete the activity on the limited time and number of attempts, on the other hand, the learners are able to analyze their mistakes due to the platform's options as well.

The next element of our course is a discussion forum which provides a title and description of what learners can expect to read in the forum. The learner can reply on a post created by the teacher for discussion. Forum allows students to exchange their ideas, express opinions, leave messages, post a picture or resource link, receive points for the correct answer. For example, the students in the process of studying Topical Unit "Mining Machining" analyze the problem connected with the proper work of the truck's diesel engine and find out the possible causes of power loss.

At the next stage of applying and analyzing the students should categorize some aspects of activities. For instance, when the students are studying Topical Unit "Impacts of Mining" they have got a task to look closely at the diagram of a mine site and consider the features and activities that could have an effect on the environment (Figure 5).

At the final evaluating and creating stage outcomes are following: to annotate the text, draft the report of the survey, develop the presentation, design the strategy plan etc. For example, two formats of presentations are included in the course content (Focusky and PowerPoint). Focusky offers possibilities to create different kinds of presentations such as online and video presentations, mind-mapping design. Students are able to develop animated presentations, edit the flash based templates and logically arrange contents, due to 3D zooming, panning and rotating effects they can make the presentation play like a 3D movie. Focusky is more powerful than PowerPoint and has only English interface that allows students to expand their vocabulary and practice foreign language in professional context. The learners can also add the text, images, video and animation in their slide presentation. They have created the presentations on the following topics: “Career of Mechanical Engineer in Mining Company”, “What does job of a mechanical engineer involve?”, “Mining Mechanical Engineering Society”, “Popular Skills for Mechanical Engineer” etc. Links to additional information and choices of assignments allow the learners to be more active participants in the studying process. The deadline for these assignments has been set and announced. Students upload their works to Moodle course, and then get teacher’s feedback and assessments, after that the presentation should be discussed in class.

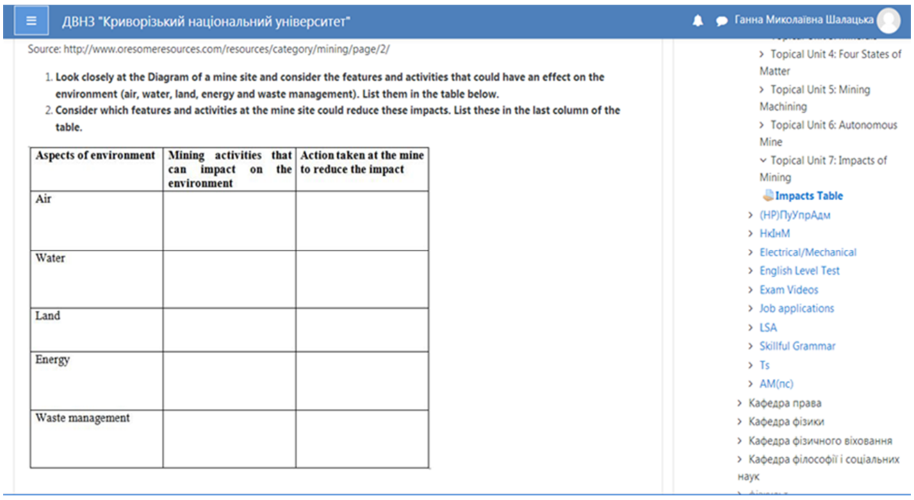

Fig. 5. Topical Unit “Impacts of Mining”

To assess objectively engineering students’ communication proficiency we have applied the complex of monitoring methods. These are the presentation of research papers at the international scientific conference “Problems of Energy Efficiency and Mechanization in Mining and Metals Sector Industry” (2019) and the term thesis on vocational subjects in English [23]. The experts assessed the level of English language proficiency based on appropriate checklists. Additionally, the students were proposed to evaluate their progress in speaking, listening, reading and writing used the same checklists.

Let us analyze the qualitative changes of the level of language proficiency at the final stage of the experiment in view of the results of self-assessment. The respondents have rated, on a scale of 1 to 10, their progress. But previously at the ascertaining stage we determined the benchmark language proficiency based on the same checklists. The quantitative results are visually represented on Figures 6 and 7.

What stands out in this figure is the steady growth of the students’ language proficiency in both experimental (Moodle) and control groups. In the CG this can be attributed to the traditional system of training in accordance with the curriculum and using the special course materials in class. At the same time Figure 7 reveals that there has been a marked increase in four types of activities and obviously the growth rates is steady higher in the MG. For example, the respondents of the MG asses their listening at 8,7 points whereas the average grade in the CG is 6,9. The experimental group maintains the positive tendency of growth on other skills as well.

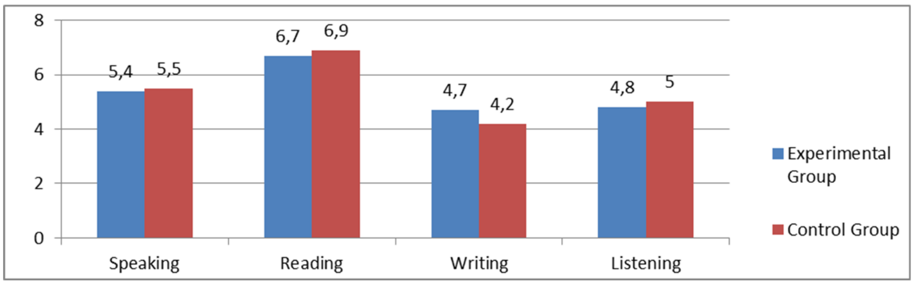

Fig. 6. Self-assessment results of English language proficiency before the experiment

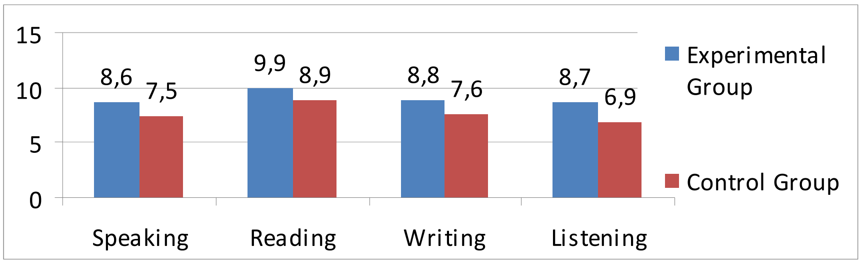

Fig. 7. Self-assessment results of English language proficiency after the experiment

In order to verify the objectivity of the results of students' self-assessment we asked the experts to evaluate students' activity using the checklist. The analysis of the results is shown in the Figure 8.

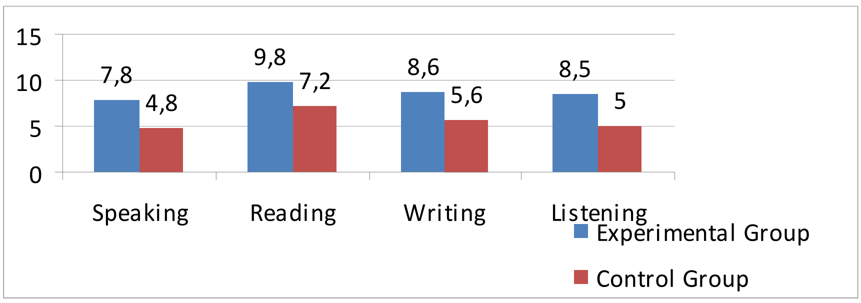

Fig. 8. The results of experts' assessment of English language proficiency after the experiment

There is general tendency of discrepancy between English language proficiency of the mechanical engineering students of two groups. Two graphs constructed using the available data confirm it.

Thus, the effectiveness of the special course “English for Mining Mechanical Engineers” and its didactic abilities clearly emerges from data. Comparing parameters of two groups at the final stage of the experiment we have aimed to determine the results of formation impact of Moodle course on the English language proficiency of the students of two groups.

Let us characterise qualitative changes in language proficiency of the engineering students of both experimental and control groups. During the conference and thesis defence the experts assessed speaking, listening and writing skills without informing the students about it, this ensured fairness of the experiment and friendly working environment. It should be noted that the experts had been able to observe the students previously at the ascertaining stage. The experts’ assessment at the final stage of the experiment was focused on comparison of the language proficiency of the respondents before and after the experiment and identifying the qualitative changes or their absence. According to the experts’ evaluations the students of the MG demonstrate high level of public speaking, they manage to represent their reports successfully, literacy and vocabulary have been improved too, the students are proficient enough in professional terminology and scientific terms as well. It stands to mention that students of both groups have been highly active during discussion of other participants’ reports and thesis. However in compliance with the experts students of the Moodle group formulate questions more accurately and correctly, find valid arguments for debates, are more flexible and more responsive in general. This is resulting from their purposeful vocational oriented training English proficiency; they have got an opportunity to improve their skills in class and additionally got an access to online course which contained authentic vocational oriented videos, texts, listening materials and appropriate exercises and tasks. They could train their language skills at their own pace. This approach has provided excellent results.

5 Conclusions and prospects for further research

The present study has been undertaken to design an ESP special course on Moodle platform for mining mechanical engineers, evaluate its effects on English language proficiency of the learners and reveal the advantages of e-learning approach to teaching and learning ESP. This research has found that Moodle can be an ideal platform for promoting efficient in-class teaching and distant self-studying because it creates multi-tool learning environment that is convenient to use by teachers and students as well.

The performed experiment has confirmed that an author’s special course “English for Mining Mechanical Engineers” has had a significant positive impact on the level of English proficiency of the experimental group students. In complying with the experts’ assessments and opinions the difference between students of experimental and control groups is distinctive. The expertise reflected in the scores on 10-point scale reveals that increase of average grades of experimental group’s students is +3,0 in speaking, +3,5 in listening, +2,6 in reading and +3,0 in writing in comparison with the control group. Considering that two groups have been trained according to the same curriculum and the only difference was that the experimental group have been engaged into Moodle course practice not only in class but as a part of individual work, and taking into account the results of students' self-assessment, experts' assessments and summed up their evaluative judgments we could make a conclusion that the author's special course "English for Mining Mechanical Engineers" on Moodle platform has exercised significant influence upon mining mechanical engineering students' English proficiency. Collected data suggest that the sufficient competence level of English can be achieved by comprehensive in-system approach of instructor-led activities and self-studying based online learning. Multimedia resources have enriched the content and made the learning environment more interesting and appealing to the learners. The experimental experience has revealed the advantages of e-learning approach to teaching and self-tuition based on ESP Moodle course "English for Mining Mechanical Engineers". These are:

- *technological flexibility*; the e-platform provides easy-to-use, affordable and diverse teaching toolkit; it allows learners to reach the course content as many times as they need so they get a deeper understanding of the educational material; the special course assignments have contributed to improve English language proficiency of prospective engineers in reading, listening, writing and speaking stemming from complex approach: glossary, texts depositary and databases provide access to a vast range of information and allow students to develop skimming and scanning techniques in reading; authentic materials and communication via discussion forums facilitate foreign language fluency; word-processing applications allow students to prepare and edit the writing assignments and then upload them on the e-platform; multimedia and flash-based presentations enables to practice technological skills along with foreign language skills; on the other hand, Moodle supports the lectures to design author's courses to be fully online, to focus on learning outcomes but not on seeking for appropriate textbooks, printing out and replication materials; in addition, content of courses can be updated easily;
- *adaptability to student's individual aptitude and abilities*; each learner has his own pace of understanding and remembering of the language materials and Moodle based course makes available to follow it; students are not limited in number of attempts, there is no time restrictions if only it is not a reading or listening comprehension test; video clips can be slowed and replayed repeatedly according to student's individual needs and improve their listening skills;
- *preventing from premonition of failure*; individual work combined with ongoing online support to assist the students in his education and to avoid mishaps and criticism from other group mates makes it possible to succeed in achieving the anticipated outcome;
- *impartial assessment*; Moodle grounded course makes available quick feedback on learner's activity and clear-eyed evaluation; offered tools ensure quality of assessment and prevent from cheating; there are self-check, machine check and tutor's assessment at participants' disposal; besides, the course can provide group-

mates' feedback exchange; as we have seen from experience, the last way of control motivates students to improve their language skills as they have not only produce own outcome but be an expert;

- *differentiation*; before designing online ESP course the authors have studied the potential learners' needs, interests and level of proficiency; the outcomes, authentic texts, video or listening elements of the course "English for Mining Mechanical Engineers" are relevant to these requirements; Moodle offers some ability to differentiate tasks and assignments according to learners' needs and pace of studying; the authors have developed the tasks with various complexity levels, preplanned and programmed different quantity of attempts or time of completing exercises, opened or closed access to some types of activities, verified deadline etc.

A further study could assess the long-term effects of self-study courses in ESP on Moodle platform. Based on the findings of this study, further research might evaluate the increasing use of the Moodle platform for studying different language programs; explore development capacity and growth perspectives in this domain. The findings from this study contribute in several ways to the current methods of ESP teaching and provide a basis for educators who are engaged in ESP course design.

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Cloud technologies for STEM education

Nataliia V. Valko[1[0000-0003-0720-3217]], Nataliya O. Kushnir[1[0000-0001-7934-5308]] and Viacheslav V. Osadchyi[2[0000-0001-5659-4774]]

[1] Kherson State University, 27 Universytetska Str., Kherson, 73000, Ukraine
valko@ksu.ks.ua, kushnir@ksu.ks.ua
[2] Bogdan Khmelnitsky Melitopol State Pedagogical University, 20 Hetmanska Str., Melitopol, 72300, Ukraine
osadchyi@mdpu.org.ua

Abstract. Cloud technologies being used in STEM education for providing robotics studying are highlighted in this article. Developing cloud robotic systems have not been used to their fullest degree in education but are applied by limited specialists' number. Advantages given by cloud robotics (an access to big data, open systems, open environments development) lead to work with mentioned systems interfaces improving and having them more accessible. The potential represented by these technologies make them worth being shown to the majority of teachers. Benefits of cloud technologies for robotics and automatization systems are defined. An integrated approach to knowledge assimilation is STEM education basis. The demanded stages for robotics system development are shown and cloud sources which could be possibly used are analyzed in this article.

Keywords: STEM-Education, Cloud robotics, Educational Projects, Cloud Resources, Robotic Projects.

1 Introduction

Cloud Computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [18].

The non-paying attention to disadvantages, with distrust to suppliers of cloud services being main, allows cloud technologies increase their popularity. Web-sites, emails, connection/communication sites and mobile services are among the most popular ones (see Fig. 1).

2 Related works

Having been developed technologies have occupied each activity sphere and caused new educational paradigm to appear "…ensuring equal access to quality continuous education for everyone who have to study, who have a wish and a need for long-life learning and for those who have an opportunity to study" [3]. This paradigm following completely depends on cloud source usage, because of its features, which in turn are a part of digital learning environmental with the benefits bellow:

- equally easy data access, regardless of user location, users' amount and time of logging;
- opportunity of team-working;
- no need of special programs installation, the most comfortable way of dealing with data would be ensured by cloud services;
- no problem with software updating as data bases and information (and services/staff) are being kept on server;
- no problem with special software installation, its license checking as cloud services are to provide comfort work level with data and information;
- increased speed of data shearing/decreased time;
- comparative safety level.

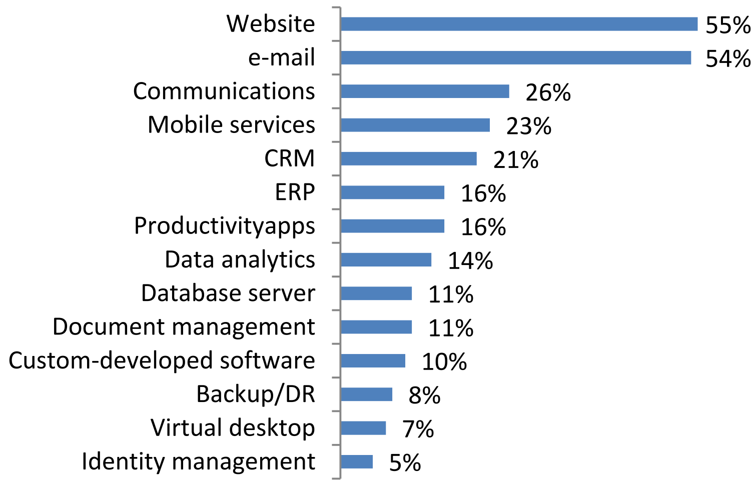

Fig. 1. Adoption Rate of Applications Fully Run in Public Cloud (2019) [5].

The traditional learning environment has been complemented by a digital one – the scope of information and communication technologies (ICT), including the Internet, mobile and related technologies and devices, as well as digital networks, databases, content and services [28]. Scientists note the cause of changes in education has been cloud technologies as part of the digital learning environment. The paper [17] identifies the relationship between cloud technologies and their place among learning technologies.

There are following changes [13]:

- subject-technological organization of information educational environment,
- regulation of accumulation processes and storage of electronic educational resources,
- equal access ensuring to educational resources for students,
- improving of ICT support of learning processes,
- measuring and monitoring of student's knowledge level.

The cloud environment serves as an integrative and system-forming function in the educational environment of an educational institution [30]. It provides resource support and serves as an independent learning tool. From the point of view of teachers and students, educational technologies fulfill five basic functions [16]:

1. Communication between students and teachers.
2. Making of documents, drawings and other works by students and teachers.
3. Dissemination of the work.
4. Saving lessons.
5. Internet access to special resources.

Due to cloud technologies development, innovative models of student's learning have acquired the new content and forms. New features are [7; 33]:

- Conducting experiments in virtual laboratories.
- Study of online courses at a race, according to the possibilities.
- Web conferencing
- Digital technology use to organize the learning process in the classroom and outside it.

Peculiarities of the organization of learning by means of cloud technologies are reflected in the forming process of a personal learning environment, in strengthening of their role in learning, in the emergence of new roles of teacher, such as: master in the studio, learning administrator, tutor [11; 15; 32; 35]. Therefore, the training of future teachers should take into account the changes in the technological world.

The issue of the quality of future teachers training with the use of cloud technologies has reached a new level; the motivation determines the content and nature of activities. Meaningful choice of activities, advanced settings, adaptive system of tasks, the possibility of real feedback and creating an atmosphere of cooperation allows developing of the comfortable learning environment [2; 14; 25; 26; 36]. The organizational factors are [20]:

- ICT competencies forming in teachers and leaders as a driving force of pedagogical innovations,
- organization of appropriate technological infrastructure as a basis for the ICT introduction in the educational process,
- reorientation of curricula and methods to the widespread use of electronic resources,
- e-learning tools and online interaction of participants in the learning process as tools of modern educational information environment.

Despite all pros mentioned above, cloud technologies usage has several cons that are to be considered at educational process supported with such a technology is being organized. For instance:

- depending on electricity availability;
- the cloud service provider is empowered with absolute access to and control on data;
- resource is being worked and supported until the cloud service provider does it;
- resources may change monetary policy and limit the functional or they are no longer available;
- the data typing and standards lacking limit the cross-platform transition between resources.

The analyze of reporting (NMC Horizon Report) over the past seven years was carried out by educational association Educause [1] and main trends, challenges and higher education technologies' breakthroughs having been paid attention were made distinguish. Rise of new forms of interdisciplinary studies, cross-institution and cross-sector collaboration, proliferation of open educational resources, deeper learning approaches, collaborative learning, growing focus on measuring learning, advancing cultures of innovation, redesigning learning spaces were mentioned among the most interesting recent trends. The usage of cloud computing is needed for the majority of them being realized.

Cloud technologies are highly likely to effect on learning tools, methods and forms changing and to cause education modernization. There are some technological developments taking contemporary educational process over [1] (see Fig. 2):

- Adaptive Learning Technologies, Artificial Intelligence (AI) usage possibilities are related to switching to personalized learning [8; 24]. Such technologies as data analytics, machine learning, natural languages processing and chat bots applying is needed for this process [10; 27; 37]. Cloud computing provides an opportunity of producing and collecting big data which in turn allows to track education effectiveness and to personalize it with using adaptive technologies aimed to improve further learning direction. Not only technology applying during lessons is not enough but profound understanding of connection between digital tools and expected results is demanded. It has to be deeply integrated into learning process.
- Next-Generation LMS, Analytics Technologies – cloud technologies allow getting learning result not only at the end of the term but keeping it up to date. The most of educational institutions manage developing their own learning platforms which organize communication and cooperation. This platform is known to deliver personalized information about schedule, email, payment, learning courses and current progress.
- Interactivity, Mixed Reality – is an essential feature of any course or technology [23]. Moreover, increasing learning result and involving greater number of students are ensured by this characteristic.
- Microlearning, Mobile Learning [19] – a possibility of learning material fallen apart caused by practice of quickly changed and visual content consumption commonly

seen from youth. Besides, a need for rapid skill achieving while work being done leads to short-term courses implementation that are accessible at any time.

— Robotics, The Internet of Things, Makerspaces – not only the work is being taken away from people by robots but they provoked a workplaces appearance. The brand-new laboratories opened students could try their skills in practice. Educational institutions tend to start up vast number of innovations.

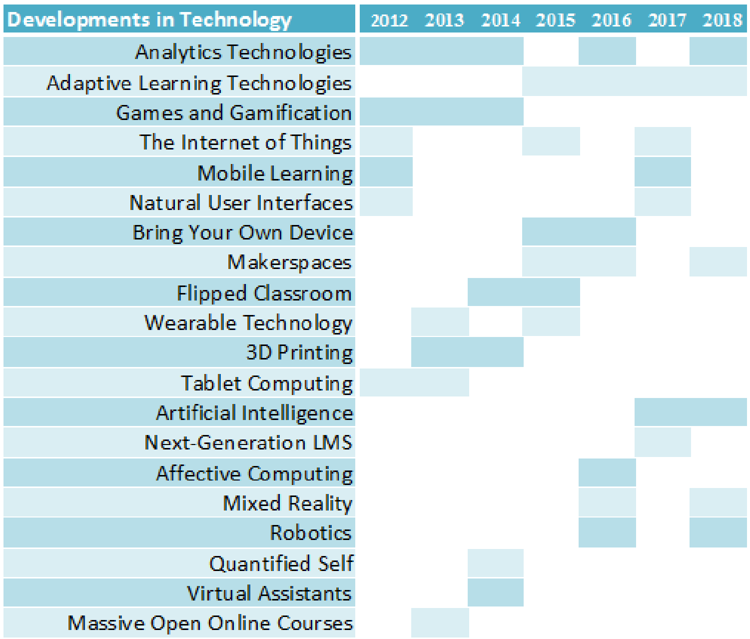

Fig. 2. Seven Years of the NMC Horizon Report Higher Education Edition (from [1]).

According to “Strategy of informational society development in Ukraine” development and application of supercomputer systems especially based on grid or cloud technologies ones are being one of the strategy realization stages in 2013-2020 years [4]. Hence, it means new digital infrastructure formation and educational digital environment reorganization.

The requirements of modern society to the level of digital media mastering, understanding of the principles of their functioning have grown significantly. It requires specialists with good natural-mathematical training. However, only about 10% of students in Ukrainian schools choose this profile as their specialization. Therefore, one of the goals of the education system is to increase students’ interest in the study of mathematics, physics, programming and other disciplines. One of the ways to achieve this goal is to develop STEM education (STEM – Science, Technology, Engineering and Mathematics) [12]. The greatest interest among students is caused by such a direction of STEM education as robotics. However, a prerequisite for the development of this trend is the availability of specialists, teachers willing to develop STEM-projects with students. It requires updating of teacher training system and advanced teacher training and mastering of necessary technological base and the corresponding cloud services.

The current stage of robotics implementation in education is reflected in scientific publications of Ukrainian scientists such as Nataliia V. Morze, Oksana V. Strutynska, Mariia A. Umryk, Olena S. Kuzminska, Mariia A. Gladun, Serhii M. Dziuba and others [20; 21; 22; 31]. The number of publications in robotics from 2012 to 2019 is indicated in the Table 1 (data taken from scientific journals in Google Scholar and in Vernadsky National Library of Ukraine). By 2016, robotics was exclusively a discipline of non-formal education for schoolchildren and professional education of future engineers. In 2016, in Ukraine, robotics became part of education, which led to its popularization. Most publications are devoted to robotics use for teaching students, including future teachers, in the context of STEM-education. Another part is devoted to the use of robotics in lessons at school. But among them there is no topic about cloud technology used to learn robotics.

Table 1. The number of publications in robotics in Ukrainian scientific journals

Year	University education	School education	Total
2012	1		1
2013	1		1
2016	5	2	7
2017	4	1	5
2018	2	4	6
2019	4	3	7
Total:	**17**	**10**	**27**

The idea of STEM technological component is widespread use of digital technologies, including cloud technology. We overviewed the cloud resources for robotics learning. The purpose of the article is to analyze modern cloud technologies of STEM learning for robotic systems designing.

3 Results of the research

It should be noted the term “cloud technology” in scientific publications refers to cloud services. Robotics is not limited onboard resources for computing, storage, or software thanks to technology advances. It has the added capabilities owing to cloud-based technologies; they enable the development of automation systems and robots that exchange data and perform calculations using neural networks or artificial intelligence [29; 34; 35]. Cloud robotics relies on network data to support its work. It has integrated storage into a single, standalone system [6].

Robotics has a number of potential benefits of the cloud [9]:

- Big Data: access to libraries of images, maps, trajectories, and descriptive data,
- Cloud Computing: access to parallel grid computing on demand for statistical analysis, learning, and motion planning,
- Collective Robot Learning: robots sharing trajectories, control policies, and outcomes,
- Human Computation: use of crowdsourcing to tap human skills for analyzing images and video, classification, learning, and error recovery.

However, the main problem of the practices introducing is teacher training. The large inertia of the education system does not allow the rapid change of the training technologies. These technologies should be tested in the educational process. A sufficient number of supporters, teachers-innovators, who will use it and share their experience, should also be formed. To accelerate the stage of introducing robotics into educational activity, there is a need to train future teachers in natural-mathematical disciplines in the use of robotic systems. So, we see the first stage of robotics, when we use SaaS for “desktop” robotics. In the next stage, cloud robotics will be used for learning.

As robotic projects require not only a technical base, but also specialized knowledge of physics, programming, and digital literacy, the use of the following free SaaS cloud resources and platforms will help to organize the work or approach to the project.

- Cloud information resources
  - Try Engineering (http://www.tryengineering.org) – the platform contains examples of engineering professions and information about engineering in general, for teachers there are examples of lesson plans.
  - Diy (http://arduino-diy.com) – portal for students, who are fond of electronics and robotic projects. Hundreds of projects for the Arduino platform have been introduced. There are tutorials with step-by-step explanations and examples.
  - Arduino.ua (https://doc.arduino.ua) – this resource contains all the necessary information for the beginner in robotics: electronic boards, connections, components etc.
- On-line programming resources
  - Made with code (https://www.madewithcode.com/projects/) – a free resource from Google for programming studying. It has examples of educational software for children from the age of five. The resource is aimed at engaging girls in programming. Visual editor develops Blockly programs. It has step-by-step instructions and guide users. For children from 8 years old.
  - Scratch (https://scratch.mit.edu) – licensed by the GNU GPL. This programming environment is free to download and free to use in school or after-school education. Multilingual visual editor designs Blockly programs. It has step-by-step instructions for beginner users. For children from 8 years old.
  - Scratch for Arduino (S4A) – is a modification of Scratch that allows simple programming of an open source Arduino platform. Visual editor develops Blockly programs. For children from 10 years old.
  - mBlock (https://www.mblock.cc) – this platform is also a modification of Scratch and supports programming of robotic systems based on Arduino microcontroller

such as: ArduinoUno, Codey Rocky, mBot, Neuron, MotionBlock, micro:bit. Visual editor designs Blockly programs, and usual programs with commands. For children from 8 years old.

— Virtual labs

- Tinkercad (https://www.tinkercad.com) – design models that will be printed on a 3D printer (Fig. 3) and modeling for connection Arduino sensor circuitry on a breadboard (Fig. 4). It allows making device connection layouts, write applications, and test them online. Visual editor designs Blockly programs, and usual programs with commands. For children from 8 years old.

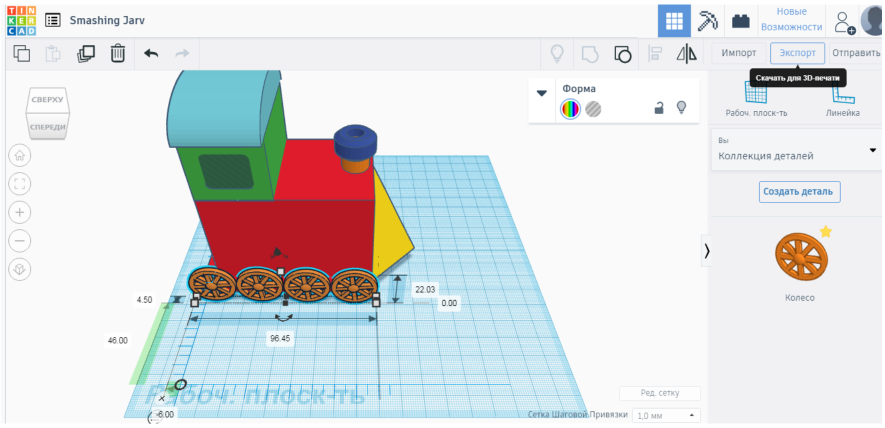

Fig. 3. An example of building a 3D model in Tinkercad

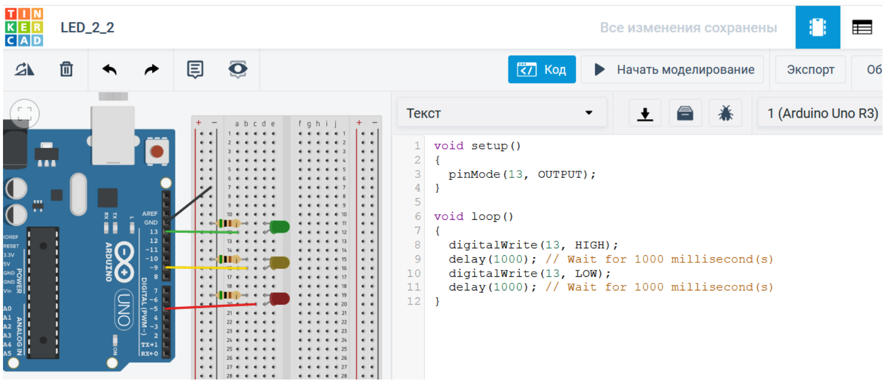

Fig. 4. An example of create device connection layouts and write applications in Tinkercad.

- Circuito (https://www.circuito.io/) – online layout of electronic circuits and creation of electronic boards. It has step-by-step instructions and guide for users. Visual editor designs programs with commands. For children from 12 years old.
- Easyeda (https://easyeda.com/) or CircuitLab (https://www.circuitlab.com) has an online resource for creating electronic circuits (Fig. 5). It has step-by-step instructions and guide for users. For children from 12 years old.

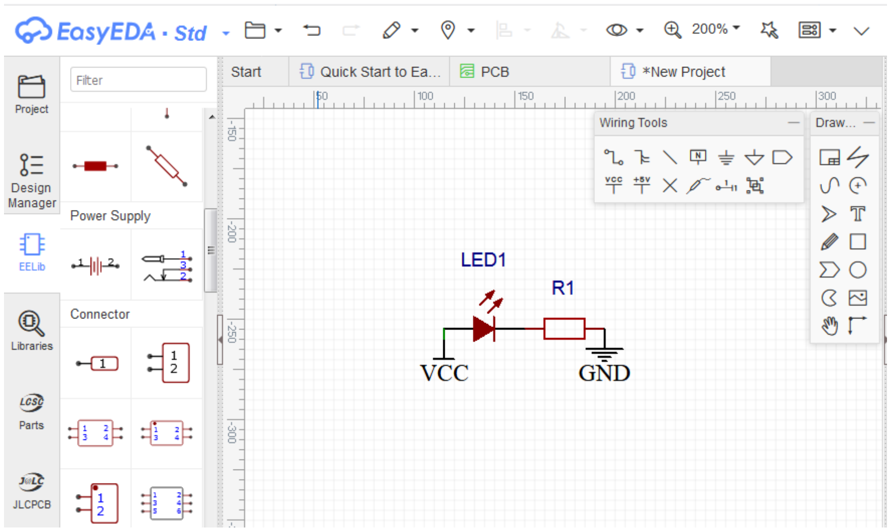

Fig. 5. An example of building electronic circuit in Easyeda.

— Professional communities – the purpose of such communities is to activate teachers and organize subject communities, join them for collaboration, and engage students in the learning process. Particularly, the most interested in information technology and robotics are the Ukrainian communities on Facebook “STEM-school”, “Digital Educator Group”, “IT scholar”, “Robotics and 3D modeling”, “Robotics of Kherson region”, “STEM step for everyone”, “Mobile Robotics Laboratory” etc.

Robotics is one of the areas of STEM education, which combines design and research activities. Such activities are different from laboratory ones by the lack of instructions on the sequence of actions, measurements, data processing, drawing conclusions. The educational projects are students drawing up an action plan, choosing a method of decision and processing of the results.

Educational scientific projects are necessary component of curricula in Physics, Informatics, Biology and Chemistry. The projects can be developed by using robotics.

Robotic project development requires the following steps:

1. Formulation and research of the problem and search for a technical solution – at this stage, theoretical and experimental modeling of reality and the search for a technical solution are performed. Organizing this stage requires robotics information resources contained the examples of projects or technological solutions
2. Robotic system development is a stage of carrying out research of a technical solution, its design, developing and approbation. At this stage, the structure, mechanical and electrical units are assembled.
   a. Modeling – at this stage, the choice of materials for the design, justification of the reliability of the selected scheme of connection of parts, an instructional scheme of assembly of the structure development are made. At this stage, the question of the functionality, ergonomics and interface of the future design is resolved. It

affects such aspects of the technical solution as convenience, safety and simplicity of use. An integral part of this stage is interface design. For this purpose, for example, on-line platforms of 3D models development are involved.

b. Design, prototype making – mechanics, electronics. At this stage, the collection of functional units, the assembly of the structure is conducted. It is important to test the design and make changes to the design. At this stage, it is functioning important to make an electronic circuit for the interaction of all robot devices and its sensors. The presence of cloud platforms allows creating a team project and schemes for working together. It also solves the problem of continuity if a project moves from one research group of students to another.
c. Programming is the developer environment. It is a stage of functioning algorithms development, writing/adjustment of the program, testing of the

3. Results sharing – the stage of presenting the work, drawing up documentation, evaluating own results.

The cloud resources use in the educational process makes possible to develop the complete educational and methodological support of the discipline "Educational Robotics". The implementation of these technologies requires specialists who have knowledge of mathematics, engineering and scientific approach to solving technology-based issues.

4 Conclusions and future work

The use of cloud technologies for robotic systems extends the capabilities: access to neural network and Big Data training databases, open competitiveness of automation and robotics systems, access to open source software. It solves problems of the educational process technologicalization, the integration of the engineering component into the learning process, the cost of experiments of electrical appliances and the training of robots. However, there is another problem that needs to be answered in the near future, such as data privacy.

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Analyzing of main trends of STEM education in Ukraine using stemua.science statistics

Yevhenii B. Shapovalov[1[0000-0003-3732-9486]], Viktor B. Shapovalov[1[0000-0001-6315-649X]], Fabian Andruszkiewicz[2[0000-0001-5318-3793]] and Nataliia P. Volkova[3[0000-0003-1258-7251]]

[1] National Center "Junior Academy of Sciences of Ukraine", 38/44 Dehtiarivska Str., Kyiv, 04119, Ukraine
sjb@man.gov.ua
[2] Uniwersytet Opolski, 11a Kopernika pl., Opole, 45-040, Poland
[3] Alfred Nobel University, 18 Sicheslavska Naberezhna Str., Dnipro, 49000, Ukraine
npvolkova@duan.edu.ua

Abstract. STEM-education is a modern effective approach that nowadays can be interpreted in very different ways and it even has some modification (STEM/STEAM/STREAM). Anyway, the "New Ukrainian school" concept includes approaches similar to STEM-education. However, there wasn't analyzed the current state of STEM-education in Ukraine. We propose to analyses it by using SEO analysis of one of the most popular STEM-oriented cloud environment in Ukraine stemua.science. It is proposed to use the cycle for cloud-based educational environments (publishing/SEO analysis/team's brainstorm/prediction/creation of further plan) to improve their efficiency. It is found, that STEM-based and traditional publications are characterized by similar demand of educational process stakeholders. However, the way how teachers and students found the publication proves that traditional keywords (47.99 %) used significantly more common than STEM keywords (2.67 %). Therefore, it is proved that STEM-methods are less in demand than traditional ones. However, considering the huge positive effect of the STEM method, stemua.science cloud educational environment provides a positive effect on the educational process by including the STEM-aspects during finding traditional approaches of education by stakeholders of the educational process.

Keywords: cloud educational environment, STEM, trends, education, scientific method.

1 Introduction

Nowadays, STEM is a very developed, modern and effective branch of education in all, elementary, middle and high education. However, there no single concept to implement it. Therefore, it was proposed to modify STEM to STEAM or even STREAM. By the way the interpretation of those approaches may differ and be modified (for example, A may be deciphered as ART [37] or as ALL [39]; R may be deciphered as READING [2; 29], as WRITING [2; 29] or RELIGION [22]). And it is a challenge as for the implementation of the STEM in cloud educational systems [43] and as for personal author who creates the STEM-lessons [17]. And it seems relevant to analyze the most demand directions in STEM/STEAM/STREAM education.

Nowadays, stemua.science [31] (Ukrainian STEM-cloud environment) is successfully functioning and few hundreds of works are already published in the e-resource. The recourse is characterized by open-type with moderation and it means that each teacher can present own work to the sociality by publication on web. Therefore, it is possible to use 2 years' experience of its functionality to provide analysis on demand usage of the methods presented on stemua.science.

This work aims to provide an analysis of the trends of usage of the STEM-methods and prediction of the further trends in STEM-education. In addition, it will be described the most popular topics and analysis of it which will be useful for the authors further.

2 Literature review and problem statement

It is well-known that STEM-education is a reaction to the market changes in USA at the beginning of the XXI century which is characterized by needs improvement of math knowledge and skills and providing critical thinking and making decisions of modern workers. Therefore, it was necessary to make changes in educational system by taking into account those challenges [7; 45].

Ukraine provides the reforms of education during a durable period. And the reforms of educational system differed from each other. Today, the reforms provided with impression of USA educational system witch partially implemented in the European countries due to its efficiency in USA. The planed reforms ("New Ukrainian school" [3; 6; 10]) are similar to those were provided in Poland where implemented the integration to study all natural subjects [13] and commonly there used transdisciplinary approaches in different forms such as providing of transdisciplinary days where students investigate some objects using whole day and research it from different points of understanding (physics, chemistry, history, art and etc.). In addition, it includes elements of international educational programs such as Science education (European Commission) [11] and Education 2030 [21]. However, Ukraine, unlike Poland, characterized by buffer state of the educational system. It means that reforms, declared by the Ministry of Education and Science of Ukraine, will be provided slower and it is necessary to provide analysis of its state. Despite the fact that STEM-education does not officially declare necessary to implement, the new educational programs include its elements such as research projects and there planned to implement transdisciplinary subject "Sciences", which, in addition to transdisciplinary, foresees using of the methods based on research. This is very similar to STEM-approach in education. Anyway, STEM-education nowadays in Ukraine is very popular and developed educational branch [5; 6; 36].

The creation of educational resources for teaching STEM no longer relies solely on the activity of traditional publishers [41]. It means that different publishers can provide the investigation of the STEM-based content and important role in it is belongs to cloud-based education environments and the effect of them usage may be even better compare to traditional approaches in education [8; 9; 14; 46] or can create some new possibilities to provide the experiment or visualization [49]. In addition, cloud-based environments characterized by possibility to overcome the limitations of traditional classrooms [30], can provide active way of cognition [4] and may provide personal-oriented education [26]. One of their advantages is possibility to find trends in the educators need by using SEO analysis results.

Nowadays, few cloud STEM-based environments function on the web. For example, http://www.sciencebuddies.org/ web-environment [12; 20] provides methodical support for STEM-education and there presented methods related to scientific and engineering methods. However, open-source statistical information about current state and trends related to this environment isn't presented. Other systems, also do not provide analysis of the current state of cloud trends in STEM-education.

Considering the above, we assume that STEM methods are used less common than traditional approaches of education in Ukraine. However, in order to prove it, providing the analysis is necessary.

3 Methods

Methods of deduction, induction, analysis, and synthesis were used. To archive results, SEO analytical systems were used. To active semantical analysis of the stemua.science, online.seranking web-service was used. Online.seranking web-service was chosen due to its high level of visualization and providing more detailed analyzing compare to well-known Google Analytics or Yandex Metrics. To obtain statistical information, Cloudflare web-service was used.

Analysis of trends of STEM-education in Ukraine was provided by analyzing the main keywords and topics on stemua.science people used. Further prognosis and the general state of STEM-education was provided using this data.

4 Method of the using SEO analysis data to find trends in the field

Development of the SEO provided the development of analytical data introduced by different SEO-services [1; 18; 48]. It is well known that SEO analytic is used in commercial [15; 42] but we propose to use it social cloud educational projects by analyzing their data and provide improvement based on the SEO analytic. Previously, it was proposed to use Google Trends (SEO analytics) to find correlation of its results with demand and it's forecasting in tourism [27; 28], housing prices and sales [47] and private consumption [44]. So, results of SEO analysis can be used to find trends and provide forecasting in different fields.

We propose to use SEO-based analysis in educational field to provide forecasting of the demand it optimization of the cloud-based environments by using of the circle of content creation in cloud educational environments (include stemua.science). The circle can be interpreter as the cycle of creation and publishing of the materials, presenting of the results, providing of the SEO analysis of the current state of the social cloud educational projects, analysis of the main keywords used to find the publication (in our case, its scientific works and methods), providing of the authors brainstorm, prediction, creation of the further plan of social cloud education system development and then circle recycling starts from publishing (fig. 1).

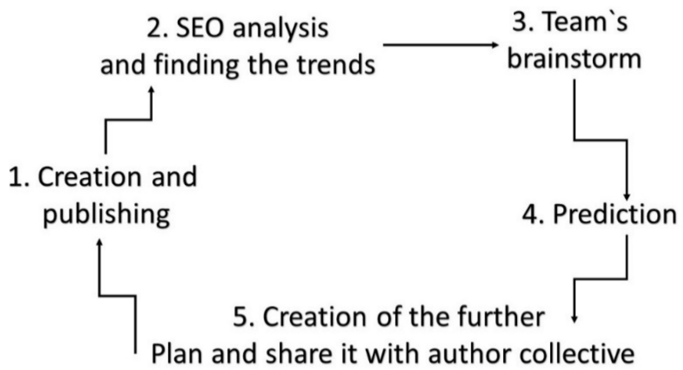


Fig. 1. Proposed method to improve the content quality of educational cloud web-environment and finding the trends

Finding the trends comes possible by modern SEO approaches such as semantic analysis [16]. The service online.seranking provides a detailed analysis include finding the most common keywords and topics people finding on. In addition, it gives the possibility find relationships between keywords people used to find and topic where its presence.

We propose to use the results of the analysis to find the main trends in STEM cloud informational field by using its correlation with the demand on the methods presented in the stemua.science environment due fact that there presented both, digital methods on casual education classes and modified methods related to STEM-approach in education. Examples of the STEM-based methods and traditional methods presented in table 1.

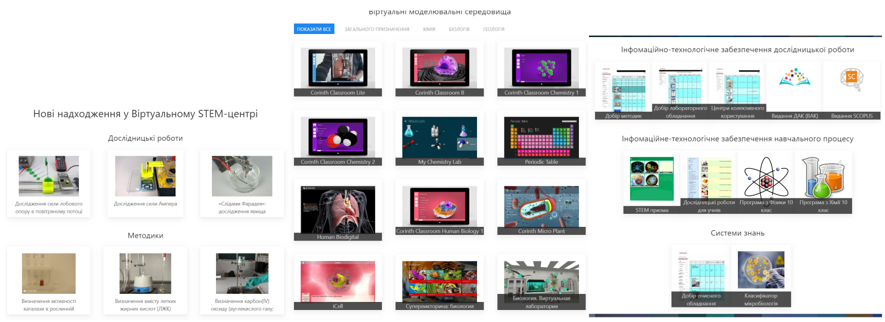
Table 1. Examples of STEM-based methods and traditional methods

STEM-based		**Traditional**	
Method	**Research work**	**Method**	**Research work**
Determination of protein isoelectric point	Water transport in the plant. Production of the artificial leaf	Determination of water hardness	The anatomical structure of the leaf
Determination of carbon dioxide in the gas mixtures	Explore the wildlife of the area using Google Lens	Methods of analysis of legal acts on the site zakon.rada.gov.ua	The structure of the Euglene green

Therefore, it is possible to provide both analysis of the most useful publications in the cloud environment and most common keywords people using to find the necessary publication. The last indicators actually will characterize the demand of the teachers and students on educational products.

5 The general state of stemua.science and it's semantic

The general idea of the stemua.science [31] is to integrate all necessary instruments of STEM-education in one cloud environment. Therefore, it represents virtual modeling environments [33; 34], including modern nowadays augmented reality instruments [19; 23; 24; 25; 38; 40], research works and methods by which it is possible to make them. In addition, ontological scientific instruments [32; 35] which will be useful for both student and teacher in their STEM-activities are located in the cloud environment. Therefore, stemua.science contains areas for all of those directions. Methods and research works, virtual modeling environments and ontological instruments of stemua.science cloud environment is presented in figure 2.



a) b) c)

Fig. 2. Methods and scientific works (a), virtual modeling environments (b) and ontological instruments (c) of stemua.science cloud environment

The cloud environment stemua.science is yang but perspective web-site. As shown in figure 3, the stemua.science is in the same semantic field that educational environments of Ukraine. However, all websites do not relevant to STEM-education and, all except studupedia.com.ua, do not characterized by containing information can be used for lessons preparation but contains information such as videos or news. Stemua.science now characterized by 782 organic keywords and 486 people per month of organic traffic (up to 20 000 unique users per mount).

Nowadays, even Ukrainian STEM-resources are demanded worldwide. Articles, written in Ukrainian, are used by users from differed countries. Sure, as it was devoted for, Ukrainian users are the most common visitors of the web-site and their traffic is up to 20 000 views of the website per day. Due to high level of STEM-education development in the USA, visitors of United States of America are characterized by high activities on the differed STEM-cloud services, include, stemua.science. The amount of their visits is up to 2 000 per day. A lesser amount of traffic comes from visitors from Germany, Netherlands, and the Russian Federation. Traffic distribution by countries is presented in figure 4 and table 1.

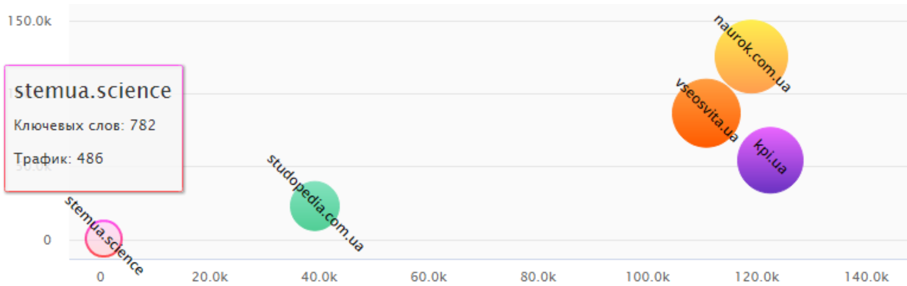


Fig. 3. Semantical characteristics of the stemua.science

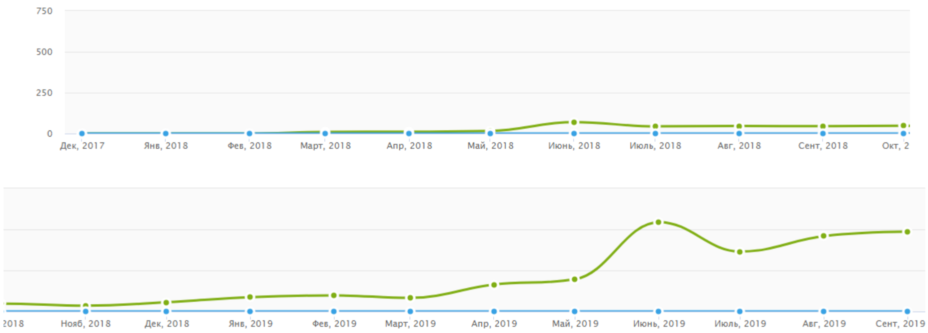
Fig. 4. Traffic distribution by countries

Table 2. Traffic distribution by countries

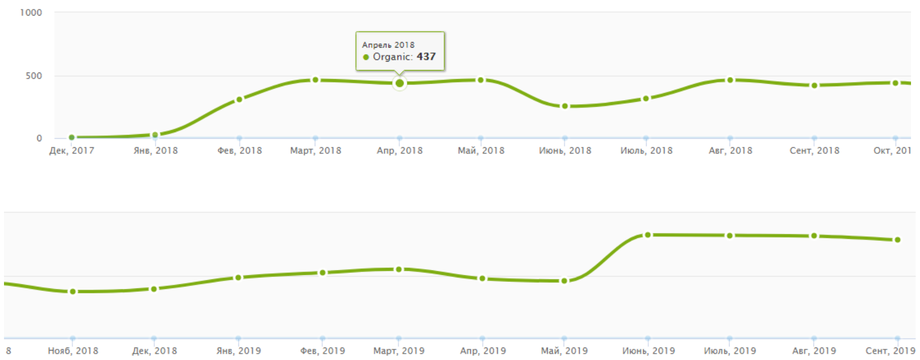
Country	Traffic, view per day
Ukraine	Up to 20 000
United States of America	Up to 2 000
Germany	Up to 300
Netherlands	Up to 250
Russian Federation	Up to 200

The organic traffic, amount of the keywords and potential costs of the traffics per mount are characterized by grooving which proves the further potential of the stemua.science environment. The dynamics of traffic, amount of the keywords and potential costs of the traffics of the stemua.science is presented in figure 5.

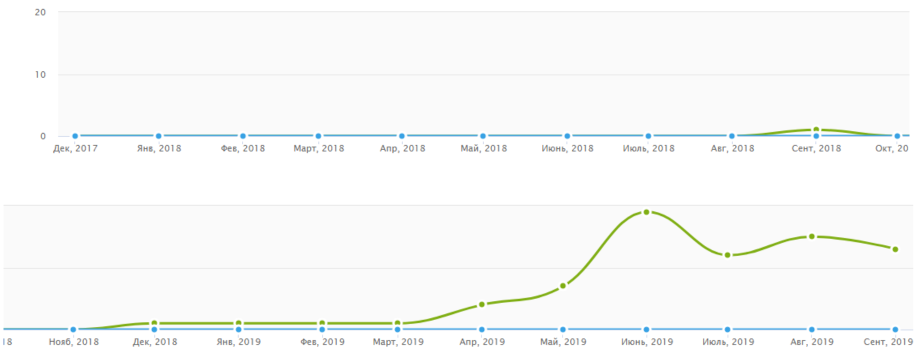
So, stemua.science is a useful international cloud resource. Its auditory is mostly represented Ukrainian teachers and students' trends and usage of its data can be used for the analysis of trends in Ukrainian education.



a)



b)



c)

Fig. 5. The dynamics of traffic (a), amount of the key words (b) and potential costs (c) of the traffics of the stemua.science

6 Finding trends of education in Ukraine, demand analyzing and adapting to trends

The results of the top pages of stemua.science in organic search represent the current state with demand on the developed methods. It proves that methods of both, traditional and STEM-approaches are used by stakeholders of educational process of Ukraine. The statistical information on the top pages of stemua.science in organic search in the table.

According to the table, 30.67 % of the organic traffic in the most popular publications comes from STEM-approach methods and research works which is not significantly higher than traffic obtained from traditional ones (with 28% of the organic traffic). Therefore, general relation between STEM-based methods and traditional ones will be close to 52 and 48 %, respectively. The relation between STEM-based methods and traditional ones in organic search is presented in figure 6 and detailed analysis of the statistical information on the top pages of stemua.science in organic search is presented in Table 3.

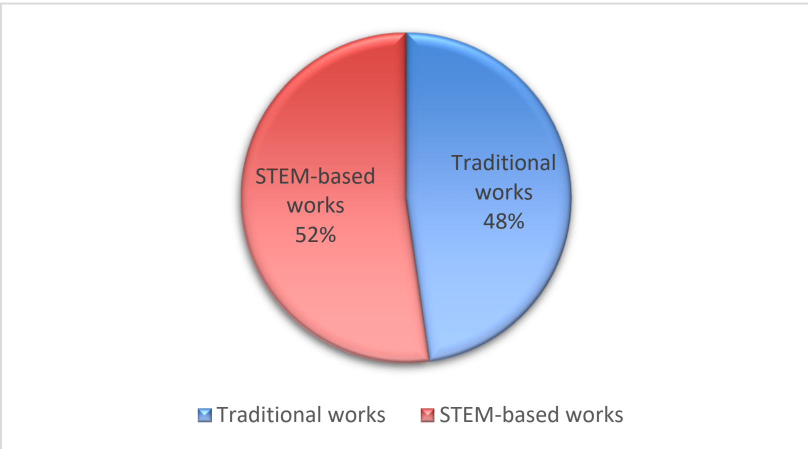


Fig. 6. The relation between STEM-based methods and traditional ones in organic search

However, a little bit more effective to find the demand of the students and teachers of educational process of Ukraine will be the keyword analysis that will represent the necessaries of the stemua.science portal. The teachers and students who are looking for the STEM-approaches will be commonly used terms which are a little bit different as declared in educational programs and they will be such as “the research of something” or transdisciplinary process researches. The group of users who are looking for information related to traditional educational process, unlike previous, will use the terms declared by educational programs of Ukraine. Therefore, it is possible to analyze the needs of users and classify them as searchers looking to find information for usage during traditional educational process and those ones which are related to finding information to create STEM-based classes. The analysis of most keywords presented in organic traffic is shown in table 4.

Table 3. The statistical information on the top pages of stemua.science in organic search

Name of the work	Traffic share, %	Estimated traffic	Keywords number	Type of the publication
Chlorophyll fluorescence monitoring	21.33	16	3	STEM
A study of the motion of a body thrown at an angle to the horizon	10.67	8	1	Traditional
Investigation of the refraction of light	8	6	3	Traditional/experiment simulation
Plasmolysis and deplasmolysis phenomena	5.33	4	5	Traditional
The study of the phenomenon of cooling the mixture	4	3	5	STEM
Methods of analysis of legal acts on the site zakon.rada.gov.ua	4	3	24	Traditional
Diffusion chamber modeling	2.67	2	1	STEM
Exploration of charged particle tracks by photos	2.67	2	2	STEM/experiment simulation

Table 4. The analysis of the most common keywords presented in organic traffic

Keyword	Relation with publication	Position	Traffic share, %	Traffic	Keyword mark
Chlorophyll	Chlorophyll fluorescence monitoring	25	21.33	16	Used in traditional education process
Body movement threw at an angle to the horizon	A study of the motion of a body thrown at an angle to the horizon	4	10.67	8	Used in the traditional education process
Refraction of light	Investigation of the refraction of light	24	6.67	5	Used in the traditional education process
Plasmolysis and deplasmolysis	Plasmolysis and deplasmolysis phenomena	1	4	3	Used in the traditional education process
Wilson camera	Diffusion chamber modeling	10	2.67	2	Is recommended demonstration in the traditional education process
Body movement threw upright	Investigation of body movement thrown upright	2	1.33	1	Used in the traditional education process
Thread tension force	Measurement of the moment of inertia of the body (option 2)	20	1.33	1	Used in the traditional education process
Aberration of lenses	Lens aberration studies	3	1.33	1	Used in the traditional education process
Spring hardness formula	Investigation of elastic properties of bodies	26	1.33	1	Used in the traditional education process

The analysis proves that organic traffic comes from the words mostly do not related to STEM education. Only term “Wilson camera” can be classified as keyword used untraditional classes (STEM-education). The terms like “chlorophyll”, “body movement thrown at an angle to the horizon”, “Refraction of light”, “Plasmolysis and deplasmolysis”, “Thread tension force”, “aberration of lenses” and, specially, “spring hardness formula” (due its used only for finding the answer on the concrete question) are can’t be classified as requests request made by users trying to finding the STEM-based material. So, 47.99 % of organic traffic (most common keywords) comes from the not-STEM keywords which are significantly higher than the ones from STEM-keywords (2.67 %; Wilson camera).

7 Discussion

So, the most important information, based on the results of the analysis of the most common keywords presented in organic traffic (table), is that stakeholders nowadays are looking for two main categories of the information: how to prepare traditional classes (teachers) and just-find-the-answers requests (students). This means that STEM-approach today not characterized by a high demand by the general stakeholders of the educational process of Ukraine. However, it is proved that there is a positive effect of the STEM-approach implementation and it is a good idea to increase the amount of its implementation. So, based on the statistical information on the top pages of stemua.science in organic search (table 3, fig. 5), which show similarity of the popularity of both STEM-based and not-STEM based publication. So, people who try to find the information on the traditional questions will be involved in the studying of the STEM-methods on the question which interested the users. Therefore, cloud environment stemua.science will gradually involve the teachers in providing the STEM-education by developing their methodological base of STEM-education even on the traditional requests.

However, nowadays, it is more necessary to create traditionally-based content. It does not mean that creation of the STEM-content isn’t important but it only means that nowadays the demand on the traditional education declared by educational programs is higher than on the STEM-based methods. The trends are changeable by time and it means that it is even more important to provide the dynamical analysis of the trends.

8 Conclusions

1. Firstly, it is proposed to used SEO analysis results to find the demand for the educational stakeholders.
2. The cloud environment stemua.science is representable to find the demand for Ukrainian educational stakeholders due its users mostly belong to Ukraine.
3. It is shown that educational stakeholders are mostly using not-STEM keywords to search for information.
4. The stemua.science environment involves educational stakeholders of Ukraine (and world) to provide the STEM-education.

5. The dynamic analysis of demand will be provided in the further researches to establish the changes of the educational stakeholders of Ukraine demand in further research work.

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Educational electronic platforms for STEAM-oriented learning environment at general education school

Nataliia V. Soroko[1[0000-0002-9189-6564]], Lorena A. Mykhailenko[2[0000-0002-9867-7495]], Olena G. Rokoman[3[0000-0002-3367-6926]] and Vladimir I. Zaselskiy[4[0000-0002-7517-5433]]

[1] Institute of Information Technologies and Learning Tools of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine
nvsoroko@gmail.com
[2] Shupyk National Medical Academy of Postgraduate Education, 9 Dorohozhytska Str., Kyiv, 04112, Ukraine
[3] Brovary secondary school of I-III levels No. 1, 153 Kyivska Str., Brovary, 07400, Ukraine
[4] State University of Economics and Technology, 5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
zaselskiy52@gmail.com

Abstract. The article is devoted to the problem of the use of educational electronic platform for the organization of a STEAM-oriented environment of the general school. The purpose of the article is to analyze the use of educational electronic platforms for organizing the STEAM-oriented school learning environment and to identify the basic requirements for supporting the implementation and development of STEAM education in Ukraine. One of the main trends of education modernization is the STEAM education, which involves the integration between the natural sciences, the technological sciences, engineering, mathematics and art in the learning process of educational institutions, in particular, general school. The main components of electronic platform for education of the organization STEAM-oriented educational environment should be open e-learning and educational resources that include resources for students and resources for teachers; information and communication technologies that provide communication and collaboration among students; between teachers; between students and teachers; between specialists, employers, students, and teachers; information and communication technologies that promote the development of STEAM education and its implementation in the educational process of the school; online assessment and self-assessment of skills and competences in STEAM education and information and communication technologies fields; STEAM education labs that may include simulators, games, imitation models, etc.; STEAM-oriented educational environment profiles that reflect unconfirmed participants' data, their contributions to projects and STEAM education, plans, ideas, personal forums, and more. Prospects for further research are the design of an educational electronic platform for the organization of the STEAM-oriented learning environment in accordance with the requirements specified in the paper.

Keywords: STEAM-oriented approach, STEAM education, STEAM-oriented educational environment, electronic platform for education.

1 Introduction

The rapid knowledge society development requires from competitive young people not only demonstrating knowledge, skills and competences in specific fields of science but also making creative solutions to various professional problems. This leads to the search for effective ways of organizing such learning environment that can ensure the formation of students' competences in accordance with the ever-increasing requirements for graduates of educational institutions.

One of these ways, in our opinion, is using an Electronic Platform (E-Platform) for the STEAM-oriented educational environment, which should facilitate the implementation of practical-oriented, interdisciplinary and project approaches in the study of the disciplines of the natural-mathematical cycle and robotics, the formation of creative thinking of students through the use in the educational process of various arts (for example, writing, rhetoric, literature, theater, dance, drawing, music) (Jacina T. Leong [5], David A. Sousa and Tom Pilecki [16]).

Heidi Sublette considers that STEM education prepares students for the challenges and opportunities in the information society and economy in the 21st century [17]. She determines STEM-education as a transdisciplinary pedagogical approach through which students are given the opportunity, through the use of the project method, to independently solve the real problems that may arise in the bit and the teaching tasks set by the teacher, during which the teacher carries out the role of facilitator.

Nataliia V. Valko, Nataliya O. Kushnir and Viacheslav V. Osadchyi consider that STEAM-education provides the study of Science and Technology through the application of technical creativity and Engineering, based on Mathematics, modeling and integrating the use of various tools of other sciences (All) [22].

Peter Charles Sinclair Taylor explains that STEAM is not just another curriculum fad but an important response to the pressing need to prepare young people with higher-order abilities to deal positively and productively with 21st century global challenges (crises) that are impacting the economy, the natural environment and our diverse cultural heritage [19].

The STEAM-oriented approach is to examine the relationship between exposure to the arts and performance in Science, Technology, Engineering, and Math (STEM) subjects (Mark E. Rabalais [12]).

The STEAM-oriented environment in school teaching is the way of motivating students to participate in educational projects related to issues with the application of science, technology, engineering, art and mathematics (Georgette Yakman) [24].

2 Theoretical backgrounds

The role of STEM-education (S – Sciences, T – technological sciences, E – engineering, and M – mathematics) implementation in a general school for student competences development has been considered by Fabian Andruszkiewicz [14], Maïté Debry and Agueda Gras-Velazquez [2], Nataliya O. Kushnir [22], Viacheslav V. Osadchyi [8], Viktor B. Shapovalov [13], Yevhenii B. Shapovalov [15] , Heidi Sublette [17], Nataliia V. Valko [21], Nataliia P. Volkova [20] et al.

The arguments that the Arts ("A") and creative approaches must be contributing to the effectiveness of STEM-education (STEAM) were considered and analyzed by Julia Smith and Louis Bergonzi [1], John Tarnoff [18], EunJung Kim, SunHoi Kim, DongSoo Nam and TaeWuk Lee [4], Daniel F. Keefe and David H. Laidlaw [3], David A. Sousa and Tom Pilecki [16] etc.

Despite a large number of scientific works on the implementation of STEM education in the general education school and the need to involve Art in the STEAM-oriented learning approach, the problem of using educational platforms for the STEAM-oriented environment that meets practical needs and demands of the society for the high level of learning outcomes is still under consideration and requires deep scientific research to improve educational platforms in order to organize the STEAM-oriented educational environment of the general school.

The purpose of the article is to analyze the use of educational electronic platforms for organizing the STEAM-oriented school learning environment and to identify the basic requirements for supporting implementation and development of the STEAM education in Ukraine.

3 Research methods

To achieve the purpose of our study and also to clarify the problem of creating the STEAM-oriented educational environment regarding the main ways of using educational e-platforms to support STEAM education there were used the following methods: systematic and comparative analysis of pedagogical, psychological, philosophical, sociological works, methodological and specialized literature; analysis of the pedagogical experience of using the STEAM-oriented educational environment in general school; synthesis and generalization to formulate the main points of the study; interpretation of the research results.

4 Results and discussion

In Provisions on the National Educational Electronic Platform, approved by the Order of the Ministry of Education and Science of Ukraine No 523 on May 22, 2018, it is noted that e-Platform is "specifically known information and telecommunication system work", the goals of which include technological support for secondary education reform; providing participants with modern educational process electronic educational resources and services; providing electronic textbooks in open access for students of complete secondary general education and relevant pedagogical staff; providing and creating the enabling environment for the development of national e-learning resources, services and e-textbooks; development of e-learning and formation of digital competence of participants in the educational process in our country [10].

Learning Platform correlates with the learning environment [9] and Learning Management System (LMS) [7]. LMS is a software specially designed to provide educational services, learning management and monitoring the learning process in distance education (Karim Qayumi) [11].

Learning Management Systems should ensure the creation of an electronic environment for education which is to be equivalent to the physical environment. This environment should be designed to facilitate teaching, management and educational processes within the on-line courses for students, in particular, systems using computer equipment and software that include distance learning as an educational concept [23].

For example, The Centre of Excellence for Simulation Education and Innovation (CESEI) at University of British Columbia (Canada) gives an access to the Electronic Platform for Education and Research (e-PER), which is an interactive Internet-based software for developing, presenting, tracking, and managing training programs, as well as for students' collaborative learning and research. Based on the ATutor, the E-Platform is an Open Source Web-based LMS to develop and deliver online courses (https://elearningindustry.com/directory/elearning-software/atutor). The ATutor is used in a variety of contexts, including online course management, continuing teacher's professional development, career development, and research. The ATutor is international and has been translated into more than fifteen languages with support for over forty additional language modules. The software is unique due to its accessibility (it can be used by students with visual disorders and disabled people) and suitability for education according to software evaluation criteria defined by The American Society for Training and Development (ASTD).

One of the requirements for the educational E-Platform in an educational institution is, above all, the selection of software that will meet the needs of teachers to deploy, use and create electronic educational resources, cooperate with all participants in this process and motivate them to teach students. Among them, Online Learning Platforms users distinguish 5 most popular ones in 2019 (https://www.g2.com/categories/online-learning-platform): Udemy, Infosec Flex, TalentLMS, McGraw-Hill, WebAssign.

Udemy is a content covering a variety of key business and technical topics ranging from development and IT to marketing, leadership, design and stress management. In addition to a curated content collection, organizations can also host and distribute their own proprietary content on Udemy. For teachers, this platform provides a wider range of audience for distance learning.

Infosec Flex is a Platform, that helps teachers to give team convenient access to training anytime, anywhere; provides award-winning security skills training and certification preparation courses.

TalentLMS is a Platform, that provides LMS ideas for delivering engaging online training courses, creating courses, and supporting multiple file types and multimedia (presentations, videos, iFrame, SCORM, etc.).

McGraw-Hill is a Platform, that combines such features as: remote computer monitoring, website and application blocking, teacher/student screensharing, interactive Quizzes, presentation Building, instant messaging.

WebAssign is the technology choice for STEM education, its wide selection of affordable, peer-reviewed academic content makes web-design within the STEM disciplines seamless and the products of tutorial banks and assessments are versatile.

Examples of international Learning Platforms for supporting the STEAM-education in general schools are as follows: STEAM Portal (https://educationcloset.com/steam/), STEAM Education (https://steamedu.com/), "GLOBE International STEM Network" (GISN) (https://www.globe.gov/web/globe-international-stem-network), STEAM CRAF (https://www.steamcraftedu.com), "A&E" (https://www.aandeedu.com/steam) etc.

The STEAM Portal is Learning Platform, which provides free support for teachers to enhance their professional development, including information and digital competence, and understand how and why STEAM-oriented approach can transform the educational system.

This portal offers free samples of tutorials for all levels starting from elementary to high school education (Free STEAM Lessons), Take the course, where you can learn how to create a STEAM student training course, Attend a conference, STEAM projects, online tools for STEAM research, for example, Robot Factory (http://tinybop.com/apps/the-robot-factory) for designing robots according to given functions, to their work environment, etc.; Pixel Press Floors (http://www.projectpixelpress.com) for designing and creating STEAM games for students, drawing models, etc.; Kahoot (https://kahoot.com) for creating games, quizzes, tests and others.

STEAM Edu (https://steamedu.com/) is a platform for teachers, which provides electronic educational resources and consultations by tutors of distance courses on implementing the STEAM-oriented approach in general school education activity. It includes adaptable concepts for recognizing and socio-emotional and academic considerations for individual and team work for the STEAM education. Here one can find information about:

- Understanding, Customizing & Implementing STEAM Program Development;
- Integrative Curriculum Mapping & Theme Development;
- Staff Development;
- Building, lab, space, equipment suggestions;
- Community Involvement & Event Planning;
- Program Sustainability.

The platform offers ideas from fellow educators how to expand on your own ideas and be exposed to new ones to adapt for your style and students; gives assistance in teachers' network and their projects by connecting with educational professionals and experts from all over the world.

The GLOBE International STEM Network (GISN) is an international network of STEM professionals who contribute meaningfully to GLOBE students around the world involved in scientific field investigations and research projects (https://www.globe.gov/web/globe-international-stem-network). The platform provides the GLOBE Teacher's Guide, an online collection of background information, science protocols (data collection procedures), and learning activities organized by Earth spheres: Atmosphere, Biosphere, Hydrosphere, and Pedosphere (Soil). The science protocols are intended to be used as written, using instruments that meet certain specifications in order to ensure data accuracy worldwide.

Another game educational platform, the “STEAM Craft Edu”, was created to encourage and increase the interest of pupils in 3-6 grades in STEAM fields. On this platform, schoolchildren are invited to participate as the main character in an intergalactic adventure (Planeteers) in a fictional universe with Earth-like habitats, flora and fauna. The pupil plays a role of a confused space explorer, collecting vital elements and making scientific discoveries, which is the key to the rebirth of his own planet. Together with his companion robot (Socket), he must build a sustainable living environment as well as study and collect materials and data for his journey back home.

The STEAM Craft Edu platform hosts student profiles, teachers’ personal cabinets, where they can track their students’ progress and estimate their learning activities; and also, there are blogs for students, teachers, and counselors in which they post articles about their game educational experience.

“A&E” (https://www.aandeedu.com/steam) is aimed at making global and high-quality education more convenient and shareable, in order to facilitate the exploration of innovative learning in the future. As the sole provider for Ningbo-Auckland Education Association, A&E is devoted to promoting cross-cultural communication and cooperation in Education sectors between China and New Zealand (over 80 schools). This platform is built for students and educators to develop future-oriented education such as the STEAM program and enhance multi-dimensional cooperation on student-centred education.

The Go-Lab ecosystem project was created in 2014. The Go-Lab Initiative developed and received its name due to the successful Go-Lab project, which lasted from November, 2012 to October, 2016. The purpose of the Go-Lab Initiative is to promote the use of online labs and educational training applications for science education in schools. The Go-Lab Initiative provides the Go-Lab ecosystem for teachers where they can find various online labs and create special training spaces. In addition, the Go-Lab Initiative includes training programmes on science education in schools and, also, on the use of the Go-Lab ecosystem for teachers all around Europe. The Go-Lab Initiative is currently funded by the Next-Lab project.

The Go-Lab enables inquiry-based learning that promotes acquisition of deep conceptual domain knowledge and inquiry skills, with the further intent of interesting students in careers in science. For students, Go-Lab offers the opportunity to perform scientific experiments with online labs in pedagogically structured learning spaces.

Online labs provide your students with the possibility to conduct scientific experiments in an online environment. Remotely-operated labs (remote labs) offer an opportunity to experiment with real equipment from remote locations. Virtual labs simulate the scientific equipment. Data sets present data from already performed lab experiments. The Go-Lab Ecosystem supports and enriches the teaching of different scientific school subjects, using the inquiry-based learning approach. It is designed to meet the needs of primary and secondary school teachers, and students aged from 6 to 18 years old. The Go-Lab Ecosystem includes two components: The Go-Lab Sharing Platform and The Go-Lab Authoring Platform (Graasp). The Go-Lab Sharing Platform provides hundreds of remote and virtual laboratories (labs), as well as inquiry learning software tools or applications (apps). The Go-Lab Authoring Platform (Graasp) enables teachers to create their own Inquiry Learning Spaces (ILS) by combining labs, apps and other resources to share with their students. A wide variety of online labs for physics, astronomy, chemistry, biology, math, and other subject domains are available.

We conducted a survey of teachers (12 primary teachers and 35 secondary school teachers) at Brovary secondary school of I-III levels No. 1 (Ukraine) in order to clarify the basic requirements and functions of the STEAM-oriented educational environment of school. The learning environment was another theme in the questionnaire as presented in Table 1. By using a five Likert scale ranging from very undesirable (1) to very desirable (5), the participants were asked what functions should the STEAM-oriented educational environment provide to support the implementation of the STEAM-oriented approach in the school [6].

The survey results are presented below (Table 1).

Table 1. The results of teachers' survey on the main functions of the STEAM-oriented educational environment to be provided for supporting the STEAM-oriented approach in school education activity

Functions to be provided by the STEAM-oriented educational environment for supporting the implementation of the STEAM approach in the general school teaching process	Mean
ensuring student learning mobility	4.9
ensuring teachers academic mobility	4.4
carrying out Olympiads, Competitions	3.2
carrying out distance courses	2.9
providing tools for STEAM research	4.7
conducting experiments within STEAM disciplines	3.8
students' algorithmic thinking development	3.5
developing students' skills to creatively solve STEM learning problems	3.8
ensuring communication and collaboration between students; between teachers; between students, teachers, professionals and employers	3.2
providing tools for students' STEAM knowledge, skills and competences self-assessment and validation	4.5
support for student and teacher collaboration within STEAM learning projects	4.2
Total ($N = 47$)	

According to the questionnaire analysis of the main functions of the STEAM-oriented educational environment to be provided for supporting the STEAM-oriented approach in general school teaching process, it was found out that teachers give importance to the following functions: "ensuring student learning mobility" (4,9 – 98%) – 40 teachers marked "5" and 7 teachers marked "4"; "providing tools for STEAM research" (4.7) – 35 teachers marked "5", 10 teachers – "4", 2 teachers – "3"; "providing tools for students' STEAM knowledge, skills and competences self-assessment and validation" (4.5) – 31 teachers marked "5", 10 teachers – "4", 3 teachers – "3"; "support for student and teacher collaboration within STEAM learning projects" (4.2) – 12 teachers marked "5", 32 teachers – "4", 3 teachers – "3"; "ensuring teachers academic mobility" (4,4) – 25 teachers marked "5", 15 teachers marked "4" and 7 teachers marked "3".

At the same time, some functions were found out to be less important. They are: "developing students' skills to creatively solve STEM learning problems" (3,8) – 2 teachers marked "5", 34 teachers – "4", 11 teachers – "3"; "students' algorithmic thinking development" (3,5) – 1 teacher marked "5", 23 teachers marked "4", 23 – "3"; "ensuring communication and collaboration between students; between teachers; between students, teachers, professionals and employers" (3,2) – 13 teachers marked "4", 30 teachers – "3" and 4 teachers – "2"; "carrying out distance courses" (2,9) – 8 teachers marked "4", 26 teachers – "3", 13 teachers marked "2".

The low evaluation of these functions can be explained by teachers' lack of experience in using information and communication technologies (ICT) for communication and collaboration between students; between teachers; between students, teachers, professionals and employers; or for conducting distance courses.

The data show that educational E-Platform for supporting the STEAM-oriented educational environment should host:

- open electronic educational resources, which include resources for students and teachers and can be distributed through e-textbooks, e-libraries, blogs for teachers and teaching staff, Ministry of Education and Science websites, distance courses, etc.;
- tools (ICT) that provide communication and collaboration between students; between teachers; between students and teachers; between professionals, employers, students, teachers, etc., that can be implemented, for example, throughout open forums, webinars, Internet conferences, etc.;
- online assessment and self-assessment, which can be conducted through contests, competitions, quests, tests, projects, etc., that motivate students to study STEAM and develop teachers digital-digital competence to ensure the modernization of education in accordance with demands of the society;
- laboratories covering simulators, games, imitation models, etc.;
- individual profiles of participants of the STEAM-oriented educational environment, where there can be placed the data about participants, their achievements in training, participation in STEAM projects or various forums; certificates, electronic educational resources, necessary for training and teaching.

The STEAM-oriented educational environment should meet the following tasks:

- supporting formal education: the environment should enable students to carry out experiments in laboratories (virtual laboratories) on physics, astronomy, chemistry, biology, math, and other subject domains, supporting students' learning activities in the classroom; supporting teachers' preparation for lessons, implementation of new ideas, and monitoring students' learning activities;

- supporting non-formal education: the environment should motivate students to learn in the STEAM fields, to work in a group on a training project, to communicate with experts in the STEAM fields and others;
- supporting informal education: the environment should promote self-organized acquisition of competence by a person in the STEAM fields, related either to professional activity or community or family or other activities.

According to the analysis of the teachers' survey results and scientific literature review, we can determine the following functions, which the STEAM-oriented educational environment at school should provide for supporting implementation and development of the STEAM education in Ukraine:

- technological, which provides communication between the subjects of the educational process, supports the implementation of laboratory, practical, control works and their assessment, gives an access to various data sources (databases, conferences, electronic libraries, etc.);
- psychological, which motivates the subjects of the educational process (teachers; students; parents; specialists in certain scientific fields of education, science, business, etc.) to participate in the STEAM educational projects, forms students' responsibility when conducting these projects and develops teachers' professional competence to encourage the participation of the subjects of the educational process in these projects;
- educational, which forms students' competences and knowledge in accordance with the educational program disciplines of the general educational institutions, and also provides the guidelines for their further professional careers;
- educative, which builds responsible behavior of students when they participate in the STEAM educational projects, take part in group activities and defend the project results;
- didactic, which implies the expedient use of computer-based educational tools, electronic educational resources, tools and services of institutions' information and communication networks in order to facilitate the educational process in accordance with the calendar and thematic plans of the educational program disciplines.

For the effective introduction of the STEAM approach into general school teaching process, it is highly important to use educational E-Platforms that will satisfy students' learning interests in the STEAM fields, affect the development of their research, creative skills and abilities. Educational E-Platforms can help teachers solve problems of students' motivation in learning by creating such tasks, educational projects, questions for students that will encourage them to use all their skills and abilities based on the synergy of knowledge from all STEAM disciplines.

5 Conclusions and prospects for further research

Thus, creating the STEAM-oriented educational environment is one of the ways to develop and reform the educational system, which, in particular, should influence on students' motivation of learning STEAM disciplines, on forming their creative thinking through the use of ICT and various arts in the educational process to solve STEM research problems.

The STEAM-oriented educational environment has to impact on the formation of students' skills in the fields of natural sciences, technology, mathematics, the formation students creative critical thinking, solving practical research issues through synergy between STEAM disciplines and the use of ICTs. The STEAM-oriented educational environment is an educational environment, in which ICTs create learning and teaching conditions in synergy with the natural sciences, technology, engineering, arts, mathematics, teamwork, cooperative work of teachers and students for the effective achievement of teaching goals, and comprehensive personality development.

Educational E-Platforms for the STEAM-oriented educational environment should include (these are general requirements): the teachers' and students' profiles; an electronic class; a discussion forum; open Digital learning objects that include resources for students and resources for teachers; a calendar of key activities, ICTs to provide communication and collaboration between participants in the educational process; ICTs that contribute to the development of STEAM education and its introduction into the general education school; tools for online assessment and self-assessment of STEAM educational skills; STEAM education labs that may include simulators, games, imitation models, and others.

The further research, therefore, should aim at adjusting a general e-platform for the STEAM-oriented educational environment to school education in Ukraine in compliance with the abovementioned requirements.

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Cloud technologies as a tool of creating Earth Remote Sensing educational resources

Ihor V. Kholoshyn[0000-0002-9571-1758], Olga V. Bondarenko[0000-0003-2356-2674], Olena V. Hanchuk[0000-0002-3866-1133] and Iryna M. Varfolomyeyeva[0000-0002-0595-524X]

Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
holoshyn@kdpu.edu.ua, bondarenko.olga@kdpu.edu.ua,
elena.ganchuk@gmail.com, iravarfolomeeva365@gmail.com

Abstract. This article is dedicated to the Earth Remote Sensing (ERS), which the authors believe is a great way to teach geography and allows forming an idea of the actual geographic features and phenomena. One of the major problems that now constrains the active introduction of remote sensing data in the educational process is the low availability of training aerospace pictures, which meet didactic requirements. The article analyzes the main sources of ERS as a basis for educational resources formation with aerospace images: paper, various individual sources (personal stations receiving satellite information, drones, balloons, kites and balls) and Internet sources (mainstream sites, sites of scientific-technical organizations and distributors, interactive Internet geoservices, cloud platforms of geospatial analysis). The authors point out that their geospatial analysis platforms (Google Earth Engine, Land Viewer, EOS Platform, etc.), due to their unique features, are the basis for the creation of information thematic databases of ERS. The article presents an example of such a database, covering more than 800 aerospace images and dynamic models, which are combined according to such didactic principles as high information load and clarity.

Keywords: Earth remote sensing data, aerospace images, ERS educational resources.

1 Introduction

1.1 Scientific relevance of the research

Nowadays, there is no doubt that the Earth Remote Sensing (ERS) data, as one of the basic directions of geoinformation technologies, is a unique source for the processes and phenomena occurring in virtually all components of the geographical envelope of the planet. In this regard, agreeing with Svetlana S. Karimova and Mikhail V. Veselov [10], Naphisa Z. Khasanshina [12; 11], we emphasize that the use of aerospace images in the educational process is not only to improve the informative content of the training, but also to contribute to the increase of students' interest in the subjects studied.

Currently, a huge collection of aerospace images has been accumulated, completely covering the entire surface of the Earth, and for many of the areas with multiple overlaping. However, despite such a large number of sources, one of the most important problems holding back the active introduction of ERS data into the educational process is the problem of providing the aerospace images with the educational process that meet the requirements for educational resources.

Ilmira B. Kiyamova [23] formulated requirements for the aerospace images selection for subject results achieving in geography training, which can be combined into three groups: scientific and pedagogical, technical and specific, due to the content of the course geography. Scientific and pedagogical requirements ensure that the content of the images corresponds to the goals and objectives of education, allow to apply appropriate methods and organizational forms of training when working with the images. Technical and specific requirements include consideration of the deciphering properties of Earth images from space, depending on the particular shooting conditions.

However, the question remains in what form, with the use of which information and communication technologies and methodological techniques it is possible to use ERS in teaching geography. Thus, the problematicity of the problem of our study is determined by the contradiction between the potential didactic capabilities of aerospace imagery, GIS data and the state of their use in the study of geography.

1.2 Recent research and publications analysis

Significant contributions to the development of the theory and methodology of aerospace imaging during the training process were made by Raimund Ditter, Michelle Haspel, Markus Jahn, Isabelle Kollar, Alexander Siegmund, Kathrin Viehrid, Daniel Volz [6] and Simone Naumann [20].

In the countries of post-Soviet area, the theory of geoinformation technologies was developed by Aleksandr D. Ivannikov, Vladimir P. Kulagin, Aleksandr N. Tikhonov, and Viktor Ia. Tsvetkov [9], Natalia V. Konovalova and Evgenii G. Kapralov [16], Oleksandr O. Svitlychnyi and Serhiy V. Plotnytskyi [22]. In the scientific literature the issues of geoinformation education in terms of higher education (Liliia E. Gutorova [8]) are more often considered in the context of training different future specialists, for example: GIS design and modelling (Aleksandr M. Berliant [2], Irina K. Lure and Vladimir S. Tikunov [17]); mining engineers (Vladimir S. Morkun [19], Serhiy O. Semerikov, Svitlana M. Hryshchenko, Kateryna I. Slovak [18]); future teachers (Olga V. Bondarenko, Olena V. Pakhomova, Vladimir I. Zaselskiy [4], Włodzimierz Lewoniewski [3], Ihor V. Kholoshyn, Olena V. Hanchuk and Ekateryna O. Shmeltser [13]).

Unfortunately, the use of ERS data in domestic school practice is often ignored by methodologists and practitioners. Despite the fact that Ukraine belongs to the elite cosmic powers, space technologies still cannot find a decent display in school programs. The ERS data is considered mainly as illustrative tools in presenting some topics of school geography courses. The development of this area contributes especially great work done by the Institute of progressive technologies led by Oleksandr V. Barladin [1], which found expression in a series of space atlases of different regions of Ukraine and methodological works of Liudmyla M. Datsenko and Vitalii I. Ostroukh [5]. Significantly different from other scientific works are those of Ihor V. Kholoshyn

[15; 14], who focuses not only on the general information about the ERS, but also on their applied meaning and pedagogical technologies for the implementation of ERS data into the practice of modern school.

1.3 Article objective

The purpose of the article is to analyze the main sources of ERS that can be used in the study of geography in school practice.

2 Results and discussion

One of the main sources of ERS is a variety of paper media. With the advent of the first photographs of the Earth's surface in the 30's and 40's of the last century and up to now, a huge amount of aerospace images have been accumulated in the educational and scientific literature. Thousands of scientific monographs and journals have published unique images of the Earth's surface with their description and characteristics. However, for a very clear reason, their use as educational resources are extremely limited.

Aerospace imagery in the educational literature and specialized training atlases are the most common sources of ERS data in school geography. Today, virtually no textbook or school atlas is complete without the publication of aerospace photographs. Definitely, such separate, fragmented images are of the most informative value and cannot be considered as teaching aids.

The main educational resources among the sources of this type can be considered specialized satellite and complex educational and scientific atlases, which have been issued or published recently in many countries of the world. The first such publication is a training atlas published in 1982 in the Soviet Union "USSR from Space" [25]. It first collected low-resolution satellite imagery demonstrating the potential of using space technology for the national economy.

Published in Russia in 2007 "The latest world atlas with space images" is of a particular interest [24]. It consists of two parts. The first part contains maps of regions of the world, made in a scale of 1:30 000 000 and supplemented with space images of the same scale and projection. The space picture gives a visual representation of the map; the map explains the space picture. The second part of the atlas shows all the continents on a scale of 1:4 500 000. Particularly interesting cities and localities are marked on the map and presented on the following pages as detailed space images. Optically accurate meter resolution information, reproduced in GeoEye's snapshots down to the smallest detail, allows you to see and explore the nature and its landscapes, giving an idea of the major capitals of the world. And most importantly, all the pictures are provided with the text descriptions containing interesting facts and details.

Over the past twenty years, a large number of atlases containing space images have been issued in Europe and the United States. One example is the large-format atlas "One Planet, Many People: Atlas of Our Changing Environment", developed in collaboration with the US Geological Survey, NASA and the University of Maryland

[21]. The atlas, which uses satellite imagery and other advanced remote sensing technologies, is designed to document global environmental changes as a result of human natural processes and activities. Most of the atlas images are taken by LANDSAT satellites.

A major obstacle to the widespread use of educational resources in a modern-day educational process is their high cost and extremely small print runs.

Apparently, aerospace images can also be obtained from a variety of individual sources. The most up-to-date and progressive approach is to recognize the possibility of obtaining space images using satellite reception stations (for example, KosmEK). They are designed to receive images of the Earth in the visible and infrared ranges transmitted from polar orbiting satellites of the NOAA, Meteor, Resource, Ocean and Sich. Up to 30 sessions can be performed on average per day. Visibility time is 6 to 15 minutes. The amount of information received in a single communication session, that is, as long as the satellite passes through the bridge type area of the station, can be 3–20 MB. The resulting image can cover vast areas across the globe, up to several million square kilometers. The images obtained can be either black and white or color in a 1:10 000 000 scale map projection.

The technology of obtaining and processing space images using the station, allows us to solve a number of important educational tasks: detection of types of cloud cover, altitude of cloud, forecast of precipitation, climate-forming factors; seasonal location and dynamics of cyclones and anticyclones development, excellent temperature characteristics of seas and lakes, fixation of fires etc.

A cheaper and more affordable way to get your own aerial imagery is to shoot the surface of the Earth from all kinds of light carriers: drones, kites and balloons. Using these fairly simple and not very expensive devices, students can independently get aerial photos of any area from a height of up to 1 km.

However, the most popular way of receiving remote sensing today is the Internet. In this case, all Internet sources can be divided into four groups.

The first group consists of various, often not specialized sites, which feature colorful and unique aerial images of high- and ultra high-resolution as visual information resources. Most of them were obtained as a result of photographing the Earth's surface by astronauts aboard orbiting stations and spacecraft (Fig. 1).

The main purpose of these images is to show the diversity and beauty of our Earth, as well as to draw the attention of the public to all kinds of problems facing humanity. Most of these images do not have an accurate mapping, often do not even contain a brief commentary, but nevertheless, taking into account their uniqueness, it is possible with some informative additions, to recommend them as a visual pictorial tool.

The second group is the sites of scientific and technical organizations and distributors, where you can view survey images, select directory images, order them, or immediately get online. Importantly, this allows you to navigate the dynamic remote sensing data market by familiarizing yourself with the characteristics of satellites, filming equipment and the product itself.

Table 1 provides examples of sites that provide free space images on the Internet. They are frequently updated, which enables us to carry out an operational monitoring of the Earth (Fig. 2).

Fig. 1. The Iravadi River Delta (Myanmar). Satellite image, ISS

Fig. 2. Three Gorges Dam, China QuickBird Image: Collected September 23, 2007

The third group is represented by various interactive Internet geoservices: Google Maps, Google Earth, NASA World Wind, EarthNavigator, EarthBrowser and others. These resources allow one to get up to ten years old medium- and high-resolution images to be scaled, with the ability to scale (Fig. 3). They all offer user-friendly object search technology, as well as various additional services (related to video and photo maps, street views, directions, etc.).

Table 1. Examples of the sites providing free space photography on the Internet

URL	Brief description of the image
https://www.star.nesdis.noaa.gov/GOES	Photos from the **GOES** geostationary satellite. Global coverage at very low spatial resolution (more than 1 km). Data updates every 15 minutes allowing you to track the dynamics of the atmospheric processes
https://eol.jsc.nasa.gov	**NASA** space images by sections: cities, natural landscapes, anthropogenic landscapes, atmospheric processes, countries of the world. Each photo is provided with geographical commentary
https://www.noaa.gov/satellites	**NOAA** images from polar-orbit satellites. The archive allows you to enter temporal and spatial criteria, type of equipment. Areas of application: meteorology, ecology, agriculture and forestry
https://glovis.usgs.gov	Relatively high-resolution space images from **LANDSAT 4-5, 7-8.** They are used for monitoring of territories and forecasting of natural anthropogenic processes
https://gptl.ru	Pictures obtained from Russian and foreign medium- and high-resolution satellites. They are used to solve a wide range of practical problems
https://earthexplorer.usgs.gov	High spatial resolution images from the **LANDSAT** satellites are used in many fields of science and economics

Fig. 3. Satellite image of the Itaipu hydroelectric station on the border of Brazil and Paraguay. Obtained using Google Earth Geosource

In particular, ignoring the details, we can say that all these geoservices have common functionality:

- visualization of the globe surface on the basis of medium-, high- and ultra high-resolution mosaic of space images (aerial images);
- easy moving around the virtual spaces of the Earth model and scaling images;
- availability of geographic tools (measuring distances, areas, determining coordinates, etc.);
- simple search services (finding different objects, routes, etc.);
- availability of custom editing tools (creating labels, lines and polygons, posting photos and comments, etc.);
- work with layers of information.

The uniqueness of such geoservices is in their interactivity, as many of them allow the user through the Internet to be not only consumers of information, but also its creators.

Like many other areas of the Internet, remote sensing also begins with the era of UGC (user-generated content) and its special case, VGI (volunteered geographic information). The emergence of wide-ranging space imagery has already led to the launch of projects that use this data as a substrate to which various geoinformation overlays are available and thousands of such projects are already being accounted for (for example, Wikimapia). In this regard, the decryption of images ceases to be the prerogative of experts and any student or pupil with a certain level of training can try to act as a decoder.

The fourth group is comprised of various cloud-based geospatial analysis platforms, which have only recently emerged but have gained widespread popularity among scientists and practitioners. First of all, it's Google Earth Engine, Land Viewer, EOS Platform and more.

These resources are free petabytes of high-resolution satellite images and have the following benefits:

1. The cloud platform provides high-speed processing of images (received, mostly, from Landsat 8 and Sentinel 2A satellites), the ability to analyze them without downloading to a personal computer.
2. The user-friendly interface allows you to find the pictures you need in a short period of time, based on their geographical location and time range.
3. A five-byte archive of publicly available remote sensing images makes it possible to find satellite images of the required area over a large time span.
4. Ability to store the desired images in the cloud.
5. Updating your snapshot database daily.
6. Selecting images from the database in different ranges (for example, Land Viewer has more than 20 combinations of ranges, such as NDVI, NBR, SAVI, etc.).

Undoubtedly, the function of comparing images taken in different time periods – time-lapse animation, is of a particular significance. The obtained dynamic models make it possible to show geographical processes in their development, help to identify the cause and effect relationships between processes and phenomena. In this way, atmospheric circulation, pollution of territories, anthropogenic changes of territories, etc. can be demonstrated (Fig. 4). The Google Earth Engine Geo-Resource site provides many classic examples of such dynamic models from satellite imagery: deforestation of the Amazon, drying out of the Aral Sea, growing the city of Las Vegas, reducing Alaska's ice cover, and more.

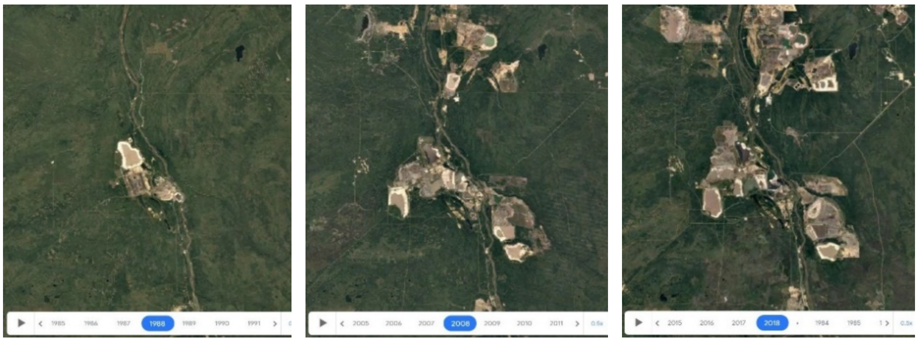

Fig. 4. Dynamic Model of Mine Technological Territory Change (Alberta, Canada) According to Satellite Shooting 1988, 2008, 2018 From Google Earth Engine Cloud Site

Through these examples, students are introduced to the potential of remote sensing as a tool for assessing environmental change and can be applied at different stages of the learning process, playing the role of a source of knowledge in explaining new material, as well as a means of generalizing and controlling knowledge.

However, it should be noted that the use of cloud geo-resources requires careful selection, processing and preparation, which includes their recovery and correction, transformation and decryption, and ultimately – to obtain the necessary training information. Most of our educators do not have the necessary training, and there is not enough time to carry out this painstaking work, which is a deterrent.

In this regard, teachers of higher education institutions and researchers face the issue of creating informative thematic databases of ERS with the help of which teachers can quickly and effectively use satellite imagery in the educational process.

Such systems are required to provide the following functions:

- placing pictures and their characteristics in a user-friendly format;
- systematization of data according to certain criteria;
- quick retrieval of information about snapshots stored in the database;
- search and select the information that flows upon user request;
- output information in a user-friendly form.

As an example, you can cite an educational resource in the form of a school atlas launched by ESA and Geospace [7] through Earth Observation. The atlas is built on satellite images of high spatial resolution (up to 0.6 m) and reflects the various processes that affect the development of the shells of our planet. At the same time, it should be noted that this atlas has a certain orientation and cannot be considered as an educational database of the ERS.

To solve this problem, we conducted a detailed analysis of the school curriculum geography course. As a result, possible areas of information load of the course by the data of the ERS were identified. Using a cloud platform for geospatial analysis of Google Earth Engine there has been created a collection of more than 800 aerospace images and dynamic models, combined with the principle of conformity to educational resources, namely: their high information load and visibility.

Thus, PhoA program was used to work with the collection, which is a simple and sufficiently efficient database for digital image management. Fig. 5 demonstrates the main program window. This mode is the start for the application. The main window of the program is built on the principle of standard Windows Explorer: on the left there is a group tree, and on the right it shows thumbnails and descriptions of the images in the left group.

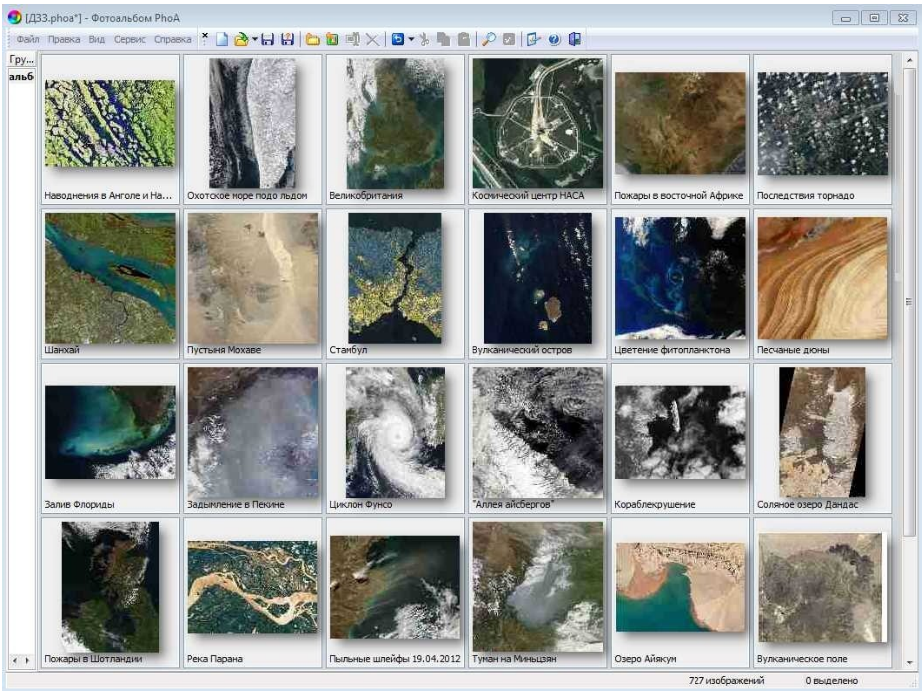

Fig. 5. PhoA Main Menu with aerial photos downloaded and dynamic models

The properties dialog page (Fig. 6) contains the following information: the name of the image, its geographical location, the storage folder, the source (the carrier of the recording equipment, time and shooting mode) and a brief description of the aerial photograph. The description focuses on the characterization of the depicted geographical features and their deciphering features to the extent that the picture is used as an illustration when studying individual sections or topics of school geography courses. PhoA has a fairly powerful image sampling tool. In View mode, the following functions are available: zoom (zoom in and out) of an image; scroll the image with the mouse or the keys if it is not placed completely on the screen; Go to the next, previous, first and last image in the current watch list switching from window to full screen and back; change the properties of the current image; switching the slide show on / off; displaying a description of the image; calling application settings, etc.

Fig. 6. Satellite image and its characteristics in the educational database of the ERS

However, given the huge number of images in the database (more than 800) and the inability to get information about the content of the image by its sketch, it should be recognized as more effective search, where the search criteria are the properties of the image and first of all – keywords. Keywords are a set of words that can collectively convey the semantic load of an object that they characterize. When adding snapshots to the ERS database, it is a prerequisite to enter keywords. The names of geographical objects and processes, the names of topics from sections of school geography courses, etc. are the keywords. The collection of aerial images on the cloud platform of Google Earth Engine geospatial analysis is designed primarily for teachers. The pictures and their accompanying comments are to get a highly effective visual aid when the teacher preparing for the lesson. In this case, finding the necessary pictures and analyzing them will not take much time for the teacher. The method and form of their use is similar to the application of fine arts techniques in geography classes.

3 Conclusions

1. ERS data are an inexhaustible source of unique information that opens doors to students into the unknown world, as their use in studying geography contributes to: a deeper understanding of the interrelations between objects and processes that take

place both in society and in nature; mastering the knowledge of theoretical bases related to the introduction, storage and processing of spatial information using geoinformation technologies; formation of skills to introduce spatial information from multiple sources, organize its presentation and storage vizualize and produce results; perform the simplest operations in the analysis and synthesis of space-and-time information; use geoinformation technologies to solve a variety of daunting application problems.

2. Nowadays, the Internet remains the primary means of obtaining Earth remote sensing data. However, school teachers lack methodological guidelines for the implementation of GIS technologies when studying geography. The authors of this article tried to overcome this disadvantage by systematizing freely available Internet sources containing space images and defining their functions along with their advantages and disadvantages.
3. We see the prospects of further scientific search in covering the process of realization of practical and research orientation in geography training on the basis of data from the ERS; development of methodological course notes for practical works.

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Learning free software using cloud services

Elena H. Fedorenko[1[0000-0002-1897-874X]], Vladyslav Ye. Velychko[1[0000-0001-9752-0907]], Svitlana O. Omelchenko[1[0000-0002-7940-0853]] and Vladimir I. Zaselskiy[2[0000-0002-7517-5433]]

[1] Donbas State Pedagogical University, 19 General Batiouk Str., Sloviansk, 84116, Ukraine
{fedorenko.elena1209, vladislav.velichko, saomel.ddpu}@gmail.com
[2] State University of Economics and Technology,
5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
zaselskiy52@gmail.com

Abstract. The article deals with the use of cloud technology services in the study of free software. Free software is a social phenomenon based on the philosophy of freedom and the right to intellectual creative activity. To date, a significant number of software products have been created that are licensed under free software and not used in educational activities. The conducted research revealed the factors promoting and hindering the use of free software in educational activities. Conducted questionnaires, analysis of open data, research of scientists made it possible to conclude on the expediency of using free software in educational activities. Cloud technology is not only a modern trend of effective use of information and communication technologies in professional activity, but also a proven tool for educational activities. To get acquainted with the free software, the use of cloud technologies has been helpful, which is the goal of our research.

Keywords: Free Software, Cloud Technologies, Training of Information Technology Specialists.

1 Introduction

Modern teaching methods involve the use of information and communication technologies (ICT) in the educational process. The use of ICT has not only changed the methods of traditional learning, redistributed priorities between forms of learning, but new forms of learning have emerged. For any method or form of training that uses high information technology, software is required, without which the technologies lose their meaning. From the interactive whiteboard controller application to multimedia application creation and distribution programs on the World Wide Web.

Free software is a significant feature of the computer industry. Launched as a philosophical concept, free software has not only found its adherents, but also has a large number of software tools used in various directions in its arsenal. The pedagogical universities are use in educational activity: systems for the organization of distance education MOODLE, ILIAS is not an exception; computer mathematics systems Maxima, Octave, GAP, SAGE, SPP; GIMP, Inkscape graphics packages; OpenOffice, LibreOffice office packages. The question remains about the full and systematic use of free software in the educational activities of professionals.

Common problems of free software, legal and philosophical aspects of its existence and use are covered in the works of Eric S. Raymond [31], Richard M. Stallman [34], Andrew S. Tanenbaum [36] and others. In Ukraine the problems of using free software in the education system are devoted to the works of Elena H. Fedorenko [41], Valerii Yu. Habrusiev [6], Yurii V. Horoshko [8], Valerii H. Khakhanovskyi [10], Liubov F. Panchenko [26], Serhiy O. Semerikov [38], Vladimir N. Soloviev [4], Illia O. Teplytskyi [32], Hryhorii H. Zlobin [46] and others. The current state of the issue of the use of cloud technologies in educational activities was revealed in the works of Dmytro S. Antoniuk [39], Vitalina O. Babenko [1], Liudmyla I. Bilousova [2], Olga V. Bondarenko [12], Olena G. Glazunova [5], Anna V. Iatsyshyn [9], Arnold E. Kiv [13], Oleksandr H. Kolgatin [14], Hennadiy M. Kravtsov [17], Iryna V. Lovianova [18], Svitlana H. Lytvynova [19], Maiia V. Marienko [28], Oksana M. Markova [20], Yevhenii O. Modlo [22], Pavlo P. Nechypurenko [23], Yuliia H. Nosenko [24], Vasyl P. Oleksiuk [25], Kateryna P. Osadcha [35], Viacheslav V. Osadchyi [40], Larysa M. Petrenko [27], Maryna V. Rassovytska [29], Ekaterina O. Shmeltser [11], Svitlana V. Shokaliuk [21], Mariya P. Shyshkina [33], Andrii M. Striuk [30], Rostyslav O. Tarasenko [37], Ivan M. Tsidylo [7], Tetiana A. Vakaliuk [16], Nataliia P. Volkova [15], Yuliia V. Yechkalo [44], Vladimir I. Zaselskiy [3], Tetiana I. Zhylenko [45] and others. However, the problem of in-depth exploration of free software capabilities and widespread use in educational activities remains. One possible solution to this problem is to study free software using cloud technology services.

2 Results of the study

Open Education Ideas provide free access to e-learning resources for everyone to learn. Such access is provided by ICT based on free software.

Our research has allowed us to identify the factors that hinder and facilitate the use of free software. One of the stages of the study was to conduct an anonymous survey of higher education teachers regarding the use of free software in their professional activities. The developed questionnaire as a form was made freely available (https://goo.gl/forms/F0BVkSnvwpHTo6H82) using Google Forms, a link to which was circulated via the “Krivorozhsky Conferences and Seminars” (https://groups.google.com/group/cc_seminar) and “Scientific journal Physical and mathematical education” (https://groups.google.com/group/fmo-journal).

The data collected allowed us to determine the following results. 92% of respondents teach science and mathematics. Young teachers, who already have experience in teaching, predominate by age (Fig. 1). 93% use free software in their professional activities. 95% recommend free software to their students for extracurricular activities.

Considering the benefits of using free software, the following were highlighted for conducting the questionnaire:

- legal (licensed purity, non-discrimination, etc.);
- technical (open standards, increased security, vendor independence);

— training (providing the necessary functionality, open source);
— social (trend, modern gadgets).

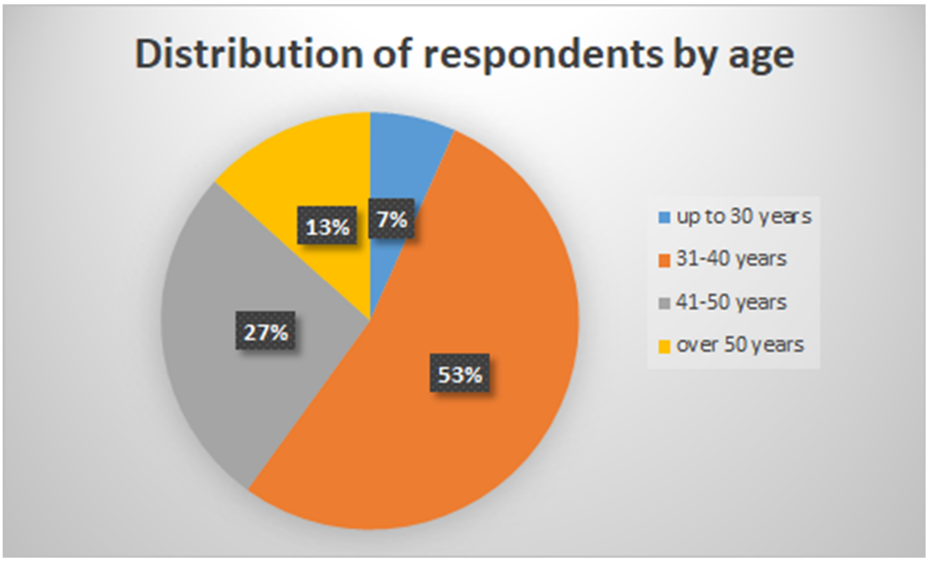

Fig. 1. Distribution of respondents by age

Respondents identified the following factors as facilitating the use of free software (Fig. 2): legal preference was given the highest importance (78%). This result is predictable. According to estimates of the Software Alliance (bsa.org), 82% of the software used in Ukraine is not licensed purity.

75% of the respondents chose among the advantages of free software its educational attractiveness. This result indicates that sufficient free software is available for educational activities. Also important is the availability and openness of software source code.

The analysis of the survey answers indicates that there are technical advantages of using free software in the process of training future professionals. This is noted by 65% of respondents. Open storage standards are an important factor in the software selection process. This gives you confidence in the continued use of your own work. User gains independence from software developers.

The low percentage (33%) belongs to social preferences. The reason is marketing policy. When promoting new high-tech devices, it does not emphasize that their work is based on free software because of its low social popularity.

The survey revealed a number of shortcomings in the use of free software in educational activities (Fig. 3). We identified the shortcomings in the following groups:

— financial (funds for migration, training, etc.);
— technical (changing the format of existing data, support for peripherals);
— software (lack of specialized software);

— methodical (lack of methodological support for application).

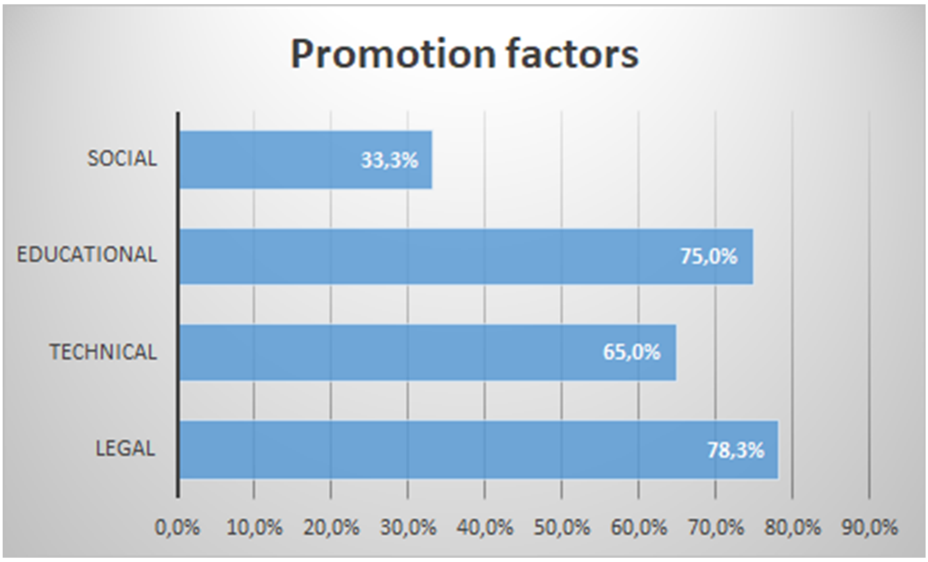

Fig. 2. Factors promoting the use of free software

The lowest percentage (20%) belongs to financial expenses. This low level of concern about financial issues is due to the lack of responsibility for the use of unlicensed software.

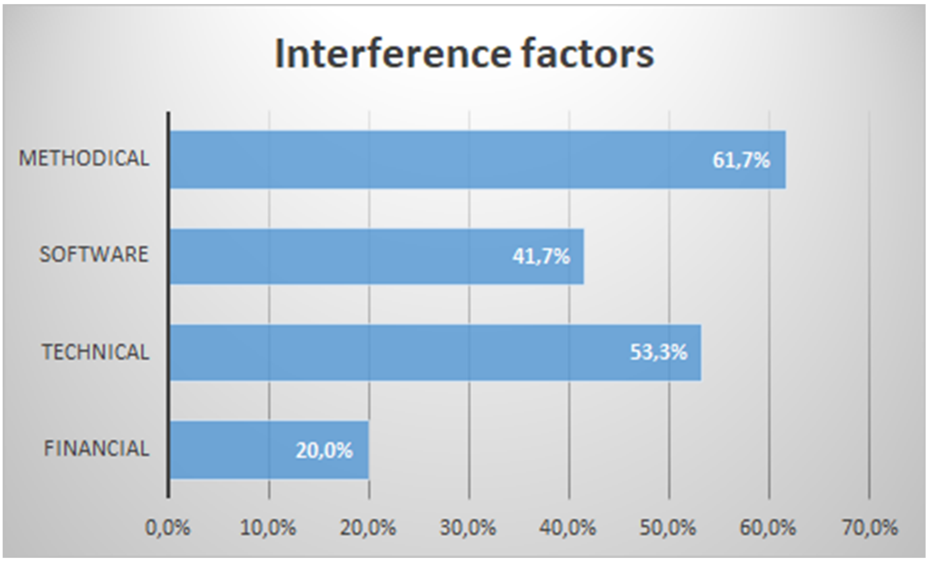

Fig. 3. Factors interferenting the use of free software

42% of respondents are not aware of its existence and localization of specialized software. GitHub.com (64 million projects), SourceForge.net (430,000 projects), bitbucket.org (170,000 projects), CodePlex.com (108,000 projects), launchpad.net (41,000 projects), Savannah.gnu.org (4,000 projects), Gna.org (1,500 projects) hosted a large number of free software products.

The downside of free software is technical issues. These include the transition to new file formats (open file formats) and software for working with peripherals. This concern was expressed by 55% of respondents. Open file formats are currently well developed. Proprietary and closed form owners are taking steps to legalize their openness due to the development of open file format standards. User-generated data can be stored and used for a long time. Users need to have confidence that they can be used for a considerable period of time. Own data must be created using open file formats.

You can estimate the popularity of using file formats by analyzing the approximate number of indexed documents published on the Internet. It is obvious that open file formats are used by both free and proprietary software. However, the results obtained from the number of documents indexed by the search engine (Table 1) indicate the popularity of open file formats.

Table 1. Number of indexed file formats by Google search engine

Format	Property	Number of indexed documents
Binary DOC files (doc)	closed	52,6 million files
Office Open XML (docx)	open	28,4 million files
Portable Document Format (pdf)	open	2,45 billion files
Open Document Format for Office Applications (odt)	open	1,35 million files
Plain Text (txt)	open	21 million files
HyperText Markup Language (html, htm)	open	8,82 billion files
PostScript (ps)	open	8,5 million files
MPEG-4 (mp4)	closed	3,8 million files
Matroska Multimedia Container (mkv)	open	3,3 million files
JPEG (jpeg, jpg)	closed	200 million files
Portable Network Graphics (png)	open	27 million files

A technical problem is the variety of peripherals and the lack of peripheral software. Peripheral developers are trying to keep the technology developed secret. The necessary technical information is not provided for public use. This fact makes it impossible to create free software for peripherals.

The biggest drawback is the lack of methodological support for the use of free software in educational activities. It was identified by 62% of respondents. The lack of free software at the beginning of the informatization led to the installation of proprietary system software as the base. Therefore, proprietary application software has also become widespread. Methodological support for the use of software exists in most proprietary software. Today, the situation with the use of free system software has not improved. According to the StatCounter resource (http://gs.statcounter.com), only 1.53% of desktop computers in the world have the Linux operating system installed.

The situation is similar in Ukraine. Only 1.42% of desktop systems are running Linux. However, the situation is beginning to change. The results of scientific and methodological research on the use of free software in education are presented at the annual FOSS Lviv conference (http://conference.linux.lviv.ua/) and more [42; 43]. Thus, at the Luhansk Taras Shevchenko National University, pre-service teachers of Mathematics, Physics and Computer science study the Linux operating system, the Maxima computer mathematics system and the Lazarus, Geany programming environment. At Pavlo Tychyna Uman State Pedagogical University, the course “Computer Network Administration” is taught on the Linux operating system. Nizhyn Mykola Gogol State University uses the OpenOffice.org software, Hot Potatoes, to study the subject of Electronic Information Processing. The basic discipline of “PC operating systems” is taught using the Linux operating system as a complete alternative to the proprietary Windows system. The courses “Using Information Technology in Education and Science”, “School Computer Science and Teaching Methods” demonstrate the possibilities of using OpenOffice.org and Scribus as an alternative to Microsoft Office, GIMP as an alternative to Adobe Photoshop, Inkscape as an alternative to CorelDraw and more.

GeoGebra Institute operates at the Department of Informatics at H. S. Skovoroda Kharkiv National Pedagogical University. The National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic University” operates the “Linux Professional Institute” (LPI). At the Bogdan Khmelnytsky Melitopol State Pedagogical University, there are such disciplines as “UNIX-like operating systems” and “Programming for open systems” in the bachelor’s curriculum.

At the Poltava V. G. Korolenko National Pedagogical University is widely used by GIMP when teaching Computer Graphics and Design, and geometry is supported by Maxima Computer Mathematics. The Maxima computer mathematics system is also widely used in the teaching of students of Physics and Mathematics at Ivan Franko Drohobych Ivan Franko State Pedagogical University.

At Sumy State Pedagogical University named after A. S. Makarenko uses software products such as GeoGebra, Dr Geo, C.A.R., Kig and KSEG to train future math, physics and computer science teachers. At the National Pedagogical Dragomanov University systems of computer mathematics Maxima, Sage, Scilab, Scidavis and many others are used in the study of the disciplines of mathematical and informative cycles. Teachers of Kryvyi Rih State Pedagogical University base their teaching on the Maxima computer mathematics system for basic mathematical training of future teachers of mathematics, physics and computer science. All of the above software products are free software products.

The expediency of using free software in the educational process of future professionals is quite high. Free software gives freedom to its users to choose to use and study both the free software products themselves and their applications. It is a direct factor in stimulating the desire for learning and self-education. The use of free software in the training of future professionals will increase the level of information culture, will teach themselves to choose forms and methods of education, will form skills for the use of free software in further professional activity, will be able to be competitive in the labor market and meet the requirements of social ordering information society in the modern specialist.

To get acquainted with the free software, it is not necessary to download it to your own personal device. You do not have to visit the computer systems labs where the appropriate software is installed. Cloud technologies make it possible to use the software as a network service. OffiDocs Cloud (https://www.offidocs.com/) is a flexible and powerful platform. It allows you to browse the web with applications using only a web browser. OffiDocs provides users with Internet applications for any device (desktop, tablet, mobile, etc.) such as LibreOffice, GIMP, Dia, AudaCity, OpenShot and many more through a web browser.

A prerequisite for using a cloud service is logging in with an ID. This account creates an account. It is available from any cloud application. Cloud applications are categorized as productivity, images & graphics, video & audio, messaging, education, games, utilities, programming.

Each of these sections of the cloud application is noteworthy. Just as interesting are mobile apps, extensions, resources and templates. Let's take a closer look at the cloud-based LibreOffice suite of services included with the file manager. It is worth noting that there are two options – the first (Fig. 4) is adapted for use in browsers, and the second, launching applications with Gnome interface with image translation in the frame of a hypertext document. Cloud service integration includes integration with Google Drive and Dropbox cloud file repositories.

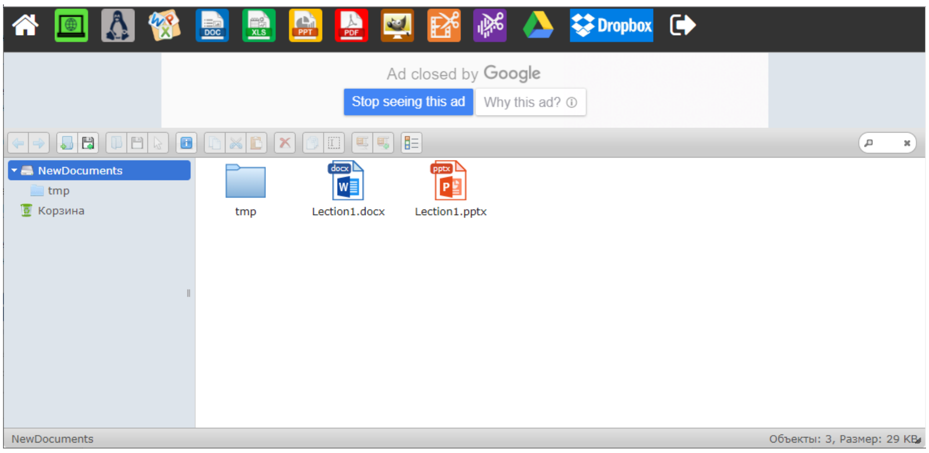

Fig. 4. An example of how a file manager works in LibreOffice

With the ability of a cloud-based environment to study free software, it becomes available to perform standard operations to create electronic educational resources. There is a possibility to use various ways of registration of the textual information (styles, fonts, font sizes, etc.). Text documents and presentations can be supplemented with illustrations (you can use the resource http://editor.pho.to/en/edit/ to process the illustrations). Once created, documents can be downloaded to your own device in ODT, PDF, and more. With http://odfviewer.nsspot.net/ you can view downloaded documents in ODT format. Use the https://smallpdf.com/edit-pdf service to view and compare PDFs visually.

Image creation, video editing and audio editing programs are just as functional. The typical task of using this cloud application is to create an online educational resource for one of the training topics using the learned applications.

Another cloud service that allows you to get acquainted with free software is the service https://www.rollapp.com/ (Fig. 5). In this dream, educational applications, utilities, office applications, games, graphics applications, development programs are available to users. Free software is available for use in this cloud after user registration. In addition, there is a rating system for evaluating the available software by users.

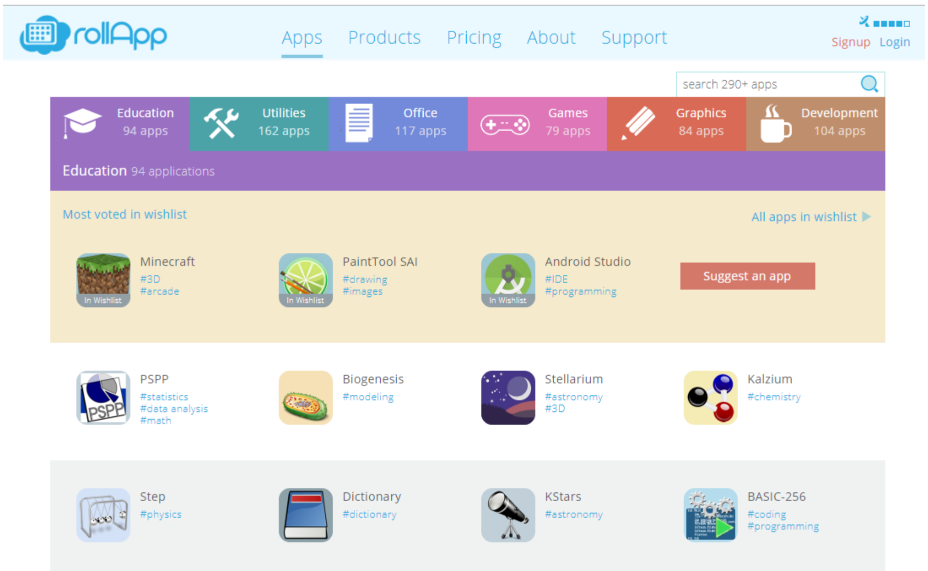

Fig. 5. RollApp cloud service

3 Conclusions and prospects of future research

The results of the long-term use of the OffiDocs cloud service at the Faculty of Physics and Mathematics of the Donbass State Pedagogical University testify to its wide opportunities to become acquainted with free software and its use in the educational activities of pre-services teachers of mathematics, physics and informatics. The availability of alternatives to cloud applications from Google and Microsoft allows us to study information technology rather than specific software. It is not necessary to study the software interfaces, as they are intuitive. The latter provides the opportunity to fundamentally train information and communication technologies and to prepare future professionals for further professional activities.

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Methods of using mobile Internet devices in the formation of the general professional component of bachelor in electromechanics competency in modeling of technical objects

Yevhenii O. Modlo[1[0000-0003-2037-1557]], Serhiy O. Semerikov[2,3,4[0000-0003-0789-0272]], Ruslan P. Shajda[1[0000-0002-7942-9592]], Stanislav T. Tolmachev[3[0000-0002-5513-9099]], Oksana M. Markova[3[0000-0002-5236-6640]], Pavlo P. Nechypurenko[2[0000-0001-5397-6523]] and Tetiana V. Selivanova[2[0000-0003-2635-1055]]

[1] State University of Economics and Technology,
5 Stephana Tilhy Str., Kryvyi Rih, 50006, Ukraine
eugenemodlo@gmail.com, rps21@mail.ru
[2] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
semerikov@gmail.com, acinonyxleo@gmail.com, vitro090@gmail.com
[3] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
stan.tolm@gmail.com, markova@mathinfo.ccjournals.eu
[4] Institute of Information Technologies and Learning Tools of NAES of Ukraine,
9 M. Berlynskoho Str., Kyiv, 04060, Ukraine

Abstract. The article describes the components of methods of using mobile Internet devices in the formation of the general professional component of bachelor in electromechanics competency in modeling of technical objects: using various methods of representing models; solving professional problems using ICT; competence in electric machines and critical thinking. On the content of learning academic disciplines “Higher mathematics”, “Automatic control theory”, “Modeling of electromechanical systems”, “Electrical machines” features of use are disclosed for Scilab, SageCell, Google Sheets, Xcos on Cloud in the formation of the general professional component of bachelor in electromechanics competency in modeling of technical objects. It is concluded that it is advisable to use the following software for mobile Internet devices: a cloud-based spreadsheets as modeling tools (including neural networks), a visual modeling systems as a means of structural modeling of technical objects; a mobile computer mathematical system used at all stages of modeling; a mobile communication tools for organizing joint modeling activities.

Keywords: mobile Internet devices, bachelor of electromechanics competency in modeling of technical objects, general professional component of bachelor in electromechanics competency in modeling of technical objects, a technique of using mobile Internet devices in learning bachelors of electromechanics.

1 Introduction

Modernization of professional training of specialists in mechatronics at Ukrainian technological universities [21] based on a balance between the fundamental [19] and technological component of the training process necessitates the search for ICT training tools [20], which not only provide the opportunity for active experimentation anytime, anywhere, but also support the development of professionally important qualities of the future electrical engineer, among which the main place is taken by competence in the modeling of technical objects. Today, such universal teaching tools are mobile Internet devices (MID) [12; 26; 35].

This work is a further development of the research begun in articles [20] and [19], the purpose of which is to develop methods of using MID in the formation of bachelor in electromechanics competency in modeling of technical objects. The *purpose of the article* is the selection and justification of the MID-based software tools, the use of which contributes to the formation of the general professional component of this competency.

2 Results

2.1 Use of mobile Internet devices in the formation of competence in using various methods of representing models

The formation of such a general professional component of the competence of a bachelor of electromechanics in the modeling of technical objects, as a *competence in the application of various methods of representing models*, involves the acquisition of knowledge and skills in the construction of computer mathematical and simulation models, their algorithmic and structural description, and the selection of adequate ways of representing computer modeling tools. Based on the content of the competence, its formation and development takes place throughout the entire training of the bachelor of electromechanics, therefore, it is inexpedient to single out the leading disciplines for this process.

So, in the teaching the “Computing Engineering and Programming”, it is possible to solve the problem of numerical integration considered in module 9 “Definite and improper integrals” of the discipline “Higher Mathematics” in a different formulation [19]: instead of using the table representation of the function, use analytic, and instead of interpolating formulas, use stochastic Monte Carlo method. In this case, the mean value theorem for integrals is used, according to which for a curved trapezoid whose area under the graph of a continuous function on a closed, bounded interval is equal to the area of a rectangle whose base is the length of the interval and height is the mean value of the integrand in the interval.

Ilia M. Sobol in [34] proposes an algorithm for the approximate calculation of a definite integral by the Monte Carlo method, noting that “in practice [one-time] integrals ... are not calculated by the Monte Carlo method: for this there are more exact methods – quadrature formulas. However, the transition to multiple integrals changes the situation: quadrature formulas become very complex, and the Monte Carlo method remains almost unchanged" [34, p. 52].

So, to determine the volume under the surface of a function, the following stochastic algorithm can be applied:

1. Limit the surface of a rectangular box, the volume of which V_{par} calculated as the product of length (determined by the integration limits [a; b] by Ox axis) by width (determined by the integration limits [c; d] by Oy axes) by height (determined by the maximum value of the integrand $f(x, y)$ on integration D).
2. Place in a certain parallelepiped a certain number of points N, the coordinates of which we will randomly choose.
3. Determine the number of points K that will be located below the surface of the function.
4. The volume V, limited by the function and coordinate axes, is given by the expression $V = V_{par}K/N$.

In order to implement interdisciplinary integration, it is advisable to jointly use this algorithm and the mean value theorem for integrals of a multiple integral:

1. We limit the integration plane to the corresponding limits [a; b] by Ox axes and [c; d] by Oy axes.
2. Place on a certain plane a certain number of points N, the coordinates of N we will choose at random.
3. At each point we measure the value of the integrand $f(x, y)$ and find the arithmetic mean M for all N points.
4. The value of the double integral is given by the expression $I = M(b–a)(d–c)$.

The first implementation is performed in the same SageCell modeling environment [17; 25], with which the value of the integral was calculated by deterministic methods (fig. 1):

```
x,y=var('x,y') # symbol integration variables

@interact # interactive model with controls
def _(f=input_box(default=x*y-x^2+y^2, label="$f(x,y)=$", width=20),
   a=input_box(default=0, label="$Lower\ integration\ limit\ by\ Ox\ "
                              "axis\ a=$", width=3),
   b=input_box(default=2, label="$Upper\ integration\ limit\ by\ Ox\ "
                              "axis\ b=$", width=3),
   c=input_box(default=1.2,label="$Lower\ integration\ limit\ by\ Oy\ "
                              "axis\ c=$", width=3),
   d=input_box(default=7, label="$Upper\ integration\ limit\ by\ Oy\ "
                              "axis\ d=$", width=3),
   N=slider(vmin=1, vmax=100000, step_size=1, default=1000,
           label="$Grid\ points\ quantity$"),
   eps=input_box(default=0.1, label="$Accuracy $", width=6)):
```

```
# analytic integration of the double integral
I0=integrate(integrate(f,x,a,b),y,c,d)
v=html("The analytic value of the double integral %1.4lf"%I0)

# Monte Carlo numerical integration
# with a known number of experiments
sum=0 # sum of function values f(x,y)
for i in range(N): # grid points quantity cycle
  xi=random()*(b-a)+a # random value generation for x and y
  yi=random()*(d-c)+c #in range [a; b] and [c; d]
  sum=sum+f(xi,yi) # sums accumulation
I=(sum/N)*(b-a)*(d-c) # integral calculations
v=v+html("\nThe numerical value of the double integral "
         "calculated by the Monte Carlo method for %s grid"
         " points,\nis %1.4lf"%(N,I))

# Monte Carlo numerical integration
# with predetermined accuracy
sum=0 # sum of function values f(x,y)
N=1 # minimum quantity of experiments
while true: # cycle without quantity of experiments limit
  xi=random()*(b-a)+a # random value generation for x and y
  yi=random()*(d-c)+c # in range [a; b] and [c; d]
  sumnext=sum+f(xi,yi) # calculating the next sum
  # break condition for the cycle - the module of the
  # difference between the next and previous
  # sum becomes less than the specified accuracy
  if(abs(sumnext-sum)<eps):
    break
  else:
    sum=sumnext
  N=N+1 # move on to the next experiment

I1=(sum/N)*(b-a)*(d-c) # integral calculations
v=v+html("\nThe numerical value of the double integral "
"calculated by the Monte Carlo method with accuracy %1.4lf,\n"
"equals %1.4lf and demanded %s grid lines"%(eps, I1, N))
# function surface visualization
show(plot3d(f, (x,a,b), (y,c,d)))
show(v)
```

Another implementation will be directed by students to conduct as many experiments as possible in order to clarify the fact that with the same number of experiments, the simulation results can differ significantly.

$f(x, y) =$ `-x^2 + x*y + y^2`

Lower integration limit by Ox axis a = `0`

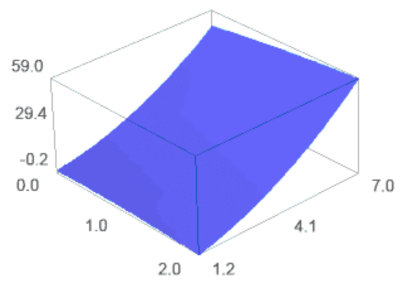
Upper integration limit by Ox axis b = `2`

Lower integration limit by Oy axis c = `1.2`

Upper integration limit by Oy axis d = `7`

Grid points quantity 1203

Accuracy `0.0100`




```
The analytic value of the double integral 259.6080
The numerical value of the double integral calculated by the Monte Carlo method for 1203 grid points,
is 254.1758
The numerical value of the double integral calculated by the Monte Carlo method with accuracy 0.0100,
equals 259.7041 and demanded 44445 grid lines
```

Fig. 1. The use of various models to calculate the value of a definite integral in a computer mathematics system

To do this, we use the mobile version of the spreadsheets, and enter the following values corresponding to the previous code. At first, the limits of integration:

A1	*a*
B1	0
A2	*b*
B2	2
C1	*c*
D1	1.2
C2	*d*
D2	7

The next step is to enter formulas for random values of x and y and calculate the function of them:

F1	*x*
F2	=RAND()*($B$2-$B$1)+$B$1
G1	*y*
G2	=RAND()*($D$2-$D$1)+$D$1
H1	$f(x, y)$

H2 =F2*G2-F2^2+G2^2

The last step is to calculate the average value of the function and the integral:

I1 *sum*/*N*

I2 =AVERAGE(H:H)

J1 *I*

J2=I2*($B$2-$B$1)*($D$2-$D$1)

In order to increase the number of points, you must copy the range F2:H2 in any number of other lines. The simulation results are presented in fig. 2.

fx =I2*($B$2-$B$1)*($D$2-$D$1)

	A	B	C	D	E	F	G	H	I	J
1	*a*	0	*c*	1,2		*x*	*y*	*f(x,y)*	*sum/N*	*I*
2	*b*	2	*d*	7		1,652183066	6,130320383	44,97953064	22,37720034	**259,575524**
985						0,03203005973	1,98753674	4,01293729		
986						0,1779508368	1,665179375	3,037475914		
987						1,083475535	1,506988334	2,729879594		
988						1,832478526	6,085571744	44,82788544		
989						0,7376209643	2,521369886	7,673036702		
990						0,4107830344	4,014181025	17,59386406		
991						0,1369868196	5,618305595	32,31622618		
992						0,5967027777	2,022590381	4,941702945		
993						1,390530277	6,093267424	43,66720629		
994						0,9838532541	4,115652797	20,01982912		
995						1,523217795	6,957248278	56,68051554		
996						1,553120525	1,274471552	1,191502299		
997						0,7101527516	3,931114998	17,74104033		
998						1,875779905	6,799857308	55,47454485		
999						1,570466309	6,017957051	43,20044143		
1000						0,267644216	6,082051505	38,54754299		

Fig. 2. Usage of the Monte Carlo method to calculate the value of a definite integral in mobile spreadsheets

A discussion of two implementations of the same model allows us to draw conclusions both on the correct implementation and on the advisability of using the selected modeling tool. So, when using spreadsheets, an increase in the number of experiments is possible only by adding new lines, however, any changes on the worksheet lead to the generation of new random numbers – instead of clarifying the results of the previous experiment, the student conducts a new experiment. At the same time, when using the model in a computer mathematics system, you can verify the erroneousness of the condition for completing the cycle – instead of `abs(sumnext-sum)<eps` must use condition `abs(sumnext/N-sum/(N-1))<eps` for all steps except the first: applying the precondition can lead to both early completion of the cycle (if the function value is close to zero in the first steps) and an overestimation of the number of iterations (if the function value becomes close to zero after reaching the required accuracy), and even to the "eternal" cycle (if the value of the function on the selected area will not be less accurate).

An important component of competence in the application of various methods of representing models is the formation of the ability to select an adequate way of representing models of computer modeling tools. One of the traditional ICT training tools for modeling is computer mathematics systems. In [23] it was pointed out that it should be used together with support systems for teaching bachelors in electromechanics for modeling technical objects, such as the Moodle LMS, supplemented by the developed SageCell filter [18]. The specified filter is able to implement a numerical solution of systems of differential equations describing mathematical models directly in the learning management system.

However, the use of only computer mathematics systems (even such powerful ones as SageMath [27]) for teaching modeling of technical objects of bachelors in electromechanics is not enough, since the synthesis and calculation of models of control systems, electric drive elements, etc. primarily use visual modeling tools that provide the opportunity to build dynamic models (discrete, continuous and models of systems with discontinuities elements). This determines the necessity and expediency of combining traditional computer mathematics systems with specialized libraries for modeling technical objects in environment for the visual construction of models. At the same time, the choice of environment for modeling should take into account the specifics of future professional activity, which for bachelors of electromechanics is the synthesis of the corresponding technical objects – electromechanical systems.

Mastering the modeling of technical objects provides theoretical and practical filling of the fundamental, general and specialized professional training for a bachelor's of electromechanics. In this regard, it is desirable that the environment for their modeling gives the user access not only to traditional libraries for modeling continuous and discrete dynamic systems, but also to libraries for electric machines and power converters. In addition, to achieve the goal of learning mobility, the modeling environment must have a high level of cross-platform access (in particular, access via a Web interface) and be freely distributed.

In order to make a reasonable choice of the environment for technical objects modeling for bachelors of electromechanics, an expert assessment of the most common systems of visual modeling was carried out, the results of which are presented in the table 1.

Currently, the Scilab has the highest expert assessment, the advantages of which were recognized in 2011 by the French Ministry of National Education, Higher Education and Science, giving Scilab a recognition of its pedagogical significance for teaching mathematics "Reconnu d'Intérêt Pédagogique" [29].

According to [28], Scilab is a package of scientific programs for numerical calculations that provides a powerful open environment for calculations, similar to the Matlab language and a set of functions for mathematical, engineering and scientific calculations. The package is suitable for professional use and use in the universities, providing tools for various calculations from visualization, modeling and interpolation to differential equations and mathematical statistics. Execution of scripts written for Matlab is supported.

Scilab was created in 1990 by INRIA scientists (Institut national de recherche en informatique et en automatique – State Institute for Computer Science and Automation Research) [9] and ENPC (École nationale des ponts et chaussées – National School of Bridges and Roads). At first it was called Ψlab (Psilab). The Scilab Consortium was created in May 2003. To promote the use of Scilab as open source software in the academic and industrial fields. In July 2008, Scilab joined the Digital Foundation to improve technology transfer [10].

Table 1. Comparison of environments for technical objects modeling

Modeling environment	**A freely distributed version availability ("yes" – 3 points, "no" – 0 points, "yes (with restrictions)" – 1 point)**	**The number of supported operating systems (for each system – 0.5 points, for "∞" – 1 point)**	**The Web interface availability ("yes" – 3 points)**	**Libraries for modeling continuous systems ("yes" – 5 points)**	**Libraries for modeling discrete systems ("yes" – 5 points)**	**Libraries for modeling electric machines ("yes" – 2 points)**	**Libraries for modeling power converters ("yes" - 2 points)**	**Total**
Analytica	yes (with restrictions)	1 (W*)	yes	no	no	no	no	4,5
AnyLogic	yes	3 (WML)	no	no	no	no	no	4,5
GoldSim	no	1 (W)	no	no	no	no	no	0,5
Insight Maker	yes	∞ (JS)	yes	no	no	no	no	7
MapleSim	no	3 (WML)	no	no	no	yes	yes	5,5
Minsky	yes	3 (WML)	no	no	no	no	no	4,5
Rand Model Designer	no	1 (W)	no	yes	yes	no	no	10,5
Scilab Xcos	yes	3 (WML)	yes	yes	yes	no	no	17,5
Simantics System Dynamics	yes	1 (W)	no	no	no	no	no	3,5
Simile	yes (with restrictions)	3 (WML)	yes	no	no	no	no	5,5
Simulink	no	3 (WML)	no	yes	yes	yes	yes	15,5
Temporal Reasoning Universal Elaboration	no	1 (W)	no	no	no	no	no	0,5
Vensim	yes	2 (WM)	no	no	no	no	no	4
VisSim	no	1 (W)	no	no	no	no	no	0,5
Wolfram SystemModeler	no	3 (WML)	no	no	no	yes	yes	5,5

* W – Windows, M – macOS, L – Linux, JS – JavaScript

In June 2010, the Scilab Consortium announced the creation of Scilab Enterprises [4]. Scilab Enterprises develops and sales, directly or through an international network of affiliate service providers, a comprehensive suite of services for Scilab users. Scilab Enterprises also develops and maintains Scilab software. Scilab Enterprises' ultimate goal is to help make using Scilab more efficient and easier. Since February 2017, Scilab has been developed and published by ESI Group, an industrial virtual reality development company [5].

Scilab contains hundreds of mathematical functions with the ability to add new ones written in various languages (C, C++, Fortran, etc.). Various data structures are supported (lists, polynomials, rational functions, linear systems), an interpreter and a high-level language.

Scilab was designed as open system in which users can add their data types and operations on this data by overloading.

Many tools are available in the system:

- 2D and 3D graphics, animation;
- linear algebra, incl. work with sparse matrices;
- polynomial and rational functions;
- interpolation, approximation;
- differential equations;
- Scicos: a hybrid tool for modeling dynamic systems;
- optimization;
- signal processing;
- parallel computing;
- statistics;
- work with computer algebra;
- Fortran, Tcl/Tk, C, C++, Java, LabVIEW interfaces;

Scilab has a programming language similar to MATLAB; the system includes a utility that allows to convert Matlab documents to Scilab.

Scilab allows to work with elementary and a large number of special functions (Bessel, Neumann, integral functions), has powerful tools for working with matrices, polynomials (including symbolic), performing numerical calculations (for example, numerical integration) and solving linear algebra problems, optimization and simulation, powerful statistical functions, as well as a tool for building and working with charts. For numerical calculations, the libraries Lapack, LINPACK, ODEPACK, Atlas and others are used.

The package also includes Scicos, a tool for editing block diagrams and simulations (the Xcos add-on is an analogue of the Simulink package in MATLAB). There is the possibility of collaboration between Scilab and LabVIEW.

Distinctive features of Scilab:

- fee free;
- small size (distribution takes less than 150 Mb);
- the ability to run in the console without using a graphical interface. This allows automated calculations in batch mode.

Starting with version 6, the program is distributed under the GPL compatible license CeCILL license [1].

Despite the lack of usability of the text interface, it is easier to adapt to MID. Among the well-known Scilab implementations for the Android OS, we distinguish two – Scilab on Aakash and Scilab Console Free.

Scilab on Aakash [30] is an Indian development that is supported in both the Android and GNU/Linux Aakash versions. In Android, Scilab is part of the APL library (Aakash Programming Lab [7], developed by Indian Institute of Technology Bombay), which provides Scilab 5.4. All Scilab functions cannot be runnging on Android, so the developers provide the user interface with only 2 windows (fig. 3): enter commands and view the results of their execution.

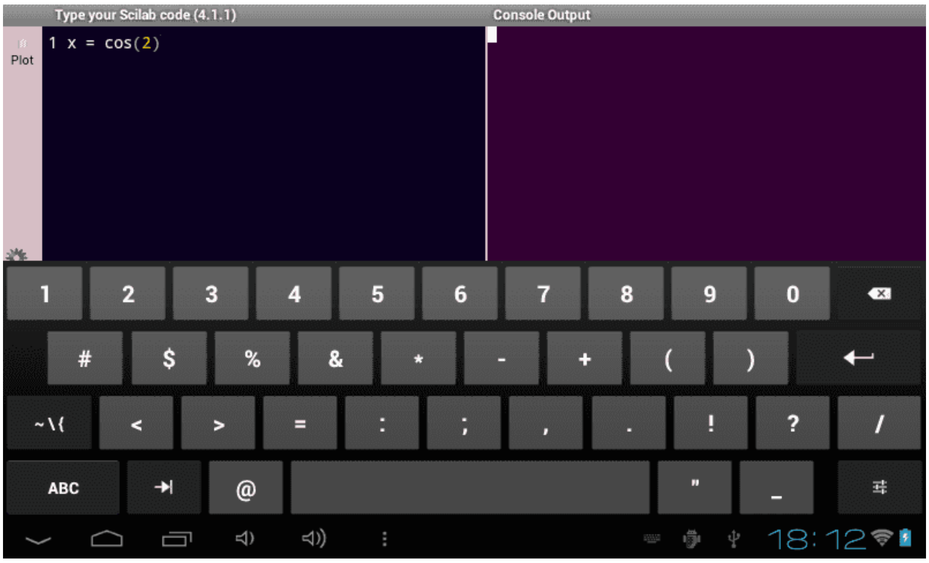


Fig. 3. Scilab on Aakash window interface

When executing graphic commands with the Plot option selected, the results of execution will be displayed in a separate window (fig. 4). This version of Scilab may be admitted as mobile, but not fully functional.

Scilab Console Free (fig. 5) – is a mobile version of Scilab for Android and iOS. Like Scilab on Aakash, this is not a fully functional version of Scilab 5.4.1: the graphic functions of Scilab and Xcos are not activated. The developers of this product went the easy way – to achieve mobility on the device you first have to install one of the Linux options (for example, using GNURoot Debian [2]).

The mobility of this version of Scilab is achieved by transferring the Linux mobile operating system and its software environment to Android and iOS. Therefore, Scilab Console Free is quite demanding on the internal memory of the mobile device and the version of the operating system.

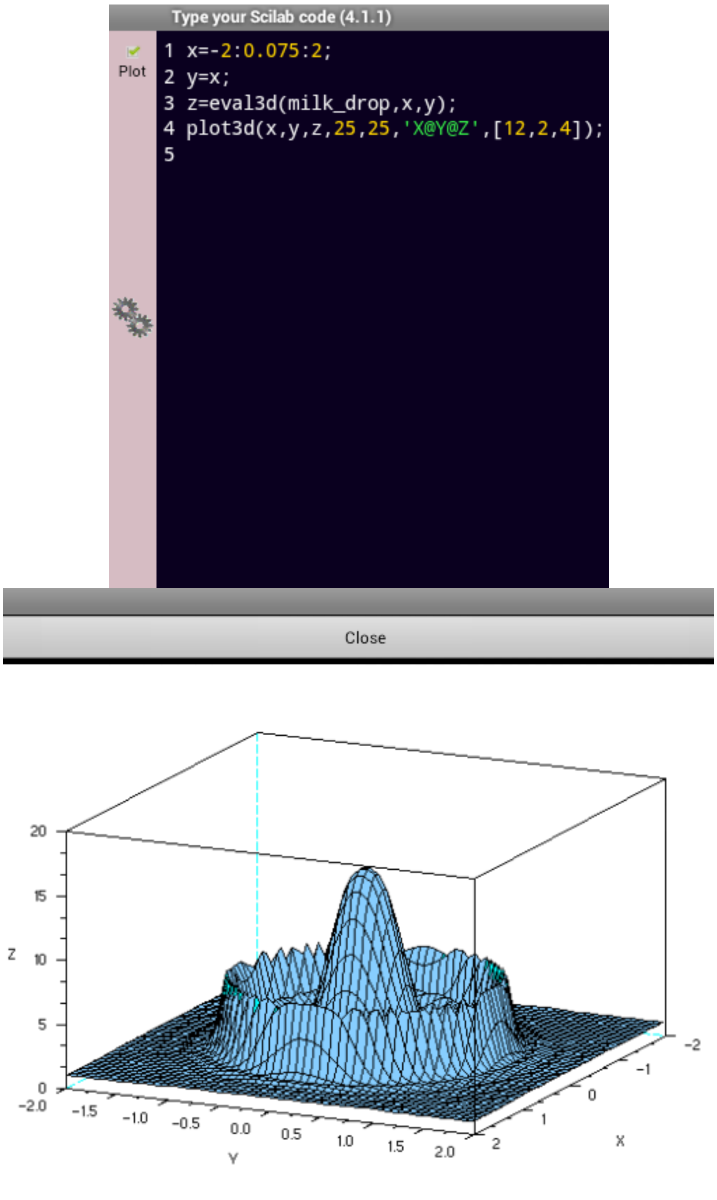


Fig. 4. Graphic plotting in Scilab on Aakash

The standard Web interface to Scilab, which is proposed by *Cloud Scilab* [36], does not provide an interface similar to the full-featured version – it is only possible to host user-created models with a Web interface (application deployment – “deploying” programs to the cloud server [15]) by creation and publication of interactive documents, the software part of which is performed on the server side, saves the resources of a MIDs (fig. 6).

Fig. 5. Scilab Console Free launch window

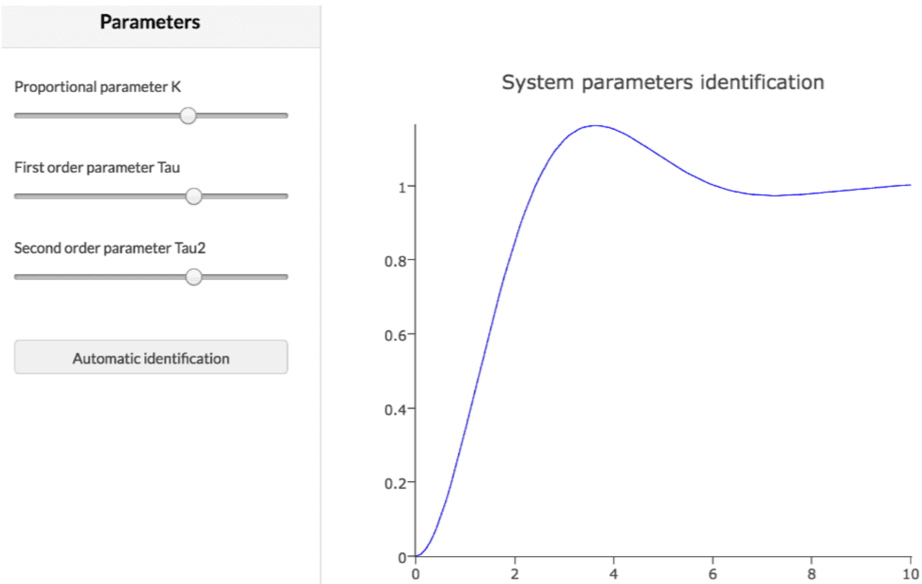


Fig. 6. An example of an interactive document in Scilab Cloud

This provides several advantages:

— centralization of data used and created by the user program;
— no need to install software on the client side;
— concealment of code from end users (as a component of intellectual property protection);
— centralization of Scilab code to ensure the effective operation of programs.

Programs deployed on the Scilab Cloud are described by the Scilab language (both algorithms and the user interface). This allows you to create programs with a visual interface both for deployment in the cloud (work in Scilab Cloud with display via a web browser) and traditional execution (launch in Scilab on the user's computer).

Despite the high level of mobility, the use of Cloud Scilab is accompanied by a number of problems:

- deployment of programs is only available with administrative privileges (requires an additional fee to the cloud service provider);
- the interface is provided only for user models, and not to the entire Scilab interface.

In terms of functionality, this service is similar to the Wolfram Demonstrations Project, however, unlike the latter, all users can publish demonstrations, and not only service administrators comply with the document distribution model in CoCalc [14]. However, Scilab Cloud does not provide access to the Xcos module. In addition, in fact, the only source about Scilab Cloud is the materials of webinars conducted by Scilab Enterprises [3], which does not contribute to the widespread use of this Web-interface.

W3 Scilab is significantly more open [13]. W3 Scilab is the Indian Web-based interface to Scilab, which is the basis of Scilab on Aakash. The interface allows users to send short fragments of Scilab code to a remote server, receive Scilab code on this server, return and display execution results in a browser.

Xcos is an addition to Scilab, which allows the synthesis of mathematical models in the fields of mechanics, hydraulics, electronics and electromechanics. This visual modeling environment is designed to solve the problems of dynamic modeling of systems, processes, devices, as well as testing and analysis of these systems. In this case, the object is modeled (system, device, process), supplied graphically in the form of a block diagram that includes blocks of system elements and the connections between them (fig. 7).

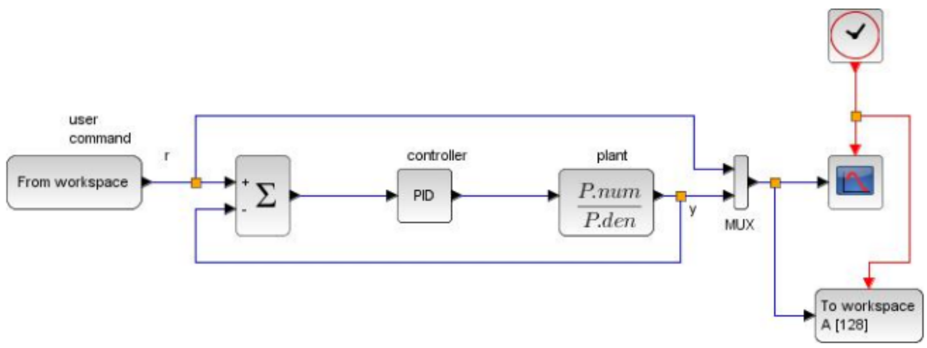


Fig. 7. Scilab Xcos model example

The most significant criteria that led to the choice of Scilab as a tool of teaching modeling of technical objects of bachelors in electromechanics are the availability of modeling continuous systems libraries (5 points), modeling discrete systems libraries

(5 points) and the presence of a Web interface (3 points). The latter makes it possible to use it on MID.

The Xcos on Cloud service provides the ability to build simulation models of technical objects (in particular, electromechanical systems) in a mobile Web browser. The current goal of the Xcos on Cloud project (formerly Xcos on Web [22]) is to recreate a fully functional version of Scilab Xcos with access via a mobile Web browser [6].

The main components of the Xcos on Cloud main window are presented in fig. 8.

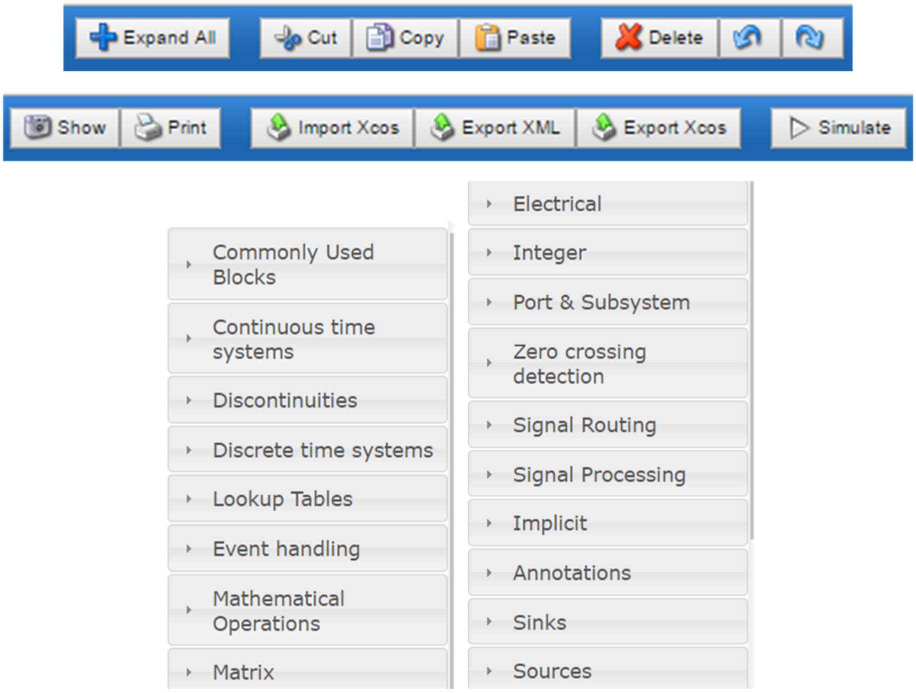


Fig. 8. Xcos on Cloud main window components

The main part of the Xcos on Cloud main window is occupied by the model building area. On the left side is the so-called palette of blocks – a library of elements from which the model is built. To use any block, just drag it from the palette to the model building area. Blocks are interconnected by communication lines.

In fig. 9 shows a DC motor model built in Xcos on Cloud. Blocks of the model have various parameters, user-configurable by double-clicking on the selected block. Unfortunately, the project is still at the preliminary development stage, so some settings are not available: for example, the first-order aperiodic unit (CLR) and amplifier (GAIN) blocks in the constructed model are unstable, as evidenced by the format specifier '%s'. This makes it impossible to conduct experiments on the model by the click of a button. *Simulate*. A temporary workaround for this problem is the ability of

Xcos on Cloud to exchange data with the traditional version of Scilab Xcos through data export tools.

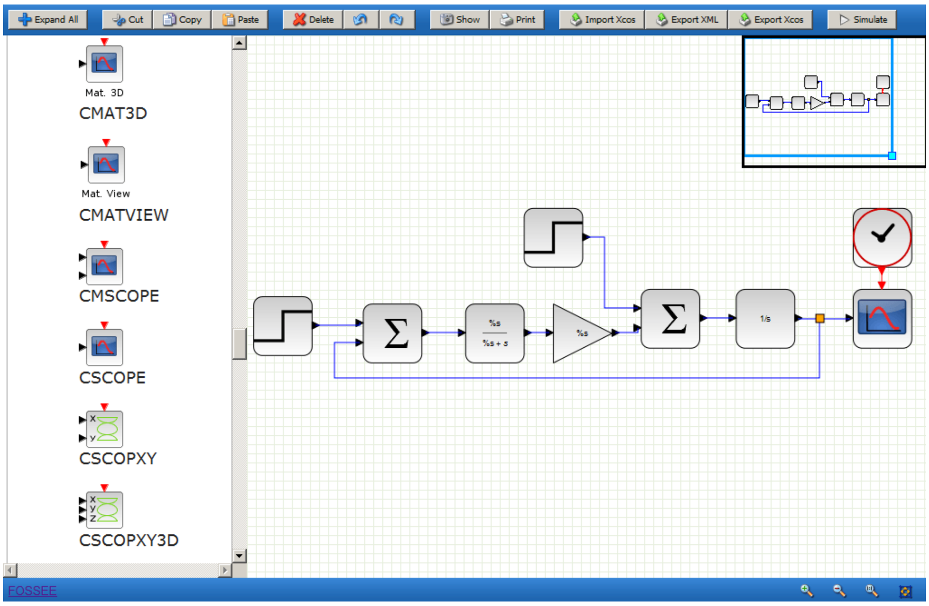


Fig. 9. DC Engine model in Xcos on Cloud

A fragment of an XML representation of a constructed model of a DC motor:

```
<?xml version="1.0" encoding="UTF-8"?>
<XcosDiagram background="-1" title="MavXcos">
    <mxGraphModel as="model">
        <root>
            <mxCell id="0"/>
            <mxCell id="1" parent="0"/>
            <BasicBlock blockType="c" id="2"
interfaceFunctionName="STEP_FUNCTION" parent="1"
simulationFunctionName="csuper"
simulationFunctionType="DEFAULT" style="STEP_FUNCTION">
...
        </root>
    </mxGraphModel>
  <mxCell id="1" parent="0" as="defaultParent"/>
</XcosDiagram>
```

The implementation of the full functionality of Scilab Xcos in Xcos on Cloud creates the conditions for a using MID in the training of bachelors in electromechanics, modeling of technical objects. Similar features are provided by the full virtualization of Scilab on rollApp [31].

2.2 Use of mobile Internet devices in the formation of competence in solving professional problems using ICT

The formation of a general professional component of the competence of a bachelor of electromechanics in the modeling of technical objects, such as *competence in solving professional problems using ICT*, provides for the acquisition of knowledge in the field of computer engineering and programming, the ability to create application software, and the skills to work with ICT tools to solve problems in field of electromechanics. The formation of this competence begins in the academic discipline “Computing Engineering and Programming” and occurs along with the formation of the general scientific component of the competence of the bachelor of electromechanics in the modeling of technical objects, in particular competencies in information and communication technologies and in applied mathematics. Its further development takes place in the process of developing models; they are considered in the academic disciplines “Theory of Automatic Control” and “Modeling of Electromechanical Systems”.

The purpose of studying the discipline “Theory of Automatic Control” is to master the methods of setting tasks, the principles of building automatic control systems, methods of analysis and synthesis of linear, nonlinear, impulse, digital, adaptive and optimal systems using modern software systems for modeling dynamic systems.

As a result of studying the discipline, students, in particular, should receive skills:

- compose differential equations for elements of automatic control systems and the system as a whole;
- draw up and transform structural diagrams of automatic control systems;
- determine the time functions and time characteristics of the automatic control system and its elements under the conditions of various types of signals;
- determine the frequency functions and characteristics of automatic control systems;
- analyze the stability of linear, impulse and nonlinear automatic control systems;
- calculate control devices (controllers) that provide the necessary quality indicators, including using the state space method;
- synthesize automatic control systems in the presence of random signals;
- apply adaptive methods to control non-stationary objects.

At the lectures of the second module “Properties and characteristics of closed control systems. Synthesis of linear continuous control systems”, the issues of influence on the system and requirements for the control process, stability of control systems, stationary (stable) modes of linear control systems, quality assessment of control systems with step and arbitrary actions, frequency methods for assessing the quality of control systems, approximate methods for choosing the control method and parameters are considered regulators, synthesis of control systems according to the logarithmic frequency characteristics. To consolidate this material, we propose laboratory works “Analysis of stability and quality of control systems” and “Synthesis and research of control systems for objects with a delay”. Consider the use of ICT tools to solve the second of them.

Objective of the work: to study the influence of the delay link on the stability and quality of the automatic control system.

The content of the work

1. The study of the influence of the delay link on the characteristics of the automatic control system.
2. Experimental obtaining the transient and frequency characteristics of the system with delay.

Theoretical information

The automatic control systems may include time delay, the equations of which are of the form:

$$y(t) = x(t - \tau), \tag{1}$$

where τ – delay time.

The transfer function of a time delay in accordance with the delay theorem (properties of the Laplace transform):

$$W_{\mathrm{del}}(s) = e^{-s\tau}. \tag{2}$$

Automatic control systems, which include a time delay, are called time delay systems.

It can be connected in the direct circuit of the system or to the feedback circuit. Moreover, regardless of the location of the delay link, the characteristic equation of a closed system with delay has the form:

$$D_\tau(s) = Q(s) + R(s)e^{-s\tau} = 0, \tag{3}$$

where $Q(s)$ and $R(s)$ – polynomials in the denominator and numerator of the transfer function of the open system without delay.

This characteristic equation is not a polynomial and has an infinite number of roots. Therefore, to study the stability of delayed systems, it is necessary to use frequency stability criteria, such as the Nyquist stability criterion. The conclusion about the stability of the system can be made on the basis of the analysis of the amplitude-phase frequency response of an open system with delay.

It can be shown that the presence of a delay link does not change the module of $A(\omega)$ but introduces only an additional negative phase shift of $-\omega\tau$. By varying the delay time τ over a wide range, one can find its value at which the closed-loop system will be at the stability boundary. In this case, amplitude-phase frequency characteristic of the open-loop phase response of the delayed system will pass through the point (-1; 0) = -1+j0.

The latency τ_{cr} and the corresponding value of the frequency ω_{cr}, at which the AFC passes through the point (-1; 0), are called *critical*. For a critical case, the following conditions are true:

$$A(\omega_{\mathrm{cr}}) = 1;\ \phi_\tau(\omega_{\mathrm{cr}}) = -\pi. \tag{4}$$

The automatic control system will be stable if the delay time τ is less than critical: $\tau < \tau_{\mathrm{cr}}$.

Work order

The subject of the study is an automatic control system, with a delay link.

1. The transfer function of the open-loop automatic control system without delay has the form:

$$W(s) = \frac{K}{s\,(T_1 s+1)(T_2 s+1)} \tag{5}$$

The value of the transmission coefficient K and the time constants T_1 and T_2 are shown in the table

Num of var.	**1**	**2**	**3**	**4**	**5**
K, s^{-1}	5	3	1	10	8
T_1, s	0,5	0,1	0,05	0,05	0,04
T_2, s	0,01	0,05	0,01	0,2	0,1

Using the Scilab package, construct the transition characteristic $h(t)$ of the closed-loop system with unit negative feedback (fig. 10, 11). Make a conclusion about the stability of the system.

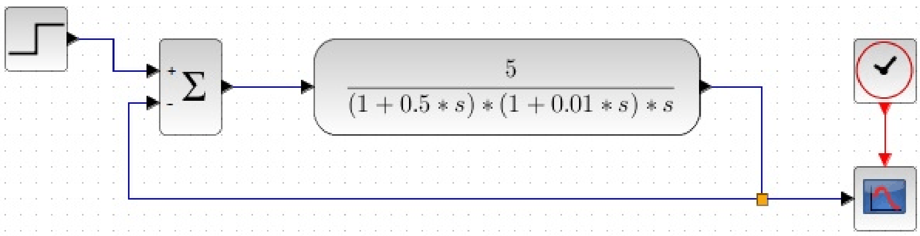


Fig. 10. Block diagram of a closed-loop system without delay

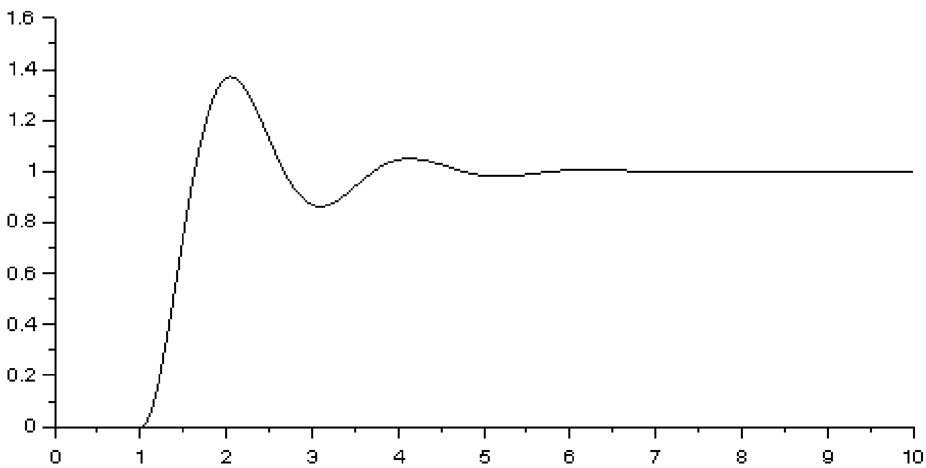


Fig. 11. Transient response of a closed-loop system with a single negative feedback without delay

2. Insert a time delay function with the delay time $\tau = 0{,}01$ s (fig. 12), into the direct chain of the system, construct the transition characteristic of the system (fig. 13) and make a conclusion how the time delay affects the quality of the transition process.

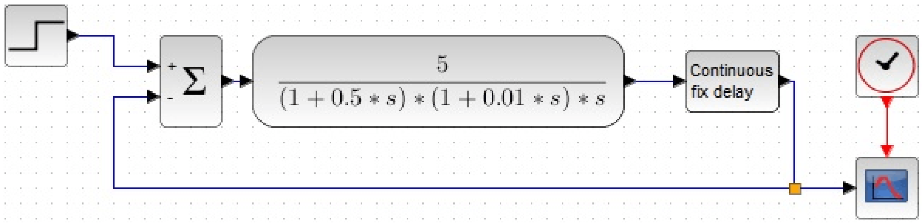


Fig. 12. Block diagram of closed-loop control system with delay time

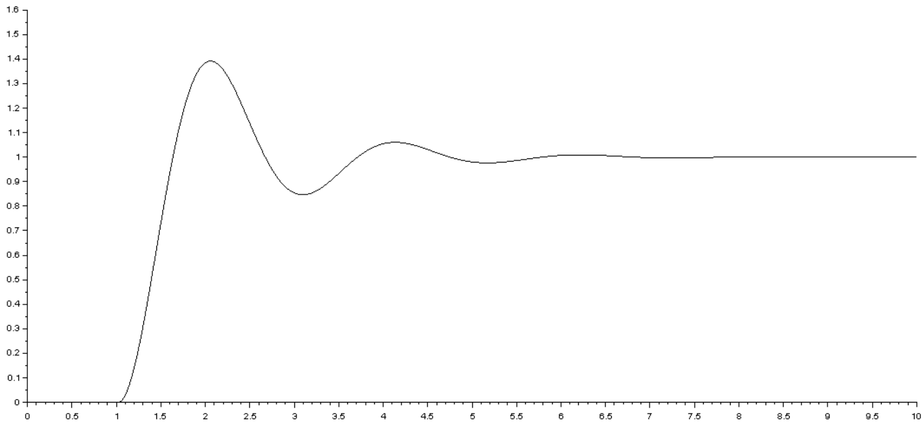


Fig. 13. Transient response of a closed-loop system with a negative feedback with delay $\tau = 0{,}01$ s

3. Increasing the time of delay, to trace how the transition characteristic of the system changes (fig. 14) to make the system lose stability (the transition process diverges).
4. To determine experimentally the value of the critical delay time τ_{cr}, when the system will be at the stability boundary (the transition process will be undamped).
5. Repeat steps 2-4 for the case when the time delay function included in the feedback circuit. Make some conclusions.

Further development of competence in solving professional problems by means of ICTs occurs in the process of completing term paper in the discipline “Theory of automatic control”. In order to develop skills for conducting professionally directed educational research, students can be invited to familiarize themselves with new results in the subject area of scientific publications in professional publications and start the coursework on their reproduction. So, in the work “Optimization of the servo-controlled automatic control system” [11] an example of servo-controlled control system of a working body of a paver with hydraulic drive is considered.

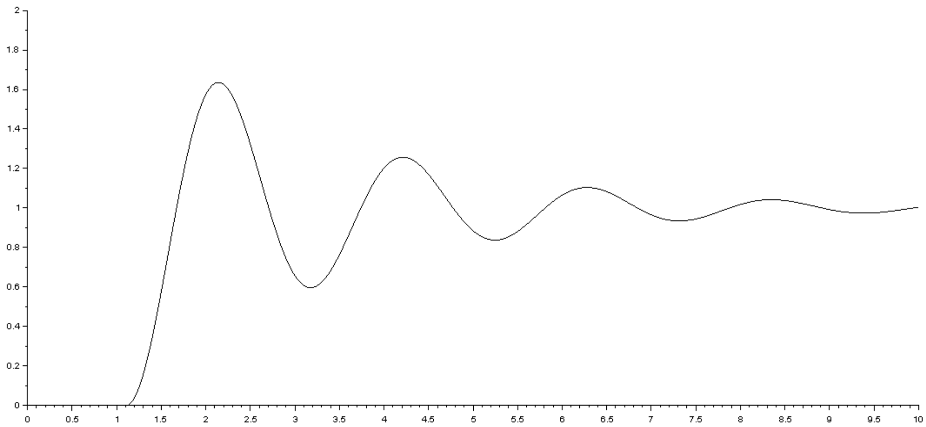


Fig. 14. Transient response of a closed-loop system with a negative feedback with delay $\tau = 0{,}1$ s

When moving the stacker along the base, which is ready for laying pavement on it, its running equipment (tracked or wheeled) makes uncontrolled random movements in the vertical direction under the influence of roughnesses in the microrelief of the base of the road. These movements are transmitted through the stacker frame and suspension of the screed to the working equipment, causing in turn uncontrolled movements of the screed, which entail a random change in the thickness and angle of the transverse slope of the stacked layer, thereby deteriorating the quality of the coating.

A simulation model of the hydraulic drive tracking system for the screed plate can be implemented in MATLAB Online, as suggested by the authors of [11]. The structure of the simulation model circuit (fig. 15) includes the following elements: a bi-directional hydraulic cylinder; three-position valve; hydraulic pump; controlled hydraulic lock; ideal hydraulic pressure sensor; the "smooths the paver plate" element; cylinder rod movement and speed sensor (feedback sensor) the ideal force sensor; the element "hydraulic fluid" (Oil-30W oil) is proportional to the servo valve of the hydraulic actuator (electro-hydraulic distributor that converts the electrical signal to movement) element "viscous friction"; ideal source of strength; disturbing influence of "microrelief"; PS-converter; capacity for working fluid; disturbing effects due to the influence of the work of other elements.

2.3 Use of mobile Internet devices in the formation of competencies in electric machines and critical thinking

In the discipline "Electrical Machines", the formation of both the general scientific component of the competence of the bachelor of electromechanics in the modeling of technical objects (the leading means of competencies in basic sciences formation were mobile augmented reality tools), and such a general professional component as *competencies in electrical machines*, including knowledge of the structure and functioning principles of electrical machines, in particular: energy conversion processes (electromagnetic and electromechanical), characteristics of certain types of electrical machines, structure of asynchronous machines, synchronous machines, DC machines, transformers; the ability to calculate the parameters and characteristics of electrical machines. To form the latter, the leading tools are mobile computer mathematics systems.

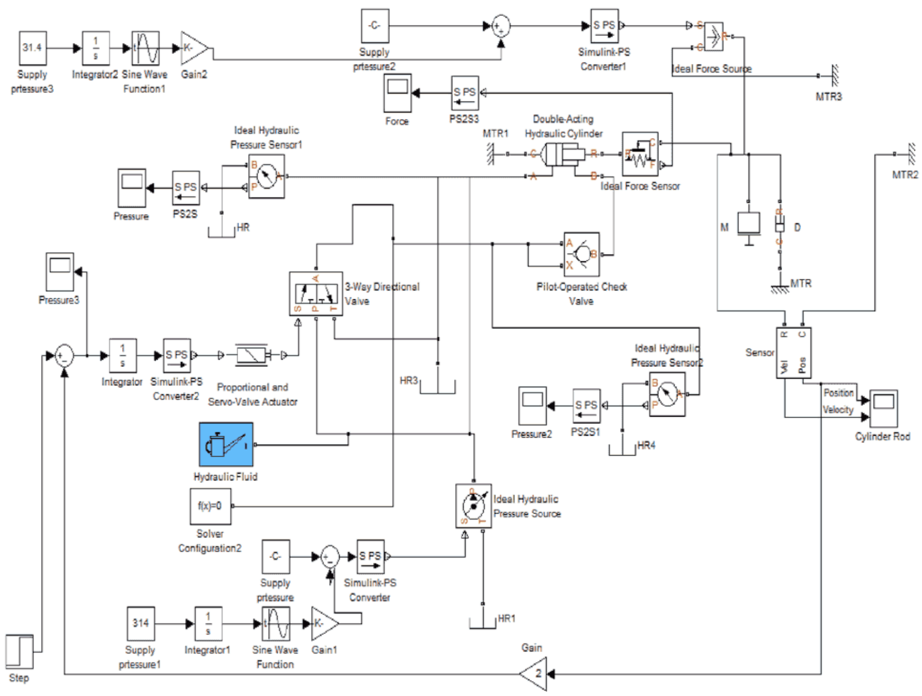


Fig. 15. Structural model of the hydraulic drive tracking system for the screed slab

The last general professional component of a bachelor of electromechanics competence in modeling technical objects is *competence in critical thinking* – the knowledge and skills of setting a problem with an insufficient amount of input data, analyzing the availability of methods and means of solving a problem, assessing your own readiness to solve a problem, independently searching for missing data and ways to solve the problem; the ability to control their own activities – both mental and practical; the ability to control the logic of deploying your own thoughts; the ability to determine the sequence and hierarchy of the stages of activity and the like. As well as for competence in the application of various ways of representing models, leading academic disciplines cannot be distinguished to this competence – its formation takes place throughout the entire training of a bachelor of electromechanics.

Neural network modeling is an effective means of modeling technical objects with a hidden or fuzzy structure [32; 33]. As the editors of the book “Neuro-Control and its Applications” note, the relevance of its application is due to the need to develop control methods for complex nonlinear systems: “The first examples of the development of control methods for nonlinear systems ... are mainly associated with methods for solving nonlinear differential equations that are adequate to a single-processor background of Neumann computational to cars. ... The development of computers with mass parallelism ... has led to the creation of fundamentally new algorithms and methods for controlling non-linear dynamic systems. They are associated with neural network algorithms for solving ordinary nonlinear differential equations and, as a result, with the inclusion of a neurocomputer in the control loop of a nonlinear dynamic system. ... The sufficiently wide development and spread of such algorithms has led ... to the creation of a whole branch of science called “neurocontrol” [24, pp. 9–10].

In an engineering context, intelligent management should have the following properties: learning ability and adaptability; survivability; simple control algorithm and user-friendly man-machine interface; the ability to incorporate new components that provide the best solutions in the face of limitations imposed by technical tools [24, p. 15].

The deep machine learning is a class of intelligent control algorithms that use multilayer neural networks with non-linear nodes. Let us consider the construction of a neural network model for approximating data described in Chapter 23 of “Neural Network Design” [8], and obtained using an intelligent sensor – one or more standard sensors connected to a neural network to obtain a calibrated measurement of one of the parameters.

The intelligent position sensor uses the voltage value from two photocells to estimate the location of the object. In fig. 16, an object located between a light source and two photocells is shown around. The object, moving along the y axis, casts a shadow on the photocells, which leads to a change in the voltages v_1 and v_2. When the position of the object y increases, the voltage v_1 first decreases, then the voltage v_2 decreases, then v_1 increases and finally v_2 increases (fig. 17).

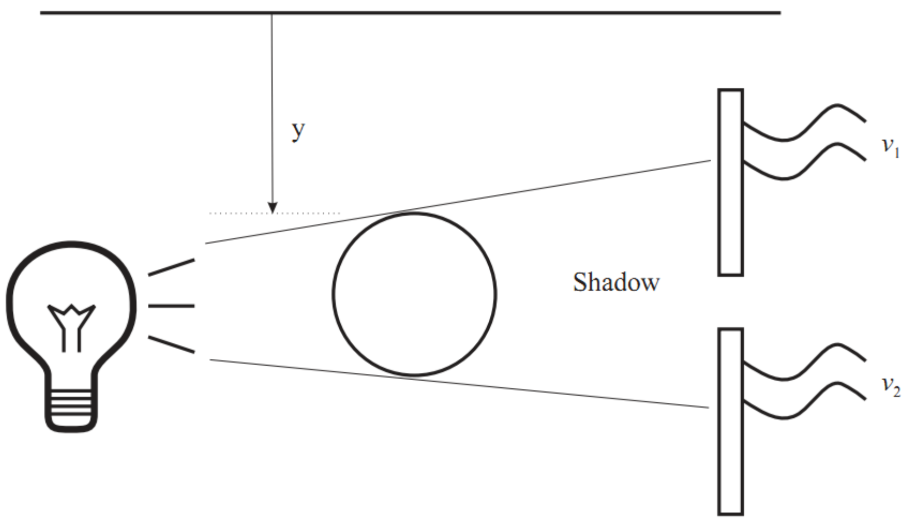


Fig. 16. Intelligent position sensor

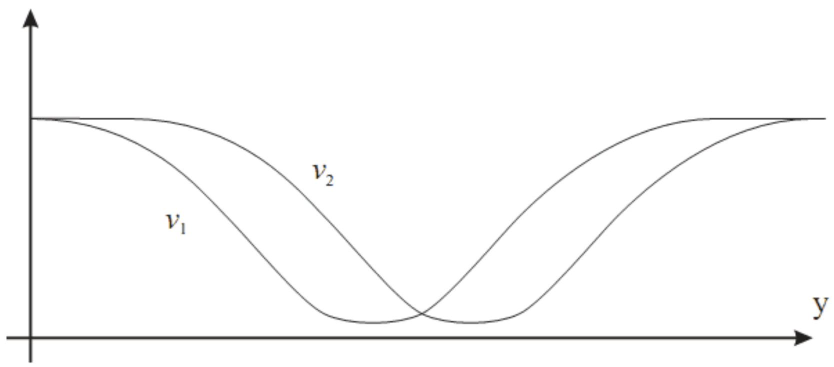


Fig. 17. An ideal model of the dependence of the voltages v_1, v_2 on the y coordinate of the object

The simulation purpose is to determine the position of the object by measuring two voltages. In order to collect data for approximation, two voltages of photocells are measured in a number of reference positions of the object. The authors of [8] used a table tennis ball for these experiments. In total there are 67 sets of measurements presented in the files ball_p.txt and ball_t.txt in the archive at the link http://hagan.okstate.edu/CaseStudyData.zip. Each point in graph 18 represents a voltage measurement in a calibration position. Coordinates are measured in inches and voltages are in volts. Flat areas of 0 volts for each curve occur where the shadow of the ball completely covers the sensor. If the shadow was large enough to cover both sensors at the same time, we will not be able to restore the coordinate from the voltage.

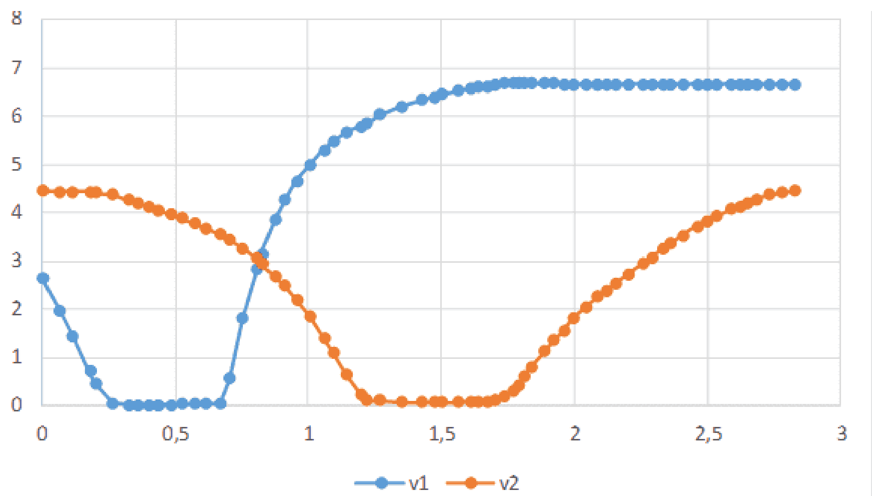


Fig. 18. The dependence of the voltages v_1, v_2 on the y coordinate of the object

To implement the deep learning model, we apply cloud-oriented Google Sheets with the Solver addition according to the technique developed in [16].

In order to determine the coordinate of the object, we will build a four-layer neural network with the architecture shown in fig. 19:

- input layer is a two-dimensional arithmetic vector (x_1, x_2), with the components are the corresponding measured voltages v_1, v_2, normalized according to the network activation function;
- the first hidden layer will have dimension 5 and is described by the vector ($h_1^{(1)}$, $h_2^{(1)}$, $h_3^{(1)}$, $h_4^{(1)}$, $h_5^{(1)}$);
- the second hidden layer will have dimension 3 and is described by the vector ($h_1^{(2)}$, $h_2^{(2)}$, $h_3^{(2)}$);
- output layer is y_{norm} value normalized according to the network activation function.

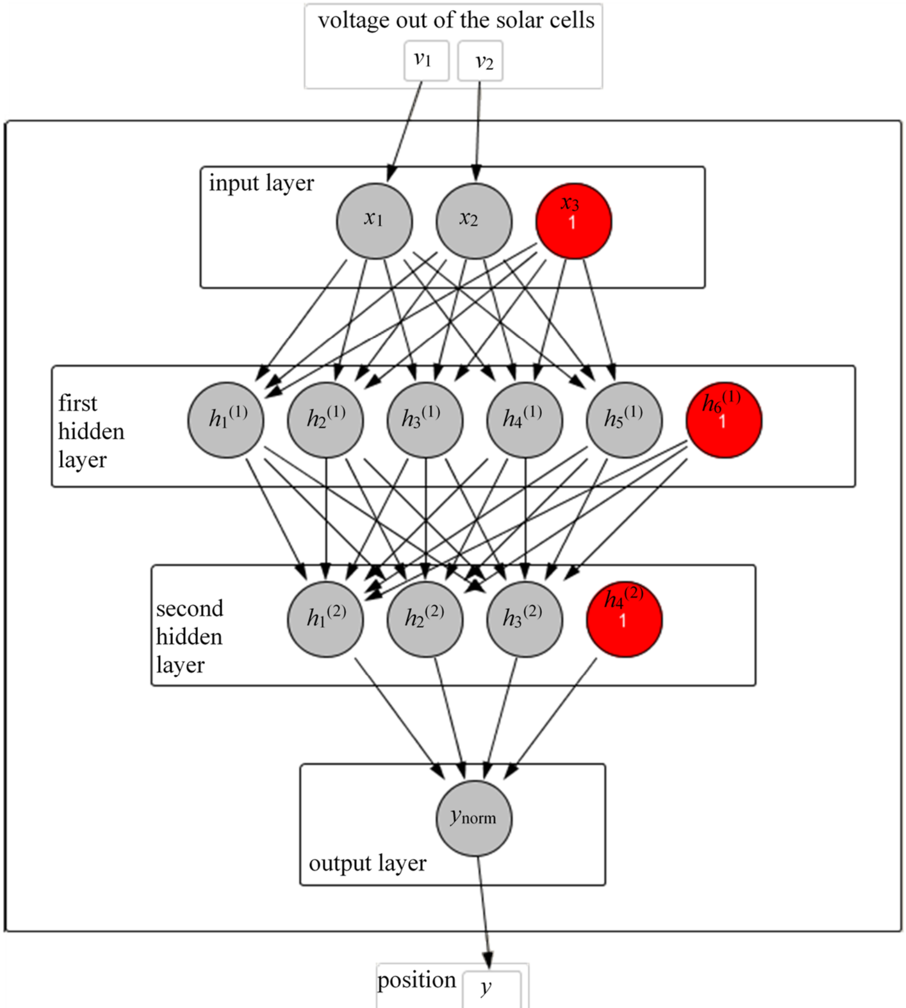


Fig. 19. Neural network architecture for solving the problem of determining the position of an object

Displacement (bias) neurons are added to the neurons of the input and hidden layers. Bias neurons value is always equal to 1 (in fig. 19 they are marked in red). A feature of bias neurons is that they do not have input synapses, and therefore cannot be located on the output layer.

First, enter the data of the measured voltages in the spreadsheets. Since the data is presented in a text file, we use the function of importing data into spreadsheets (fig. 20).

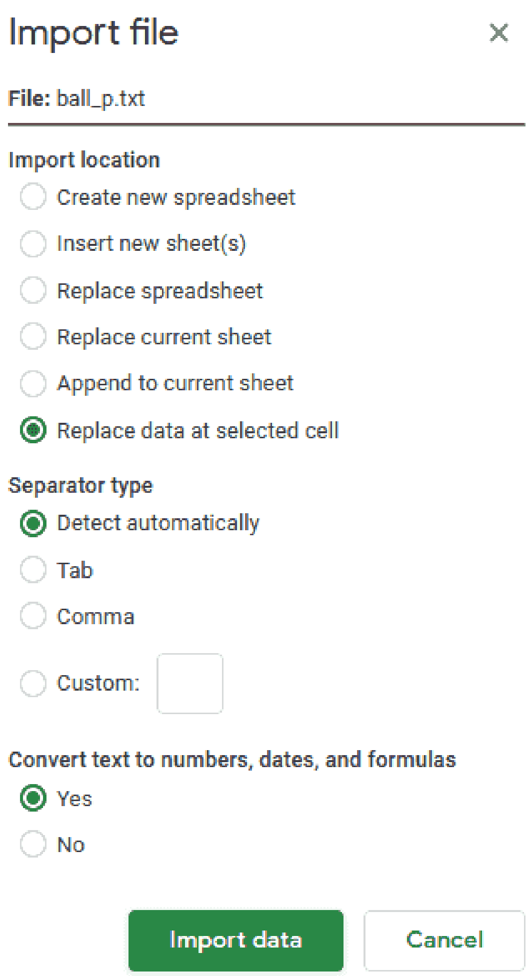


Fig. 20. Import data to spreadsheet

As a result of import, the following values are entered in the table cells:

B1:BP1 v_1 voltage output data
B2:BP2 v_2 voltage output data
B3:BP3 y coordinate

For convenience of processing, we transpose the obtained data and put them in cells A10:A76 for v_1, B10:B76 for v_2, C10:C76 for y. To do this, we add the following values to the table cells:

A8 *data*
A9 v_1
B9 v_2
C9 y
A10 =TRANSPOSE(B1:BP3)

Based on the fact that the constructed neural network will have a polar activation function, all values at the network input should be normalized (reduced to the range [0; 1]). At the output of the network, you must perform the reverse operation – denormalization.

Normalizing is performed for each column separately. To do this, we find the minimum and maximum values for them by entering the following formulas in the cells:

E5 v_1
F5 v_2
G5 y
D6 *max*
D7 *min*
E6 =max(A10:A76)
E7 =min(A10:A76)

Further, the range E6:E7 is copied to F6:G7.

The essence of normalizing is easy to understand by the expression (5):

$$\text{normalized value} = \frac{\text{input value-minimum value}}{\text{maximum value-minimum value}}. \quad (5)$$

With this approach, the minimum value is normalized to 0, and the maximum up to 1. The normalized voltage values must be feed to the input layer of the neural network:

E8 *input layer*
E9 x_1
F9 x_2
E10 =(A10-E$7)/(E$6-E$7)

Cell E10 is distributed in the range E10:G76.

In accordance with the selected architecture of the neural network, add to the 2 neurons of the input layer a bias neuron. To do this, insert its name (x_3), in cell G9, and its value (1) in the range G10: G76. At this stage, the input layer is formed in the form of a signal vector (x_1, x_2, x_3).

The next step is to transmit the signal from the input layer of the neural network to the first hidden one. To determine the signal power, it is necessary to have weights of the neural network. Denote by:

- $w_{ij}^{xh(1)}$ the weight coefficient of the synapse, which connects the neuron x_i (i = 1, 2, 3) of the input layer with the neuron $h_j^{(1)}$ (j = 1, 2, ..., 5) of the first hidden layer;

- $w_{kp}^{h(1)h(2)}$ the weight coefficient of the synapse, which connects the neuron $h_k^{(1)}$ (k = 1, 2, ..., 6) of the first hidden layer to the neuron $h_p^{(2)}$ (p = 1, 2, 3) of the second hidden layer;
- $w_{dq}^{h(2)y}$ the weight coefficient of the synapse, which connects the neuron $h_d^{(2)}$ (d = 1, 2, ..., 4) of the second hidden layer with the neuron $y_{\text{norm}q}$ (q = 1) of the output layer.

Then the power of the signal arriving at the neuron $h_j^{(1)}$ of the first hidden layer is defined as the scalar product of the signal values at the input layer and the corresponding weighting coefficients. To determine the signal, we will go further to the second hidden layer, we apply the logistic activation function $f(S) = 1/(1+e^{-S})$, where S is the corresponding scalar product. The formulas for determining the signals on the first (6) and second (7) hidden and output (8) layers are:

$$h_j^{(1)} = f\left(\sum_{i=1}^{2+1} x_i w_{ij}^{xh(1)}\right), \tag{6}$$

$$h_p^{(2)} = f\left(\sum_{k=1}^{5+1} h_k^{(1)} w_{kp}^{h(1)h(2)}\right), \tag{7}$$

$$y_{\text{norm}q} = f\left(\sum_{d=1}^{3+1} x_d w_{dq}^{h(2)y}\right). \tag{8}$$

Accordingly, it is necessary to create three matrices:

- The $w^{xh(1)}$ matrix of size 3×5 contains the weights connections of 3 neurons of the input layer (the first two contain normalized stress values, and the third is the bias neuron) with the neurons of the first hidden layer;
- The $w^{h(1)h(2)}$ matrix of size 6×3 contains the weights connections of 6 neurons of the first hidden layer (of which five are calculated, and the sixth is the bias neuron) with the neurons of the second hidden layer;
- The $w^{h(2)y}$ matrix of size 4×1 contains the weights connections of 4 neurons of the second hidden layer (of which three are calculated, and the fourth is the displacement neuron) with the neurons of the output layer.

For an "unlearned" neural network, the initial values of the weights can be set either randomly, or left undefined, or equal to zero. To implement the last method, fill the cells with these values:

I8	$w^{xh(1)}$
I9	*input layer*
J8	*first hidden layer*
J9	1
K9	=J9+1
I10	1
I11	=I10+1
J10	0
I14	$w^{h(1)h(2)}$
I15	*first hidden layer*
J14	*second hidden layer*
J15	1

K15 =J15+1
I16 1
I17 =I16+1
J16 0
I23 $w^{h(2)y}$
I24 *second hidden layer*
J23 *output layer*
J10 1
I25 1
I26 =I25+1
J25 0

To create matrices, it is necessary to copy K9 cell to the range L9:N9, I11 – to I12, J10 – to J10:N12, K15 – to L15, I17 – to I18:I21, J16 – to J16:L21, I26 – to I27:I28, J25 – to J26:J28 (fig. 21).

fx =(A10-E$7)/(E$6-E$7)

	E	F	G	H	I	J	K	L	M	N
8	*input layer*				**wxh(1)**	*first hidden layer*				
9	**x1**	**x2**	**x3**		*input layer*	*1*	*2*	*3*	*4*	*5*
10	0.3986	0.9982	1		1	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.2963	0.9959	1		2	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.2155	0.9957	1		3	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.1065	0.9938	1							
14	0.0686	0.9904	1		**wh(1)h(2)**	*second hidden layer*				
15	0.0079	0.9811	1		*first hidden layer*	*1*	*2*	*3*		
16	0.0004	0.9578	1		1	0.0000	0.0000	0.0000		
17	0.0001	0.9430	1		2	0.0000	0.0000	0.0000		
18	0.0000	0.9231	1		3	0.0000	0.0000	0.0000		
19	0.0013	0.9092	1		4	0.0000	0.0000	0.0000		
20	0.0018	0.8871	1		5	0.0000	0.0000	0.0000		
21	0.0036	0.8679	1		6	0.0000	0.0000	0.0000		
22	0.0036	0.8442	1							
23	0.0040	0.8241	1		**wh(2)y**	*output layer*				
24	0.0082	0.7903	1		*second hidden layer*	*1*				
25	0.0826	0.7664	1		1	0.0000				
26	0.2688	0.7271	1		2	0.0000				
27	0.4236	0.6788	1		3	0.0000				
28	0.4703	0.6537	1		4	0.0000				

Fig. 21. Fragment of a spreadsheet after normalizing input data and creating matrices of weighting coefficients

To calculate the scalar product of a row vector of input layer values by a column vector of the matrix of weight coefficients $w^{xh(1)}$, it is advisable to use the matrix multiplication function:

P8 *first hidden layer*
P9 $h_1^{(1)}$
Q9 $h_2^{(1)}$

R9 $h_3^{(1)}$
S9 $h_4^{(1)}$
T9 $h_5^{(1)}$
U9 $h_6^{(1)}$
P10 =1/(1+exp(-mmult($E10:$G10,J$10:J$12)))
U10 1

Next, copy cell P10 to the range P10: T76, and U10 to U11: U76.

Given that all elements of the matrix of weight coefficients $w^{xh(1)}$ are initially equal to zero, after copying the formulas, all measured elements of the hidden layer are equal to 0.5.

Similarly, we perform calculations of the elements of the second hidden and output layers:

W8 *second hidden layer*
W9 $h_1^{(2)}$
X9 $h_2^{(2)}$
Y9 $h_3^{(2)}$
Z9 $h_4^{(2)}$
W10 =1/(1+exp(-mmult($P10:$U10,J$16:J$21)))
Z10 1
AB8 *output layer*
AB9 y_{norm}
AB10 =1/(1+exp(-mmult($W10:$Z10,J$25:J$28)))

Next, copy cell W10 to the range W10:Y76, Z10 – to Z11:Z76, AB10 – to AB11:AB76 (fig. 22).

fx =1/(1+exp(-mmult($W10:$Z10,J$25:J$28)))

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
8	*first hidden layer*							*second hidden layer*					*output layer*
9	**h(1)1**	**h(1)2**	**h(1)3**	**h(1)4**	**h(1)5**	**h(1)6**		**h(2)1**	**h(2)2**	**h(2)3**	**h(2)4**		**ynorm**
10	0.500	0.500	0.500	0.500	0.500	1		0.500	0.500	0.500	1		0.500
11	0.500	0.500	0.500	0.500	0.500	1		0.500	0.500	0.500	1		0.500
12	0.500	0.500	0.500	0.500	0.500	1		0.500	0.500	0.500	1		0.500

Fig. 22. Fragment of the spreadsheet after calculating the initial values of the weighting coefficients of the hidden and output layer

To obtain the result y_{calc} from the normalized value of the output layer, it is necessary to calculate it by the formula inverse to the original:

output value = minimum value + normalized value * (maximum value – minimum value)

To do this, enter the following values in the table cells:

AD8 *result*
AD9 y_{calc}
AD10 =$G$7+AB10*($G$6-$G$7)

Next, copy cell AD10 to the range AD11: AD76.

Neural network training takes place by varying weights so that with each training step, the difference between the calculated values of y_{calc} and the desired (reference) values of y is reduced. To determine the difference between the calculated and the reference output vectors, we calculate the squares of the deviations and their sum:

AF8	*squared deviation*
AH8	*sum*
AF9	$(y - y_{calc})^2$
AH9	S
AF10	=(C10-AD10)^2
AH10	=sum(AF10:AF76)

Next, copy cell AF10 to the range AF11: AF76. Cell AH10 contains the sum of the squared deviations.

Within this formulation of training, the neural network can be considered as an optimization problem in which the objective function (the sum of the squared deviations in the cell AH10) should be minimized by varying the weights of the matrices $w^{xh(1)}$ (range J10:N12), $w^{h(1)h(2)}$ (range J16:L21) and $w^{h(2)y}$ (range J25:J28). To solve this problem, standard Google Sheets tools are not enough, so you need to install the Solver add-on by choosing Add-ons → Get add-ons ... (fig. 23).

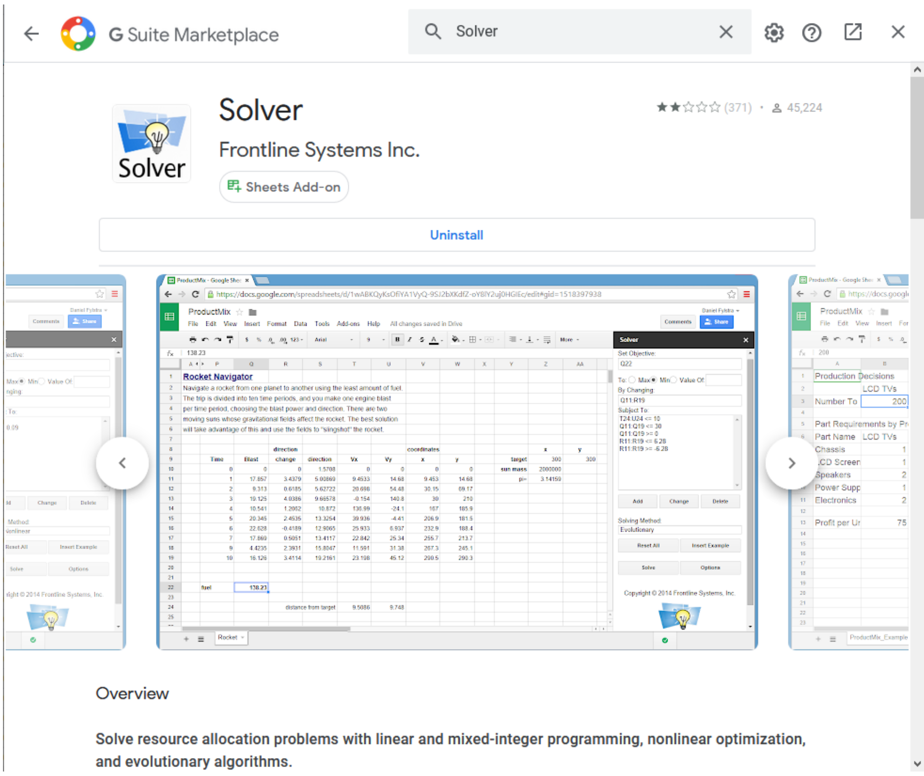


Fig. 23. Install the Solver Google Sheets add-on

In fig. 24 shows the settings of the Solver add-on for solving the task: the objective function (Set Objective) is minimized (To: Min) by changing the values (By Changing) of the weighting matrices in the range (Subject To) from -20 to +20 using one of the optimization methods (Solving Method).

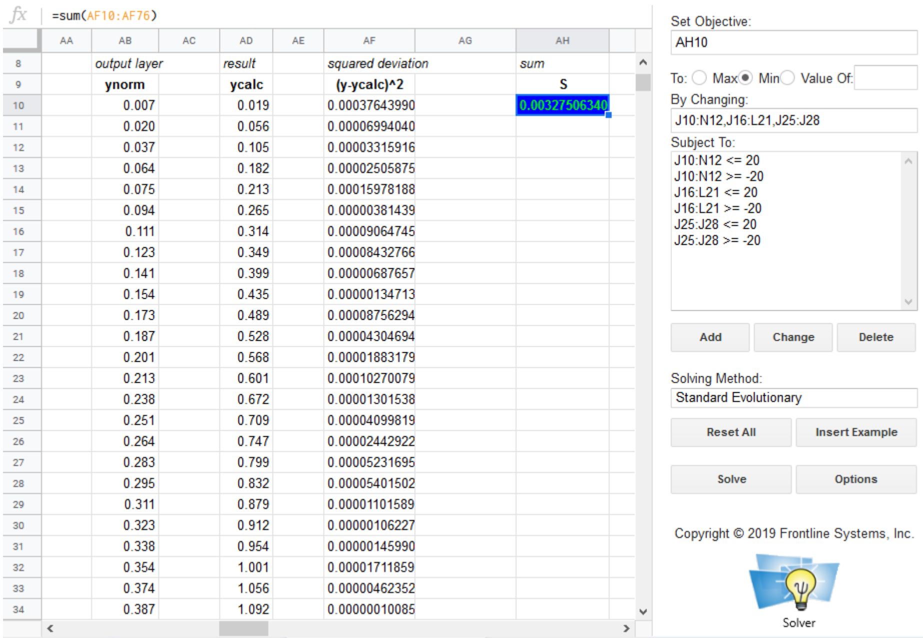


Fig. 24. Optimization result for selected Solver parameters

To reduce the sum of squared deviations, Solver can be called up many times: it is advisable to experiment with the combined use of various optimization methods, changing the limits of variation of the weight coefficients. In this case, it is not necessary to try to prove the value of the sum of the distances to zero – this may be more than a (rather small) value.

For clarity of the simulation results, it is advisable to construct a graph of the ratio of experimentally obtained (measured) y values and calculated (approximated) y_{calc} (fig. 25). The quality of approximation is determined by the degree of deviation of the graph points from the beam, divides the first quadrant in half. From the figure and the sum of the squares of deviations obtained after optimization, we can conclude that the constructed neural network model is adequate.

To test the model limitations, we propose the next task: using given in the table 2 values of voltages v_1, v_2, calculate the y coordinate of the object, and explain the choice of voltages and obtained result.

Table 2. Model testing

No	v_1	v_2	y_{calc}	Explanation
1	0.000	4.000	0.467	Measurement only with the second sensor. The result is adequate because the pair v_1, v_2 has a match in the test data set
2	0.000	1.000	1.366	Measurement only with the second sensor. The result is inadequate

No	v_1	v_2	y_{calc}	Explanation
3	5.000	0.000	1.187	Measure only with the first sensor. The result is inadequate
4	1.000	0.000	1.368	Measure only with the first sensor. The result is inadequate
5	6.660	3.800	2.493	The data set is on the trend line. The result is adequate
6	3.000	3.000	0.809	Intersection of lines 1, 2. The result is adequate
7	0.000	0.000	1.374	Minimal values. The result is inadequate due to incorrect regularity
8	10.000	10.000	2.825	Numbers beyond the range of measured values. The result is the maximum value of the position

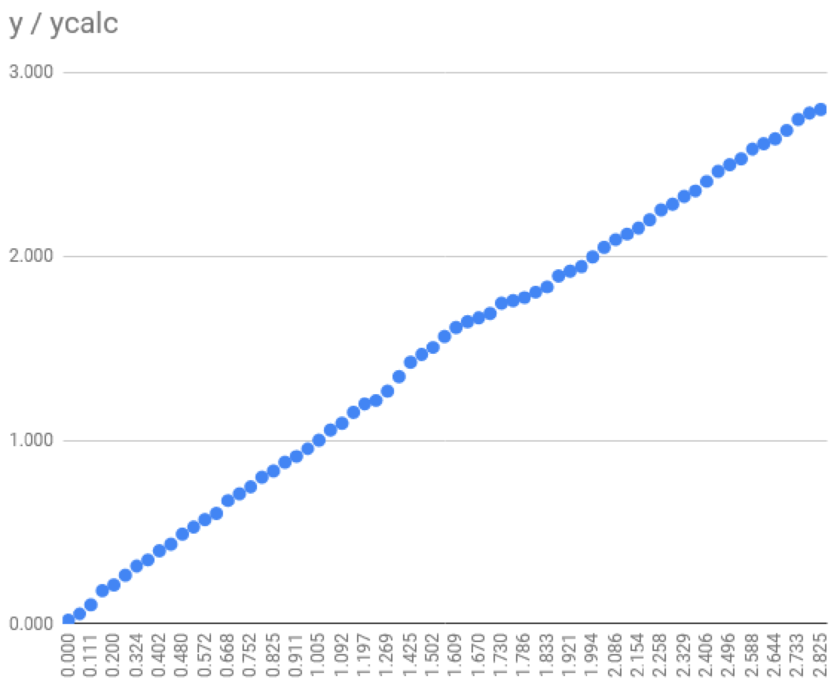


Fig. 25. Graph of measured y values and approximated y_{calc}

3 Conclusions

Thus, in the process of formation of the general professional component of the competence of a bachelor of electromechanics in the modeling of technical objects, it is advisable to use the following software for mobile Internet devices:

— cloud-based spreadsheets as modeling tools (including neural network);
— visual modeling systems as a tools of technical objects structural modeling;
— mobile computer mathematical systems used at all stages of modeling;
— mobile communication tools for organizing joint modeling activities.

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Methodology of using mobile Internet devices in the process of biology school course studying

Alla V. Stepanyuk[1[0000-0002-1639-0926]], Liudmyla P. Mironets[2[0000-0002-9741-7157]], Tetiana M. Olendr[1[0000-0002-1665-6413]], Ivan M. Tsidylo[1[0000-0002-0202-348X]] and Oksana B. Stoliar[1[0000-0002-8579-2881]]

[1] Ternopil Volodymyr Hnatiuk National Pedagogical University, 2 M. Kryvonosa Str., Ternopil, 46027, Ukraine
{alstep, olendr, tsidylo, Oksana.Stolyar}@tnpu.edu.ua
[2] Sumy State Pedagogical University named after A.S. Makarenko, 87 Romenska Str., Sumy, 40002, Ukraine
mironets19@gmail.com

Abstract. This paper considers the problem of using mobile Internet devices in the process of biology studying in secondary schools. It has been examined how well the scientific problem is developed in pedagogical theory and educational practice. The methodology of using mobile Internet devices in the process of biology studying in a basic school, which involves the use of the Play Market server applications, Smart technologies and a website, has been created. After the analyses of the Play Market server content, there have been found several free of charge applications, which can be used while studying biology in a basic school. Among them are the following: Anatomy 4D, Animal 4D+, Augmented Reality Dinosaurs – my ARgalaxy, BioInc – Biomedical Plague, Plan+Net. Their choice is caused by the specifics of the object of biological cognition (life in all its manifestations) and the concept of bio(eco)centrism, which recognizes the life of any living system as the highest value. The paper suggests the original approach for homework checking, which involves besides computer control of students' learning outcomes, the use of Miracast wireless technology. This demands the owning of a smartphone, a multimedia projector, and a Google Chromecast type adapter. The methodology of conducting a mobile front-line survey at the lesson on the learned or current material in biology in the test form, with the help of the free Plickers application, has been presented. The expediency of using the website builder Ucoz.ua for creation of a training website in biology has been substantiated. The methodology of organizing the educational process in biology in a basic school using the training website has been developed. Recommendations for using a biology training website have been summarized. According to the results of the forming experiment, the effectiveness of the proposed methodology of using mobile Internet devices in the process of biology studying in a basic school has been substantiated.

Keywords: school education, blended learning, smart technologies, website, biology.

1 Introduction

Specificity of the modern information society leads to a change of the ways of human life. This causes significant transformations in the educational system. Its transition to a qualitatively new state requires the optimization and management of the mechanisms of interaction of all the subjects of learning environment. Its peculiarity is the functioning of multi-vector information flows that need to be taken into account in the educational process. Within such a system of relations, all the subjects of the educational process interact with each other as active mutually influential participants. They interact with modern information technologies (IT) – social networks, Internet services, etc.

Modern ICT involve wide opportunities to the students' development. In consequence of the potential of mass interactivity, immersion, learning in joint activities, they become an effective tool of learning. The appropriateness of ICT use in the biology school course is caused by the specifics of the object of biological cognition (life in all its manifestations) and the concept of bio(eco)centrism, which recognizes the life of any organism as the highest value.

Biology studying at secondary education institutions in Ukraine is aimed at the formation of ten major key competences, among which are the following: information and digital competence and core competences in sciences and technologies. It is relevantly to form such competences by means of the use of modern mobile Internet devices in the educational process. We consider a computer, an interactive Smart Board, a multimedia projector, a smartphone, Google Chromecast adapter, and others to be the modern information devices.

A number of works of Ukrainian and foreign scientists (Yurii O. Doroshenko [1], Olena V. Komarova [5], Nadiia Yu. Matiash [6], Liudmyla P. Mironets [8], Yevheniia O. Nevedomska [12], Anatolii H. Shcherbakov [17], Tetiana V. Starova [4], Alla V. Stepaniyk [19], etc.), have dealt with the possibilities of using a computer in the process of teaching biology. In her study, Nadiia Yu. Matiash underlines the necessity of using a computer during biology school course to increase the effectiveness of the lesson and the efficiency of the learning process [6]. Alla V. Stepanyuk studies the problem of using computer learning tools in the methodological training of future biology teachers [19]. Yevheniia O. Nevedomska considers the positive and negative aspects of the use of computer technologies in the teaching biology while examining the levels of information and computer systems that form the quality criteria of the theoretical and practical implementation of pedagogical computer tools [12].

Theoretical aspects of mobile learning are disclosed by Vita A. Hamaniuk [3], Mariia A. Kislova [21], Liudmyla P. Mironets [8], Yevhenii O. Modlo [11], Olena O. Pavlenko [13], Serhiy O. Semerikov [9], Ekaterina O. Shmeltser [2], Vladimir N. Soloviev [20], Andrii M. Striuk [15], Viktoriia V. Tkachuk [22], Stanislav T. Tolmachev [10], Tetiana I. Zhylenko [24] and others. Models of presentation of knowledge and data of the subject discipline in the form of computer ontology are presented in the work of Ivan M. Tsidylo, Hryhorii V. Tereshchuk, Serhiy V. Kozibroda, Svitlana V. Kravets, Tetiana O. Savchyn, Iryna M. Naumuk and Darja A. Kassim [23]. However, the analysis of scientific and pedagogical works shows that the practical aspect of using of mobile Internet devices for conducting educational studies in biology was not the subject of a separate study and remains quite weighty. Therefore, there is a contradiction between the innovative nature of the mobile Internet devices and the development of scientific and methodological support for their implementation in the educational process in biology.

The objective of this paper is to outline the possibilities, as well as the appropriateness of use of mobile Internet devices in the process of biology school course studying.

The objective was realized through the following tasks:

1. To clarify the state of development of the problem at the levels of pedagogical activity and personal property of students.
2. To analyze the content of the Play Market for availability of free applications that can be useful for studying biology in a basic school.
3. To develop and substantiate the methodology of using mobile Internet devices in the process of biology school course studying and to test experimentally its effectiveness in a basic school.

2 Methods

To achieve the abovementioned objective and tasks, a number of methods have been used, namely: theoretical – comparative analysis to find out different views on the problem, identify areas of study; modeling to develop a methodology for using mobile Internet devices in the process of biology school course studying; systematization and generalization to formulate conclusions and recommendations for improving the educational process in biology; empirical – generalization of pedagogical experience, scientific observation, interviews, questionnaires in order to determine the state of implementation of the problem in practice; pedagogical experiment, which provided verification of the effectiveness of the proposed methodology; statistical methods for analyzing and establishing the reliability of the study results.

Experimental research has been carried out on the basis of Ternopil general secondary schools No. 24, 26, Terebovlia general secondary school No. 1 (Ternopil region) and Sumy specialized school No. 7, 9, and 25 (Sumy region). Summative experiment involved 528 students and 212 biology teachers. Forming experiment lasted for two years (2016-2018) in 7-8 grades. 553 students (220 in control (C) and 333 in experimental (E) groups) participated in it.

Effectiveness of the proposed methodology was checked during the forming experiment. The students of experimental groups, grades seven and eight, were trained in accordance with the methodology we proposed, and students in the control groups were trained according to the traditional methodology. After the experimental training the diagnostic survey was carried out with the aim to determine the effectiveness of the proposed methodology. We used qualitative analysis, developed in the studies of Mikhail N. Skatkin and Volodar V. Kraevskii [18]. Separate quality indicators of the entirely learned knowledge were studied, namely: completeness, awareness, consistency and systematicity. These indicators are most closely connected with the changes in students' knowledge that they have received using mobile Internet devices.

The indicator "completeness of knowledge" was determined by the amount of all the knowledge about the subject of study, which is provided by the curriculum. Students' answers were arranged in groups according to the following criteria: correct complete answer; correct incomplete answer; no answer. Correct complete answer encompassed all the knowledge about the object, which is provided by the curriculum in biology. In the correct incomplete answer only some part of the necessary knowledge was represented.

The indicator "awareness of knowledge" is characterized by understanding of links between knowledge, ways of acquiring knowledge, ability to justify them. Students' answers were also arranged in three groups: correct answer; incorrect answer; no answer. Consistency of knowledge assumes systematicity as its precondition and contains its certain characteristics. Therefore, the indicators "consistency and systematicity" were investigated together. Students' answers were arranged in four groups: correctly correlated concepts of different levels of generality; one violation was made in the ratio of concepts; two or more violations were made in the ratio of concepts; no answer. Validity of variance in indicators between separate groups was estimated with the help of χ^2 criterion.

3 Results and discussion

With the aim to study the state of the problem in the practice of biology teaching we carried out a survey of 212 biology teachers and 528 students of the city schools in Sumy and Ternopil regions. We analyzed the way teachers train students to work with different sources of information. Thus, 43.87% (93 teachers) train students how to work with the catalogue, 73.58% (156 teachers) train how to work with the textbook orientation apparatus, 24.53% (52 teachers) form the ability to search the necessary information on the Internet.

198 teachers (93,40%) use computer as a tool for biology teaching, an interactive Smart Board is used by 46 teachers (21,70%), 86 teachers (40,57%) use multimedia projector, a tablet and a smartphone is used by 10 teachers (4,72%), and 8 teachers (3,77%) use Google Chromecast Adapter. All the 212 teachers (100%) use computer during the preparation to the lessons. However, only 154 teachers (72,64%) give their students home task to search for the additional information on the Internet, and 198 teachers (93,39%) offer students to prepare presentations in the form of a report on the performance of a specific task. There are the following reasons for the inadequate use of modern mobile Internet devices by teachers in the educational process: insufficient level of their own computer literacy – 104 teachers (49,06%); lacking of material and technical as well as educational and methodological support for biology school course teaching – 148 teachers (69,81%); the reluctance of teachers to study life phenomena and processes using a computer – 52 teachers (24.53%). Only 10 teachers (4,72%) know that a mobile Internet device can be used as a tool for teaching biology.

The majority of students have shown moderate interest to the TV programs about nature (77,65%). Only 7,20% claimed that they are not interested in such programs at all. 60,23% of students like observing plants and animals and 16,10% demonstrate moderate interest in such an activity. 74,43% of students sometimes address the Internet sources to answer questions during the lesson and 19,70% of the students often address various information sources in this case. 5,87% of the students stated that they don't search for the answers in additional sources.

The majority of teenagers (87,31%) possess mobile Internet devices (smartphones, tablets), but they use them mainly for fun or socializing with peers in social networks. 18,56% of students know that a mobile Internet device can help in conducting a research both at school and beyond it, but only 4,55% of respondents use smartphones for this purpose.

However, the study of the practice of the secondary education institutions and personal practical experience show that the use of the Internet facilitates better learning of education material by students. At the same time the effectiveness of lessons increases significantly and it encourages students to study. The educational process is intensified through the increase of its informativeness. Due to this, students improve their ability to orient themselves in the information space and, in this case, the teacher acts as a mentor, consultant. All the above mentioned actualizes the necessity in the development of the methodology of using mobile Internet devices in the process of biology studying.

Our experimental methodology involves the use of the mobile Internet devices and mobile learning (M-learning) technology. It is caused by the main advantages of M-learning use, namely: bringing new technology into the classroom; possibility to use portable devices to support the learning process; possibility to use the technology as an additional tool for learning; as a useful add-on tool for students with special needs; available synchronous learning experience; allows widened opportunities for timing, location, accessibility and context of learning [16].

The challenges of introducing M-learning technology were also taken into account. Among them are as follows: accessibility and cost barriers for users; incompatibility of some mobile devices with other applications and devices; frequent changes in device models, technologies, functionality; number of file formats supported by a specific device; risk of distraction and fragmentation of learning; restriction of educational information visualization; required bandwidth for nonstop and fast streaming; tracking of results and proper use of the information and the lack of well-developed students' self-control skills; insufficient "technical" training of school teachers in creating of mobile application [16].

Smartphones and tablets based on the Android operating system allow you to use Internet resources and various free applications that are downloaded from the Play Market. Analyzing the Play Market, it has been found that it contains a lot of applications that are permanent helpers in the biology learning with the possibility of free downloading. All applications are installed on the teacher's smartphone, and using Google Chromecast adapter, they are displayed on the multimedia projector screen.

We present examples of educational applications, involved in our methodology.

The Anatomy 4D application carries students and anyone who wants to learn about the internal structure of the human body into an interactive 4D world of human anatomy, stunning visually. Anatomy 4D uses augmented reality and other cutting edge technologies [7] to create the perfect foundation for 21st century education. It is much more than an application, the Anatomy 4D takes viewers on a journey inside the human body and heart, revealing the spatial relations of our organs, skeleton, muscles, and body systems. It is a simple-to-use 3D learning environment is great for use in the classroom, or anytime.

The Anatomy 4D application enables: to learn about and explore the human body and heart in the smallest details; highlight various organs and systems separately. You can, for example, focus on just the musculoskeletal, digestive, or respiratory system; change the sex of the body under investigation; zoom in to study profoundly each organ or body part.

The Animal 4D+ application brings you a new way of seeing animals in augmented reality, which unambiguously broadens students' horizons and understanding of animals, and their external structure. Using the Animal 4D+ alphabet cards, the animals spring to life making the acquaintance with them much better.

The Augmented Reality Dinosaurs – my ARgalaxy application helps students to dive into the world of dinosaurs. Augmented reality enables to feel oneself as a part of the fauna development history.

The BioInc – Biomedical Plague application is a complex biomedical simulator in which you make life or death decisions. The application acquaints students with various diseases and the ways of their transmission, shows more than 100 realistic biomedical conditions. The game is not only educative, but it also teaches a careful attitude to one's health and the value of human life.

The Plan+Net application is a powerful tool to identify plants in the photo. During an excursion the teacher takes a picture of an unknown plant by his smartphone and then using the mobile application analyzes the received information. After the work completing, plant details can be checked using printed version of a plant catalogue. Students can use such an educational application not only at biology lessons, but also during their individual work in the process of research at the centers of research and experimental activities.

The use of mobile Internet devices at a lesson at the stage of homework checking allows to diversify the forms of students' learning outcomes control. Thus, in addition to computer testing, Miracast wireless technology can be used for this purpose. This requires the owning of a smartphone, multimedia projector and Google Chromecast adapter. There is a great deal of educational content available on Google Play Market application of your smartphone, including programs for student' learning outcomes control. One of them is Plickers. This web server lets you survey your class at the lesson and conduct instant checks for understanding of the learned and current material in a test form.

To start working with it, it is necessary to download a free application Plickers to the teacher's smartphone. Then, in a separate application, prepare the tests and print a set of cards. One set of cards can be used for different classes. Each student is assigned a unique Plickers card that has a black and white image similar to a QR code. The number of the card corresponds to each student (according to the list). Then you will need to take your smart device, choose the Plickers application.

Choose the class and necessary question from the list. The chosen on your mobile device question will be automatically displayed on the screen with the help of a projector. Using the scanner of your smartphone scan your students' cards and record their answers. Students should hold their cards so that the letter of the correct answer is located at the top. Colored highlighting helps quickly to find out how well the students answer the questions: grey marks the students who haven't answered yet, red means incorrect answers of students, and green stands for correct answers.

The use of smart technologies makes it possible to solve the following topical issues: use the latest IT in training; improve the skills of students' independent work in the Internet databases; improve the students' knowledge, skills and abilities; make the learning process more interesting and meaningful; develop creative potential; control through testing and a system of questions for self-control; increase the cognitive activity of students due to various video and audio information.

Smart Board is a touch screen, which allows you to manipulate anything on the screen using your fingers. It is connected to a computer. Multimedia projector, which is also a part of the board, transmits an image of the computer screen to the Smart Board. Smart Board acts as an interactive touch screen monitor for the computer. By touching the Smart Board, the user is able to click on buttons, highlight text and drop and drag items right from the Smart Board.

Smart Board helps the teacher to work with a variety of multimedia visual aids that allows you to display an object in a variety of ways. In the course of his work a biology teacher can use everything that the student is able to perceive clearly.

While working with the Smart Board, there is a rapid increase in the amount of visual information, which in its turn increases the quality and effectiveness of the lessons. Unique possibilities of Smart Board involve students in active cognitive activity and enhance their creative potential. There is a chance to work with a large amount of information at the lesson that creates the optimal conditions for students' individual research work in biology. Students work with computer models, during such work they can carry out experiments and check hypotheses.

During the work with the Smart Board a number of traditional didactic principles are being implemented: sequence, systematic character, scientific approach, visual training, students' activity and consciousness, connection of theory with practice, availability and duration of knowledge. The principles of visualization, availability and systematicity are realized through adding tables, video and audio materials, and analysis of materials of electronic textbooks during the explanation of new material. However, the interactive whiteboard is mostly used during the principle of visualization due to which you can present educational material in the form of schemes, dynamic algorithms or generalizing tables, which are a concise statement and a picture of the main conceptions of the material and its use at the lesson.

Our methodology involves the use of a website as a means of increasing the effectiveness of the learning process. Nowadays any teacher can create a website. There are hundreds of different website building platforms and website builders. You can get either free or for the payment information-technological base and real resource in the form of electronic space, modules, templates, control systems.

Site pages can be simple static file sets or created by a special computer program on the server. It can be either custom-made for a specific site, or be a ready-made product designed for a specific class of sites. The structure of a website consists of two parts: internal and external. The internal part of the structure is represented by the headlines, sub sections, site sections, labels and other navigation elements. The external part of the structure of a website is a scheme of the content blocks, that is, how the header, the main content, the comment block, and other elements of the site are located. A well designed website layout, where convenient and interesting interface is combined with actual information is a very important point in the development of this resource and it is better perceived by users [14].

Having analyzed the functions and tasks of various websites, we chose the website builder Ucoz.ua. The appropriateness of this website builder choice is caused by the fact that it contains all the necessary components for creating namely a training website and allows to create multifunctional universal websites free of charge. It involves a sufficiently large number of educational category templates, with an appropriate interface, convenient ways to add and edit existing web pages, site management options from both the control panel and the admin panel that rejects force majeure during learning, because if you have problems with logging into the admin panel, the teacher will be able to manage the site through the control panel. This builder contains a specific, comprehensible control panel which requires registration and has a definite password used to log. It will protect the site against hacking, illegal spreading of information which is stored on it, as the website administrator has certain copyrights.

In the context of experimental learning we have developed a methodology for organizing a biology teaching process in a basic school using various mobile Internet devices. We used them variously at lessons of different types: at the introductory lesson, to activate the cognitive process and to report new knowledge; at the lesson of studying new material in order to expand and deepen the students' knowledge; at the generalizing lesson or for final control and correction of knowledge.

Mobile Internet devices were used at different stages of the lessons: at the stage of actualization basic knowledge: tests (Plickers), video clips (Smart Board), models of objects and phenomena (Smart Board); at the stage of learning activity motivation: coloured drawings, animated snippets, virtual biological experiments (Augmented Reality Dinosaurs – my ARgalaxy, Animal 4D+ application, website; at the stage of learning new material: photos, slideshows, animated plots (Anatomy 4D), interactive models (website), video clips (Smart Board); at the stage of summing up of the studied material: multiple-choice tests (Plickers), pictures, establishment of sequence of biological processes (Smart Board); at the stage of generalization and systematization of obtained knowledge: thematic control with automatic verification (Plickers), control – diagnostic tests (website).

They were also used in various forms of learning: during the class work and practical classes (website); during virtual excursions (Smart Board); during students' individual work and research (website); while doing students' homework (website, mobile applications).

Using a training website in biology learning process greatly facilitates student-teacher interaction. It is advisable to use a training website to prepare students for independent work on the tasks that the teacher places in advance in the suitable section on the website. At the lesson preceding the lesson of generalization and systematization of knowledge, the home assignment will be as follows: the students should refer to the website, the address of which is reported by the teacher, and in the section "Preparing for independent work" do the assigned tasks (there may be different variants). At the lesson of generalization and systematization of knowledge it is necessary to do the tasks placed on the site, or to use them as a plan for the survey of students. Thus, students can revise, generalize, systematize the obtained knowledge and fill in the gaps. By using the website in preparation for the students' independent work, we give them more time to prepare and diversify the process, which will then have a positive impact on the learning outcomes.

Using a website is also productive at the lesson that precedes practical work. Biology teaching involves performing such practical work that requires certain conditions that cannot be created in the classroom. For example, the curriculum contains practical work on the theme "Determining the threshold of auditory sensitivity" as a part of the topic "Sensory systems". For the fairness of the experiment and obtaining accurate results, it is better to ask students to carry out this practical work at home with the help of their parents, and to place the plan of work and instructions how to carry it out in the section "Practical work" on the website before conducting it and, to discuss the results at the stage of actualization knowledge at the next lesson.

It is convenient to place some research themes on this training website, as this will help students to prepare for students' conferences, because they will be able to get the theme at the beginning of the academic year and work on it throughout the year and after that to defend it at conferences.

The website can store all the theoretical information necessary for conducting lessons so that the student can access it at any time. This way of placement is convenient for students who were absent from the lesson, as they can independently study the material which was missed in the home environment.

The results of examination of the effectiveness of the proposed methodology of using mobile Internet devices in the process of biology studying, which are reflected in the change of students' knowledge quality of experimental classes (E) and control classes (C), are presented in the table 1.

Analyzing the data of table 1, we can see that the results of examination of the students' knowledge according to the indicator "completeness of knowledge" showed that the students of E classes mastered the material much better. 91,0% of the students of these classes gave correct complete answers. Whereas in C classes such answers were given only by 61,8% of students. 1,8% of the students of E classes and 5,5% of the students of C classes did not answer the questions. The students of E classes comprehend acquired knowledge better than the students of C classes. 87,7% and 33,6% of students answered correctly respectively. 10% of the students of C classes do not understand the difference in the ways of acquiring knowledge and means of their justification (indicator "awareness of knowledge").

Table 1. Results of examination of the students' knowledge quality of the program material in biology

<table>
<tr><th rowspan="3">Indicators of knowledge quality</th><th rowspan="3">Answer groups</th><th colspan="4">Number of students, whose answers correspond to the arranged groups</th></tr>
<tr><th colspan="2">Control classes</th><th colspan="2">Experimental classes</th></tr>
<tr><th>Number of students</th><th>%</th><th>Number of students</th><th>%</th></tr>
<tr><td rowspan="3">Completeness</td><td>correct complete answer</td><td>136</td><td>61,8</td><td>303</td><td>91,0</td></tr>
<tr><td>correct incomplete answer</td><td>72</td><td>32,7</td><td>24</td><td>7,3</td></tr>
<tr><td>no correct answer</td><td>12</td><td>5,5</td><td>6</td><td>1,8</td></tr>
<tr><td rowspan="3">Awareness</td><td>correct answer</td><td>74</td><td>33,6</td><td>292</td><td>87,7</td></tr>
<tr><td>incorrect answer</td><td>124</td><td>56,4</td><td>32</td><td>9,6</td></tr>
<tr><td>no answer</td><td>22</td><td>10,0</td><td>9</td><td>2,7</td></tr>
<tr><td rowspan="4">Consistency and systematicity</td><td>correctly correlated concepts of different levels of generality</td><td>60</td><td>27,3</td><td>182</td><td>54,7</td></tr>
<tr><td>one violation was made in the ratio of concepts</td><td>60</td><td>27,3</td><td>74</td><td>22,2</td></tr>
<tr><td>two or more violations were made in the ratio of concepts</td><td>66</td><td>30,0</td><td>55</td><td>16,5</td></tr>
<tr><td>no answer</td><td>34</td><td>15,4</td><td>22</td><td>6,6</td></tr>
</table>

The results according to the indicator "consistency and systematicity" showed that the quality of acquiring knowledge by the students of E classes is higher than that of the students of C classes. 54,7% of the students of E classes correlated correctly the notions of different levels of generality. In C classes, such answers constitute only 27.3%. The majority of the students in C classes (15.4%) compared to (6.6%) in E classes did not answer the question.

Thus, the comprehensive analysis of the results of the forming experiment allowed us to conclude that proposed by us methodology of using mobile Internet devices in the process of biology school course studying is effective. For greater reliability of the obtained conclusions, a statistical analysis of the results of the quality of students' mastering the knowledge in biology was carried out using the χ^2 criterion. It confirmed that to study using experimental methodology enhances the quality of students' mastering the knowledge in biology.

4 Conclusions and prospects for further research

Modern ICT allow to create a single information environment, the basis of which is integrated computer networks and communication systems, which gives an opportunity to accompany and coordinate educational processes. When introducing mobile Internet devices into the educational process in biology, the principle of reasonable conservatism and continuity must be observed. The computer cannot substitute a teacher in the process of teaching; it is only a means of broadening possibilities to master new knowledge. The teacher always has to play the key role in any educational innovation.

The methodology of using mobile Internet devices in the process of biology studying in a basic school involves the use of the mobile applications, smart technologies and a website. It is relevantly to use free Android applications while studying biology in a basic school. They are as follows: Anatomy 4D, Animal 4D+, Augmented Reality Dinosaurs – my ARgalaxy, BioInc – Biomedical Plague, Plan+Net. Their choice is caused by the specifics of the object of biological cognition (life in all its manifestations) and the concept of bio(eco)centrism, which recognizes the life of any organism as the highest value. During homework checking it is advisable to use Miracast wireless technology besides computer control of students' learning outcomes. This demands the owning of a smartphone, a multimedia projector, and a Google Chromecast type adapter. It would be appropriate to use the website builder Ucoz.ua for creation of a training website in biology.

Based on the synthesis of the obtained data, recommendations for the use of a biology training website were developed: the use of the website should not be the only means of training; each lab work using a training website must be preceded by a mandatory introductory instruction; the information in the sections should be precisely matched to the relevant theme of the lesson; the answers to the questions for self-examination should be mandatory checked, either in the course of group activity at the lesson or individually, in order to trace the gaps in the knowledge of a particular student; take into account wishes of the students, because in order to enhance their academic performance, socialization and improvement, such a training website is created.

The educational process which involves the use of mobile Internet devices encourages the independent work of each student, creates a favorable communication situation and conditions for the development of creative abilities of the individual, which are especially important for each student; increases the motivation and cognitive activity of students, improves the individualization, differentiation and intensification of the learning process, broadens and deepens interdisciplinary links, systematizes and integrates knowledge of certain subjects, organizes systematic and reliable control, avoids subjectivism in assessment.

Further studies need to be carried out in order to investigate the following problems: the impact of the use of mobile Internet devices on the formation of students' general competencies in the process of biology studying, the model of students' bioethical behaviour; preparing of future biology teachers to model educational activities using mobile Internet devices.

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Technologies of distance learning for programming basics on the principles of integrated development of key competences

Svitlana V. Shokaliuk[1[0000-0003-3774-1729]], Yelyzaveta Yu. Bohunenko[1],
Iryna V. Lovianova[1[0000-0003-3186-2837]] and Mariya P. Shyshkina[2[0000-0001-5569-2700]]

[1] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
shokalyuk@kdpu.edu.ua, {liza.bogunencko, lirihka22}@gmail.com
[2] Institute of Information Technologies and Learning Tools of the NAES of Ukraine,
9 M. Berlynskoho Str., Kyiv, 04060, Ukraine
shyshkina@iitlt.gov.ua

Abstract. In the era of the fourth industrial revolution – Industry 4.0 – developing key competences (digital, multilingual and mathematical competences in particular) is of paramount importance. The purpose of this work is to investigate the content of key competences of a secondary school student and to develop a method of teaching for the integrated development of multilingual and mathematical competences in the process of teaching Programming Basics with the help of distant technologies. The objectives of the research include generalizing and systematizing theoretical data on the structure and the content of key competences and the potential of informatics lessons for the development of separate components of multilingual and mathematical competences; generalizing and systematizing theoretical data on the ways of arranging distant support for informatics learning, Programming Basics in particular; to investigate the content and the methods of teaching Programming Basics in 7th-11th grades; to develop the e-learning Moodle course using Python for Programming Basics on the principles of integrated approach to developing separate components of multilingual and mathematical competence with determining some methodical special features while using it. The object of the study is to teach informatics to junior high school and high school students. The subject of the study is the means and the methods of realizing distant support in the process of teaching Programming Basics using Python on the principles of an integrated approach to developing multilingual and mathematical competences.

Keywords: key competencies, digital competence, multilingual competence, mathematical competence, programming basics, integrated approach, Python, Moodle.

1 Introduction

According to the European Commission recommendation [8, p. 7], *the competence* is defined as a combination of knowledge, skills and attitudes where:

- knowledge is composed of established facts and figures, concepts, ideas and theories which are necessary for the understanding of a certain area or subject;
- skills are defined as the ability and capacity to carry out processes and use the existing knowledge to achieve results;
- attitudes describe inclinations, preferences and mentality that form the mode to act or react to ideas, persons or situations.

Law of Ukraine "On Education" [35] defines *competence* as a dynamic combination of knowledge, skills, abilities, thinking methods, views, values, other personal qualities that determines the ability of a person to socialize successfully, to carry out professional and / or further educational activities.

There exists the subject, intersubject and key competences.

The subject competence is the experience gained in the course of study of a specific activity related to the acquisition, understanding and application of new knowledge [35].

The intersubject competence is an ability to apply knowledge, skills, activities and relationships that belong to a certain range of academic subjects (disciplines) and educational areas to an intersubject circle of problems [35].

The key competences are those that all people need for personal self-improvement and development, a great provision of employment, social inclusion, sustainable lifestyle, successful life in peaceful societies, health management and active citizenship. They are developed for the whole life, from the early childhood, through formal, non-formal and informal learning in all contexts, including a family, a school, a workplace, neighbourhood and other communities [8, p. 7].

The key competences are:

- a literacy competence;
- a multilingual competence;
- a mathematical competence and competence in science, technology and engineering;
- a digital competence;
- a personal, social and learning to learn competence;
- a citizenship competence;
- an entrepreneurship competence;
- a cultural awareness and expression competence [8, pp. 7-8].

Taking into account the objectives of this paper, we will examine in more detail the interpretation, structure, and the role of the school subject "Informatics" in forming and/or developing individual components of the three core competences – multilingual, mathematical, and digital.

The multilingual competence is understood as the ability to use different languages correctly and effectively for communicating; the competence is based on the ability to express and interpret concepts, ideas, feelings, facts and opinions, both orally and in writing (listening, speaking, reading and writing) in an appropriate range of social and cultural contexts according to needs.

The multilingual competence manifests itself in:

- the knowledge of the vocabulary and the functional grammar of different languages and awareness of the main types of verbal interaction and language registers; the knowledge of social conventions, cultural aspects and language variability;
- the ability to understand oral messages, initiate, maintain and finish conversations and to read, understand and write texts with different levels of proficiency in different languages according to a person's needs;
- a positive attitude to predicting an appreciation of cultural diversity, an interest and curiosity about different languages and intercultural communication; respect for each person's individual linguistic profile, including respect for the mother tongue of persons belonging to minorities and/or with migratory background, and an appreciation of the official language(s) of the country as a common basis for interaction.

During informatics lessons, such components of multilingual competence are developed:

- the ability to use software tools and resources with an English-language interface;
- the ability to use software tools to translate texts and interpret foreign words;
- the ability to operate the basic international IT terminology;
- awareness of the role of IT in interpersonal communication in a global context;
- understanding of the need for foreign language skills for online learning and active involvement in European and global communities [20].

The mathematical competence is understood as the ability to develop and apply mathematical thinking and intuition to solve a number of problems in everyday life. Based on solid numeracy skills, it relies on process and activity as well as knowledge. Mathematical competence implies, at different levels, the ability and desire to apply mathematical thinking and concepts (formulas, models, structures, graphs, diagrams).

The mathematical competence is manifested in:

- the knowledge of numbers, measures and structures, basic operations and basic mathematical presentations, understanding of mathematical terms and concepts and awareness of the questions that mathematics can offer answers to;
- the ability to apply basic mathematical principles and processes in the context of everyday life at home and at work (e.g., financial skills), and to apply and evaluate logical chains of arguments; the ability to think mathematically, understand mathematical demonstrations, and communicate in the mathematical language; and the ability to use appropriate tools, including statistical data and graphs, for understanding the mathematical aspects of digitalization;
- a positive attitude towards mathematics based on respect for truth and a willingness to search for reasons and appreciate their validity [8, p. 9].

Informatics lessons improve such components of the mathematical competence as:

- the ability to understand, use and create mathematical models of objects and processes for solving problems from different subject areas by means of information technology;

— awareness of the role of mathematics as one of the fundamentals of IT [20].

The digital competence is interpreted as the competence that involves confident, critical and responsible using of digital technology for development and communication, the ability to use some tools of information and communication technology safely and ethically in learning and other life situations.

The digital competence includes information and data literacy, communication and cooperation, designing digital content (including programming), security (including digital well-being and competences related to cyber security), the issues of intellectual property, problem-solving and critical thinking [15].

The digital competence manifests itself in:

— understanding how digital technology can support communication, creativity and innovation; awareness of the possibilities, limitations, impacts and risks of digital technology; understanding the general principles, mechanisms and logic of digital development and the knowledge of the basic functions and using various devices, software and networks; critical awareness of the validity, reliability and significance of information and data provided through digital devices; the knowledge of legal and ethical principles related to using digital technologies;
— the ability to use digital technology to support active civic and social integration, cooperation with others and creativity to achieve personal, social or commercial goals; the ability to use, access, filter, evaluate, create, program and distribute digital content; the ability to manage and protect information, content, data (including personal) and to recognize and interact effectively with software, devices, artificial intelligence or robots;
— interaction with digital technologies and content, provides a reflective and critical, even curious, open and forward-looking attitude towards their evolution, as well as a moral, safe and responsible approach to using these tools [8, pp. 9–10].

It is obvious that informatics, as a school subject, plays a decisive role in forming and developing the components of digital competence primarily. However, the efficiency of the development of the components of digital competence depends on the level of formation of separate components of multilingual and mathematical competence. The formation of multilingual competence is manifested in the absence of language barriers when working with software with the English-speaking interface. The formation of mathematical competence is indispensable at different stages of computer modeling – from setting a problem, through constructing a mathematical model, to the computational experiment and conclusions. At the same time, the system of reasonably selected subject (informative) English-speaking tasks with mathematical content is a certain potential for integrated improvement of separate components of multilingual and mathematical competences.

The integration of learning content triples the educational purpose of the lesson and intensifies the process of the lesson. The effectiveness of such lessons cannot be considered satisfactory in terms of quality and pace of improvement of neither key nor subject competences without attracting additional tools. The distance technology tools will help to compensate for the lack of lesson time (on a thorough actualization of basic knowledge the special thematic English vocabulary and/or mathematical foundations, writing integrated mini-complexes, solving a sufficient number of learning problems, personalized summarizing the lesson).

2 Basic approaches as for implementing distant support into the information-mathematical cycle in general and higher education schools

Taking into account the national experience in providing distant support into general education and, in particular, the cycle of information-mathematical subjects, which are taught in general secondary and higher education institutions [3; 23; 33; 34], three main approaches can be noted:

- the first approach is based on displaying the educational resources (and methodical materials) on the official website pages of an educational institution (or its structural subdivisions) or the teachers' personal websites. The educational resources placement is in the distant cloud storages, Google Drive mostly (if there is an opportunity to use advantages of the Google corporate account because of its unlimited cloud storage [11]);
- the second approach is based on the presentation of educational resources as e-courses created and implemented in the educational process with the help of systems or services of learning management, the most common of which today is recognized as Google Classroom and Moodle [1; 14; 22; 32];
- the third approach (only distributed) is based on the specialized tools and services using for educational and scientific purposes, in particular informatics and mathematics, such as CoCalc (formerly SageMathCloud) and Jupyter Notebook [12; 13; 25; 26; 30; 31].

The most popular approach today for the implementation of distant support education, in particular, informatics, into general secondary education institutions is the Google Classroom, and in the higher education institutions is the Moodle.

Among the main common features of Moodle and Google Classroom for teachers should be noted:

- the placement and fast modification of basic and auxiliary teaching resources as files in various multimedia formats or URLs;
- the placement and fast modification of elements of learning activity (both individual and group) – primarily tasks (for practical and laboratory lessons, for individual and group work) and tests (forms). Various multimedia fragments can be added to the content of the tasks and tests (and answer options on them);
- automated control over the timeliness of the students' assignments and archiving of the results provided;
- automated checking of test results (except the "Essay" type questions for Moodle);
- automated recording of learning results in the course log;
- tools for real time remote consultation – chat, etc.;

- automated management by the course users (co-developer (assistants) and students).

Among the main common features of Moodle and the Google Classroom for the course participants (students) should be noted:

- mobile ("always and everywhere") access to all elements of the course – basic and auxiliary training resources of the lesson (class), tasks for practical performance, tasks of home (independent) work, training tests, etc.;
- the calendar of events and a reminder of deadlines for completing tasks;
- tools for communication with the teacher and other course participants;
- constant access to view the achievements of your own.

Obviously, neither the Moodle nor the Google Classroom is a specialized tool for learning informatics in general and programming in particular. However, the openness and extensibility of the Moodle system through new solutions (modules, plug-ins or filters), the above features and benefits for teachers and students have become decisive in the selection of a tool to implement remote support for teaching teachers or students (and teachers-to-be) the basics of Python programming using an integrated approach to the development of key competences.

3 The content and educational tools for teaching programming basics at school informatics lessons

According to the informatics curriculum for 5th-9th grades, the students which did not study informatics in the primary school (2nd-4th grades) will learn the programming basics starts in the 8th grade and continue in the 9th [21]. The teacher has the right to choose the programming language and IDE.

The analysis of the IT textbooks recommended by Ministry of Education and Science of Ukraine for the 8th and 9th grades has shown that in the majority of informatics textbooks (the authors' teams are headed by Yosyp Ya. Ryvkind [27; 28], Olena O. Bondarenko [6; 7], Andrii M. Hurzhii [9]) the subject of study is the compiled programming language Pascal in IDE Lazarus. And only in the textbooks [18; 19], whose author's team is headed by Nataliia V. Morze, the study subject is not the compiled programming language Pascal in IDE Lazarus only, but also it is the interpreted programming language Python in IDE PyCharm. The authors of the textbook propose various options for organizing the process of programming education in their methodical recommendations:

- to study one language from the proposed ones (the teacher's choice);
- to study both languages by parallel (if the students are ready).

There are studying the compiled language C++ and the interpreted language Python in the Polish informatics textbook for 8th grade [10].

For the students, who studied informatics in primary school [20], the studying the text programming language basics begins from the 7th grade (first time in the 2018-2019 academic year).

The available informatics textbooks for 7th grade (2015 edition) does not contain any educational materials on the programming – the teachers are given full freedom to use the educational materials for program implementation. At the same time, the informatics textbooks for 5th and 6th grades (the team of authors, headed by Olena O. Bondarenko [4; 5], instead of the recommended Scratch propose to study the programming basics in Python. Moreover, the programming language Python is also a subject of study according to the informatics textbooks for the 10th-11th grades recommended by the Ministry of Education and Science of Ukraine.

Thus, the analysis of textbooks has shown that Python becomes the main educational programming language rather than an alternative one at the secondary level. The problem of insufficient didactic support for study Python, primarily in the 7th grade, is solved by attracting the resources of national e-learning platforms [24] and author's developments [23]. The above mentioned confirms the relevance of the author's development – the distance Moodle course "Programming Basics (Integrated Approach)" [2].

4 Results

The course "Programming Basics (Integrated Approach)" is corresponded the curriculum (the programming basics on the non-visual programming language) and has a modular-thematic structure (see Table 1).

Table 1. Programming Basics (Integrated Approach) Curriculum

No	Topics	Training hours
1	Introduction to programming	1
2	The linear algorithms: design and implementing	3
3	The conditional algorithms: design and implementing	3
4	The cyclic algorithms – cycles with a precondition: design and implementing	3
5	The cyclic algorithms – cycles with a counter: design and implementing	3
6	The combined algorithms: design and implementing	2
	Summary	15

Each thematic module of the course has the main elements:

1. for forming and developing the programming competence:
   - Moodle pages with new theoretical information;
   - Moodle tasks for practical implementation;
2. for developing the mathematical competence:
   - Moodle glossaries with mathematical references;
   - Moodle tests of mathematical content for training;
3. for developing the multilingual competence:

- URL links to English-Ukrainian dictionaries (Google Sheets) with the topic vocabulary;
- Moodle tests for training proper spelling of the topic vocabulary words;

4. for complex testing of training results:

- control complex Moodle tests on programming, mathematics and English fundamentals.

In addition to the integration of content, defining features of the author's course is the implementation of interactive and action-oriented and differentiated approaches to learning.

The interactive-functioning approach at the stage of familiarizing with new theoretical information is implemented through the possibility of executing the source program code using Python directly on the Moodle page with new theoretical information (see Fig. 1).

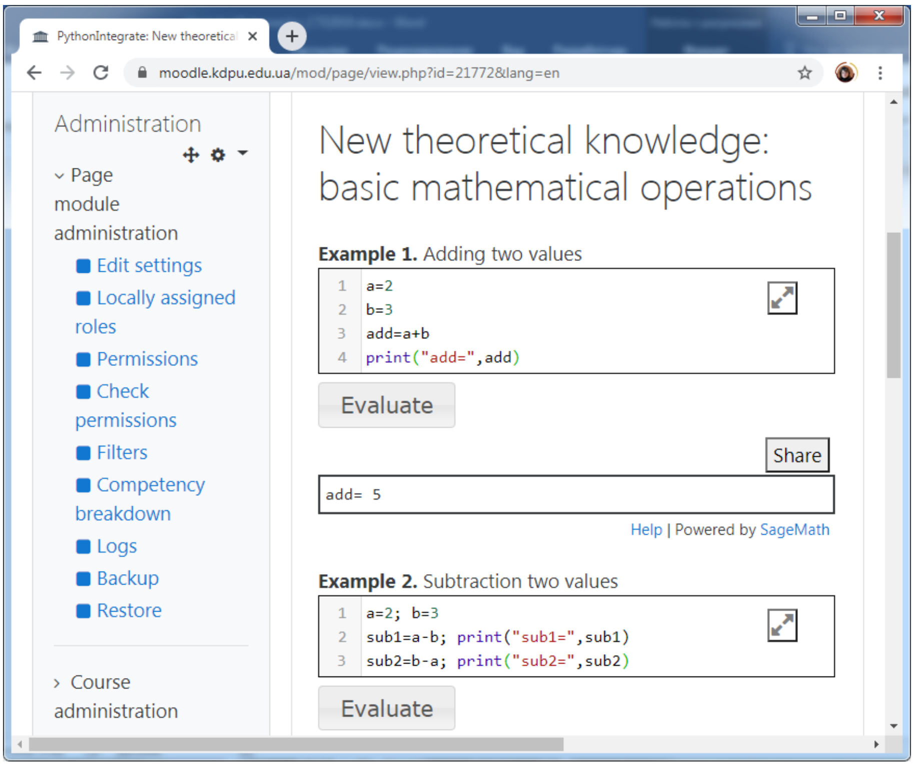

Fig. 1. Moodle page fragment with new theoretical information

Under such conditions, the students taking the course do not need to use local tools (installed integrated programming environments) or other Internet services (browser systems or programming environments). They can check the execution of the proposed program code, make changes to it if necessary and execute it again, and monitor the results of updates on the course page directly.

The ability to execute a program code using Python directly on the Moodle page is implemented by adding a script (see Fig. 2) of a command cell of the network system of computer mathematics SageMath [29].

```
<script src="https://sagecell.sagemath.org/static/embedded_sagecell.js"></script>
<script>
    $(function() {
        // Make *any* div with class 'compute' a Sage cell
        sagecell.makeSagecell({
            inputLocation: 'div.compute',
            languages: ["python"],
            evalButtonText: 'Evaluate'
        });
    });
</script><b>

<div class="compute">
    <script type="text/x-python">
        import random x=random.randint(0,10) print("x=",x)
    </script>
</div>
```

Fig. 2. Moodle page fragment (parameter editing mode) with Web-SCM SageMath command line script

At the stage of practical application of the acquired theoretical knowledge and development of competences in programming (when doing practical tasks) the interactive and action-oriented approach is implemented is implemented with the help of e-workbooks, which are external (relatively Moodle) digital educational resources – the collection of sheets in Jupyter Notebook (see Fig. 3).

Our students are offered workbooks as a task of CoCalc course [26, pp. 54–61], as well as their backups (ipynb files) for working in an offline mode.

At the stage of testing the results of training the interactive approach has been realized by developing a system of tests, where some test questions such as *CodeRunner* and questions such as *Wiris Quizzes* are included (in addition to the traditional test questions – questions such as “multiple choice”, “match”, “short answer”).

The test questions like *CodeRunner* (see Fig. 4) are traditional questions of programming courses, where students are asked to write a programming code for some specification, and then this code is evaluated by the results of taking/passing a series of tests.

Regardless of the behaviour chosen for a quiz, CodeRunner questions always run in an adaptive mode, in which students can click a Check button to see if their code passes the tests defined in the question. If not, students can resubmit, typically for a small penalty. In the typical ‘all-or-nothing’ mode, all test cases must pass if the submission is to be awarded any marks. The mark for a set of questions in a quiz is then determined primarily by which questions the student is able to solve successfully and then secondarily by how many submissions the student makes on each question. However, it is also possible to configure CodeRunner questions so that the mark is determined by how many of the tests the code successfully passes.

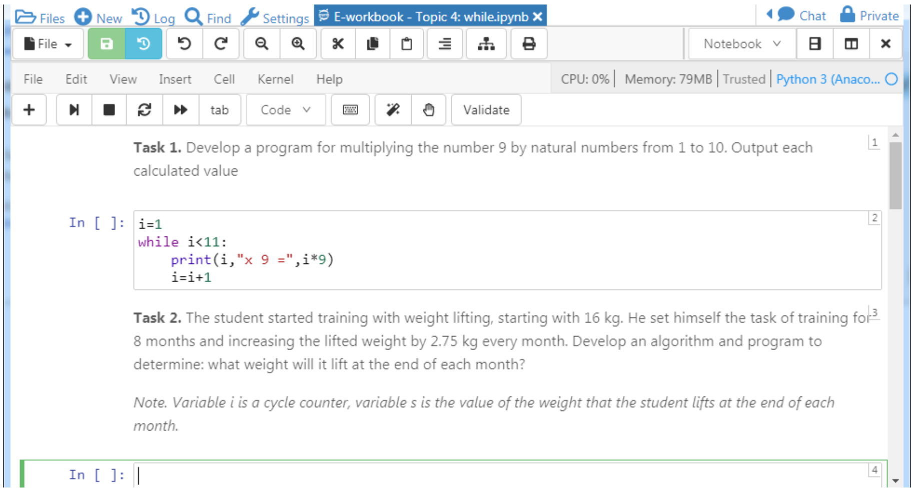

Fig. 3. The workbook page fragment with programming basics in the Python language

CodeRunner has been in use at the University of Canterbury for over seven years, running millions of student quiz question submissions in Python, C, JavaScript, PHP, Octave and Matlab. Laboratory work, assignment work and mid-semester tests in the introductory first year Python programming course (COSC121), which has around 650 students in the first semester and 350 in the second, are all assessed using CodeRunner questions [16].

In test questions of Wiris Quizzes type (Fig. 5) the answer of mathematical content (a fraction, a root, an analytical function, etc.) is automatically processed, entered without keyboard, by means of the touchscreen of a mobile device or simply drawn with a mouse only [17].

The differentiated approach in mastering the basics of programming is implemented by selecting tasks for practical execution and tests taking into account the level of mathematical knowledge of students in different grades (from 7th to 10th). The students are not limited in a choice of tasks for the practical decision – a student of 10th grade has an opportunity to revise mathematics for 7th-9th grades and a junior high school student can try his hand at solving problems with new (that has not been taught yet at algebra and geometry lessons) mathematical content.

The first experimental version of the course “Programming Basics (Integrated Approach)” has been implemented in the educational process of Kryvyi Rih State Pedagogical University:

— within the framework of provision of non-formal and informal education for the students of 9th-10th grades;
— in the process of training informatics teacher-to-be.

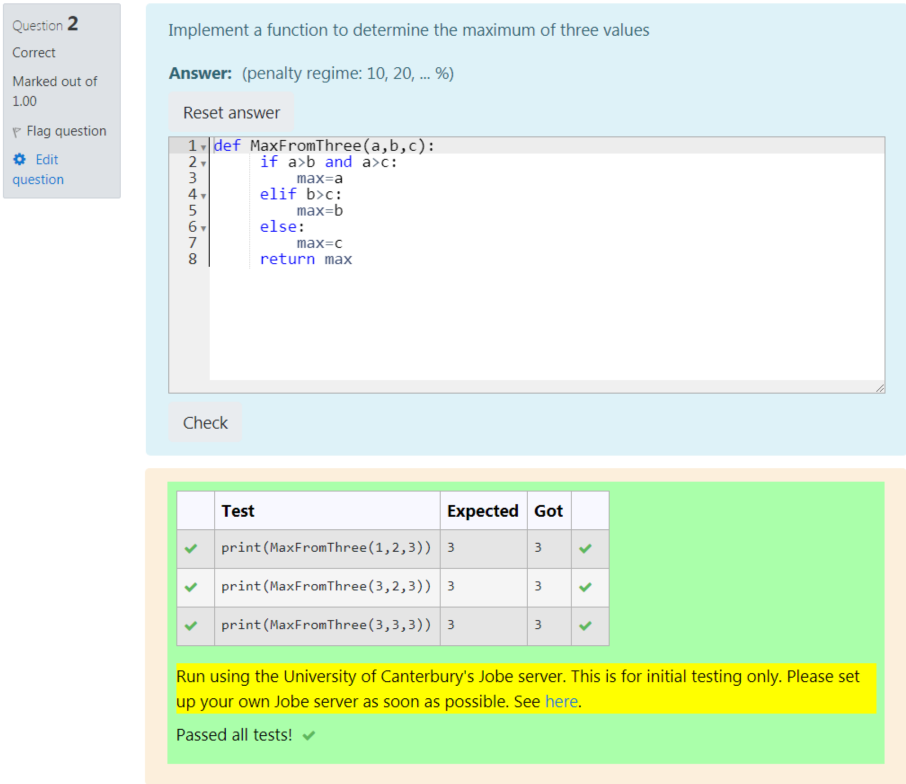

Fig. 4. Illustration of the test questions like *CodeRunner*

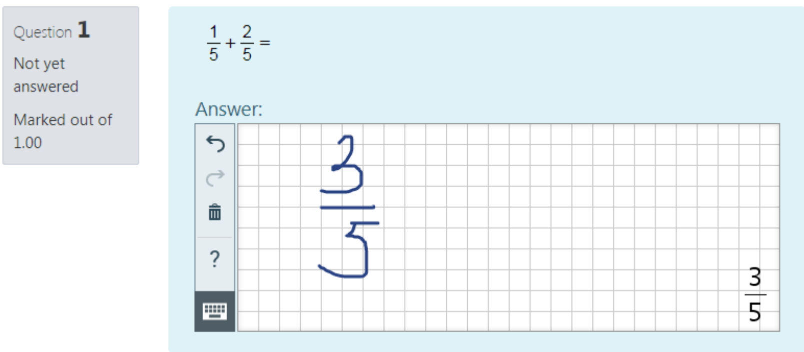

Fig. 5. Illustration of the test questions like *Wiris Quizzes*

An experimental group of 8 students from the 9th and 10th grades are successfully finishing to study the course. The students are self-motivated. The introduction is carried out in their free time when they aren't at school: after lessons or on the weekends. The combination of classroom and distant forms of work ensures continuity and expected effectiveness during the educational process.

The future informatics teachers – 39 1st year master's students specialized in informatics, acquire the content of the experimental version of the course within the framework of the variable component of the discipline "Modern Informatics Lesson".

The results of educational tests and periodic surveys (on the presence of errors and discrepancies, comprehensibility of the content and convenience of software and services, etc.) of both students and future informatics teachers will be taken into account in designing a next version of the course "Programming Basics (Integrated approach)". In the very near future, along with the methodical recommendations for the course, its large-scale implementation will be started.

5 Conclusions

1. The school subject "Informatics" plays an important role in forming a digital competence as subject and key competences. The way of joint improvement of multilingual and mathematical competences at informatics lessons is a construction of system of tasks in English with mathematical content.
2. The lack of lesson time for successful implementation of the triple educational objectives of the lesson – effective mastering new information knowledge and acquiring relevant competences, the special English thematic vocabulary and basic foundations of school mathematics – can be compensated by educational process with the involvement of distant technologies.
3. In support of a thorough study of the basics of text language programming, taking the importance of the content line "Algorithmization and Programming Basics" for the school informatics course into consideration, a distant e-learning Moodle course "Programming Basics (Integrated Approach)" was designed and implemented in the educational process.
4. The success of the experimental training of students and future teachers in the process of studying the integrated course was facilitated by forming an interactive and action-oriented approach, namely:

   - interactive acquiring new theoretical information on programming (doing the source codes directly on the Moodle page);
   - interactive improvement of the special thematic English vocabulary and the fundamentals of school mathematics (working with test tasks in a training mode with no limits in the number of attempts);
   - interactive acquisition of practical skills in programming (performing a system of training exercises on the pages of an e-workbook).

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Informatics teacher's training for design of innovative learning aids

Liudmyla I. Bilousova[1[0000-0002-2364-1885]], Liudmyla E. Gryzun[1[0000-0002-5274-5624]], Julia O. Rakusa[1[0000-0002-5089-0705]] and Ekaterina O. Shmeltser[2]

[1] H. S. Skovoroda Kharkiv National Pedagogical University,
29, Alchevskyh Str., Kharkiv, 61002, Ukraine
Lib215@gmail.com, Lgr2007@ukr.net
[2] State University of Economics and Technology,
5, Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
shmelka0402@gmail.com

Abstract. In accordance with its goal, the paper covers practical aspects and experience of Informatics teachers' preparation for the design of innovative learning aids as one of the important components of the renewed model of teachers' training. Theoretical background of the research includes holistic educational approach and functional basics of electronic didactic aids development. The specific example of such an experience (students' project activity on the design of English multimedia tutorial for schoolchildren) is depicted in details. The prospects of further research are outlined.

Keywords: model of Informatics teachers' training; holistic education; cloud-based cognitive environment; design of innovative learning aids, multimedia tutorial.

1 Introduction

The process of training of pre-service Informatics teachers is a complicated task which nowadays needs for modernization. It becomes incredibly urgent and topical due to some factors connected with the requirements to a contemporary Informatics teacher. These factors include rapid development and changing of digital technologies; challenges to work at school with a new generation of so-called "digit-natives" who have their cognitive peculiarities and special educational requests; growing demand for IT-specialists on the labor market. These factors encourage changing the role of Informatics teachers who have to be able to raise and educate schoolchildren in the lines of advanced interest to Computer Science, its deep understanding, and motivation to potential professional activity in IT-sphere.

Thus, it becomes really important to build the renewed model of teachers' training on the basis of new paradigms. One of such a paradigm might be the holistic educational approach, which is emphasized in a number of normative documents, such as the Concept of the New Ukrainian School [4], the National Strategy for the Development of Education in Ukraine for 2012-2021 (2013), the Law of Ukraine "On Higher Education" (2014), the Law of Ukraine "On the Concept of National Education information programs" (2015), Education for Sustainable Development Goals: Learning Objectives (UNESCO, 2017) and others.

According to recent research papers on the theory of holistic education it is considered as a paradigm which provides educators with a system of principles that can be used in various ways [3; 10; 13; 12]. The central idea of holistic education is the cohesive development of the whole personality of a trainee both at the intellectual and emotional levels [16]. It is also emphasized that such a cohesive development should be supported by strong links between personal experience and real life problems.

On the other hand, the evidence of real educational practice testifies that productive and important ideas of holistic paradigm are accepted in quite a limited way without using its significant facilities as for providing integrity at the levels of the content of education, means and forms of its implementation.

Minding these speculations, at the developing of the renewed model of the Informatics teachers' training, we eager to implemented holistic approach in the complex of various aspects, in particular: to form the content of Informatics learning, to select the proper ways of it representation and mastering, and to arrange professional educational practice for pre-service Informatics teachers. This idea is specified in the implementation of (1) concentration and generalization of Informatics educational content basing on the integrative approach to the structuring of the curriculum disciplines in pre-service teachers' training; (2) multi-code representation of the educational content directed on the stimulating of cognitive processes; (3) natural merging of teachers' educational practices with innovative ICT applications to real-life challenges that can be achieved via project-based learning. It is important to point out that the said aspects at the same time cause and complement each other. In such a way the holistic idea obtains more comprehensive understanding and deeper penetration into educational practice.

In this context, particular attention must be paid to teachers' preparation for design and implementation of efficient didactic aids which are able to provide holistic approach to classroom activity at learning of different school subjects. Thus, one of the important components of the renewed model of Informatics teachers' training based on the holistic approach (covered and justified above) is the teachers' preparation for the design of innovative learning aids.

The purpose of the article is to cover practical aspects and experience of this kind of training.

2 Theoretical framework

During the research, the set of theoretical, empirical, and modelling methods were applied. In terms of mentioned model of the Informatics teachers' training built on the holistic approach, their preparation to design of innovative didactic aids is realized comprehensively in the process of learning of the complex of curriculum disciplines (both of common and vocational training) and via the project-oriented activity.

Theoretical background of the teachers' training for development of innovative learning aids, in particular, e-tutorials, can be considered holistic educational approach (covered above in brief) and functional basics of electronic didactic aids development.

Problems of defining didactic functions of e-learning guides and functional approach to their design have recently become the focus of researchers and practitioners (in particular, of Liudmyla I. Bilousiva [3], Liudmyla E. Gryzun [6], Volodar V. Kraevskii [8], Isaak Ia. Lerner [9] and others). This approach is based on a deep analysis of the didactic functions of the textbooks and the means of their implementation. It opens practical ways to develop the structure of e-tutorials that can be used as a theoretical basis for their projecting [15; 17; 14]. The project embodies the idea of a tutorial as an object of creation. The process of e-tutorials design includes determining the structure of the tutorial that fixes the interconnections of its components, establishes the mechanism of implementation of these links, etc. Functional approach to creating of an e-tutorial enables to establish the functional load of its structural elements and the connection between the performance of their necessary functions [2; 6; 8; 9]. These ideas become increasingly important nowadays in the context of exactly multimedia tutorials design, as their role is getting more and more essential in education.

As it was said above, the process of contemporary tutorials development must rest on their deep learning as an object of design. Thus, it is relevant to reveal that a multimedia tutorial in its state-of-art sense has been recently transformed into the integral learning environment which adsorbs functions of the whole complex of learning aids. It has happened due to attracting to its design advanced multimedia and cloud-based technologies.

Among the leading features of a multimedia tutorial ([2; 5]), it is possible to distinguish the following basic didactic functions: informational, transformational, systematic, integrating, coordinating, developing, the functions of consolidation, self-control, self-education. Thus, projecting the structure of any multimedia tutorial it is necessary to provide proper components for leading didactic functions realization.

The covered above theoretical background made a basis for arrangement of pre-service Informatics teachers' training for the design of multimedia teaching aids.

3 Results and discussion

The practical aspects and experience of this kind of training are covered below on the example of students' development of multimedia tutorial for English learning support. The tutorial was designed in the process of the students' project-oriented activity which rested on the previous learning of such curriculum subjects as Programming, Computer Graphics, Pedagogy, English (common academic subjects) and Computer-oriented systems of learning, Basics of E-pedagogy, Design of didactic aids (professionally-oriented subjects).

On the initial stage of the project the didactic functions and structure of the multimedia tutorial were specified due to needs and problems of foreign languages mastering at school.

In particular, pre-service Informatics teachers' revealed basic demands to the tutorial, determined its functional facilities and defined its structure. In such a way, there was concluded that in order to provide the fulfilment of the leading didactic functions the English multimedia tutorial for 6th grade pupils has to realize the set of facilities. First of all, it must provide high-quality visualization of educational content and interactive dialogue with a trainee. It will help to realize in proper way informational, transformational, developing didactic functions, as well as functions of feedback, correction and control.

It should also ensure that the acquisition of linguistic competence is enhanced by the complex involvement of many information perception organs, which will provide the implementation of transformational and developing functions.

The tutorial also has to enable working out of various skills of speech training and in such a way to realize systematic and consolidation functions. It should guarantee the cognitive activity management including game activity for ensuring realization of didactic functions of developing and self-learning. In addition, the tutorial must provide a strong feedback with a teacher and other trainees to obtain consultations, help, assessment etc.

Finally, the tutorial has to be easily integrated with other e-resources which will guarantee it integrative and coordinative didactic functions.

Based on the above functions and relying on research [1; 7; 11], it became possible to design the structure of the multimedia tutorial, since it is conditioned by the need to implement its didactic functions. Thus, students concluded that the tutorial should be the complex of interconnected components characterized below.

For high-quality information visualization, the tutorial should include a *multimedia illustration library* that offers text, graphics, video, and audio materials.

To build language competence via the comprehensive involvement of many sense organs, the tutorial contains an *interactive video library* with didactic support.

To develop a variety of skills, the manual has a *bank of interactive exercises* with an immediate output of the results of their implementation.

For learning activity management, the tool has a *learning activity management component* with repetition of the material and involvement of game elements.

To automate the processes of information retrieval and integration with other electronic sources, the manual has a *technological component* that will provide its online uploading and the ability to be integrated with other resources.

To communicate with the teacher and other students, the tutorial has an appropriate component.

Defined and specified didactic functions and structure of the multimedia tutorial became the basis of its design.

Thus, on the subsequent phases of the project the multimedia English tutorial for 6th grade schoolchildren has been developed with the help of the tools of Ourboox environment, whose capabilities were enhanced by the students' programmed elements. It's worth noting that it does not need to be installed or downloaded due to the fact that it is a cloud-based multimedia book called MultiEnglish. It covers the main topic taught in the 6th grade during English lessons: My family, My friends, Shopping, Food, Sport, Traveling, Ukraine, Great Britain, School life (Figure 1).

Fig. 1. Content of the multimedia tutorial

Each topic is represented in four headings (Let's focus on…) that target formation and development of four basic language skills: Let's focus on Vocabulary, Let's focus on Reading, Let's focus on Grammar, Let's focus on Listening and Speaking, Let's focus on Writing (Figures 2-6). The sections contain relevant teaching materials, questions, tasks and various exercises. The demo version of the tutorial is available via the link (https://www.ourboox.com/books/multimediaenglish/).

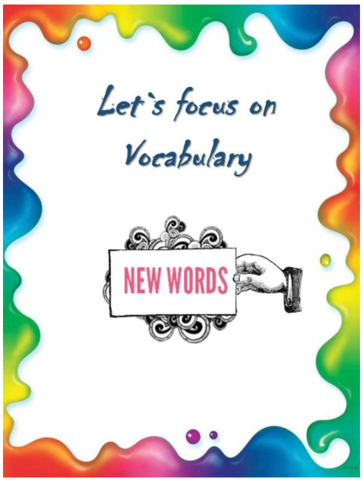

Fig. 2. Category Let's focus on Vocabulary

While designing the tutorial, according to its didactic functions and structure, standard features of the Ourboox environment have been extended by HTML markup programming.

Adding appropriate language instructions allowed students to supplement the tutorial with interactive elements of other services that are not provided by the Ourboox environment toolkit. In particular, training exercises, interactive videos, interactive posters, games, static and dynamic illustrations, hyperlinks of a number of services (LearningApps, Quizlet, YouTube, Edpuzzle, Vizia, Gettyimages, ThingLink, ESL Game Plus, Jigsaw Planet, Google-forms) were integrated into the tutorial (Figure 7).

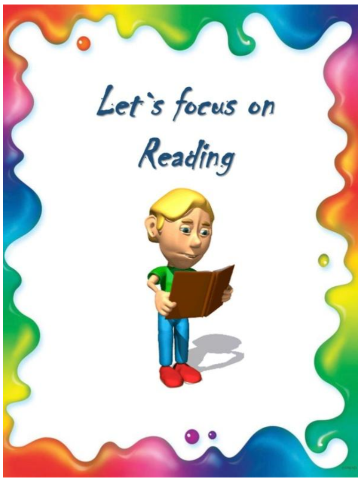

Fig. 3. Category Let's focus on Reading

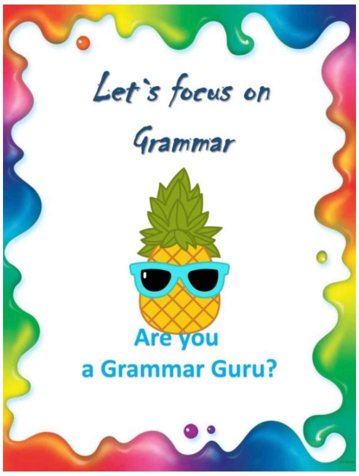

Fig. 4. Category Let's focus on Grammar

In addition, due to editing the HTML code of the tutorial pages, the media content was created. For example, the students-developers could combine text, graphics, video elements and the necessary hyperlinks (Figure 8).

Using HTML, it was enhanced Ourboox's capability to format text. For example, it was developed code fragments in HTML with CSS elements to align text (Figure 9) and to create numbered lists (Figure 10).

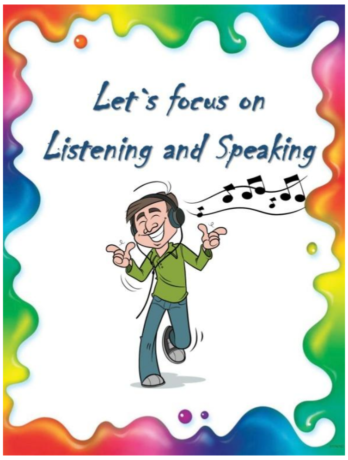

Fig. 5. Category Let’s focus on Listening and Speaking

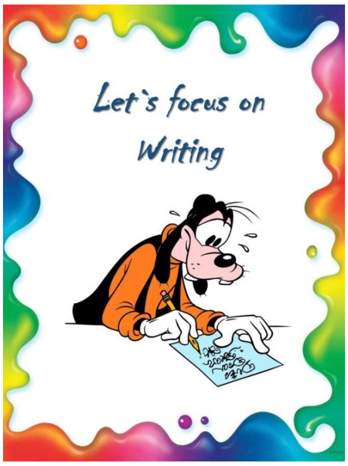

Fig. 6. Category Let’s focus on Writing

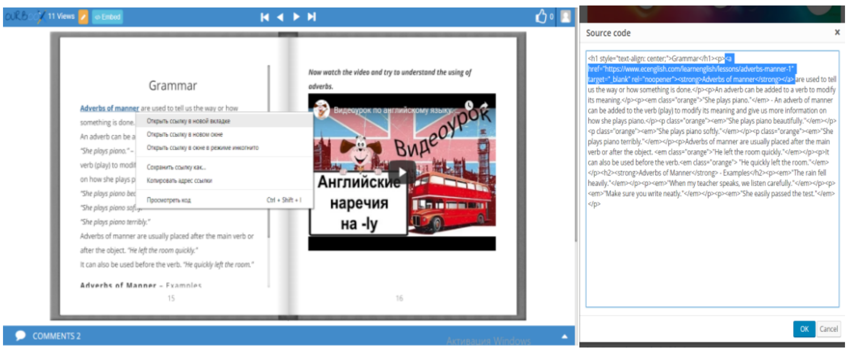

Fig. 7. An example of an interactive element of a multimedia tutorial embedded with HTML

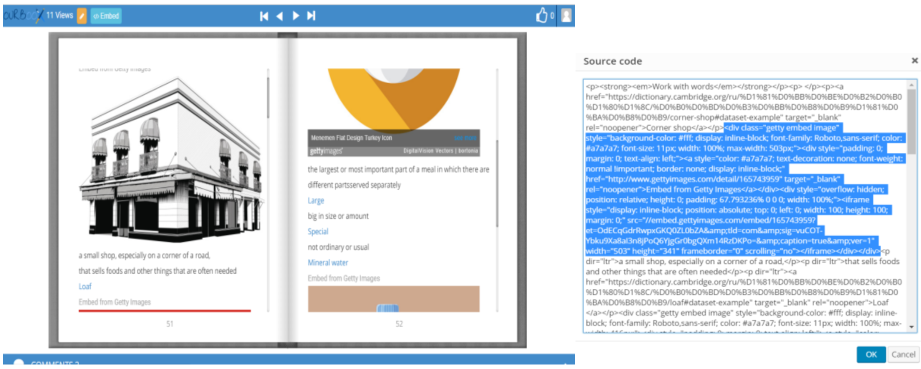

Fig. 8. Creating multimedia content by editing HTML

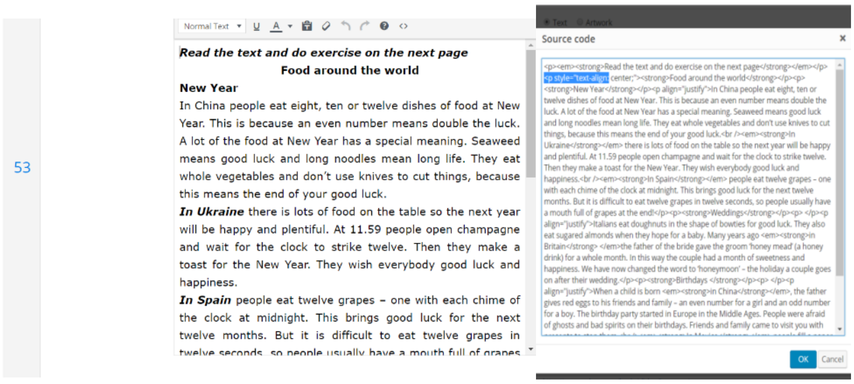

Fig. 9. Extension of text formatting with HTML using CSS elements

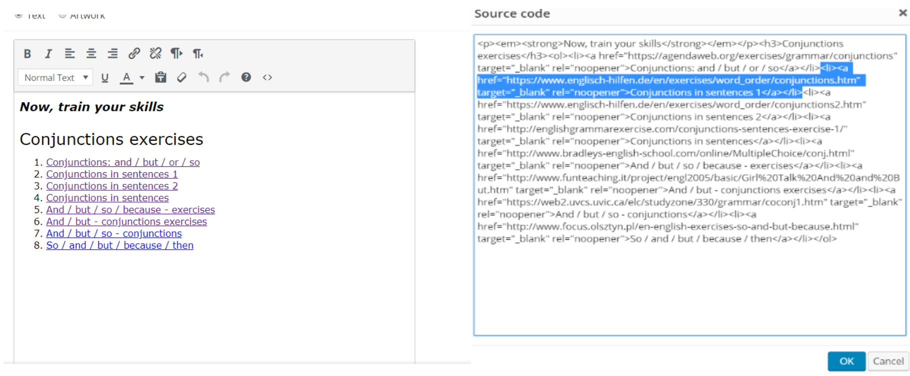

Fig. 10. Create of numbered lists using HTML with CSS elements

In addition, students-developers programmed integration with interactive didactic support into the tutorial. This element allows a trainee to watch the video with a pause at the marked places and do interactive tasks to the video story.

On the whole, thanks to the programmed elements that were added, the multimedia tutorial is able to perform all its didactic functions, defined at the first (theoretical) stage of the students' project.

At the final stage of their project, pre-service Informatics teachers do analysis and reflection of the designed tutorial, revealing its didactic features.

Discussing the didactic capabilities of the MultiEnglish multimedia tutorial, designed on the basis of a functional approach by the pre-service Informatics teachers at their project activity, we would emphasize its following features. The tutorial provides high-quality visualization of educational information and interactive dialogue with the student. A vast library of multimedia illustrations of the application visualizes the necessary elements of the educational content and provides instant feedback. The library contains static and dynamic illustrations of various types, including interactive posters. This type of illustrations enables quick boosting and checking a trainee's vocabulary (Figure 11).

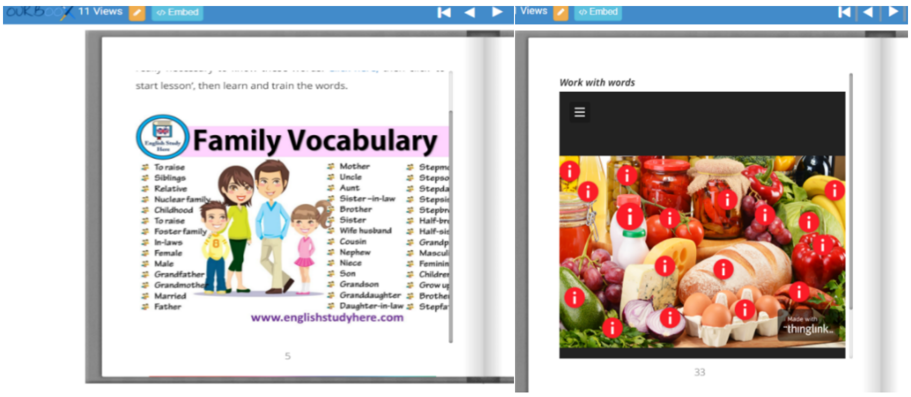

Fig. 11. Fragments of work with the multimedia illustration library

This tutorial capacity provides high-quality implementation of informational, transformational, developing didactic functions, as well as the functions of feedback, correction and self-control.

In addition, the tutorial enhances the effectiveness of language competencies through the comprehensive involvement of multi-senses activities. In particular, the tutorial allows you to organize the learning activities of the student with interactive video stories, for which it has been developed appropriate didactic support. Thus, while viewing the pupil is provided with the tasks that develop their audio skills, replenish their vocabulary, encourage the conscious using of grammar (Figure 12).

Also the multimedia tutorial has the ability to record a student's speech in order to develop his or her oral and communication skills (Figure 13). This helps to realize the transformational and developing functions.

The manual provides training of various skills and can be used as a simulator. The Bank of interactive exercises offers the trainee a variety of tasks of different formats: word search, matching, interactive text, puzzle solving, audio and video tasks. In such way, the systematic and anchoring functions are realized. Fragments of different types of training tasks are shown in Figures 14-17.

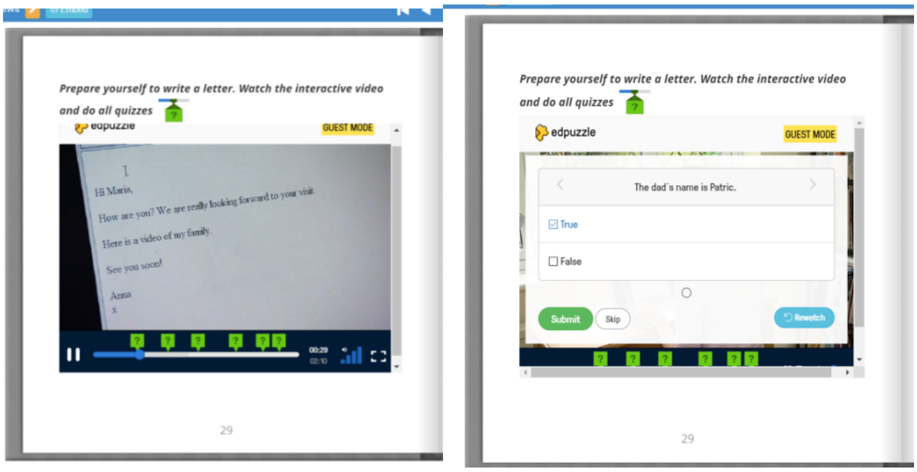

Fig. 12. Fragments of the using the interactive video "My Family"

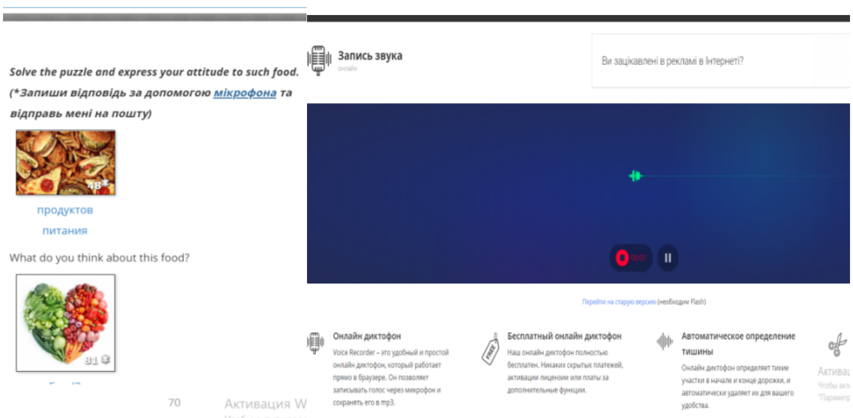

Fig. 13. A fragment of a student's voice recording while learning the topic "Food"

The functionality of the developed multimedia tutorial also includes the arrangement of cognitive activities, including game activity. That means that a trainee is able to work at their own pace, both independently and under the guidance of the teacher. In addition, all of the tasks offered to the student can be performed several times to achieve the best results. In order to increase motivation for learning, the tutorial involves pupils into game activities. It offers quizzes, crossword puzzles, cognitive grammar trips, quests etc. (Figure 18). These kinds of activity provided by the tutorial ensure fulfillment of the developing, systematic and consolidation functions.

The tutorial expects technological capability of its uploading to other websites and be integrated easily with other electronic sources and environments (Figure 19), which facilitates the implementation of integrating and coordinating functions. It is also essential that the tutorial works correctly with all browsers like Google Chrome, Microsoft Edge, Opera, Mozila Firefox, Internet Explorer, Yandex Browser.

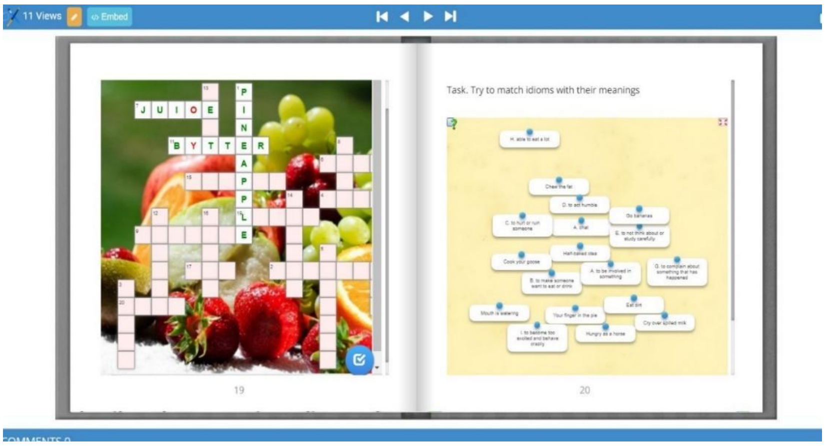

Fig. 14. A fragment of matching and interactive crossword puzzles

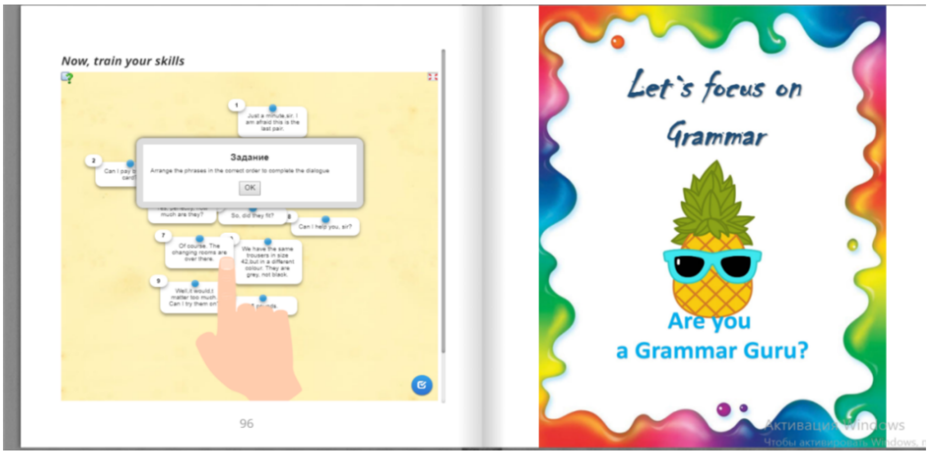

Fig. 15. Fragment of the ordering task

In addition, the tutorial has the functionality, which helps students to communicate with their teacher. For example, *comments element* can be used to ask questions, to do the exercise, send a speech to a teacher, or ask for help from other trainees (Figure 20). In such a way, the tutorial implements the didactic feedback function.

Thus, the analysis of the developed multimedia tutorial (provided by the students on the final stage of the project) testifies that the tutorial designed on the basis of functional approach becomes really innovative, as it creates for a trainee the integral cloud-based cognitive environment oriented on the activity-centred learning. In fact, the tutorial provides pupils with a platform for their independent cognitive activity, for their motivation to learning due to availability of tasks choice and ways of their fulfilling. As a result, it promotes cohesive development of both of students and their potential pupils.

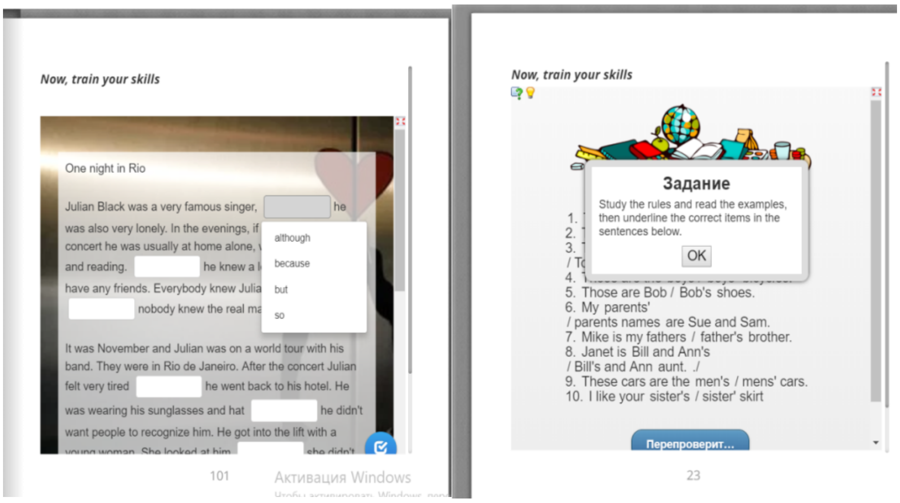

Fig. 16. Fragments of work with the interactive text

Fig. 17. Fragment of work with the video content

Summing up the depicted experience and specific example, we would emphasize the following. On condition of such an interdisciplinary preparation and project activity, pre-service teachers obtain meta-skills on the design of innovative learning aids. In the process of this kind of training, potential teachers obtain full understanding and capability for practical embodiment of core ideas of holistic educational approach via their personal experience of development of the learning aids. It will consequently raise their motivation to the implementation of such an approach into their own professional activity with the help of the specially prepared aids.

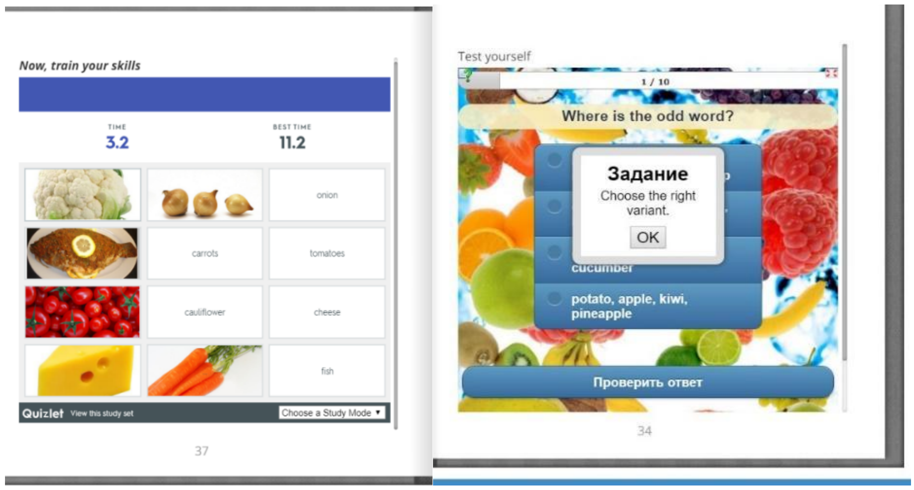

Fig. 18. Fragments of the Learning Activity Management component with repeated material and involvement of game elements

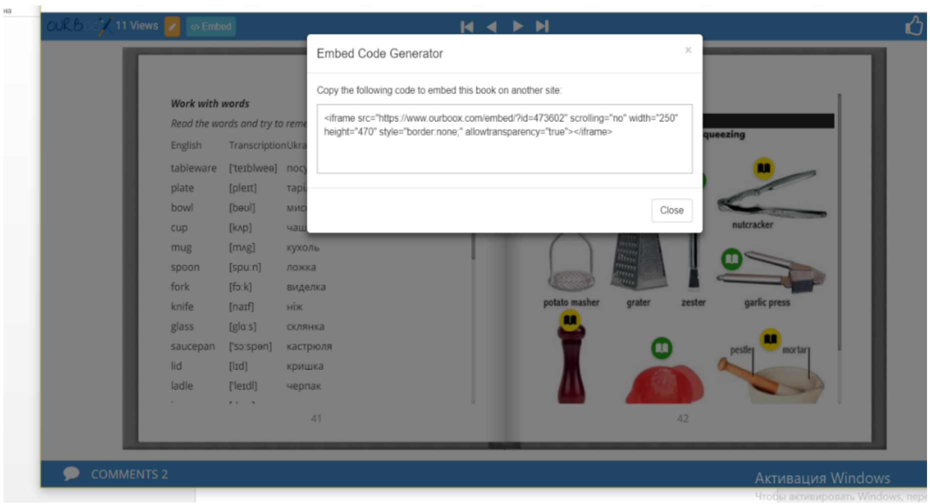

Fig. 19. A fragment of the technology component that allows you to embed the author's tutorial on other websites

It seems to be reasonable to predict positive influence of this kind of training on the forming of the students' holistic system of professional knowledge and skills. Elaboration of proper methodology of its diagnosing and estimation is a prospect of our further research.

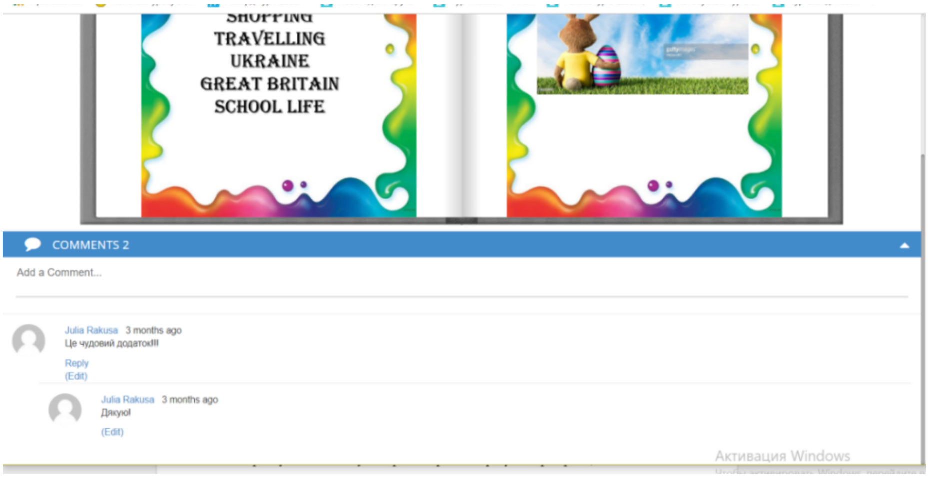

Fig. 20. Fragment of work with comments element of the tutorial for feedback realization

4 Conclusions

In accordance with its goal, the paper covers practical aspects and experience of Informatics teachers' preparation for the design of innovative learning aids as one of the important components of the renewed model of teachers' training. Theoretical background of the research includes holistic educational approach and functional basics of electronic didactic aids development. The specific example of such an experience (students' project activity on the design of English multimedia tutorial for schoolchildren) is depicted in details. The prospects of further research are outlined.

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Training elementary school teachers-to-be at Computer Science lessons to evaluate e-tools

Nadiia V. Olefirenko[1[0000-0002-9086-0359]], Ilona I. Kostikova[1[0000-0001-5894-4846]], Nataliia O. Ponomarova[1[0000-0002-0172-8007]], Kateryna O. Lebedieva[1[0000-0001-7560-3226]], Vira M. Andriievska[1[0000-0003-1632-4045]] and Andrey V. Pikilnyak[2[0000-0003-0898-4756]]

[1] H. S. Skovoroda Kharkiv National Pedagogical University,
29 Alchevskyh Str., Kharkiv, 61002, Ukraine
{olefirenkonn, ilonakostikova, ponomna, andvera80}@gmail.com
[2] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
pikilnyak@gmail.com

Abstract. The study purpose is to develop methodological support for students' training for evaluation e-tools for young learners and to check its effectiveness experimentally. The module "Expert evaluation of the quality of e-tools for young learners" is offered for teachers-to-be. The determination of the weighting factor of each criterion by expert evaluations was organized. Educational principles, correlation e-tool content with the curriculum, interactivity, multimedia, assistance system, ergonomic requirements are mentioned. On the basis of the criterion rank, the significance of each criterion was calculated. The indicators to determine the level of preliminary expert evaluations of e-tools are proposed. The results are calculated with nonparametric methods of mathematical statistics, in particular, Pearson's criterion χ^2. The conclusion is the expert evaluation has different activity stages, gradually becoming a common phenomenon. Training teachers-to-be for e-tool expert evaluation at Computer Science, Mathematics, English is a complex process.

Keywords: e-tools; young learners; elementary school; experimental research; expert evaluation; weighting factor.

1 Introduction

Elementary school teachers-to-be are implementing a state policy on reforming education; they should train young learners for life and activities in a digital society, in a world where the process of getting new knowledge is constantly changed, where new skills and life-long learning are needed [17; 18; 35]. To our mind, a teacher of elementary school plays great role in learners' success to be ready to live in a high-tech society [23].

UNESCO recommendations emphasize that for a modern teacher it is not enough to be knowledgeable in the field of information and communication technologies (ICT) and be able to formulate appropriate technological skills for young learners. A teacher should be able to help children to use modern technologies to cooperate successfully, to solve problems, to study creatively. In the curriculum one of the key competencies is a digital one, which provides confident and, at the same time, critical application of information and communication technologies, ownership of information and media literacy, understanding ethics when working with information (copyright, intellectual property etc.).

At the present stage of information technology development the spectrum of digital tools that became available for use in the elementary school has expanded considerably. For a lesson preparing at education web portals and web pages (Ukrainian forums of education ideas "Lesson" http://osvita.ua/publishing/urok/5934, "Island of Knowledge" http://shkola.ostriv.in.ua), multimedia presentations [14; 31], e-textbooks and manuals [3; 15], e-tools for testing [1; 19], videos of real experimental researches [20; 30], digital schemes and cards [29] and so on are offered. The presented e-tools are developed by the experienced teachers for their own lessons, taking into account the specifics of their own approaches to teaching a particular subject or topic at school.

However, every lesson is unique, and every computer using must be justified, a teacher during a lesson preparation should not only use a proper e-tool, but also evaluate it as for the effectiveness in achieving the lesson goals. So, training university students as elementary school teachers-to-be how to evaluate e-tools for young learners is important.

2 Recent work

Different aspects of training elementary school teachers-to-be to use the different technologies in young learners' education are analysed in many scientific studies. Thus, the problems of development students' information competence, use of information technology in young learners' education are considered in the writings of Clive L. Dym and co-authors [7], Mandina Shadreck [27], Bernard Atrogor Oko and Louisa Uwatt [21], Gladwell Wambiri Njeri and Mary Nyokabi Ndani [34], Vanessa W. Vongkulluksn, Ananya M. Matewos, Gale M. Sinatra and Julie A. Marsh [33]. General criteria are reflected in some documents [25; 32].

Different problems of evaluating and improving ICT use are analysed in some works [2; 4; 5; 9; 8; 26; 29].

Our previous works highlight the education potential of e-tools for teaching young learners, e-tool creation in various instrumental environments [22], ICT use for young learners at English lessons [12], in students' English learning [13]. However, some problems of students' training for evaluation e-tools for young learners to select the appropriate ones have not been covered in previous research studies.

The purpose of the article is to develop a methodological support for students' training to evaluate e-tools for young learners and to check its effectiveness experimentally.

3 Material and methods

3.1 Explored materials used in the experiment

The choice of e-tools used in the experimental study is connected to the type diversity of e-tools that teachers use at different lesson stages at elementary school (apps, video tools, multimedia presentations, e-manuals, education environments, etc.). To train teachers-to-be for elementary school at Computer Science, Mathematics, English lessons we offered some tools that cover subject or topic learning.

To investigate e-tools for young learners we chose the e-courses for 3-4 grades at elementary school: the complex of educational games "Hour-of-code" for teaching Computer Science with young learners (Fig. 1); the e-course GeoGebra for Mathematics lessons "Adding Fractions" (https://www.geogebra.org/m/xm7EHdmG), "Build a Square Workshop" (https://www.geogebra.org/m/w6kbvzmp) (author John Golden) (Fig. 2); the e-course that is a part of the English language course "Fairyland Express Publishing i-eBook" (Fig. 3), and other popular e-courses as e-tools.

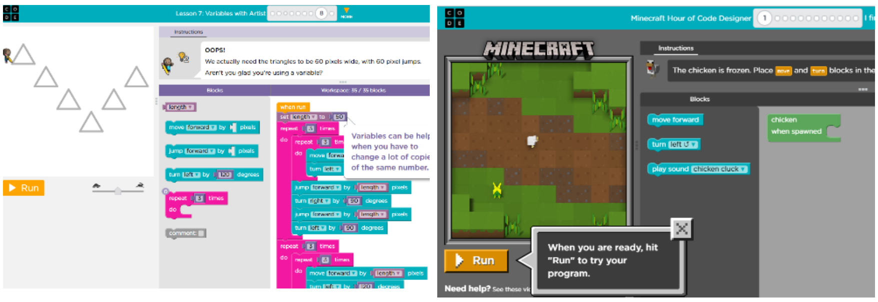

Fig. 1. The complex of educational games "Hour-of-code"

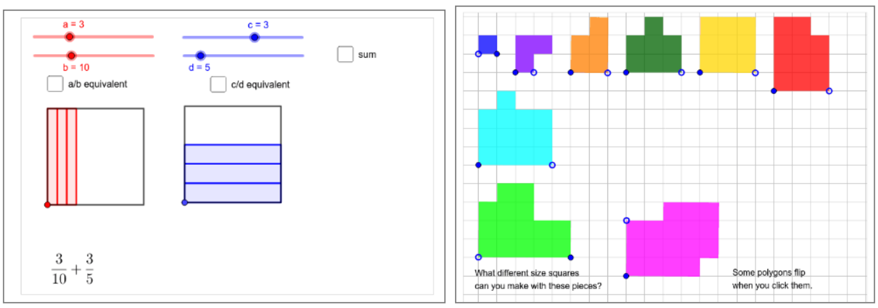

Fig. 2. The e-course GeoGebra for Mathematics lessons

3.2 Methods for investigation

To solve article purpose the following research methods were used.

Fig. 3. The course "Fairyland Express Publishing i-eBook" for English

Theoretical ones: analysis of scientific works, systematization of scientists' views and results, study of documents (to know the requirements for e-tools, to determine some aspects of training teachers-to-be to evaluate e-tools for young learners).

Experimental ones: a pedagogical experiment for checking the effectiveness of the offered methodological support; diagnostic ones as questionnaires, observations, analysis of the students' test results (for collecting data about students' evaluation skills); nonparametric methods of mathematical statistics, in particular, Pearson criterion χ^2 (for calculating the results of empirical research); the method of "expert evaluation" with the rank definition of each criterion (for calculating concordance coefficient that indicates the consistency degree of all "experts" opinions).

4 Results

To our mind, the expert evaluation of different e-tools is based on students' skills to evaluate an e-tool for adhering to the complex of psychological, pedagogical, ergonomic, technical requirements, the skill to check the effectiveness of every component, the skill to finish the e-tool untimely, the skill to assess the general design of e-tools, the skill to predict young learners' actions in digital environment, their reactions to learning information and help, the skill to assess the level of the developed e-tools to the lesson aim.

Consequently, to train students-to-be the structure of the learning module "Expert evaluation of the quality of e-tools for young learners" was developed. The module is taught in the Computer Science classes within the discipline "Information and communication technologies in education" for teachers-to-be, future masters of the specialty "Primary Education".

In order to take up the learning module "Expert evaluation of the quality of e-tools for young learners" we identified the tasks and expected results (knowledge and skills) for students after studying this module (Fig. 4). The module content was developed, a set of educational and methodological materials was prepared such as demonstration materials for familiarizing students with the requirements to be met by learning the e-tool, the algorithm of expert evaluation, electronic templates for the expert evaluation, the content of practical and laboratory tasks for students was selected, the task for self-learning and further discussion was selected, the set of e-tools for students' training was selected.

Module

"Expert evaluation of the quality of e-tools for young learners"

Tasks:

- to highlight the content and types of expert evaluation of learning e-tools;
- to show the procedure of expert evaluation of any learning e-tool;
- to acquaint with the principles of professional e-tool evaluation.

Expected results:

knowledge:

- the demands to learning e-tools;
- the types of expert evaluation of learning e-tools;
- the criteria for the quality of learning e-tools;

skills:

- to determine indicators to the quality of learning e-tools for expert evaluation;
- to use the expert evaluation method to rank certain indicators;
- to carry out a preliminary evaluation of learning e-tools according to the determined indicators.

Fig. 4. Module content "Expert evaluation of the quality of e-tools for young learners"

The topics from "Expert evaluation of the quality of e-tools for young learners" are presented in Table 1.

The pedagogical experiment was conducted during 2018-2019 on the basis of the Faculty of Primary Education in H. S. Skovoroda Kharkiv National Pedagogical University, Ukraine. The experiment involves 188 teachers-to-be. The experiment was carried out at several stages initial, developing, final ones.

At the initial stage the experimental and control groups were formed. To do this, we conducted a survey on the awareness of the importance of the preliminary expert evaluation of e-tools, available knowledge and skills in this activity.

To determine the level of awareness of the skills, the students answered the questions about their attitude towards the use of e-tools in the classroom, the frequency of use (at each lesson or not), readiness to select a specific lesson in Mathematics with e-tools, attitudes toward knowledge and skills for acquisition expert evaluation. In addition, we asked to determine the importance of each requirements for the analysis and evaluation of e-tools on a scale from 0 (not important) to 5 (necessary): scientific presentation of e-tools, problem statement, availability of e-tools, visibility, consistency in learning, interactivity, multimedia, assistance system, adaptability to young learners' opportunities and needs, game component, visual design in e-tools, ensuring success situations. In addition, we asked the students to identify the statements from the proposed list with which they agreed:

- I understand that the skill to carry out an expert evaluation of the quality of e-tools is important for my future professional activity.
- The level of my teaching skill does not depend on the ability to assess e-tools.
- The skill to select and use high-quality e-tools in primary education enhances my own status, public recognition, allows me to implement various educational, research and other opportunities.

Table 1. Topics of the module

Topic	Main content
Psychological and pedagogical demands for e-tools	Specificity of young learners as users of e-tools. Psychological and pedagogical requirements, which apply to all types of learning e-tools such as scientific presentation of e-tools, problem statement, availability of e-tools, visibility, consistency in learning. Psychological and pedagogical requirements, which are additionally advanced to e-tools such as interactivity, multimedia, assistance system. Concepts and types of interactivity in software e-tools. Requirements to be met by e-tools designed for teaching young learners (adaptability to young learners' opportunities and needs, game component, visual design in e-tools, ensuring success situations). Ways of providing psychological and pedagogical requirements in e-tools.
Ergonomic, technical and health-saving requirements for e-tools	Ergonomic concept in the learning digital environment. Ergonomic requirements for learning e-tools (overall visualization of software environment, colour characteristics, object location on a screen, text outlook, numeric and sign information, audio information, user's feedback, hyperlinks and navigation elements; time-limiters in performing individual actions). Health-saving requirements. Technical requirements. Ways to ensure the health and technical requirements for e-tools.
Educational expertise of e-tools	Educational expertise of e-tools as an activity aimed to develop a reasonable evaluation of the quality of the developed tools and its conformity to lesson aim. Content, methodical, design, ergonomic demands. Standardization of learning e-tools. The concept of 'electronic certification'. Criteria and indicators of learning e-quality. The quality of the implementation learning e-tool in a curriculum as an object of the educational expertise.
Quantitative methods of expert evaluation of e-tools	Application of the expert evaluation method when choosing criteria for assessing the quality of e-tools. Determination of weighting factors of the criteria to the developed e-tools.

To determine the initial level of knowledge and skills in evaluating e-tools, we proposed to determine the content of some requirements such as the scientific presentation of the educational e-tools, system assistance, game component. On the one hand, they are intuitive, and, on the other hand, they demand some additional explanations. In addition, we suggested the students to determine the advantages and disadvantages of e-tools at Computer Science lessons, at English lessons, to evaluate their quality and create the ways to improve them.

According to the surveys results, we combined the students as for the level of their motivation, knowledge and skills to evaluate e-tools into four groups: low, average, sufficient, high. On the basis of the obtained data, the contingent of the experimental and control groups was set up – 104 students were included in the control group, 84 – in the experimental group, which was determined by the set of academic groups. The data obtained at this research stage are presented in Table 2.

Table 2. Initial stage of expert evaluation skills for e-tools (persons)

Indicator	Low		Average		Sufficient		High	
	C	E	C	E	C	E	C	E
awareness of importance of the preliminary expert evaluation of learning e-tools	35	32	32	28	21	13	16	11
understanding the system of requirements for learning e-tools for schoolchildren	32	28	33	28	24	16	15	12
skill to evaluate the system of requirements for learning e-tools for schoolchildren	34	26	48	42	17	14	5	2

The obtained results were calculated by nonparametric methods of mathematical statistics, in particular, according to the Pearson criteria χ^2: at this stage, the difference between students of experimental and control groups was insignificant and obtained the value χ^2 from 0.4 to 1.2 at the level of significance of 5%, which is less than read by young learners from a computer screen, taking into account competently the psychological and physiological characteristics of young learners.

We offered such tasks.

1. Analyze the slide visualization for:

   - the compliance of a general tool design with its content;
   - the emotions that a slide can cause to a child;
   - the presence of homogeneous or aggressive fields, the feasibility of making changes;
   - the number of objects that are designed once in a child's view.

2. Make rules for tool visualization for young learners, taking into account their psychological and physiological characteristics.
3. Make presentation slides "Animals" at English lesson using the elements. Change the object size, amount in one slide, background, color scale, etc., if necessary. Explain the need for the changes made.
4. Using a color wheel, select the colors those that are contrasting, analogous, making a contrast triad (Table 3).
5. Take a look at the psychological and pedagogical requirements, which should correspond to the e-tool. Determine how each requirement in the chosen e-tool is implemented. Fill in table 4.

Table 3. Colors: contrasting, analogous, making contrast triad

Color	Sample	Contrasting Color	Analogous Colors	Making contrast triad
Green		red	blue, light green	purple, dark orange
Red				
Purple				
Light green				

Table 4. The psychological and pedagogical requirements in the chosen e-tool

Requirement	Brief requirement content	How it is implemented (what elements, which way)
scientific presentation	For example, "the content should correspond to the current state of science development"	
problem statement		
availability		
visibility		
consistency in learning		
interactivity		
assistance system		
adaptability		
game component		
visual design		
ensuring success situations		

6. Analyze the presentations for young learners. Determine whether different types of fonts are used, and the headset and size are selected. Determine the distance from which the entire presentation content is clearly visible (Table 5).

Table 5. Presentation content

Presentation name	Age / Grade	Headset	Font	Font height	Letter height at demonstration through projector

During practical classes at University, students learned to identify the criteria and indicators that were essential for analyzing the quality of the author's e-tools, to analyze the compliance of professional and own developments with the selected criteria. The determination of the weighting factor of each criterion by the method of expert evaluations was organized [10; 16; 36].

For this purpose, in each academic group, students identified a set of criteria for later e-tool evaluation. They minded educational principles; correlation e-tool content with the curriculum; interactivity, multimedia, assistance system; ergonomic requirements.

To determine the weighting factor of each criterion, the students in academic group acted as experts and determined individually the rank of each criterion (from 1 to 4). The experimental group received the data presented in Table 6.

Table 6. Table of criterion rank for e-tool expert evaluation

Criterion / Expert #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
educational principles (x_1)	1	1	1	1	1	2	3	1	1	1	3	1	3	3	1
correlation e-tool content with the curriculum (x_2)	3	4	2	2	4	1	1	3	2	2	1	4	1	1	2
interactivity, multimedia, assistance system (x_3)	2	2	3	3	2	3	2	2	3	3	2	2	2	2	3
ergonomic requirements (x_4)	4	3	4	4	3	4	4	4	4	4	4	3	4	4	4

Next, the concordance coefficient was calculated, which indicated the consistency degree of all students' opinion as "experts". In the experimental group the value was $W = 0.52$, indicating the average degree of consistency in expert evaluations. It should be noted that in the control group, after calculating the concordation coefficient, the table of criterion rank needed coordinating and editing.

On the basis of the table of criterion rank, the significance of each criterion was calculated. For that we found the values that were inverse to the rank sum for each criterion, and then determined the required weighting factors. According to the experts, the importance of each criterion was: educational principles 0.36; correlation e-tool content with the curriculum 0.26; interactivity, multimedia, assistance system 0.24; ergonomic requirements 0.14.

The students chose one e-tool for self-evaluations. Every student evaluated the criterion degree in the e-tool and expressed it in points from 0 to 3. For example, 3 points for high level, 2 points for sufficient level, 1 point for medium level, 0 point for low level. After that, every student calculated the e-tool evaluation, taking into account weighting factor of each criterion (by the formula $\Phi = \sum \mathrm{V_k} \times \mathrm{P_k}\ \Phi = \sum \mathrm{V_k} \times \mathrm{P_k}$, where V_k – weighting factor of each criterion on the basis of expert evaluations, P_k – the demonstration degree of each criterion).

Consequently, as a result of the e-tool expert evaluation, every student gave it a general score: 2.51–3.0 for high level, 1.51–2.50 for sufficient level, 0.76 –1.50 for medium level, and 0.0 – 0.75 for low level.

According to the results, students did not always come to the same consensus about the e-tool quality. It indicated different experience levels of using such e-tools, subjectivity in expert evaluation. At the same time, such activities allowed teachers-to-be to pay more attention to suggestions for improving e-tools, before giving their own evaluation about the e-tool quality.

In the final stage of the experiment, we formulated the indicators to determine the level of preliminary expert evaluations of e-tools:

- importance of preliminary e-tool expert evaluations;
- requirements to e-tools for young learners;
- knowledge of expert evaluation content;
- checking the data reliability;
- using expert evaluation to indicator ranks;
- expert evaluation for e-tool requirements for young learners;
- level of self-readiness for e-tool expert evaluation.

The results of the experiment about the effectiveness of teaching students to e-tool expert evaluation based on the indicators presented in Table 7. In Table 7, the control group is marked with letter C, and the experimental one is marked with letter E.

Table 7. Results of the effectiveness of teaching students to e-tool expert evaluation based on the indicators (percent)

Indicator	Group	Level			
		Low	Medium	Sufficient	High
importance of preliminary e-tool expert evaluations	C	24.0	28.8	26.9	20.2
	E	8.3	10.7	38.1	42.9
requirements to e-tools for young learners	C	17.3	37.5	26.9	18.3
	E	7.1	13.1	36.9	42.9
knowledge of expert evaluation content	C	30.8	43.3	11.5	14.4
	E	6.0	14.3	33.3	46.4
checking the data reliability	C	17.3	29.8	30.8	22.1
	E	4.8	20.2	25.0	50.0
using expert evaluation to indicator ranks	C	47.1	43.3	7.7	1.9
	E	2.4	7.1	46.4	44.0
expert evaluation for e-tool requirements for young learners	C	17.3	35.6	37.5	9.6
	E	4.8	2.4	44.0	48.8
level of self-readiness for e-tool expert evaluation	C	21.2	34.6	30.8	13.5
	E	11.9	39.3	41.7	7.1

So, the quantitative data show that there are significant changes in the experimental group as for teaching students for e-tool expert evaluation in comparison with the previous experiment stage: the difference between the control and experimental groups is quite noticeable in almost all indicators.

For example, in the control group the high and sufficient levels as for the second indicator ‘requirements to e-tools for young learners’ is 18.3% and 26.9% accordingly, in the experimental group 42.9% and 36.9% accordingly. A significant difference is between the groups according to the fifth and sixth indicators as ‘using expert evaluation to indicator ranks’ and ‘expert evaluation for e-tool requirements for young learners’. The obtained results are calculated with nonparametric methods of mathematical statistics. In particular, according to Pearson’s criterion χ^2: the obtained values are significantly higher than the critical value, it indicates the effectiveness of teaching students to e-tool expert evaluation.

5 Discussion

General criteria and indicators of the ICT quality in teaching and learning, their evaluating and improving were analyzed in some works [4; 5; 9; 8; 26; 28].

No doubt, that a modern teacher should be trained to work in a new digital society, in the face of high expectations regarding teachers' competences relating to the development of e-tools that promote effective schooling. As for expert evaluations by students, any teacher, in our opinion, should be able to choose and develop their own evaluation methods that are consistent with lesson aims and content, to use evaluation data to improve teaching, and to motivate children's learning.

The problems of evaluating the teaching and learning quality, e-books, any curriculum, e-tools are the research subject by many scholars. The most scholars conclude that educational evaluating is a complex process. The experimental researches on the problem of educational evaluation are investigated in some works. Ghaida Alayyar, Petra Fisser, Joke Voogt underline "the Technological Pedagogical Content Knowledge (TPACK) framework has been used to prepare pre-service science teachers at the Public Authority of Applied Education and Training in Kuwait for ICT integration in education. Pre-service teachers worked in teams to design an ICT solution for an authentic problem they faced during in-school training" [2]. Most researchers insist on the need to train students to evaluate e-tool quality.

As for peculiarities of young learners' teaching the results of Mandina Shadreck's pilot studies show that elementary school teachers have a lack in their knowledge and skills to integrate tools into the learning process with schoolchildren [27]. Birgit Pepin and co-authors write "digital curriculum resources (DCR) offer opportunities for change: of understandings concerning the design and use of DCR; of their quality; and of the processes related to teacher / student interactions with DCR – they provide indeed the foundations for change" [24]. Nils Frederik Buchholtz and co-authors underline the importance of educational evaluation: "combining and integrating the two forms of assessment present the possibility of evaluating different aspects of the pre-service teachers' perceptions of opportunities to learn" [6].

To sum up the researchers' results we confirm our data that the expert evaluation has different activity stages, gradually becoming a common phenomenon. To our mind, the research in the field of e-tool evaluation is connected probably with the standardization and systematization tendency of e-tool content.

6 Conclusions

After the experiment, we came to the conclusion that training students – teachers-to-be for elementary school – for e-tool expert evaluation in Mathematics, Computer Science, English is a complex process. During the experiment, students learned the peculiarities of selecting such e-tools that can be used at the school lessons in different subjects. We have created and developed the methodological support for training students for elementary school to e-tool expert evaluation. The experimental checking passed successfully, as it is confirmed by the methods of mathematical statistics, so we can recommend the offered methodological support for students' training for evaluation e-tools for young learners to use.

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Methodology of teaching cloud technologies to future computer science teachers

Vasyl P. Oleksiuk[1[0000-0003-2206-8447]] and Olesia R. Oleksiuk[2[0000-0002-1454-0046]]

[1] Ternopil Volodymyr Hnatiuk National Pedagogical University,
2 M. Kryvonosa Str., Ternopil, 46027, Ukraine
oleksyuk@fizmat.tnpu.edu.ua

[2] Ternopil Regional Municipal Institute of Postgraduate Education,
1 V. Hromnytskogo Str., Ternopil, 46027, Ukraine
o.oleksyuk@ippo.edu.te.ua

Abstract. The article deals with the problem of training future computer science teachers for the use of cloud technologies. The authors analyzed courses from leading universities to study cloud technologies. On this basis the model of application and studying of cloud technologies in the process of training of future teachers of informatics was developed. The basic principles of this model are proposed: systematic, gradual, continuous. It contains target, content, operating and effective component. Therefore, the stages of using cloud computing technology were proposed: as a means of organizing learning activities, as an object of study, as a means of development. The article summarizes the experience of designing a cloud-based learning environment (CBLE). The model is based on such philosophical and pedagogical approaches as systemic, competent, activity, personality-oriented, synergistic. Hybrid cloud is the most appropriate model for this environment. It combines public and private cloud platforms. CBLE also requires the integration of cloud and traditional learning tools. The authors described the most appropriate teaching methods for cloud technologies such as classroom learning, interactive and e-learning, practical methods. The article contains many examples of how to apply the proposed methodology in a real learning process.

Keywords: future informatics teachers, competence, model, methodology, cloud computing.

1 The problem statement

Today, the trend of ICT development is the digitization of all sectors of public life. As a consequence, there is an intensive integration of information and communication technologies (ICT) into the learning process. Nowadays, teachers are often used cloud computing in training process [16; 34]. This remote computing model provides greater accessibility and openness to education [2]. Cloud computing enables students to work with educational materials regardless of their hardware, software and geographical location. Therefore, the study and use of these technologies is mandatory in the curricula of colleges and universities. This problem becomes especially relevant in the case of preparing bachelors of computer science and teachers of informatics.

The purpose of the article is to design content and study methods for cloud computing in the process of training future computer science teachers.

The following tasks are required to achieve the goal of the research:

1. To analyze the state of education in cloud technologies at leading foreign and Ukrainian universities.
2. To define the concept and principles of teaching cloud technologies to future computer science teachers.
3. To offer content and training methods for cloud technologies.

The object of the study is the computer science teachers training process.

The subject of the study is a model of study cloud technology by future computer science teachers.

We used a set of research methods: theoretical – analysis of scientific, technical literature, experience; generalization of experience of using cloud computing in education, empirical: observation, analysis, modeling method.

2 Analysis of cloud computing learning experience

Cloud technology training is on the list of courses from leading US and European universities. Some of them are focused on the study of individual cloud platforms, while others involve the study of the theoretical foundations of cloud technologies. One major subject is administration training, while other students are learning to develop cloud applications.

For example, at Harvard University, students are offered a course in Fundamentals of Cloud Computing with Microsoft Azure. The content of this course covers the fundamental architecture and design patterns necessary to build highly available and scalable solutions using key Microsoft Azure platform as a service (PaaS) and server-less offerings. The students learn fundamentals necessary to make a system ready for users, including always-up architecture and deployment strategies, rollback strategies, testing in production, monitoring, alerting, performance tuning, snapshot debugging in production, and system health analysis using application insights and analysis services [9].

Berkeley University offers a Cloud Computing: Systems course. In this course, teachers describe the technology trends that are enabling cloud computing, the architecture and the design of existing deployments, the services and the applications they offer, and the challenges that needs to be addressed to help cloud computing to reach its full potential. The format of this course will be a mix of lectures, seminar-style discussions, and student presentations. Students will be responsible for paper readings, and completing a hands-on project [6].

Cambridge University invites students to study cloud computing. This course aims to teach students the fundamentals of cloud computing covering topics such as virtualization, data centres, cloud resource management, cloud storage and popular cloud applications including batch and data stream processing. Emphasis is given on the different backend technologies to build and run efficient clouds and the way clouds are used by applications to realize computing on demand. The course includes practical tutorials on different cloud infrastructure technologies. Students assessed via a Cloud-based coursework project [5].

At the University of Helsinki, students take the Cloud Computing Fundamentals: AWS course. Students learn how to use Amazon Web Services as a cloud computing platform. This course covers topics required for AWS Developer Associate certification. The course involves the creation and use of a trial account on AWS [4].

Yale University offers a Cloud Networking and Computing course. In this course, students will visit the critical technology trends and new challenges in cloud and data center designs for different trade-offs of performance, scalability, manageability, and cost in the networking layers and big data analytical frameworks. This course includes lectures and system programming projects [7].

Another approach is to study cloud technology in research labs and training centers. At MIT there is a laboratory called “Parallel & Distributed Operating Systems Group”. Teachers and students have conduct research in cloud systems, multi-core scalability, security, networking, mobile computing, language and compiler design, and systems architecture, taking a pragmatic approach: they build high-performance, reliable, and working systems [29].

The California State Polytechnic University is implementing a project to create a data center training facility through a partnership between the university and leading cloud platform developers (Microsoft, Avanade, Chef, Juniper). The Center is engaged in the deployment of a corporate cloud, through which practitioners will teach students the design, configuration, implementation and maintenance of cloud services and platforms [11].

Another promising way to acquire ICT competencies is to study with massive open online courses (MOOCs). Students have the opportunity to acquire knowledge independently when they study in them. Universities can also integrate these courses into their own subject disciplines. Leading online platforms offer many cloud technology training courses.

For example, there is an Introduction to Cloud Infrastructure Technologies course on the EdX platform. It contains many chapters. These include basic: Virtualization, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Containers and the latest such as Tools for Cloud Infrastructure, Internet of Things, How to Be Successful in the Cloud [20].

Coursera offers several courses to study: Essential Cloud Infrastructure: Foundation, Essential Cloud Infrastructure: Core Services, Elastic Cloud Infrastructure: Scaling and Automation, Google Cloud Platform Fundamentals: Core Infrastructure. These courses explore the Google Cloud Platform and AWS platforms [8].

Udacity has developed a Become a Cloud Dev Ops Engineer nanodegree program. It provides learn to design and deploy infrastructure as code, build and monitor pipelines for different deployment strategies, and deploy scalable microservices using

Kubernetes. At the end of the program, students will combine new skills by completing a capstone project [3].

The Computing Curricula 2017 document that is used in the development of IT education standards in the IT domain ITS-CCO (Cloud Computing) involves the study of such chapters [13]:

- ITS-CCO-01 Perspectives and impact;
- ITS-CCO-02 Concepts and fundamentals;
- ITS-CCO-03 Security and data considerations;
- ITS-CCO-04 Using cloud computing applications;
- ITS-CCO-05 Architecture.
- ITS-CCO-06 Development in the cloud.
- ITS-CCO-07 Cloud infrastructure and data.

Researchers and teachers from Ukrainian universities are also developing cloud computing courses. For example, the standards of the specialty "123 Computer Engineering" defined the ability of a specialist to analyze and design high-performance computer systems with different structural organization using the principles of parallel and distributed information processing [28]. The course "Cloud Technologies and Services" was developed in National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". This course covers the following topics: Cloud technologies and services, Cloud security, Service Models, Google App Engine for Java platform, RESTful API build in Java. The Cloud Technologies course is taught at the Kyiv Taras Shevchenko National University's Faculty of Information Technologies. The course covers basic information about the emergence, development and use of cloud computing technologies. Typologies of cloud deployment (private, public, hybrid, public, etc.), cloud computing service models (SaaS, PaaS, IaaS, etc.) are considered. The discipline provides an overview of the modern solutions of the leaders of the cloud computing market – Amazon, Microsoft and Google. The advantages and disadvantages of cloud computing models and their solutions are considered. To develop practical skills in the discipline, it is proposed to deploy transactional web applications in cloud environments, transfer ready-made solutions to them, learn how to administer them, and work with virtualization technologies [15].

3 Designing a cloud computing training model

Teaching future IT teachers the use of cloud technologies is also relevant. Usually, the pedagogical universities of Ukraine study courses focused on the use of cloud technologies in education. Most of them focus on the study of public clouds of Google Suite or Microsoft Office 365 [14; 18; 27].

In general, Ukrainian and European universities use cloud platforms to create their own cloud-based learning environment (CBLE). Liudmyla I. Bilousova [1], Valerii Yu. Bukov [2], Olena G. Glazunova [10], Anna V. Iatsyshyn [12], Svitlana H. Lytvynova [21], Maiia V. Marienko [30], Oksana M. Markova [22], Nadiia S. Ponomareva [17], Serhiy O. Semerikov [23], Svitlana V. Shokaliuk [24], Mariya P. Shyshkina [25], Oleg

M. Spirin [37], Andrii M. Striuk [31], Illia O. Teplytskyi [33], Tetiana A. Vakaliuk [19], Vladimir I. Zaselskiy [40] and many other Ukrainian researchers are developing a methodology for using cloud computing for train informatics teachers and postgraduate students.

We interpret the concept of "the use of cloud technology" as an introduction to the practical work of a computer science teacher. Appropriate training of bachelors of computer science should be carried out continuously and in stages throughout the study period. Its effectiveness depends on the level of use of the tools in the learning process. Therefore, it is necessary to develop a model of organization of students' learning based on cloud technologies. As a result of the introduction of the proposed model, students develop ICT competencies for using distributed cloud resources for training and research.

The cloud-based student learning organization model changes the traditional reproductive approach to practically oriented learning. For its design we have analyzed similar models [32; 39; 38].

They all transform the educational process from a system that operates on externally set standards to a self-evolving system. The main components of our model are shown in the figure 1.

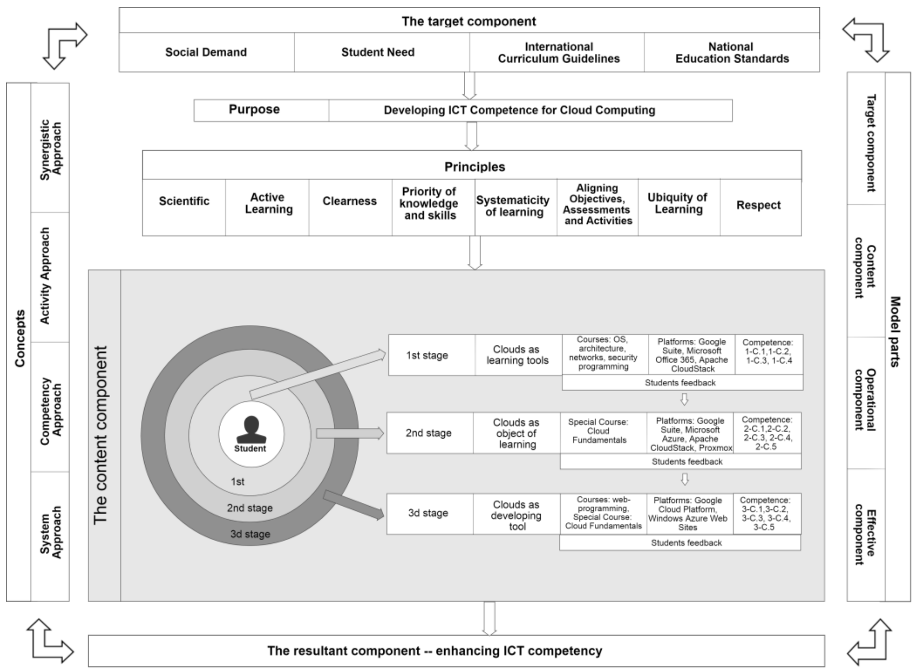

Fig. 1. The model for learning cloud computing

The target component of model provides the creation of conditions for the organization and support of joint educational and research work of students. It provides for the formation of cloud-based learning environment of a university. Based on the previous analysis, we can claim that there is a social demand for a teacher who has competencies in the use of cloud technologies. Such a teacher should be able to organize the CLBE of school, to form the appropriate competence in students. In each of these three stages, we envision students using cloud computing at a different level of awareness. The purpose of this component is the goal setting of stage, on which the effectiveness of the whole process depends. The target component also determines the creation of conditions for the formation of personal capacity for future professional activity in the conditions of modern technological changes.

The purpose of training is implemented through methodological approaches such as:

- the competency approach allows to identify the content of ICT competencies in the use of cloud technologies, to improve the practical orientation of the learning process;
- the system approach allows to consider all components of the proposed model as a coherent system. A systems approach requires designing the model as a set of interrelated elements. Integrative dependencies and interactions of these elements are also needed;
- the action approach focuses on the prioritization of active learning methods;
- the synergistic approach considers the basic processes of student self-organization and interaction. Learning according to this approach is an unstable process. This instability complicates adaptation, cognitive operations, and overall activity.

The guiding principles of the methodology according to our model are the traditional principles of science, accessibility, continuity, systematicity and consistency, activity, clarity. Other principles of learning such as mobility, adaptability, flexibility, ubiquity are also important.

The content component of the model is aimed at developing both the key (digital, personal, social, educational) and subject competences of future computer science teachers.

At the center of the proposed model is a student. Accordingly, the competence structure defines the components by the stages of implementation. They correspond to the preparatory, activity, generalization stages of the use of cloud technologies. The study in the preparatory and activity stage should be done in the bachelor's degree. The generalization stage can be implemented as a master's program.

At the preparatory stage, cloud technology is a means of organizing educational and cognitive activity. The relevant components of subject competence are such as

- ability to be guided by features of modern cloud technologies, to understand their functionality and to be used for basic educational tasks;
- ability to distinguish between features and characteristics of "traditional" Internet services, hosting web resources, running virtual private machines in cloud infrastructures;
- ability to determine the ways of using cloud technologies for the organization of training and research activities according to service models;

- ability to behave adequately and responsibly in a cloud environment, to demonstrate knowledge and understanding of the legal, ethical aspects of using cloud services and digital content;
- ability to actively and constantly explore new services, implement them in their activities, awareness of the role of cloud computing in the current stage of IT and education.

In the activity stage, cloud computing is the object of study. The relevant components of subject competence are such as

- knowledge of basic concepts, deployment models and service models of cloud technologies, principles of operation and technology of server system virtualization, architecture and standards of distributed computing, and features of hardware and software solutions of modern data centers;
- ability to install, configure and maintain system, tool and application software of cloud platforms according to the basic service models;
- ability to evaluate and determine effective CBLE deployment decisions based on an analysis of the functional characteristics of cloud services and the needs of educational institutions;
- ability to design, deploy and integrate ready-made cloud platforms to improve the IT structure of the educational institution;
- ability to monitor, support and analyze the functioning of the CBLE.

At the generalization stage, cloud computing is a development tool for creating educational resources and learning tools. The relevant components of subject competence are as follows

- ability to formulate requirements for quality assurance of software development for its functioning in the cloud applications;
- ability to evaluate and identify effective deployment solutions for CBLE based on a comparison of the technical and economic properties of cloud computing services, as well as for solutions based on private and hybrid cloud systems;
- ability to formulate ways to increase the efficiency of the use of cloud technologies in solving organizational educational and scientific tasks;
- ability to develop software for educational institutions in a cloud computing environment, test and debug relevant hardware and software;
- ability to project activities, work in a team to jointly solve educational and scientific tasks.

The technological component of the model defines the system of teaching methods. We consider appropriate methods of teaching cloud technologies such as:

- classroom training (lectures, storytelling, presentations, group discussions, tutorials etc.);
- interactive methods (quizzes, small group discussions, case studies, participant control, demonstrations etc.);

- e-learning (web-based training, web meetings, webinars, collaborative document preparation, work in CBLE);
- practical training methods (project, training).

In general, these methods aim at providing a blended learning methodology. Their application is possible during lectures, laboratory work, self-study trainings, individual and group consultations. We include the traditional means and components of CBLE in the training tools.

To provide group work and student feedback in each course, we use tools such as:

- emails and messengers;
- software for remote access to the objects of students in CBLE;
- module and final tests;
- Likert-scale course feedback.

The resultant component of the model involves providing ubiquitous access to learning resources through standardized protocols, enhancing students' ICT competency, improving the quality of educational process organization and pedagogical research.

We consider it necessary to use public and private clouds as a teaching tool not only in the first stage, but also throughout the whole time of studying the bachelor of computer science. Such public clouds are G Suite and Microsoft Office 365. Their developers offer free subscriptions to educational institutions. Students and staff can get corporate accounts of these cloud platforms. The use of these platforms can be practiced in almost all courses of professional training of the future computer science teacher.

For example, a teacher can schedule study assignments, student work, online consultations using Calendar services. For training demonstrations, webinars can be effective cloud services such as Google Meet and Skype for Business and more.

Topical issues of using cloud technologies in training are their integration with each other and with other learning tools. Such integration should provide single authentication (Single Sign-On – SSO), content availability in various cloud services, access from mobile devices, and ability to monitor student activity.

Great technical and training capabilities are in the deployment of private academic cloud according to the IaaS model. We have deployed a similar cloud-based on the Apache CloudStack platform. It combines the system resources of 4 servers. This allows you to run 20-50 virtual machines at a time. With Apache CloudStack's enhanced networking capabilities, we have integrated these computers into a large number of virtual local area networks (VLANs). To provide universal access to the virtual labs, 2 virtual private network (VPN) servers were set up. They work with different protocols. Therefore, students are able to work with these labs from any device that has Internet access. All these services have formed a cloud infrastructure that is integrated into the university's LAN. Such an academic cloud makes it possible to create "cloud laboratories". In our opinion, a cloud lab is a system where virtual ICT objects are generated through cloud computing and networking. Cloud labs are best used to teach basic computer science courses, such as computer architecture, operating systems, programming, computer networks, and more.

One of these laboratories (CL-OS) was deployed for training. Its purpose was the development of ICT competences, the education of the need for systematic updating of knowledge, the formation of project activity skills. To complete with the tasks, the students were supposed to have basic knowledge of the following disciplines: Operating Systems, Computer Architecture and Software. The main teaching methods in this training were group and project techniques. Students' educational projects were about practically important tasks, such as: recovery of destroyed data, increase of operating systems performance, error correction during loading, virus removal.

Students use G Suite and Microsoft Office 365 public clouds to discuss learning problems, create and edit shared documents (diagram, abstract, brochure, booklet, infographics). They acquire teamwork skills such as communication, teamwork and group leadership; formulation of tasks for yourself and colleagues, perform tasks in a timely manner [36].

Each of the group members was provided with a separate virtual machine. It had defects of one of the above types. Students were able to work on solving problems not only from any university computer, but also from their home PC. To train one group of students, an academic cloud provided 20-30 virtual machines (VMs).

Another cloud lab (CL-EVE-NET) was organized to study computer networks. We have integrated the Apache CloudStack and EVE-NG Community Edition platforms to deploy it. Nested Virtualization technology was used for this purpose. The EVE-NG platform makes it possible to emulate the operation of different nodes that are integrated in an internetwork. These nodes can be virtual machines running different operating systems. The integration of EVE-NG and Apache CloudStack platforms enables the use of full-featured network OS.

The integration of EVE-NG and Apache CloudStack platforms enables the use of full-featured network OS. They can be accessed via the EVE-NG platform web interface and through Telnet and VNC protocols. This lab uses both Apache CloudStack virtual networks and ENE-NG platforms. If the student configures the network connections correctly, access will also be available through the appropriate protocols.

We used the CL-EVE lab to study basic computer network topics, such as: switching and bridging, network monitoring tools, basic and NAT routing; dynamic routing protocols; load-balancing Internet channel, policy base routing, data filter with firewall, network protocols and services (DHCP, ARP, DNS); virtual private network protocols [35].

This cloud lab allows you to bring together individual student networks. As a result, we get an internetwork of group. This approach ensures student collaboration and teamwork. An error with one of them can causes problems throughout the network. For the training of one group of students, an academic cloud provided the functioning of 20 "parent" VMs. They ran up to 10 nested virtual network devices (bridges, switches, routers, hosts).

The CL-ADM cloud lab has been deployed for the network administration course. In this course, we use both Windows and Linux. So, to study each topic, we create at least 2 virtual machines as servers and at least 2 VMs as clients.

The main topics of the course are:

- network administration of Windows and Linux servers (local users and groups, filesystems security, network shares, remote administration);
- domain administration (Active Directory, Samba, NIS);
- server application administration (Apache, ProFTPd, IIS, Postfix, Dovecot SQUID).

To train one group of students, an academic cloud provided 30-40 virtual machines.

Training at the activity and generalization stages is carried out according to the special program “Cloud Technologies Fundamentals”. The course involves the study of: publicly available cloud platforms by recognized software development vendors (Google Inc., Microsoft), and open source software as the foundation for enterprise cloud.

The main topics of the special course are:

- public cloud platforms (G Suite and Microsoft Office 365);
- cloud platforms for private clouds (Apache CloudStack, Proxmox).

We used to study the G Suite and Microsoft Office 365 public platforms in the form of a Cloud Services to Every School project [26]. The objectives of the project were to design and deploy cloud services for secondary schools. The basics of the project concept were: absence of material costs for deployment and support of cloud services, voluntary nature of participation in the project. In collaboration with computer science teachers, students determined which services needed to be configured or migrated to the cloud. The problems of maintenance and support required a lot of time. Teachers had questions about administering, configuring, monitoring cloud services. We solved such problems by organizing face-to-face and distance seminars, workshops, also through the involvement of students in the support of deployed systems.

The results of the “Cloud Services to Every School” project is in line with the indicators of a cloud-based learning environment. They are: quality and accessibility of learning, adaptability, interactivity and mobility of ICT tools, unification of the school’s IT infrastructure, ensuring its security.

We propose to study private clouds on the example of open platforms. We suggest exploring private clouds as an example of open platforms. Their advantages are open source, freeware, English documentation, the ability to deploy advanced cloud infrastructures. However, such platforms are usually not supported by the developer. Therefore, teaching students with such platforms often requires them to look for solutions to various problems. This approach requires modern hardware. Private clouds require servers that perform different functions. For deployment by students of such clouds it is necessary to use the group method. It is a division of tasks. Students can perform tasks together or individually such as:

- configuring the database server;
- cloud platform setup;
- installing hypervisors;
- creating virtual computers;
- distribution of system resources.

In the future, students change roles. Since at our university the special course "Fundamentals of Cloud Technologies" is studied in the master's program, we consider it appropriate to use a research approach. It is that the teacher formulates detailed technical requirements for the cloud. Students research and customize platforms to meet these requirements. The results of such research can be summarized by the method of comparative analysis. For example, one platform may have better performance for the production platform and another platform will perform more effectively as part of the CBLE.

Important in the ICT competency of the future computer science teacher is the possession of software development tools. Cloud services should be at the forefront of creating students' own educational information resources. The third stage of our model is dedicated to this task.Training can be based on this platform leader in software and cloud.

Microsoft has developed a Windows Azure Web Sites product that enables students to create new and host existing web applications in a secure cloud storage. Windows Azure Web Sites implements a Platform as a Service (PaaS) model. Therefore, students will be able to fully focus on the programming and direct development of their cloud projects.

Google also offers a similar Google Cloud Platform (GLP) cloud service. It allows you to create, test and deploy your own applications in the cloud. Students can learn how to create state-of-the-art web applications and mobile applications on the open Google App Engine cloud platform. It is a managed platform that completely abstracts the cloud infrastructure, which helps to focus training on development tasks.

Deployment of cloud laboratories is also appropriate for a full study of these systems. Unfortunately, Google has not yet provided academic grants to use GLP for Ukrainian universities. However, students are free to use their own accounts for one year. A similar situation with Microsoft products. It is necessary to get a Microsoft Azure Education Grant for effective learning.

We propose to use a comprehensive approach and project methodology in the process of studying these tools. The main requirements of applying the project methodology at this stage are as follows:

- identifying the main problem that the created project should solve;
- requirement for student creativity in project development;
- no restrictions on the tools and their functionality;
- the value of the expected result, that is, a cloud-based application must be developed and deployed;
- organization of joint activities of students;
- identification of pre-formed competencies for project creation;
- the project's focus on modern cloud and web technologies.

The third (generalization) stage of our methodology consists of several logical parts. They combine a relatively small amount of theoretical material. It's a good idea for a teacher to start learning about the Google Cloud Platform (GCP). The practical part involves setting up the environment and creating a project, configuring a cloud database. The next task is to log in and log in. After that, students should focus on project architecture and development of core functionality.

We invite students to develop a contact manager. Its main functionality is to enable an authorized user to create, view, edit and delete records. It also has the option of sending e-mails to selected contacts. This basic functionality is present in almost every modern web application. Students can use GCP cloud products such as Google App Engine standard environment, Google Cloud SQL, Google Cloud Datastore, Google Cloud Storage and Google Cloud Pub to develop it.

Application development in the Google Cloud Platform facilitates group form organization. The teacher can add new project participants and assign them specific roles to determine the degree of access. In this project, the teacher demonstrates GLP capabilities based on such programming tools as PHP and Node.js. Important issues for cloud-based application development are understanding:

- basic functionality of PHP and Node.js;
- basics of a modular, file and batch system;
- file management;
- use of the postal service;
- work with the MySQL database.

The next step is to introduce students to the Google Cloud Platform environment, the basics of App Engine, and the application deployment process. It is a good idea for the teacher to organize the development of the project in a private university cloud and then deploy it into a public cloud. It is also possible to develop the project only in a cloud environment. Both approaches include steps to develop a web application that will allow users to submit requests to the server.

After completing these tasks, students develop their own ICT competencies such as:

- creating a GCP project based on App Engine;
- writing a web server on Node.js;
- deploy code on App Engine and view the web application in real time;
- adding updates to an already deployed service.

After creating this application, students move on to expand its functionality through other GLP services. Further practical work focuses on developing students' own cloud applications. These can be an online study log, e-library, video hosting service, photo gallery etc. Their students perform in small groups of 2-3 people. They can offer their own themes for development. Upon completion, students present projects and share their experiences and achievements.

4 Conclusion

The problem of the use of cloud computing in the process of training future computer science teachers is actual and needs further research. Training for the use of cloud technologies should be carried out throughout the student's study period. The model of application and studying of cloud technologies in the process of training of future teachers of informatics contains target, content, technological and resultant component. The content component realizes during 3 stages such as

1. Cloud technology is a means of education.
2. Cloud computing is the object of study.
3. Cloud computing is a development tool.

The study in the first and second stage should be done in the bachelor's degree. Stage 3 can be implemented as a master's program.

The current level of cloud computing development makes the project method demanded and effective. Participation in the proposed projects contributes to the development of students' skills of independent and responsible work with cloud technologies. They have opportunity to focus on results. Students can recognize themselves as successful network administrator, programmer and teacher.

Our model provides combination of face-to-face and online learning allows teachers to make use of advantages offered by the cloud base learning environment.

The perspectives of further research are in experimentally test the effectiveness of the designed model.

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The approaches to Web-based education of computer science bachelors in higher education institutions

Svitlana L. Proskura[1[0000-0002-9536-176X]] and Svitlana H. Lytvynova[2[0000-0002-5450-6635]]

[1] National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", 37 Peremohy Ave. Kyiv, 03056, Ukraine
slproskura@gmail.com
[2] Institute of Information Technologies and Learning Tools of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine
s.h.lytvynova@gmail.com

Abstract. The problem of organizing of Web-based education of bachelors, and the bachelors of computer science in particular, is relevant for higher education institutions. The IT industry puts forward new requirements for future IT professionals training. This, in its turn, requires the educational process modernization: content specification, updating of forms, methods and means of training to meet the demands of socio-economic development of the society in general and bachelors of computer science in particular. The article analyzes and clarifies the notion of Web-based education of bachelors; as well as a line of approaches, such as approaches to the organization of Web-based learning for A La Carte, Station Rotation, Lab Rotation, Individual Rotation, Flipped Learning scenario; the necessity of cloud computing and virtual classroom use as a component of Web-based learning is substantiated. It is established that with the advent of a large number of cloud-based services, augmented and virtual realities, new conditions are created for the development of skills to work with innovative systems. It is noted that the implementation of the approaches to the organization of student Web-based education is carried out on international level, in such projects as Erasmus+ "Curriculum for Blended Learning" and "Blended learning courses for teacher educators between Asia and Europe". The article features the results of programming students survey on the use of Web-based technologies while learning, namely the results of a new approach to learning organization according to the formula – traditional (30%), distance (50%) and project (20%) training.

Keywords: information and communication technologies, Web-based education, approaches to Web-based education organization, cloud computing, distance learning, inverted learning, online learning.

1 Introduction

Ukraine's entry into the Bologna process stimulates the formation of new principles and approaches to the development of higher education. This, in its turn, requires the improvement of forms, methods and tools aimed at creating a coherent system of continuing education. The requirements for the results of student's studies at universities orientate the teacher to the use of tools that are adequate to the level of development of modern technologies, processing and transmission of information, and, which is equally important, for the needs of students of the new millennium. It is becoming obvious that the tools basis of the educational process in higher education institutions should be made by means and services of ICT, augmented and virtual realities [14; 24], cloud-based and network technologies [20; 32]. The teacher should help students to initiate an internal desire to perceive the world around them with the Internet and high-tech tools which are able to create conditions for universal access to educational content as well as the latest ICT learning systems in order to make this desire a natural need.

In particular, the expected results of the adoption of the Law of Ukraine "On Education" [37] are the creation of a new generation education system that has to provide conditions for education to be received by all categories of the population of Ukraine, an effective system for ensuring comprehensive human development and promoting substantial growth of intellectual, cultural, spiritual and moral potential of the society and personality [39].

Therefore, today we are actively discussing the approaches to the Web-based education [9] of bachelors in Ukrainian universities, and, in particular, for future bachelors of computer science training, which requires substantiation of such provisions as motivational, technological, procedural support of the educational process as a holistic pedagogical system that takes into account individual interests, abilities and inclinations and the newest strategies of teaching the 21st century students.

2 Literature review and research methods

Different aspects of Web-based bachelor education in the system of higher education institutions are highlighted in the works of Olga V. Bondarenko [2], Valerii Yu. Bykov [3], Svitlana H. Lytvynova [8], Oksana M. Markova [31], Oleg M. Spirin [33], Andrii M. Striuk [34], Serhiy O. Semerikov [23], Tetiana A. Vakaliuk [11] et al. Organizational-active, general-didactic, methodological and psychological aspects are considered in their studies.

Valerii Yu. Bykov [3; 4] analyzed a model of organizational systems of open education, the use of which is possible while using Web-based technologies, examined distance learning as a component of Web-based learning. In their works, Oleg M. Spirin and Tetiana A. Vakaliuk [10; 33] consider the main possibilities of using different types of Web-based technologies and their analysis in programming training, while Svitlana H. Lytvynova states that cloud-based learning environment is a component of Web-based learning and emphasizes that synthetic web environment has to be Web-based in order to prepare bachelors of computer science as well as to enable students to engage in innovative learning tools [17; 19]. Serhiy O. Semerikov and Andrii M. Striuk proposes the organizational model of blended learning in universities, which involves the use of a learning management system and reflects the current state of development of theory and methodology of using ICT in education [35], Volodymyr M. Kukharenko et al. research Web-based learning as a combination of traditional and online learning elements [12; 13]. Yurii V. Tryus and Inna V. Herasymenko [40] treats Web-based learning as a purposeful process of knowledge acquisition, skills acquiring, with the aim of improving the quality of education. Scientists at the Clayton Christensen Institute consider Web-based learning as a combination of new, disruptive technology [1].

Methods. This article examines such research methods as theoretical sources analysis, studying the advanced experience of foreign and domestic experts in the problem of using ICT for teaching students of technical institutions of technical higher education institutions, as well as surveys, questionnaires, modeling.

3 Research results

Rapid development of information and communication as well as Web-based changes the principles and approaches to teaching programming to bachelors of computer science in higher education institutions. There accordingly appears a need to rethink and restructure the learning process itself, update the content of the educational program, forms, means and teaching methods. It is both learning technologies and the approaches to the Web-based education organization which are changing rapidly and significantly, the education of computer science bachelors in particular.

We understand Web-based learning as a system of forms, methods and Web-based tools for the formation of professional competences of bachelors of computer science. One of most advanced and effective technologies is blended learning, which will serve as the basis for the introduction of innovative technologies, and Web-based learning in higher education institutions in particular.

The system of Web-based education has become widespread in Europe and the United States. Its rapid implementation was facilitated by the development of information and communication technologies, technical (computer) equipping of students, their high level of computer literacy as well as their ubiquitous Internet access. An important contribution to addressing the problem of Web-based education was implemented by the Online Learning Consortium, which continues dealing with the challenges associated with the Web-based education organization, improving the quality of online learning throughout the world [38, p. 99].

A significant contribution to the dissemination of the latest infrared technologies in higher education has been made through a number of international projects, including the latest learning strategies the Erasmus+ “Curriculum for Blended Learning” project, which involves the following countries: Latvia, Austria, Great Britain is devoted to innovative educational strategies. This project aims at raising national and European understanding of Web-based education, implementing the goal of integrating ICT into the process of learning, combining innovative practices with systematic, scientifically-based strategies for ICT integration [38, p. 100]. Recent studies at the Center for the Digital Education show that 90% of the teachers interviewed use creative approaches in teaching subjects using Web-based education technologies [5, p. 4]. In Ukraine, Web-based education technology is only beginning its way.

Various definitions of it can be found in the works of scientists doing their research in the field of educational methodology. In their report on the potential effects and approaches to the Web-based education technology implementation the Sloan Consortium defined the means of hybrid or blended education as ones which integrate online with traditional face-to-face class activities in a planned, pedagogically valuable manner. Michael B. Horn and Heather Staker see Web-based education itself as an educational approach which uses online technology to not just supplement, but transform and improve the learning process [7].

Scientists at Clayton Christensen Institute describe Web-based education as a combination of the new, disruptive technology with the old technology, which represents a sustaining innovation relative to the old technology, and is actually focused on mechanical blending, i.e. combining old traditional methods of teaching with new ways arising due to the advanced technologies, which appear to be innovative in relation to old technology and, which is most important, do not offer the old technology in its full form [1].

Ukrainian experts are now at the start of the Web-based education technology implementation as well as its analyzing. Basing on experience and works of their foreign colleagues they are developing approaches to Web-based education, methodology and a system of practical recommendations which can be applied in the higher education institutions of Ukraine. Thus, Volodymyr M. Kukharenko states that disruptive approaches to bachelor's education organization give a new impetus to the development of education, they are more effective, accessible, individualized, and they will over time prevail over traditional approaches to education organizing. He also states that Web-based education as a disruptive technology can not appear on its own. Preconditions for its emergence have to be formed, as well as additional efforts, both from teachers and students' part are required during its implementation and development. [12, p. 54].

Yurii V. Tryus treats Web-based education as a purposeful process of acquiring knowledge, skills and abilities, as well as mastering the methods of cognitive activity by the subject of learning and developing his creative abilities on the basis of complex and systematic use of traditional, innovative pedagogical technologies and information and communication technologies training on the principles of mutual complementation in order to improve the quality of education [40, p. 304]. Web-based learning is an educational concept that combines traditional learning with distance education and online methods which allows students to control the time, place, trajectory, and pace of learning, Kostiantyn A. Lisetskyi notes [15, p. 2].

In particular, Valerii Yu. Bykov emphasizes that distance learning is a kind of training that is fundamentally based on the use of information and communication technologies where active participants of the learning process perform mainly individualized learning interaction both asynchronous and synchronous in time [4, p. 34].

Volodymyr M. Kukharenko et al., after analyzing works of various authors, specify that Web-based education is:

- combination of elements of traditional education and online learning;
- combination of elements of traditional education and online learning;
- combination of pedagogical theories and technologies;
- educational methodology of teaching and approach that combines traditional methods used in a classroom with computer learning activities;
- the result of integrating online courses with traditional training;
- combination of different technologies into a single integrated learning approach;
- learning program which contains a mix of auditorium and e-learning, a range of formats and media [13, p. 49-50].

Marina S. Nikitina represents approaches to Web-based education as a process that involves creating a comfortable educational information environment, a communications system that presents all the necessary training information. In this context, the information environment of a modern university is understood as a combination of traditional and innovative (electronic) forms of learning with the continuous build-up of information and communication technologies (ICTs) and digital resources, as well as constant improvement [25, p. 2].

Scientists at Clayton Christensen Institute (the USA), in their definition of blended learning as a part of Web-based learning emphasize that blended learning involves leveraging the Internet to afford each student a more personalized learning experience, including increased student control over the time, place, path, and/or pace of learning. They imply that Web-based learning has high potential. And it is not only the approaches to the organization, technology selection and ways of learning, the main idea is defined as the personalization of learning [6]. According to foreign experts personalized education involves the following major trends: deep student-centered learning experience, engaging more digital learners, building up higher-order thinking skills, realizing benefits for both teachers and students, blended and iterative approach, productive gamification etc. [1]. All students are different, they perceive information in different ways, at different rates. There is no “correct” way of mastering knowledge. It is the Web-based learning and blended learning as the basis of it that aim at helping students, who, in their turn, will be able to receive knowledge both on their own and with a teacher, as well as make a flexible individual training schedule etc.

Web-based education appears to be popular and is successfully used in various higher education institutions in Europe, the USA, Asia, Russia, Ukraine both by teachers and students. Ukrainian experts are now at the start of the Web-based education technology implementation as well as its analyzing. Basing on experience and works of their foreign colleagues they are developing approaches to Web-based education, methodology and a system of practical recommendations which can be applied in the higher education institutions of Ukraine.

Let’s consider the main approaches to the organization of Web-based education for students, in particular, the bachelors of computer science in higher education institutions.

The approach to Web-based education organization with A La Carte scenario implies doing and learning a teacher’s online course aimed at accompanying other kinds of learning. The A La Carte scenario gives the students an option to take an online course with an online teacher and develops a more flexible schedule as well. A La Carte scenario courses can become a perfect option when educational institutions have no learning capacity for students with special needs. It is considered to be one of the most popular Web-based education organization approach [7]. For example, the well-known Coursera platform at Stanford University in the United States which follows this scenario offers a large number of free courses in various disciplines, including programming

The Prometheus project is a public project for open online courses in Ukraine. The purpose of the project is to provide access to online courses for all people interested in the topic. On this platform, the courses are presented not only by the teachers of the leading Ukrainian higher education institutions, but also by professors from other countries. For example, since 2016, the course "CS50: Fundamentals of Programming", [26], built as a lecture by Harvard University, has been actively used in Ukrainian higher education institutions in the blended learning format. A student or any other person may have access to video collections recorded directly in the auditorium in live communication, to summaries, tasks, additional video materials and workshops from leading experts in the field of computer science. It is worth while saying that in 2015 Yale University refused from their own introductory course of programming for freshmen in favor of using CS50, and this practice continues as long as present days.

The approach to Web-based education with Station Rotation scenario is applied for rotating in one classroom or a group of classrooms, where at least one of the stations is connected with online learning. The organization of training in this approach provides that several lessons are held in regular classes (front-end teacher-student work), and after that – students go to a computer class where they individually work on computers or tablets to consolidate knowledge.

The Lab Rotation approach to Web-based education contains a lot of points which are similar to the Station Rotation approach. The difference is that the Station Rotation Model implies students moving within the classroom allocated for them. In the Lab Rotation students move to an educational laboratory where they conduct online tutorials [7]. The Individual Rotation scenario to Web-based education organization approach enables each student to study with an individualized program mode and individual schedule. Students rotate within their individual schedule developed by the teacher [7]. The approach to Web-based education organization following the Flipped Classroom scenario assumes that students, with the help of various gadgets, listen to and review video tutorials, study additional informational sources individually (in extra-curricular time), after that they discuss new concepts and different ideas in-auditorium, where the teacher helps to apply in practice the knowledge they gained. This is the type studying process organization which encourages students to learn from each other [16, p. 235]. Individual exercises, practical tasks and independent work are also performed by students online. In other words, this approach "exchanges" classroom work and homework at home students do passive learning (i.e. reading and video lecture watching) while in the lecture room they do active learning by discussing the material more deeply.

Thus, Svitlana H. Lytvynova proves the general advantages of the Web-based education within the Flipped Learning scenario, namely: conditions for active learning are created, a differential approach is implemented, various gadgets and latest technologies are used, the educational process is organized taking into account the needs of each individual student; conditions for team work are created; students develop leadership skills within the curriculum, the process of learning obtains personalized traits, active interaction between the teacher and the student is created, access to educational materials is enlarged; conditions for monitoring the knowledge level with the help of computer technologies are created; parents have the opportunity to participate in the child's educational process [16, p. 35].

While analyzing different aspects of the use of Web-based education of bachelors of computer science in higher education institutions of Ukraine, it is worth dwelling on the Web-based education organization for technical disciplines, which was proposed by the scientists working in the team guided by Volodymyr M. Kukharenko. This approach is considered as a methodical system, which is based both on face-to-face learning and on-line technologies (distance learning) and provides a coherent understanding of the content, internal structure, interconnection and interdependence of the elements of the process of teaching technical disciplines. [13, p.268]. Basing on the results of their own research as well as the research of foreign scientists, they offer a combination of 30% of traditional learning technologies and 70% of distance learning technologies. Classical didactic principles were used within the scope of this approach to Web-based education: consciousness, visibility, systematic, durability, accessibility, scholarly learning, as well as theory and practice close interconnection [13, p. 261]. The principles of MOOC (Massive Open Online Course) were considered as well as the principles of co-operation pedagogics and social education.

It is worth noting that while using the Web-based education, teachers use methodology which includes: forms (individual, group, collective), methods (heuristic conversation, brainstorming, discussion, situational analysis, the method of projects, training quest, etc.), tools (laboratory models, virtual simulators, electronic textbooks, etc.).

One of the approaches to the Web-based education system implementation in higher education institutions of Ukraine is the use of the Moodle [21]. The teacher uses the Moodle environment to place educational and methodological material on the discipline in various formats: text, graphics, animation, hypertext etc. Video tutorials are also placed within the Moodle in order to increase the students' motivation to study the educational material. The Moodle system gives the student access to his resources, which makes it possible to study the discipline. The student independently studies the educational material, performs the necessary training tasks, takes testing procedures in the form of exams, questionnaires, tests as well as gets involved in the forum, e-mail. This allows students to communicate with both groupmates and the teacher and ask questions without having to wait for the lecture. But, as noted by Galina A. Cherednichenko and Liudmyla Yu. Shapran, the teacher needs to clearly organize the educational process, stimulate self-control and develop different ways of productive work with students. An important factor is the formation of a stable motivation for educational and cognitive activity, which has to be maintained throughout the whole learning process [5, p. 11].

It is important to add that Web-based education methodology will work efficiently involving the following:

- interactive online learning environment;
- high-quality dynamic content (personalization of student's training, the use of adaptive technologies, coordination with national standards);
- analytical capabilities of learning management systems (LMS);
- automatization of the teacher's work;
- students' motivation [13, p. 270].

An important factor in approaches to Web-based computer science bachelor education is to ensure that programmer students have access to innovative resources which are implemented on Web-based technology basis which comes as a powerful tool for ubiquitous access to information and software systems [30, p. 104]

It is worth noting that one of the important points in Web-based training of Computer Sciences Bachelors is non-auditorium work, the proper organization of which requires the following conditions: student's motivation for independent work; availability and accessibility of educational and methodological support and reference materials; availability of computer classes; a system of regular quality control of independent studying; counseling teacher assistance [28, p. 5]

Studying approaches to the organization of Web-based training in the research of foreign and domestic scientists, as well as analyzing their long-term experience of teaching programming languages and checking the results of students in practice, the authors concluded that it is advisable to combine 30 % of innovative learning technologies and 20% of project learning technologies in Web-based learning. Project learning includes teacher – student collaborative work, teamwork and project (mini-projects development) activities of students. In the article, the authors demonstrated model of Web-based learning of Computer Science Bachelors (Fig. 1), which is presented as a set of the following components.

- independent work of the student with educational material at any place, at any time (in the classroom, at home, in another country, in transport, with the help of virtual class, by means of Moodle);
- use of Web-based environments: innovative tools (cloud computing, virtual class), skills of working with innovative systems (Web-based compilers (GitHub, AWS Cloud), programming environments, intelligence cards, automated systems of programming knowledge assessment);
- control of Computer Sciences Bachelor academic achievements. If a student is not satisfied with the level of academic achievement, he/she can complete additional tasks and increase his/her level.

Cloud services and cloud platforms, which appear as part of cloud-based learning environment, are used in the educational process to enhance professional competencies of computer science bachelors. As noted by Svitlana H. Lytvynova, the Cloud-Based Learning Environment is a specially created environment, covering all aspects of using cloud computing in organizing the training of students of all categories in different forms and models of learning [19, p. 9]. The development of students' IC-competencies is offered on the basis of creating a synthetic Web-based educational environment to enable students to use innovative learning tools, in particular in programming [27, p. 143].

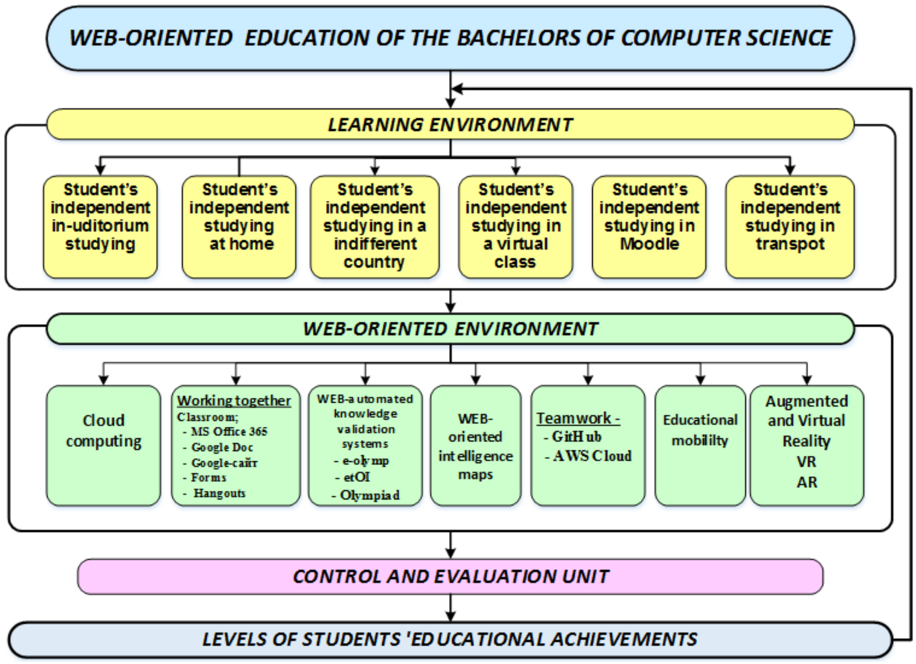

Fig. 1. The Model of Web-based learning of Computer Science Bachelors.

Such applications such as Office 365 and G Suite facilitate student-teacher collaborative work. Students' teamwork is realized through the use of Cloud-Web-based services: compilers, intelligence maps, automated knowledge testing systems for programming. Knowledge level control has to be accomplished with tests.

Important role in student activity organization is played by virtual classes (Skype, Myownconference, Etutorium, Zoom, Cisco etc.). This model is as close to real-time learning online as possible. We understand the virtual class as a special learning environment in which learning takes place in real time, integrating Internet and information-communication technologies and combining the common educational goals and objectives for the student and the teacher [18, p. 6]. A student who is absent for any reason can by virtual class means listen to the teacher's lecture in real time and participate in the discussion of the educational material.

The use of the complex approach to Web-based education of bachelors will enable students to use the learning mobility. It allows him to take an active part in the learning process while being outside the higher education institution. For example, a student is doing internship in another country, but has the opportunity to attend lectures by means of the virtual class, use the services of the Cloud-Web-based technologies for learning, use educational contents, accomplish home assignments as well as individual tasks, communicate with the teacher etc. Academic mobility is based on an international program which implies that a student of one higher education institution can study in a different higher education institution abroad after concluding a contract.

Society's request for the development of virtual and augmented reality objects require programmers to be able to use the advanced technologies, such as the Vuforia platform, BeyondAR framework, Beyond Reality Face Nxt project, 3D tracking technologies for image recognition, tracking and geolocation AR for mobile devices, tablets and smart glasses etc. [36]

Thus, within the scope of Web-based education organization approaches analysis a survey was conducted among the students of the Technical University "Igor Sikorsky Kyiv Polytechnic Institute" within the analysis of the Web-based education of future bachelors of computer science in higher education institutions. 105 respondents took part in the survey. It was conducted to determine the programming students' attitude to the organization of blended learning in their individual preparation to programming disciplines.

The survey results showed that 59 students (56.2%) know the basic principles of Web-based education, and 46 students (43.85%) do not obtain all the necessary information about it. It is worth noting that 79 students (84.8%) would like to practice more of Web-based education, the basis of which is blended learning. In other words, students study the educational material at home independently via electronic resources, and after that to consolidate and practice the knowledge gained, in the form of a discussion (or laboratory work), under the guidance of the teacher in the auditorium. A total of 26 students (15.2%) adhere to the traditional approach to learning. The authors' point is that the latter appear to have a lack of sufficient information on the forms, methods and means of Web-based education.

Nowadays such apps as MS Office 365, Google Doc, Google Sites, Hangouts, Google Classroom are not implemented at a sufficiently high level at the departments of the university. Therefore, out of 100 respondents, 43 students (43%) use Excel Online, 42 students (42%) – Word Online, 34 students (34%) – Google site, 32 students (32%) – PowerPoint Online, 28 students (28%) – Forms Online, 16 students (16%) – Google Classroom, 67 students (67%) Telegram, etc. (Fig. 2).

The IT industry activity sphere increases each year, new programming languages appear, new computer science methodologies and technologies are developed, and project management is improved. This, in its turn, increases the amount of educational information for a programming student to master. There is a large number of techniques for processing information today. The use of Web-based intelligence cards appears to be the most important. It is the application of intelligence card method itself that becomes a new tool that provides structuring, systematization, specification and effectively influences student's memorizing information for further use [31, p. 132]. This method not only visualizes and organizes large volumes of educational information, but becomes a motivator for further studying as well.

According to respondents' survey results, the use of Web-based and cloud-based intelligence cards in the university departments is low: 11.8% of students apply them in educational activities, and 88.8% do not pay sufficient attention to these services. A similar survey among programming students was conducted in 2018, its results showed that "in the educational process of programming languages teaching in higher education institutions such web-based technologies as compilers, automated programming verification systems, intelligent maps are not applied in the full capacity" [29, p. 84].

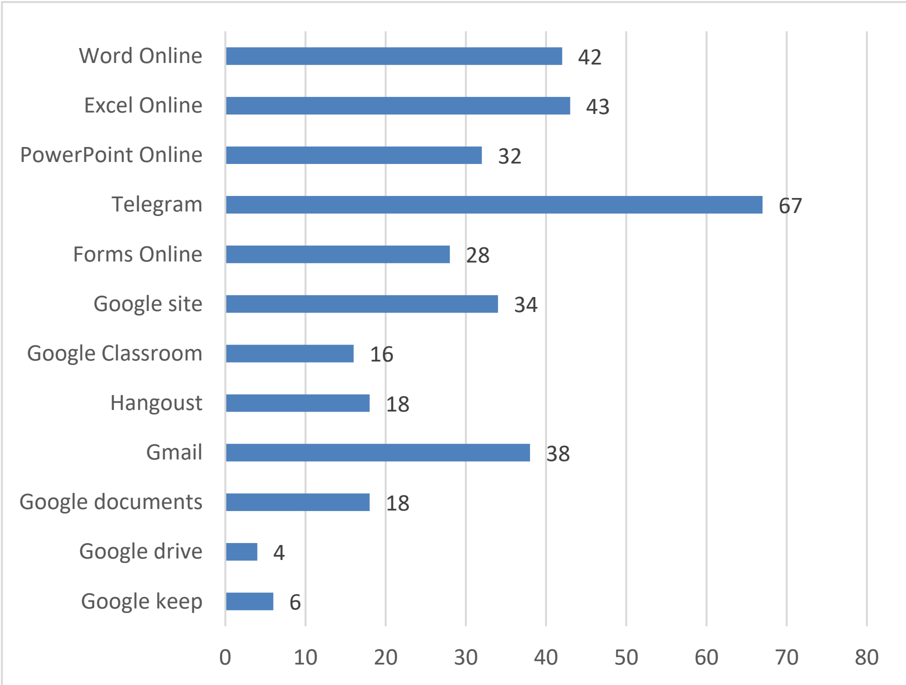

Fig. 2. Using of Applications in the course of Web-based Computer Science Bachelor's training.

After comparing the results of 2018 and 2019 surveys, the authors conclude that the use of Web-based intelligence cards within the independent study of teaching materials in the discipline of programming grew by only 1.8%, which actually means it didn't change. The polling rate of respondents in the 2019 survey makes 11.8% [29, p. 84] compared with 10% of the 2018 poll.

Respondents' survey results showed that future bachelors of computer science should pay more attention to the use of Web-based and cloud-based automated testing systems for programming tasks in preparation for practical lessons in the course of programming. The statistics on the use of these systems is presented in Fig. 3 and it demonstrates that out of 112 respondents, 78% do not use any of the systems presented in the programming tutorials, 33% – use E-olymp, etc.

One of the peculiarities in the learning process of future bachelors of computer science is the point of studying several programming languages. Therefore, it is important for comprehensive development in programming that students-programmers get acquainted with different types of compilers, such as Web-targeting and cloud compilers, starting from their first year of studying. This will enable them to program from any location, at any time and thereby accelerate the process of programming learning.

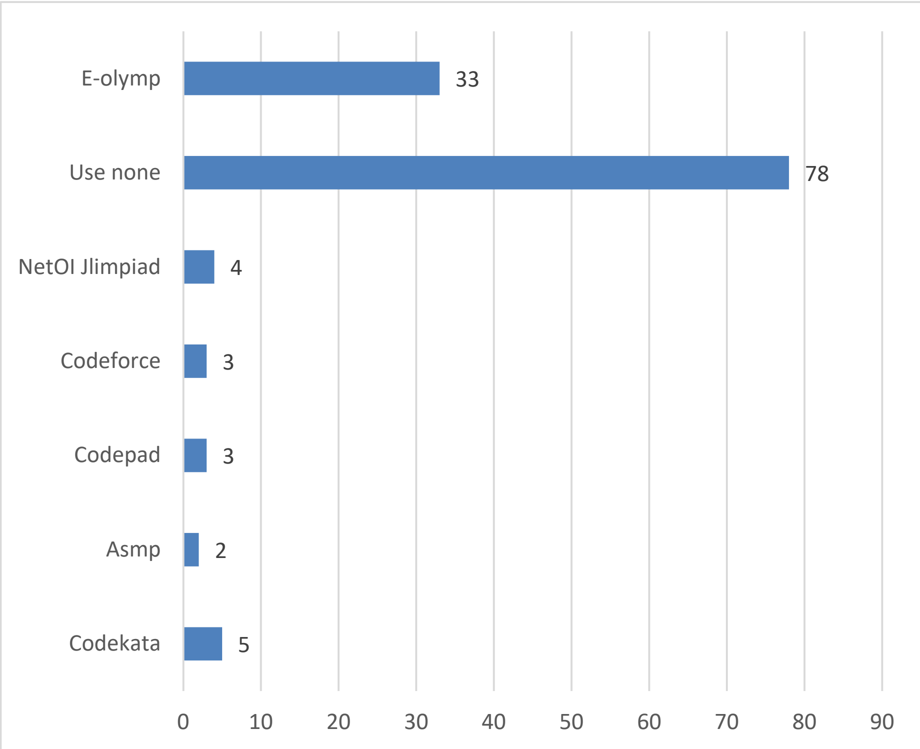

Fig. 3. Using of Web-based automated systems for testing programming tasks in the course of Web-based Computer Science Bachelor's training.

Figure 4 shows the rate on the use of Web-based compilers within the students' independent work on practical programming tasks, namely: Codepad.org (3%), Ideone.com (4.1%), Cppshell (9%), jsFiddle (2%), WandBox (20%), Tutorials Point (4%), do not use any Web-based compiler (89%).

Use of Web-based automated systems for testing programming tasks in the course of Web-based Computer Science Bachelor's training.

Analyzing the results of NTUU "Kiev Polytechnic Institute Igor Sikorsky" student-programmers survey the authors came to the conclusion that such innovative technologies as Web-based and cloud-based applications are highly required for students to master while learning. Therefore, it is advisable to include practical lessons, laboratory work, project development, innovative software in the educational curriculum.

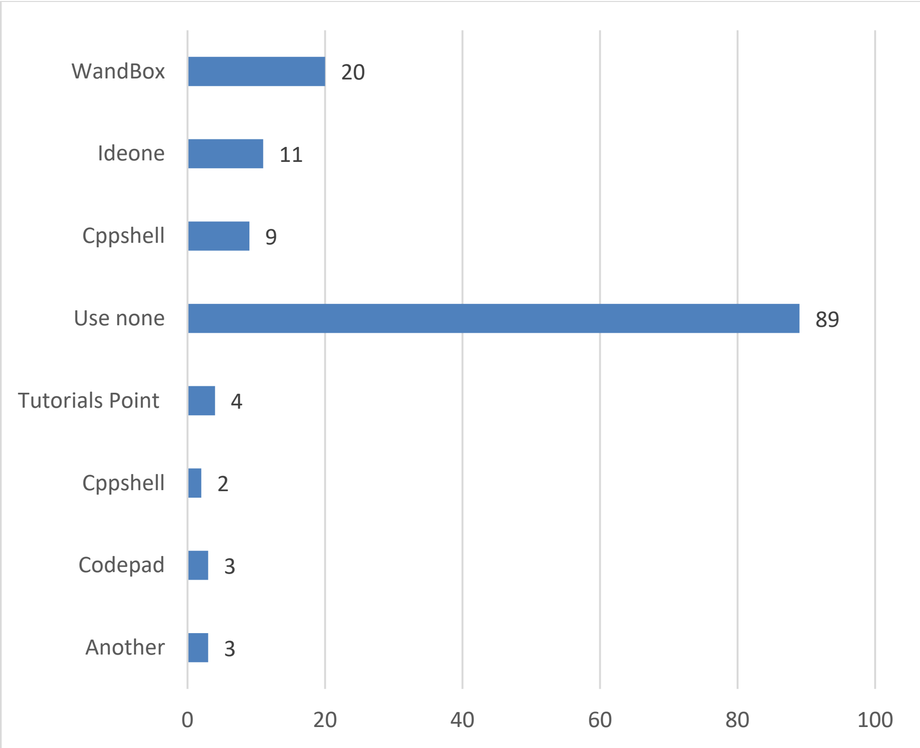

Fig. 4. Using Web-based Compilers in the course of Web-based Computer Science Bachelor's training.

4 Conclusions

After analyzing the experience of applying Web-based education approaches in different countries, we conclude that both in Ukrainian universities and abroad – various approaches to bachelor educating (and computer science bachelors in particular) in higher education institutions are used quite actively. The difference lies in national traditions as well as the approaches to the content of education itself.

It is noted that Web-based education organization implementation is applied internationally, in such well-known platforms as Coursera (USA), Prometheus (Ukraine), international projects like Erasmus +, "Curriculum for Blended Learning" and "Blended learning courses for teacher educators between Asia and Europe". However, it is not applied in the system of higher education institutions widely.

The article considers approaches to Web-based education organization, in particular, blended learning of future bachelors of computer science, such as flipped learning approaches, A La Carte, individual rotation, which are popular among higher education institutions in Europe, the USA, Asia and Russia. Meanwhile Moodle and flipped learning have been widely used in Ukraine.

While studying the Web-based learning organization approaches in the research of foreign and domestic scientists, as well as analyzing the results of the student-programmers survey, the authors emphasize that it is advisable to use the Web-based programming teaching system for educating future bachelors of computer science, which offers 20% of project training, 30% of traditional and 50% of distance learning.

Some of the disadvantages of blended learning include the fact that teachers need to devote a lot of time for preparing interesting and understandable teaching materials (video lectures, methodological guidelines for carrying out practical work, etc.). It is also very important for the strategy of Web-based learning to be supported by the administration of higher education institutions.

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Motivation readiness of future software engineer's professional self-improvement and prospects of its formation in college cloud environment

Larisa M. Petrenko[1[0000-0002-7604-7273]], Iryna P. Varava[2[0000-0001-5168-2775]] and Andrey V. Pikilnyak[3[0000-0003-0898-4756]]

[1] University of Educational Management of the NAES of Ukraine,
52A Sichovykh Striltsiv Str., Kyiv, 04053, Ukraine
laravipmail@gmail.com
[2] National Aviation University, 1 Komarov Ave., Kyiv, 03058, Ukraine
varavairina8@gmail.com
[3] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
pikilnyak@gmail.com

Abstract. Innovative technologies have an impact on the countries socio-economic development, the structure of labor market and educational services transformation. Rapid IT industry development constantly requires qualified programmers capable of professional self-improvement throughout life, the driving force of which is the individual motivation which activates the individual self-development process, optimizes thinking and develops special professional qualities, moral and ethical values. The main article purpose is to analyze the state of the form of motivational readiness for future programmer's professional self-improvement, to identify problems of its formation in colleges and to determine the ways of its increase as one of the main factors of quality improvement. To achieve it, a complex of theoretical and empirical methods was used, with help of which a number of problems were revealed which slow down the process of improving the quality of future programmers professional training. To eliminate them, a system of phased motivation for future specialists professional self-improvement has been developed on the basis of general secondary education, which can be integrated into the teaching of both general education and professionally-oriented disciplines; ways of improving the quality of the educational process through the creation of a cloud of oriented environment, the introduction of innovative teaching technologies, special training of teachers in the system of professional development.

Keywords: readiness, motivation, professional self-improvement, college, IT-specialists.

1 Introduction

1.1 Statement of the problem

Modern progress in the software field, human's life various spheres computerization requires the formed skills of self-improvement, which will be necessary for the future software engineer to maintain the status of IT-specialist, constantly follow the innovations in their professional world, master and apply them in practice, to improve their skills [16; 18; 45; 51]. Ultra-fast rates of computer and information technologies development put on time the need for such IT-specialists capable of creative search and continuous self-education, who independently and continuously replenish their knowledge, improve their own skills and professional skills [57, p. 5]. Formation of such abilities at the future technicians-programmers for today is extremely important problem for pedagogical collectives of colleges. Its solution will allow the requirements of the labor market and ensure the competitiveness of college graduates on it. After all, the development and implementation of technological innovations cause their integration into all sectors of the economy, which leads to the reorganization of industries, companies, the use of new opportunities at each workplace, therefore, changes in priorities in the professional training of specialists for the IT-industry [12; 20; 26; 42].

1.2 Analysis of recent research and publications

As the analysis of scientific works shows, in recent years, scientists and practitioners have increasingly raised the problem of forming a readiness for professional self-improvement of future specialists during training in vocational and higher education institutions. That's because "lifelong learning is becoming increasingly important for our societies and economies, as well as for the wellbeing of our citizens" [27, p. 5]. Formation of readiness for professional self-improvement of future software engineers is a process of conscious, permanent formation of personality, aimed at high professional achievements through constant progress to perfection, which is realized through motivation, planning, organization and personal control [58].

The results of studying problem of the formation of readiness for professional future software engineer's self-improvement indicate the existence of a number of complex issues caused primarily by the low level of motivation of students to acquire knowledge, skills and ability to self-development. The meaning of the concept of "selfdevelopment" is often considered by scientists in the circle of such categories as "professional self-development", "self-improvement", "professional self-improvement". In pedagogy, professional self-improvement is understood as "a conscious, purposeful process of raising the level of one's own professional competence and development of professionally significant qualities in accordance with social requirements, conditions of professional activity and own development program" [8, p. 41]. Mykhailo M. Fitsula notes that the reference point in the development of professionalism of a future specialist is his qualification characteristic, "on the basis of which a program of individual self-study for future professional activities is built.

Requirements for a modern specialist should correspond to modern needs" [8, p. 41]. Motivated students will demonstrate a higher level of readiness for professional self-improvement of future software engineers, will further promote their social mobility, continuous professional development, will allow them to gain access to higher education at any time of life [39, pp. 5–6] and to develop a strategy for career growth.

The issues of forming the development of professional self-improvement of various specialists are revealed in the scientific works: Oleksandr V. Didenko [6], Aleksandr A. Galochkin [9], Galina V. Grivusevich [11], Galina A. Klimenko [17], Arie W. Kruglanski [21], Liudmila V. Markelova [24], Irina A. Pogrebnaia [35] , Tetiana V. Shestakova [46], Larysa O. Sushchenko [52], Zoia V. Turianytsia [53].

Grigorii A. Volkovitckii studied the formation of motivation for professional self-improvement [62], and its dynamics was studied in the dissertation of Irina S. Vasilenko [59]. The results of the analysis of scientific works testify to the diversity of forms, methods, means, technologies and methods of both the formation and development of readiness for professional self-improvement of various specialists in modern educational institutions, as indicated by Kadyrbech D. Dzybov [7], Serik Praliyev [39], Botakoz I. Sarsenbaeva [44]. However, the majority of scientific research is aimed at studying the problems associated with the professional development of teachers [3; 15; 29; 30; 33; 49; 54; 60; 61; 63; 64]. As of today, we have not identified any studies in the open access, which reflect the results of the formation of readiness for professional self-improvement of future software engineers.

1.3 The purpose of the article

Taking this into account, the purpose of this article is to analyze the motivational readiness for professional self-improvement of future software engineers, to identify problems of its formation in colleges and to determine the ways of its improvement as one of the main factors in improving the quality of their training.

2 Research methodology

In order to achieve the goals of this study, we applied a set of theoretical and empirical methods. Theoretical analysis of pedagogical, psychological research (Alexander A. Galochkin [9], Galina V. Grivusevich [11], Galina A. Klimenko [17]) with the use of methods of analysis, comparison and synthesis and structural-semantic analysis of vocabulary allowed to define the essence of the concept of "readiness" and to highlight its main components. Based on the study of materials related to the psychological aspect [13; 14; 21; 22; 39; 65], clarifies the essence of the concept of motivational readiness" and its impact on the effectiveness of self-improvement of specialists. The study of experience and best practices is covered in the works of Kadyrbech D. Dzybov [7] Olexander V. Didenko [6].

Our analysis is based on empirical methods, including questionnaires to study: cognitive activity of students (Boris K. Pashnev [32]) and motivation of success and fear of failure (Arthur A. Rean [43]) questionnaire for self-assessment by future software engineers of readiness for professional self-improvement and revealing students' understanding of the meaning of professional self-improvement (developed by the authors). A total of 363 students were interviewed (a sample of 6,691 students from the general population who attended colleges and technical schools in this specialty). The received data are analyzed, a number of problems of formation of motivational readiness of students to professional self-improvement are revealed.

3 Results and discussion

At the beginning of the study we considered it necessary to define the essence of the scientific category "readiness". On the basis of the study of scientific works we have come to the conclusion that readiness is a system characteristic, dynamic education, active state of personality, a set of professional and pedagogical knowledge, skills, skills and personal qualities, purposeful expression of personality, integral expression of all substructures of personality. Personal education, integrative quality, result of professional and pedagogical training, essential precondition for effective activity.

Structural and semantic analysis of the definition of "readiness", carried out with the use of vocabulary and scientific literature, allowed to identify a number of structural components, namely: motivational readiness (cognitive and professional interests), intellectual readiness (general and special abilities, system of knowledge, skills and abilities), emotional and volitional readiness (attitude to learning, self-control) and social readiness (communicative abilities and responsibility, consciousness in a situation of choice) [58, p. 107]. The content of these components allows us to speak about their correlation with the description of the National Qualification Framework (Ukraine) [38] and their correspondence to the very character of "ascent of each person on" the stairs of "formation of his personality" (Sergei Ia. Batyshev) [1, p. 10].

In order to solve the problem of formation of readiness for professional self-improvement of future software engineers, the component of which is motivation readiness, it is important to define the content of each of the above mentioned components. To this end, we have turned to the theory of professional education. It was found out that at the first stage of formation of a specialist's personality, as a rule, elementary and functional literacy is achieved, i.e. basic knowledge, skills and abilities, worldview and behavioral qualities of a person, necessary for a wider and deeper education, are formed at an accessible, minimum necessary level [1, p. 10]. According to the Ukrainian legislation, elementary and functional literacy is formed at the level of basic secondary education [66] (second level of the National qualification). That is why ninth-grade secondary school graduates enter the college and are suitable for "performing typical simple tasks in typical situations in a well-defined structured sphere of education, performing tasks under the guidance of a supervisor with elements of independence" [38]. They are expected to have a basic empirical knowledge and understanding of basic learning processes; the ability to use relevant information to perform simple tasks and solve everyday problems in typical situations, using simple rules, instructions and tools; to evaluate their own performance against established criteria; to apply reasoning to support their own thoughts and conclusions; to communicate skills: to interact with the team to Their autonomy is characterized by the ability to learn under the control of the teacher with a certain autonomy. Thus, at the beginning of their studies, freshmen have elementary and functional literacy, formed knowledge, skills and abilities for self-development.

In the context of our research it should be noted that the professional training of future specialists in Ukrainian colleges “has a binary character: students receive both general education and vocational training at the same time as getting a diploma of junior specialist ...” [34, p. 13]. Therefore, according to the basic principles of professional pedagogy, colleges are developing individuals at the same time at the second and third levels of education.

At the second level, a future specialist acquires general secondary education: necessary and sufficient knowledge about the world around him/her and master the most general ways of activity (skills) aimed at cognition and transformation of certain objects of reality [1, p. 11]. This level corresponds to the level of specialized secondary education and the third level of the National Qualification at which it is necessary to develop the ability of a person to perform production or learning tasks of medium complexity according to certain algorithms and established norms of time and quality [38]. They should form: knowledge of facts, principles, processes and general concepts in the field of education and professional activity (in the first year of study, in addition to the curriculum, special disciplines are taught in the curriculum), the ability to perform typical tasks and solve problems through the selection and application of basic methods, tools, materials and information; assessment of the results of tasks in accordance with known criteria; the ability to work effectively in a team, perception of criticism, advice and instructions, expression of They should be aware of their responsibility to perform tasks during work and study, and of the need to adapt their behaviour to external circumstances when performing tasks or solving problems [38].

At the college, the ascent to the third stage of personal development corresponds to the degree of professional competence associated with the formation of such professionally significant qualities for the individual and society on the basis of general secondary education, which enable the individual to fully realize his or her potential in specific types of work, in accordance with the socially necessary division of labour and market mechanisms to stimulate the most productive and competitive functioning of the employee of a particular qualification

Therefore, in the course of training in college, future software engineers should be able to independently perform complex specialized production or training tasks in a particular area of professional activity and in the course of training, be responsible for the results of their activities and those of others in certain situations. It is supposed to obtain empirical and theoretical knowledge in the field of professional activity and / or training, the formation of skills to solve complex problems in specialized areas of professional activity and / or study, to find solutions to specific problems, involves the identification and interpretation of information, planning, analyzing, monitoring and evaluating their own work, the work of others in a specialized context. In terms of communication skills, software engineers should be able to communicate their understanding of knowledge, judgement and experience to a wide range of people (colleagues, managers and clients) after graduation from college, especially in the field of professional activity; they should be able to interact with colleagues and the professional community in order to carry out professional activities or study. They will have to be prepared to manage the work of others in a professional or learning context that is subject to change and to continue further training with elements of autonomy [38].

Based on the results of the study of the peculiarities of the formation of the future specialist, which are outlined above, we believe that they should be taken into account in the formation of motivational readiness for the professional self-improvement of future technicians-programmers, starting from the first course. The scheme of stage-by-stage formation of a specialist's personality in the college is highlighted, which gives an opportunity to "systemically and holistically present the process of personal development, and, consequently, the process of educational support of such development" [1, pp. 10–11].

According to the logic of further research and in order to determine the theoretical foundations of the subject under study, we carried out a structural and semantic analysis of the conceptual field of study, which forms a circle of commonly used and close to professional self-improvement constructs: "self-development" and "self-improvement" [8]. Semantic analysis of the concept of "profession" [56, p. 570] has shown that its essence is the basic qualification, specialty, skill and even talent of a person to a certain case. In our opinion, it correlates with the concept of "self-improvement" as "improvement of oneself (physical, moral, etc.), one's professional skills, etc." [2, p. 30]. So, we can outline the range of definitions of language units that characterize the subject of our study, and clarify their essence:

- *Self-development* is an internal process of self-knowledge, on the basis of which the individual determines the life goals of transforming his or her own life to a higher level of organization;
- *Self-improvement* is a conscious and purposeful process of increasing the level of one's own professional competence and development of professionally significant qualities in accordance with social requirements, conditions of professional activity and own development program;
- *Professional self-improvement of future software engineers* us the process of individual management of the development of knowledge, practical skills and abilities of a specialist, creative abilities, optimization of methods of own thinking and special professional qualities, the formation of those moral and ethical values that contribute to the achievement of high performance in the field of computer science, modern software, automation of production and other processes.

In modern scientific works readiness for any type of professional activity is defined as a set of stable motives that do not depend on current situations. Taking into account the stated topic of our research, let's focus our attention on the formation of motivational readiness for professional self-improvement of future software engineers. Liubov Iu. Pakhomova studied it within the framework of studying readiness for professional activity [31, p. 13]. She justified its essence and structure as "an integral unity of development of components of motivational readiness of students to the profession (orientation, personal and volitional, professional and cognitive)" [31, p. 20]. The scientist singled out a set of external and internal conditions that contribute to the development of students' readiness for professional activities in the educational space of higher education institutions and change the nature of educational activities. She referred to the external conditions as follows: educational technology, which is based on the real experience of students; psychological and pedagogical support of the development of psychological features of personality; group form of work, which makes "living together with others" socially significant situations; creation of an environment for personal manifestation of students. Among the internal conditions, the scientist singled out: the level of students' personal activity as an indicator of their involvement in the work; the willingness of the student to experiment with "their behavioral repertoire in order to obtain and understand new experience"; the ability to understand the changes that occur with them in professional training [31, p. 21]. The efficiency of implementation of internal conditions aimed at the development of students' motivation for professional activity in the conditions of educational space has been proved experimentally: statistically significant changes in the Student's t-criterion ($p < 0.001$) occurred among the students of the experimental group, and the data remained practically unchanged among the students of the control group [31, pp. 18–19].

It should be noted that in the process of professional training the role of internal motivation related to self-affirmation of a person as a professional is crucial. And it does not depend on the type of his professional activity, but always is an individual process, which depends on the personal psychological peculiarities of the subject, the method, the level and conditions of work organization, etc. [25]

The results of the Steffen Jahn and Mario Geissler study are important for our pedagogical experience. In the study of motivational readiness, they proceed from an understanding of its essence (inclinations or tendencies to meet the need for entrepreneurial activity) and the structure, which is characterized by concepts: "Behavioural intentions, propensity to act, implementation intentions, commitment". This approach gave them an opportunity to consider the concept under study as a "unified motivation", which strengthens entrepreneurial activity [14]. In their concept, they represent the "driving force of entrepreneurial activity" in the new theory of entrepreneurship. Scientists link "motivational readiness with entrepreneurial actions and the corresponding feedback effect". In their opinion, the model of motivational readiness model of entrepreneurship, developed by them, helps to better understand "why some entrepreneurs are more likely to start an entrepreneurial activity and constantly participate in it than others" [14]. Steffen Jahn and Mario Geissler conclude that in the case of "entrepreneurial entrepreneurship", motivation is primarily determined by entrepreneurial desire, while expectations soften the relationship. It is obvious that in the formation of motivational readiness as a component of the readiness for professional self-improvement of future software engineers during the training at the college it is necessary to develop in them the desire for entrepreneurial activity as a driving force for self-development and in the future for independent work in the modern labor market in the industry, which is rapidly developing and erases the boundaries between countries, integrates different knowledge, skills and competencies.

Evgeniia A. Zakharova notes that it is precisely because of "motivation that the interaction of a person with the environment and social conditions is carried out", and the motivation readiness of a person for professional activity "is considered as an actualization of the need for personal and professional self-development in work" [65, p. 16]. Therefore, the allocation of motivational readiness in the structure of readiness of future software engineers for professional self-improvement is quite reasonable. The study of the state of its formation among students during their studies in college will improve the quality of their professional training.

As noted above, motivation readiness is a structural component of the "readiness" design, which reflects the cognitive and professional interests of future specialists. In order to study cognitive activity, we conducted a survey of third and fourth year students using a questionnaire developed by B. Fig. 1 shows that 33.3% of students named the motive of achieving success as the main motive of their educational activity, while 28.8% of the surveyed are dominated by the motive of ensuring material wellbeing. It should be noted that one fifth of the respondents (about 20%) consider it important to receive information.

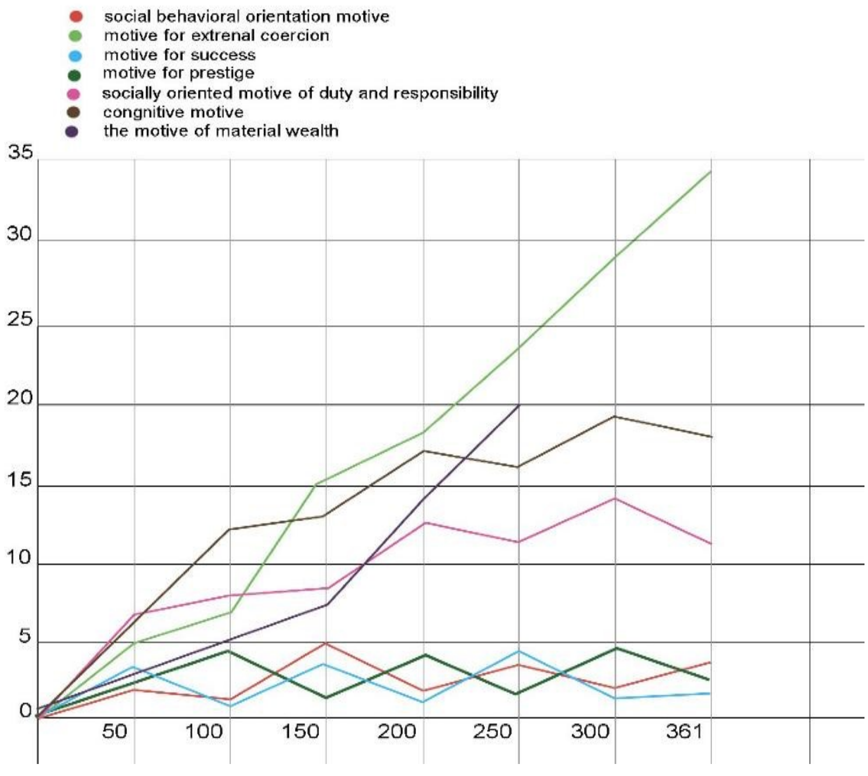

Fig. 1. Results of the study of cognitive activity of future software engineers (according to Boris K. Pashnev)

Similar data were obtained based on the results of the application of Arthur A. Rean's technique. 35.7% of students (Fig. 2) believe that studying at the college will ensure their success in their future professional activities and will allow them to become highly qualified specialists. However, only 12% of respondents aspire to acquire in-depth and solid knowledge, 8.3% have intellectual pleasure in learning, and 5.8% study to obtain a diploma. Summarizing it is possible to notice that modern students aspire to achievement of success in the future professional activity and material well-being, reflects moods of the Ukrainian society. At the same time, it turned out that in the understanding of most of them high success in professional activity and personal life, the level of qualification does not depend on the depth and strength of knowledge. This has led us to look for the reasons for this discrepancy.

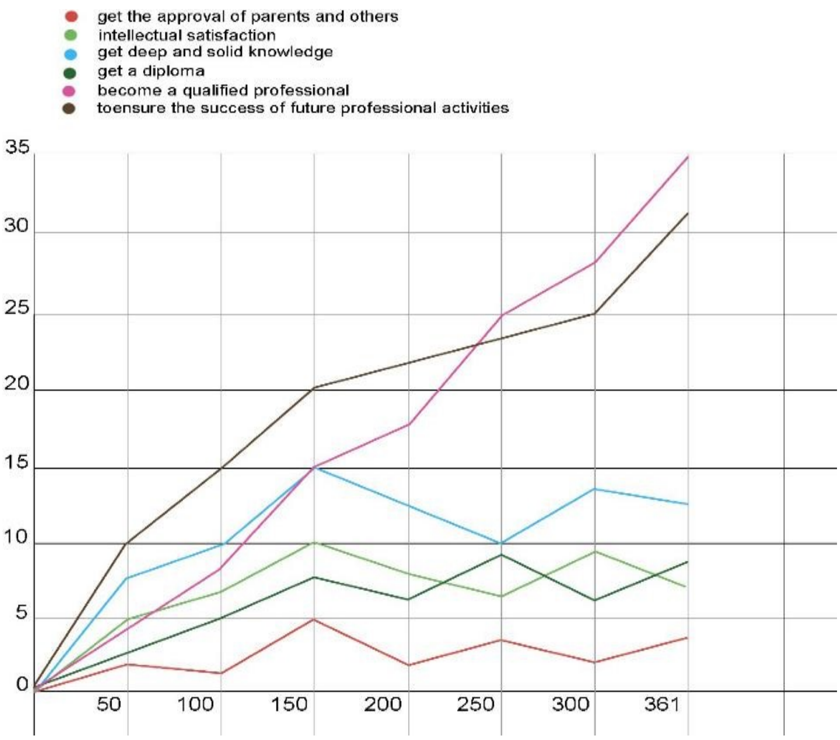

Fig. 2. Results of determination of the main motives of educational activity by future software engineers (according to Arthur A. Rean)

In order to find out and assess the state of students' understanding of the meaning of professional self-improvement and its importance for future professional growth, we used a specially developed questionnaire, which suggested ranking 25 indicators describing this design. The results of the survey are highlighted in Fig. 3.

The data presented in the diagram gives us an idea of the insufficient understanding of the meaning of the concept of "professional self-improvement" by future software engineers: almost 12% of students took the first place to maintain the required level of qualification, 9.42% – the search for the best ways to solve problems, 8.03% – the preservation of competitiveness in the labor market, 6.65% – interest in innovation, 5.82% – the development of an actual product. At the same time, the obtained empirical data and the results of the interview with certain groups of students from different colleges showed the lack of understanding of causal links between professional self-improvement and correspondence of one's own development to the level of society's development; career growth, desired level of salary and desire to study, constant search for new information; development of an actual product and independent study of the newest technologies, communication with more qualified people.

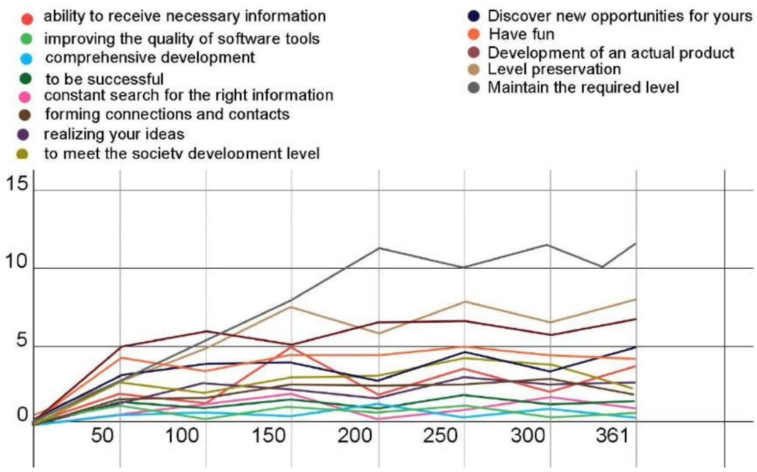

Fig. 3. Results of ranking the main indicators characterizing the meaning of professional self-improvement

In order to find out the students' intentions on farther development of professional self-improvement skills, we used a questionnaire developed by us. One of his questions: "What do you consider it necessary to educate yourself for your professional self-improvement?" The majority of students (28.25%) chose the following answers: ability to apply creative abilities that characterize readiness to create fundamentally new ideas different from traditional ones; systematic thinking; 19.11% – ability to persistently achieve the set goal; 13.57% – ability to use Internet resources to solve experimental and practical problems in the field of professional activity; 10.8% – ability to use professionally profiled knowledge and skills in the field of practical use of computer technologies. Only 1.7% of students pointed out the need to form the skills to apply: research skills, special knowledge in mathematics, physics, chemistry, etc. in solving professional problems, orientation in the schemes of algorithms, programs, data and systems. Despite these contradictions in the evaluation judgments about the readiness of future software engineers for professional self-improvement, the majority of them (65%) believe that they have an average level of readiness, 26% – high, and only 9% – low. These data are illustrated in the diagram in Fig. 4.

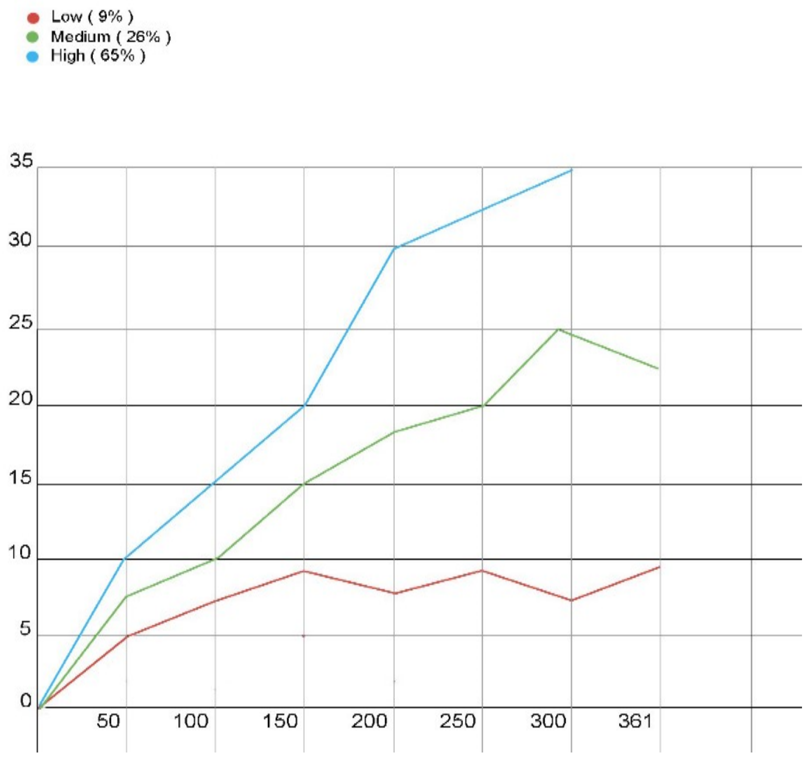

Fig. 4. Results of self-assessment by future software engineers of their readiness for professional self-improvement

Thus, having a high level of motivational readiness for professional self-improvement, college students - future software engineers do not all understand the main mechanisms of its formation. At this stage of research and development, it can be assumed that the high level of motivation is due to the cooperation of the majority of students in the third and fourth years of study with different employers. It is in IT companies that they get the necessary skills and experience of readiness to reach a certain state. In our opinion, this is why the majority of students (62.6%) assess their motivation to study as mediocre, another 27.42% – as high and only the rest – as low (9.97%). In the interviews with the participants of the experiment it was found out that the main internal factor in the acquisition of the profession of a software engineer is the expectation in them, which motivates to include them in the cognitive processes.

Arie W. Kruglanski notes that in terms of its intensity or motivation, it can be measured in the range from low to high degree of readiness. He studies motivational readiness in different contexts – entrepreneurial activity [22, p. 368], as well as the activities of extremist organizations [22, p. 380], but its essence is interpreted as an intention or aspiration to achieve the goal and emphasizes: a high level of motivational readiness is characterized by purposefulness and is expressed in the meaning of the goal

[21, p. 368]. In his opinion, it is much easier to find the goals of organizations than the goals of an individual. We're pretty much in agreement with that.

For our research it was important to identify that students aim to become successful in life and competitive in the labor market, as well as whether they have the necessary tools to achieve this goal. He was asked a number of questions to clarify the latest trend. Let's bring in a few of them. For example, to the question: "Do you want to improve yourself, read additional literature, spread your experience, are you interested in novelties in your future professional sphere?" More than half of the students (54.57%) answered that they want it from time to time. At the same time, when asked: "In training you have clear goals, you know what you want to get, what you want to know, what you want to learn, what you need to learn" 46.2% said that they know about it sometimes, and 3.88% never know about it. Thus, almost half of the surveyed students do not define goals in their learning activities and often do not know why they would like to study. It appeared that the main majority of respondents (51.25%) sometimes make a plan of action and foresee possible consequences; 56.79% sometimes resort to self-analysis of their cognitive activity. As for the emergence of problems on the way to achieving a certain goal, 47.92% of respondents said that they usually distract and slow them down, more than a third of students tend to solve their problems only from time to time, almost half (49.31%) are not always self-confident, and 16.62% – do not trust themselves at all, 24.65% have underestimated self-esteem.

Since self-improvement implies the development of professionally relevant qualities in accordance with social requirements, we have noticed that 46.81% of respondents hide their feelings and thoughts; almost 30% experience tension, anxiety and anxiety; more than a third do not always control themselves, their emotions and actions; 61.77% are reserved for critical remarks – in their opinion, only a few critical remarks should be made for constructive interaction; 41.83% experience difficulties in communicating from the ground up. They can't always listen to the rest of another person, understand and try to accept her opinion, which is different from their own more than 45% of future specialists.

Guided by the fact that the professional self-improvement of future software engineers is a process of individual management of the development of knowledge, practical skills and abilities of a specialist, students were asked to carry out self-assessment of the ability to manage other people, the organization of joint activities. The results of the survey turned out to be quite high: 36.84% consider this ability high, and 47.65% – average.

Formation of readiness for professional self-improvement of future specialists is carried out in the process of professional training in colleges and problems in definition of the purposes of cognitive activity, its planning, overcoming of difficulties in performance of tasks, development of critical thinking, communicative competence, etc. should be solved during study. Also, the student was offered several questions, the answers to which require evaluation judgments on the organization of the educational process. Thus, 48.75% of respondents believed that they do not contribute to the formation of readiness for professional self-improvement in the college. And in the opinion of 13.02% of respondents, conditions have been created to slow down this process. To the question: "How often do your teachers use active and interactive methods (games, trainings, case studies, discussions, etc.) of learning?" The level of preparation for professional activity at this stage of education at the college is rather unsatisfactory at 23.6%, and 27.7% of respondents noted that it is difficult to answer this question (Fig. 5).

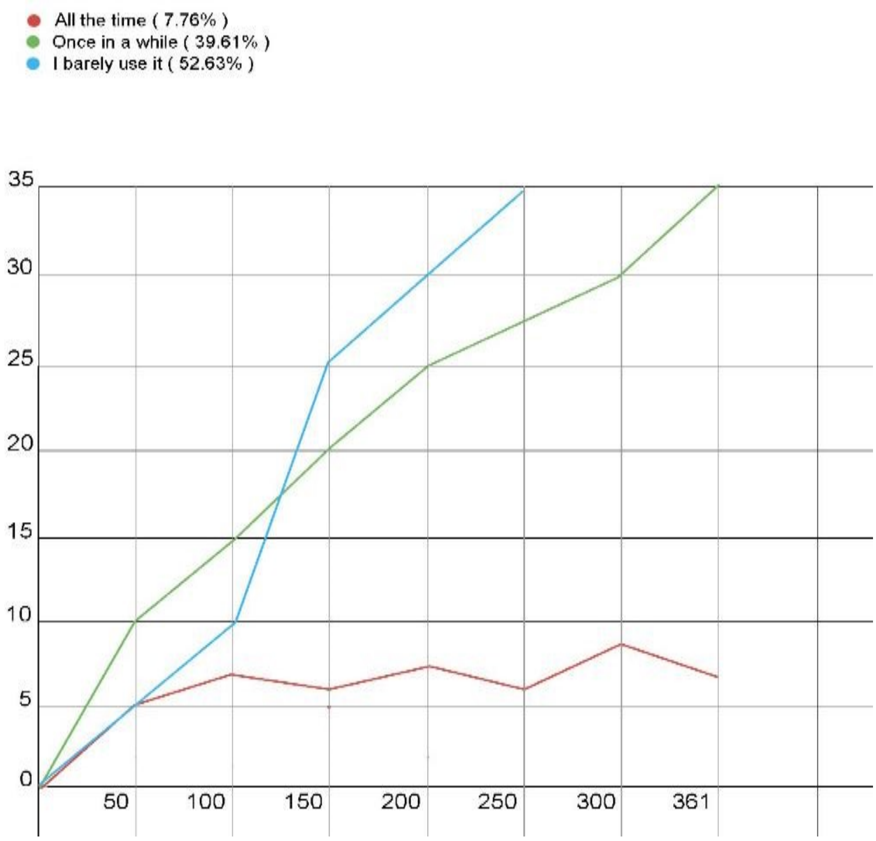

Fig. 5. Results of assessment of the frequency of use of active and interactive teaching methods by college teachers

Having analyzed the results of the survey of students, we believe that the formation of motivational readiness for professional self-improvement of future software engineers should be carried out taking into account the requirements of the information society. This is noted by Svitlana L. Proskura and Svitlana H. Lytvynova, who emphasize that now the level of competencies of software graduates does not meet the requirements of IT industry employers. Among the reasons they mention the insufficient level and quality: teaching of subjects related to programming, from the first to the last courses; provision of educational information; mathematical training; organization of laboratory tests; understanding of the application of knowledge gained for farther use in professional activities. In addition, scientists point to the need to apply: web-oriented technologies of teaching programming; forms, methods and means of education that meet the needs of modern students; automated systems for checking programming tasks; intellectual maps to systematize the knowledge obtained, and more [40].

In search of ways to improve the quality of training of future software engineers in colleges, the formation of their motivation at a higher level, we turned to the scientific works of famous Ukrainian scientists. Thus, Valerii Yu. Bykov, Andrii M. Hurzhii and Mariya P. Shyshkina consider the creation of a higher education institution as one of the tools to solve this problem. The concept they have promulgated notes "The use of cloud services is aimed at improving the learning process by improving access to electronic educational resources, which is characterized by the following innovative features as adaptability, mobility, full interactivity, free network access, unified supporting systemwide infrastructure, providing a universal approach to work" [5, p. 25].

The need to formulate the motivational readiness of future programmer technicians for professional self-improvement during their professional training in college has motivated the teaching staff to search for those training tools that would meet their personal interests, correlated with the profession and youth hobbies. Observing students' interactions with each other, their presence on social networks, and surveys have made it possible to identify these tools – Google services and various applications [4; 19]. Google services were the most affordable and convenient to use. In our opinion, the greatest effect in creating a cloud-based environment can be achieved by engaging students in this process. Therefore, they were asked to choose, together with the teachers, services that are convenient for use in the study of a particular discipline. It should be noted that this is a rather lengthy process, which is not without its various surprises. At the beginning of the use of Google services for teaching there were considerable difficulties in mastering them by the teachers, and there were some inconveniences in the interaction of the subjects of learning.

Creating a cloud-based environment in college is still in its infancy – its individual elements are being formed, and functions such as educational, developmental and communication are being mastered. The team created a project team that develops the concept of cloud-based environment development and its model. As this is a topic of a separate scientific study of applied nature, we consider it pedagogically appropriate to dwell on certain teaching aids, namely those which contribute to the formation of students' motivational readiness for professional self-improvement. Currently, college-based cloud-based learning tools are widely used in the college to organize student activities, such as: Google services (Google Docs, Google Dictionary, Google Drive, Gmail, Google Calendar, Keep, Google Forms, Google Classroom, Blogger, You Tube). Their application makes it possible to organize collaboration both during the class and remotely (Google Docs, Google Classroom, Google Dictionary, Google Drive). Popular among students are the services that make it possible to organize educational activities: Google Calendar, Google Keep, Google Classroom. LMS Moodle should be added to this list [28]. This is due to the fact that starting from the second year, students seek to work in different companies in the future specialty, which motivates to save time, mastering self-management skills, and these services help in this.

The use of Google services in the learning process makes it possible to create cloud-based environments [10; 23; 37; 47; 48; 50; 55]. For example, in the study of humanities in Google Docs the following joint projects are created: “Collective portrait of successful technician-programmer”, “Valuable orientations of citizen of modern Ukraine”. Teachers use the Mentimeter mobile application to co-create Word Cloud with technical English words. Google Forms is an effective tool for: telecommunication projects (registration of participants of various events – conferences, competitions, seminars, workshops, competitions, etc.); organization of teamwork, self-esteem, reflection; collection of statistics on the results of the survey, questionnaire; control testing.

Teachers and students blog on Google Blogger. In this service, future professionals often post the results of their project activities, creating electronic portfolios for self-presentation and promotion of their achievements [36; 41].

It should be noted that, while constantly working with various Google services, future technicians-programmers develop their information skills, learn to work with electronic libraries, various cognitive websites, and more. They actively communicate with employers who are interested in their activities – projects, developments and more. Establishing such relationships is the best motivator for professional self-improvement.

So, creating a cloud-based environment in college involves organizing it, managing it, and further scientific exploration in that direction.

4 Conclusions and prospects for further research

Having carried out theoretical analysis and surveys to identify the state of formation of motivation readiness for professional self-improvement of future programmers, we came to the conclusion:

1. Motivational readiness for professional self-improvement of future software engineers activates the process of individual management of the development of knowledge, practical skills and abilities of a specialist, creative abilities, optimization of methods of own thinking and special professional qualities, the formation of those moral and ethical values that contribute to the achievement of high rates of professional activity in IT.
2. The students of the colleges are highly motivated in getting this profession, and at the same time they have little understanding of what kind of knowledge, skills and abilities they need; organization of the educational process in colleges needs: creation of oriented environment clouds; introduction of innovative teaching technologies; special training of teachers in the system of professional development and in the inter-course period; development of the program.
3. The result of this research is: the definition of the content of the stage-by-stage formation of motivational readiness for professional self-improvement of future IT specialists on the basis of general secondary education, which can be integrated in the teaching of both general education and professionally-oriented disciplines; identification of a number of problems that need to be solved through the use of

project technologies, wide involvement of students, teachers of colleges on the basis of partnership.

This article is aimed at the realization of the idea (the prospect of further research) to improve the quality of professional training of IT-specialists who are able to constantly improve their professional competence, quickly adapt to the requirements of the information society.

Acknowledgement. This study was conducted as part of the dissertation work carried out to develop a model for the formation of the readiness of future programmers to professional self-improvement.

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Web-based online course training higher school mathematics teachers

Kateryna V. Vlasenko[1[0000-0002-8920-5680]], Sergei V. Volkov[2[0000-0001-7938-3080]], Daria A. Kovalenko[2[0000-0002-1362-9241]], Iryna V. Sitak[2[000-0003-2593-1293]], Olena O. Chumak[3[0000-0002-3722-6826]] and Alexander A. Kostikov[1[0000-0003-3503-4836]]

[1] Donbas State Engineering Academy, 7 Academic Str., Kramatorsk, 84313, Ukraine
[2] The Institute of Chemical Technologies (the town of Rubizhne) of the East Ukrainian Volodymyr Dahl National University, 31 Volodymyrska Str., Rubizhne, 93009, Ukraine
[3] Donbas National Academy of Civil Engineering and Architecture, 14 Heroes of Heavenly Hundred Str., Kramatorsk,84333, Ukraine
vlasenkokv@ukr.net, sergei.volkov@ukr.net, daria.kovalenko07@gmail.com, sitakirina@gmail.com, chumakelena17@gmail.com, alexkst63@gmail.com

Abstract. The article looks into the problem of theoretical aspects of using Web 2.0 technology in higher education. This paper describes answers of 87 respondents who have helped to identify the most required types of educational content for the integration to pages of the online course training higher school mathematics teachers. The authors carry out a theoretical analysis of researches and resources that consider the development of theoretical aspects of using web tools in higher education. The research presents the characteristics common to online courses, principles of providing a functioning and physical placement of online systems in webspace. The paper discusses the approaches of creating and using animated content in online systems. The authors describe the methods of publishing video content in web systems, in particular, the creation and use of video lectures, animation, presentations. This paper also discusses several of the existing options of integrating presentations on web pages and methods of integrating mathematical expressions in web content. It is reasonable to make a conclusion about the expediency of promoting online courses, the purpose of which is to get mathematics teachers acquainted with the technical capabilities of creating educational content developed on Web 2.0 technology.

Keywords: Web 2.0 technology, online-course, training higher school mathematics teachers.

1 Introduction

1.1 Problem statement and its topicality substantiation

With the emergence of web education which is defined by Horton as “any purposeful use of web technologies with the aim of person’s formation” [11], scientists have faced an important task which is to create a perspective new system of education. The usage of teaching aids in the educational process, based on using Web 2.0 tools, has enabled it [13; 14; 25]. Dina Rosen and Charles Nelson [27] have stated that these tools have a great potential for education providing a new quality of students' self-study. Yasemin Koçak Usluel, Sacide Güzin Mazman [15] and Kulthida Nugultham [22] agree with this idea. In their research they determine that using Web 2.0 in the educational process can increase the motivation level and stimulate creative students' skills, and in its turn, it encourages the formation of self-education culture. Akhilesh K. S. Yadav and Amala A. Patwardhan [39] have stated the actuality of Web 2.0 technology during education while analyzing an economically profitable solution to the integration of their tools. Among the conclusions, scientists have noted an insignificant usage of Web tools in higher schools. Pavel Livotov [18] has raised issues connected with pedagogical use of Web 2.0 technology. In the scientist's opinion, in spite of all the barriers of involving such services, web-oriented education is a rapidly growing educational area. With the help of these services, we can offer a bright educational environment created with the usage of different strategies and technologies of education. Gabriela Grosseck [9] has related online systems to such environment, indicating the actuality of developing theoretical aspects of using Web tools in higher education. Scientists have claimed that it has to influence the creation of programs of future research and development of scenarios concerning Pedagogy 2.0 for the higher education sector.

1.2 Analysis of the latest researches and publications

We have investigated the experience of scientists who have contributed to the implementation of Web technologies to higher education. Carrying out such analysis we have studied recommendations by Ricardo Torres Kompen, Palitha Edirisingha, Richard Mobbs [33] who point out the importance of describing Web 2.0 tools and services that may be chosen to collect and process the information. Under these conditions, according to scientists, students' formal and informal education is under control during the whole life. This idea corresponds with the conclusions made by Gintarė Tautkevičienė, Mindaugas Dubosas [31], who have agreed that continuing education and knowledge refreshment should become an integral part of a student's education. Scientists have emphasized the need to develop such Web 2.0 tools that will encourage students' desire for publishing and sharing the knowledge created by them. Describing the assistance that should be provided by the teacher using Web 2.0 tools in the education, Isidoros Perikos, Foteini Grivokostopoulou, Konstantinos Kovas and Ioannis Hatzilygeroudis [24] have offered the development of online courses for tutors' informal education that would ensure the enhancement of experience and skills of higher school teachers.

So, each of the aforesaid scientists has recommended starting the implementation of Web tools into education from their analysis. According to the experts, such an approach will help to understand what every tool can offer for students' education and how they can be integrated into educational classes and remote courses of higher schools.

Following the conclusions made by scientists, we can see the usage of such an approach to develop online courses with the purpose to prepare higher school mathematics teachers [35; 37; 38]. The majority of conducted surveys among teachers using the platform “Higher School Mathematics Teacher” [10] have confirmed our decision to start the description of using only the questions that interest respondents the most at the moment. So, this article aims to carry out a theoretical analysis of peculiarities of developing educational online systems and to review several technical capabilities to create educational content for the integration on the pages of online courses training higher school mathematics teachers.

2 Method

We have held a survey of higher school mathematics teachers on using Web technologies to provide online education. The analysis of respondents’ answers to the survey questions published at the forum of the platform “Higher School Mathematics Teacher” [10], has influenced the description of technical capabilities to create educational content for the integration on the pages of online courses training higher school mathematics teachers. Besides, we have carried out a theoretical analysis of researches and resources, which consider the development of theoretical aspects of using Web-tools in higher education. Since the development of online courses of the platform involves the usage of a significant proportion of mathematical content, we also analyzed methods for integrating mathematical formulas into web content and developed a model for creating mathematical content on the pages of online courses.

2.1 Online course as a kind of electronic education

Electronic education is a general term to describe the areas of online education, web-education, and education using technologies. Costinela-Luminiţa Ciobanu (Defta) and Nicoleta-Magdalena Ciobanu (Iacob) [5] relate online-education (web-education) to electronic education. According to scientists, computer-oriented education can be considered as a component of electronic education that does not require constant interaction with the teacher and other students.

Ciobanu [5] idea has been agreed with the results of the research by Tuncay Sevindik, Necmi Demirkeser, Zafer Cömert [29] and Paulo Alves, Luísa Miranda, Carlos Morais [2]. The scientists define online course as a kind of electronic education, in other words organized purposeful educational process built on pedagogical principles, which is realized on basis of technical tools of modern information-communication technologies and represents logically and structurally completed educational item, methodically provided by a unique complex of systematized electronic tools of education and control.

Investigating the characteristics common to online courses while considering technical support of online courses, we follow the positions developed by Ciobanu [5]:

- the educational process is carried out in the virtual class;

- educational material is available on the Internet and includes the text, links to other Internet resources, images, audio, and video material;
- the virtual audience is coordinated with the instructor who plans the activity of working group participants, discusses the aspects of the course using the discursive forum or chat, provides additional resources, etc.;
- education is a social process; the studying community is created through interaction and cooperation between the teacher and working group participants;
- tutors provide control over the participants' activity, work with subgroups, audio, and video interaction etc.

Besides, we have taken into consideration the recommendations FAO [6], DIGICOMP [32] and Leicester Learning Institute [17] concerning the development of materials for online courses. The developers of recommendations emphasize the importance of video materials, animation, photo materials, audio materials, animated graphics, tables, presentations, etc.

2.2 Principles of providing a functioning and physical placement of online systems in webspace

Educational online systems as network software require the detection and description of technical conditions of the use. Online systems, which are built using the client-server architecture, are widely used at the moment. Thus, it is necessary to define technical requirements to both the client and the server. Among the main factors of educational online systems activity, Mark S. Frank, Keith Dreyer [8] and Borka Jerman-Blažič [12] have distinguished its physical placement on the server. The quality of hardware-generated and software of the server and width of the communication link play a critical role in the quality of provided educational services.

Nowadays several main kinds of hosting are being widely used as a server.

1. *Virtual hosting (Shared)*. It represents a server, the resources of which are equally divided among the users. Using such kind of hosting is expedient for web systems of a small scale with the number of visitors usually no more than 100 per 24 hours.
2. *Virtual private server (VPS/VDS)*. It provides individual resources to every user. With its help, it is possible to set up the operating system and other software. Such hosting is used for projects of average visiting rate and processing degree.
3. *Dedicated physical service*. The user rents or organizes by him/herself the server by hardware under independent control. Its use is expedient to develop resource capacious projects with high requirements for information processing speed and the number of visitors.

It's necessary to take into account the fact that kinds of hosting 2-3 require the appropriate qualification from the teacher or a specialist 's involvement to set up and support system software of the server.

2.3 Approaches to create and use animated content in online systems

Using animation in educational web content plays an important cognitive role while studying any course, in particular, mathematics. The analysis of research results made by Michael D. Byrne, Richard Catrambone, John T. Stasko [4], Orhan Ercan, Kadir Bilen, Ayşe Bulut [7], Ramón Rubio García, Javier Suárez Quirós, Ramón Gallego Santos, Santiago Martín González, Samuel Morán Fernanz [28], Thorsten Rasch, Wolfgang Schnotz [26], Kateryna Vlasenko, Olena Chumak, Irina Sitak, Olga Chashechnikova, Iryna Lovianova [36] has proved the efficiency of adding animation to the educational information.

Using animation implies the stages of creation and placement. The stage of creating animated effects requires founded choice of realization technology considering the specifics of the objects to which the animation will be applied.

Nowadays there are several approaches to creating animation.

1. *Animated GIF images*. GIF image format differs from other raster graphic formats by its special feature of animation maintenance. It is used for the images that have up to 256 colours with a 24-bit RGB span. The animation is realized in the form of a static frame sequence where every frame is a separate raster image with a time-lapse created in between. The use of such format is expedient to create short-term animation with a small number of colours. It is explained by the fact that a great number of long-term animation frames considerably increase the physical size of the file. This format does not support the sound and interactivity.
2. *Flash animation*. Nowadays it is a popular and powerful technology of creating complete multimedia web use. It can use raster and vector images, build in the sound. Due to the built-in Action Script programming language, this technology supports the interactive constituent. With the emergence of mobile gadgets, technology use has faced the problem of cross platforming and security vulnerability, which led to the loss of use relevance. Starting from 2020 the company Adobe will stop supporting Flash technology.
3. *HTML5 animation*. With the emergence of HTML5 standard, web developers could create animation through direct programming with the use of JavaScript language without using additional application programming interfaces or plugins. The standard enables the creation of interactive animation with integrated audio content. Separate libraries for animation such as Three.js and A-Frame are created to facilitate the development process [20].

2.4 Video content publishing in web systems

The subject matter of online courses consists of various educational materials that are used to increase the level of motivation among listeners. Video lectures are one of the most popular kinds of such materials. There is considerable experience in using video lectures while giving mathematics courses.

Ana-Maria Suduc, Mihai Bîzoi, Gabriel Gorghiu, Laura-Monica Gorghiu [30] and Natalia A. Parkhomenko, Sergei A. Zolotukhin [23] believe that one of the greatest advantages of using video in the educational process is that video lectures provide a personality-oriented approach to the education. The listener can learn the material according to his/her pace of assimilating the educational material. We support the researchers' idea that video content has a major emotional impact on the listener in comparison to the text.

There are various methods of adding video content to the web page. We offer to review several of them.

1. Preliminary video publishing on services that provide video hosting services.

Video hosting is a web service that enables us to publish, store, review and promote a video on the Internet. Nowadays the most popular video hosting is YouTube. It allows downloading in formats such as avi, mov, 3gp, mpg, mpeg, mp4, mkv.

Besides YouTube, there are also alternative services, in particular, Vimeo, Dailymotion, etc. The listed services provide functional opportunities similar to Youtube but have their peculiarities. While integrating video content publishing on video hosting to the web page, there is a possibility to both download their video and add one of those stored at the service.

Among the advantages of such a method we can point out the following ones:

- downloaded video files don't take up space on hosting;
- video content downloading takes place quite fast;
- there are no strict restrictions concerning the size of downloaded files;
- video is available for review both on your site and video hosting.

One of the disadvantages is that the process of downloading a new video file takes up additional time.

2. Integration of video content published on social media pages.

This method of video integration is similar to the one described above except for the fact that servers of social media are used as video hosting. We offer to state the main characteristics by the example of social network Facebook.

The use of such a method enables to create a direct connection between the page on Facebook and the web-page where the video is integrated. The posted video reflects the name of the page, from which it was downloaded. It influences positively the process of promoting the page on Facebook. We can point out the opportunity of setting up video autorun among the advantages.

The disadvantage is the dependence between confidentiality settings of the publication on Facebook and video publishing on the web page. In other words, if the video was posted on the site page and then on Facebook, confidentiality settings were changed and video publication stopped being publicly available, then there will be a notification on the site that this video is not available anymore for reviewing.

2.5 Presentation publishing

While developing an online course we need to integrate PowerPoint presentations on web pages. PowerPoint presentation is a complex mixture of text, graphics, explanations, modern functions of software and interaction in real-time with the audience. According to Çiğdem Uz, Feza Orhan, Gülşah Bilgiç [34] such programs as Microsoft PowerPoint allow preparing organized, visually attractive presentations that can be easily remembered by listeners.

We have analyzed the research related to the influence of the presentation on the students' motivation level and academic progress while studying mathematics. Different results are recorded in this research. For instance, in their article about the influence of PowerPoint presentation on short term and long-term memory, Hossein Nouri and Abdus Shahid [21] have determined that students' attitude to PowerPoint was positive and PowerPoint presentations have an impact on short term memory. However, it is revealed that PowerPoint presentations don't influence students' long-term memory.

Tutors can use presentations on web pages as a supplement to text materials, video or audio content. Presentation slides can contain a succinct summary of the educational material.

We offer to review several of the existing options of integrating presentations on web pages.

1. *Direct presentation downloading to the web site and publishing a link to it on the page*. The use of such a method enables users to download the presentation file to their computer for a further acquaintance without any introductory review on the web page.
2. *Converting the presentation into PDF*. The disadvantage of this method is that animation, sound, and interactivity disappear after converting.
3. *Converting the presentation into a video*. The video keeps all the presentation features, except for interactivity.

While giving mathematical concepts there is a necessity to publish a significant number of presentations with their constant updates. More complicated integration methods exist for this purpose. Among such methods, we can point out presentation publishing with the use of Google Slides service. Among the advantages of using this method, we can mark the possibility to edit presentations without a necessity to add them again to the page. Such publishing does not require public access to the presentation on Google Slides to build it in on the web page. The disadvantage is that a considerable part of animated, sound effects, which were used in the presentation, disappear.

The alternative way of Google Slides service is the use of services for storing presentations, for instance, SlideBoom.com, Projeqt, SlideShare.net, etc.

2.6 Methods of integrating mathematical formulas in web content

While publishing mathematical content in web there is a problem of displaying mathematical formulas. Nowadays this problem does not have a general solution. Thus, the question of displaying mathematical formulas is actual for discussion. We offer to consider four methods of publishing formulas in web systems.

1. A mathematical formula as a static image.

This method has been the only solution to the problem so far. MS Word is widely used to create mathematical texts and it has an integrated formula editing program MS Equation or MathType. The problem is that while transferring content to the web page using copying the formulas are ruined. For the correct display, every formula should be exported in raster image and should have a link to it in the web document. The disadvantages of such display of formulas are the problems with scale-up, stylization, and alignment of formulas to the text.

2. A mathematical formula as a result of generating structural code.

With HTML5 standard, the tag <math> was added to the maintained tags, it generates mathematical expressions written in the code of the web page using layout language MathML based on syntax XML. However, nowadays this method has an issue of cross browsing that makes it impossible to use it broadly.

3. A mathematical formula as a front-end library object.

This method of displaying formulas is based on the usage of JavaScript libraries of mathematical expressions. In this case, the formula is written in the form of structured code, usually using the semantics of the TeX computer layout system. The recorded code is converted by the library into images and displayed on a web page. The conversion takes place in the user's browser. The libraries used include such as KaTeX, JsMath and more powerful MathJax [19].

4. A mathematical formula as a back-end library object.

This method of displaying formulas is similar to the previous one, but a server's library of mathematical expressions is used. The conversion takes place on a platform server, which can create additional server load. The library used is PhpMathPublisher.

Through content analysis, we have developed the model of methods for creating mathematical content on the pages of the online courses (see Fig. 1).

3 Results

In order to carry out the analysis defined by the aim of the research, we have held the survey among the higher school mathematics teachers concerning the detection of types of educational materials, which are necessary for the process of creating online courses of mathematical direction using Web 2.0 technology.

We have offered the respondents to go through a survey using the forum on the platform "Higher School Mathematics Teacher" [10]. 87 respondents from different higher schools took part in it. Teachers' answers helped to identify the most demanded types of educational content for its integration on pages of the online course. We asked them to range the types of educational content according to the scale: 1 – such type of educational content is necessary while creating a course; 2 – use of this type is not expedient. Table 1 provides the ranked survey results.

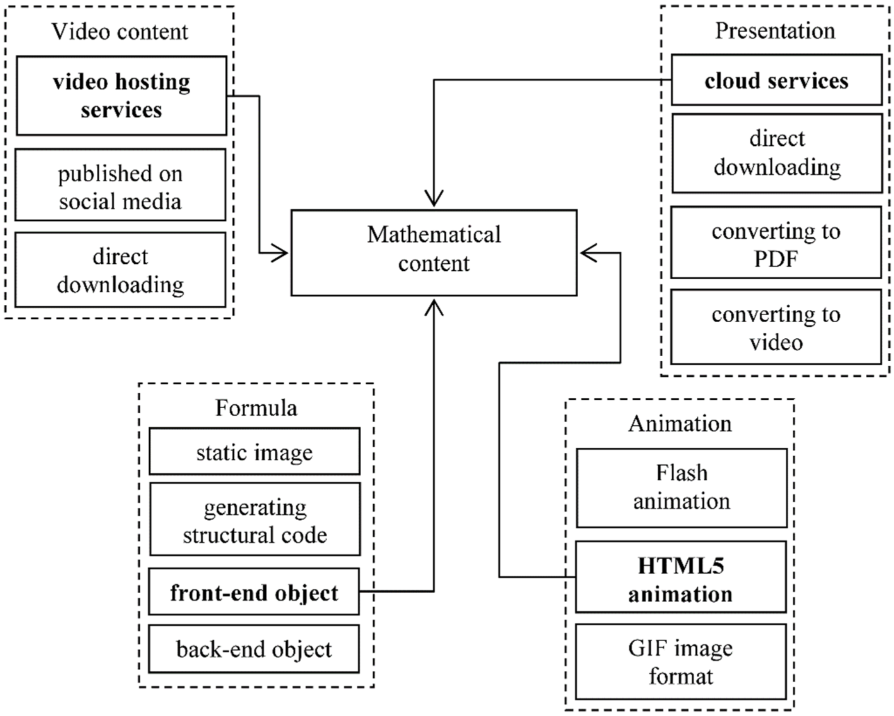

Fig. 1. The model of methods for creating mathematical content on the pages of the online course.

Table 1. The ranking results of types of educational content for its integration on the pages of the online course.

No	Type of educational content	Respondents' answers 1	2	Result
1	Video content	60	5	55
2	Animation	51	4	47
3	Presentations	42	8	34
4	Math formulas	38	6	32
5	Audio content	32	5	27
6	Formatted text	25	7	18
7	Tables	14	6	8
8	PDF content	14	8	6
9	Structures	13	14	-1
10	Diagrams	12	21	-9
11	Schemes	12	24	-12
12	MS Office content	9	22	-13
13	Photos	8	29	-21
14	Special symbols	7	61	-54
15	Columns	8	65	-57
16	Pseudocode	3	63	-60

According to the ranking results, we make a conclusion that the most required types of educational content are video lectures, animation and presentations (see Fig. 2). Also, a great number of teachers consider it necessary to include mathematical formulas to the subject matter of the online course.

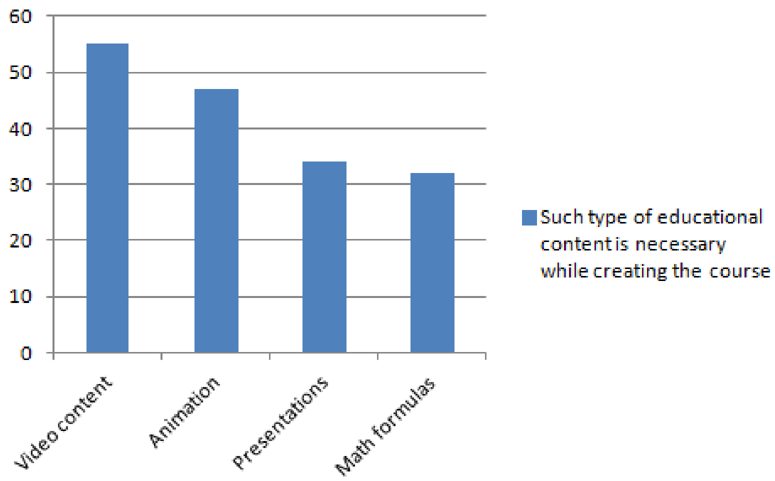

Fig. 2. The most demanded types of educational content.

4 Discussion and conclusions

Taking into account the conclusions of the researches by Gintarė Tautkevičienė, Mindaugas Dubosas [31], Patrícia B. Scherer Bassani and Débora Nice Ferrari Barbosa [3] about the limited involvement of Web 2.0 tools by teachers, following Ricardo Torres Kompen, Palitha Edirisingha, Xavier Canaleta, Maria Alsina Josep, Maria Monguet [16] we believe that it depends on the teachers' experience or their education. In most cases teachers are not just acquainted with Web 2.0 tools, thus they don't use them while creating online courses for students. We completely agree with Riyadh Alhassan [1] that teachers' acquaintance with the involvement of technical tools to create educational content for its integration to pages of online courses has to be carried out gradually. The research by Akhilesh K. S. Yadav and Amala A. Patwardhan [39] has proved our idea about the necessity to carry out a theoretical analysis of technical capabilities of Web 2.0 technology, the use of which can interest teachers. Thus, analyzing scientific literature and resources that describe the use of web technologies, we have taken into consideration the idea brought by mathematics teachers expressed at the forum of the platform "Higher School Mathematics Teacher" and have given an analysis of tools, which nowadays are actual for mathematics teachers.

Recommendations and Future Studies. Modern students are active Internet users, though its limited use has been marked during the education. It means that teachers have to show students how they can use web applications in their educational activity. We believe that it's possible to do it only through promoting online courses, the aim of which is the acquaintance of mathematics teachers with technical capabilities of creating educational content, developed on basis of Web 2.0 technology. Teachers' and students' training to involve web tools in their activity is one of the directions of our future research.

Acknowledgments. We are grateful to everyone who has become an active participant in the forum.

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Auto Checker of Higher Mathematics – an element of mobile cloud education

Tetyana I. Zhylenko[0000-0002-9717-3033], Nataliia S. Martynova[0000-0003-0057-471x], Irina A. Shuda[0000-0003-0184-8057], Yevhenii A. Chykalov[0000-0001-6531-8173] and Danyla A. Kuzmuk[0000-0001-6995-7212]

Sumy State University, 2 Rymskogo-Korsakova Str., Sumy, 40007, Ukraine
t.zhylenko@phe.sumdu.edu.ua

Abstract. We analyzed the main cloud services in the article. We also described the main contribution of mobile cloud technology to education. The article presents the author's development from the field of mobile cloud education in higher mathematics. The design architecture of this application is described in detail: QR generator and scanner, authorization, sending tasks. Block diagrams and images are presented that clearly demonstrate the operation of the application. We showed an example of solving the integral from the section of integral calculus for higher mathematics and showed how to download the answer in the form of a QR code and find out whether it is correct or incorrect (this can be seen by the color on the smart phone screen). It is shown how this technology helps the teacher save time for checking assignments completed by students. This confirms its effectiveness. Such an application provides students and teachers with the ability to store and process data on a cloud computing platform.

Keywords: Mobile Cloud Technology, Mathematics, Auto Checker.

1 Introduction

Modern educational environments are aimed at providing quick learning, provide information richness and constantly update the information component of education. Students are in dire need of a new educational environment, as they have the ability to interactivity and accessibility of information, but do not have sufficient skills to search sources for training. Information and communication technologies lead to the transformation of the educational environment. The use of cloud technology at the same time is actively growing and becoming an integral part of education [3; 5].

Cloud computing is the generation of computing for the future [8]. The main benefits of cloud computing are flexibility, collaboration, cost-effectiveness, scalability and personalization. These features make mobile cloud computing important among users and organizations, including universities [11]. They are used in universities in advanced countries of the world and in developing countries. Each educational institution has its own platform. The main characteristics, pros and cons of some of them are described in the article [17].

Universities face many problems: the need to change the infrastructure, improve and modernize education in order to be accessible to people of different categories.

Now, some students are quickly accepting e-learning and m-learning, while some are not accepting [2]. So, in article [17], the main attention is paid to the factors that contribute to the adoption of m-learning among university students [19]. This enables teachers to choose the right methods and switch to the new generation of educational tools using universal tools for the gamification of learning [14]: quests, quizzes, intellectual games [7], virtual boards, tests, questionnaires, didactic games and classes. University teachers are working to make the learning process less costly, accessible in remote corners of the world and interesting [8]. Everyone tries to interest in their methods and enrich students with knowledge as much as possible.

During one of the lessons in higher mathematics, the idea was proposed to create an application for working with tasks with a QR code and auto-checking the solution of problems hidden behind these QR codes, which would become an alternative to traditional methods of teaching and checking solutions and would be more perfect than existing ones applications [13]. Technologies used during application development were Unity engine [6] and PHP [9].

Their work is based on the use of cloud technology. Cloud technology has completely absorbed the computing environment of our planet [18]. The scope is growing every day.

The following services can be implemented using cloud technology [10]:

Storage-as-a-Service – makes it possible to save data in external storage, in the cloud [4].

Database-as-a-Service – gives the opportunity to work with databases [4].

Information-as-a-Service – makes it possible to remotely use any kind of information that can change every minute or even every second.

Process-as-a-Service – represents a remote resource that can link together several resources to create a single business process.

Application-as-a-Service/ Software-as-a-Service – the software is located on remote servers and each user can access it via the Internet.

Platform-as-a-Service – the user is provided with a computer platform with an installed operating system and some software [16].

Integration-as-a-Service – this is an opportunity to get a complete integration package from the cloud, including software interfaces between applications and the management of their algorithms. This includes well-known services and features of centralization, optimization and integration of enterprise applications (EAI) packages, but provided as a cloud service [16].

Security-as-a-Service – quickly deploying products to ensure the safe use of web technologies, electronic correspondence, and local network. This allows users of this service to save on the deployment and maintenance of their own security system.

Management/Governance-as-a-Service – allows you to manage and set the parameters of one or many cloud services. These are mainly parameters such as topology, resource use, virtualization [4].

Infrastructure-as-a-Service – provides a computer infrastructure, usually virtual platforms (computers) connected to a network, which it independently configures for its own purposes [16].

Testing-as-a-Service – it enables the testing of local or cloud systems using test software from the cloud.

Now let's look at what cloud technologies are in the form of ownership. Here, there are three categories:

- public;
- private;
- hybrid.

The analysis made it possible to highlight the following advantages of using cloud technologies in the educational process [4]:

- organization of joint work for a large team of teachers and students;
- an ability, both for students and teachers to share and edit documents of various types;
- quick engagement of created products into the educational process thanks to the absence of territorial binding of the user and the facility;
- organization of interactive classes and collective teaching;
- students are performing independent work, including collective projects, with no restrictions of time and audience type or size;
- interaction and collaboration with peers, regardless of their location;
- creation of web-oriented laboratories in specific subject areas;
- organization of various forms of control;
- moving to a cloud of used Learning Management Systems (LMS);
- new opportunities for researchers to develop, provide access, spread and apply the models.

We have developed a new model of computer program as an additional element of the teacher's pedagogical toolbox. Auto Checker can be used as didactic material in classroom classes, and in online learning. Teachers are already familiar and take advantage of the classtools.net teacher app. Our application is different in that it is intended only for working with QR codes, it has a profile for each student and saves all points, and we will also ensure that it always works in free access.

2 Methodology

Auto Checker can be used to test students' readiness to learn new material or to consolidate learned material. This is a new way to use QR code in lessons while in one place. We are widely aware of the use of QR codes during quests [7], when students move along a specified route in search of clues. In subjects such as mathematics, it is very difficult to travel long distances and write answers to assignments. Such a method cannot often be applied to physical and mathematical subjects. Our methodology is aimed at the concentrated work of students in a playful way. The main idea is that students receive a task from the teacher as a QR code, scan it, decide, enter the answer, and immediately learn the answer is correct or incorrect. In addition, the teacher also sees students' answers and can characterize their success.

You can create QR codes using various free sites, but storing them in the cloud costs money. We offer a free option for storing information encrypted in QR code and methodological material, which can be updated, supplemented, improved without taking up space on the computer. Our development is a symbiosis of a test with a QR code that can be used both in classroom classes and during online training.

The main job of the teacher is to fill the bank with tasks and answers to them. To do this, follow these steps:

- Write a task and save it in the form of a picture or document with a different extension. Create a link to the task. (To do this, you can use the capabilities of the site [15] insert a photo and save.)
- A short link to this document is generated, paste it into the QR code generator, for example [12], and generate the QR code.
- Then create a link to this photo using the same site [15].
- After that, you can proceed to work on filling the task bank in the application database.
- Open it at [1], register the task in the database: insert the generated link to the QR code into the task line, write the answer in the answer line using numbers and letters (Fig. 1).
- Save the result.
- Then you can create a new task on the same principle.

The task in the database will be stored in a structure that contains 2 arguments. The key will be the first argument, and the value will be the second.

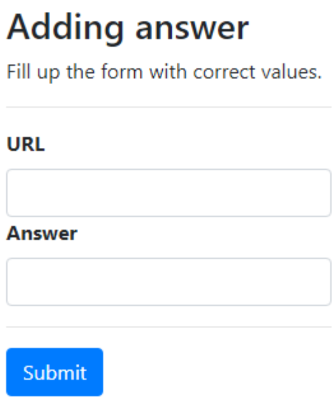

Fig. 1. Adding answer

When scanning the code, an instance is created that will first hold the URL of the task. After entering an (correct or incorrect) answer, a value will be added to this instance that corresponds to the answer in the database. When the user confirms the response to the task, an SQL request to the database is created. As a result of a (successful or unsuccessful) request, you will get the result as a JSON file.

If the parsing result contains the string "True" then the task will automatically become completed. Otherwise, the user makes a photo report.

A student must use the following steps to use the full functionality of this application:

- Log in or register.
- Press the button "Scan".
- Scan the QR code.
- Write the answer and press the button "Send".
- If the answer is wrong – student makes a photo report.

3 The main steps of the program

Let us consider in detail the principle of the program that we developed for automatic verification of tasks in higher mathematics [9].

At the beginning, the program tests access to the Internet using a request link to the site where the database with user profiles is located. If there is no response from the web source, a corresponding message is issued to the user. The Retry Connection button retests the Internet, and the Exit button closes the application. This testing also occurs with every request to the database (registration, authorization, etc.).

If everything is good with Internet access, the main menu of the application opens. Here we can either log in to our profile or create a new one. Clicking on the Registration button will bring you to the appropriate form of profile creation.

Here we need to enter the user name, login name, password and with repeat it to prevent incorrect entry (password is closed with "*" for security), e-mail to confirm registration or password recovery; select the group and your option. The client-level application checks some fields before sending a request to the server:

- Fill in all fields;
- Incorrectly chosen variant (does not belong to a set of positive integers from 1 to 33);
- Password and password verification do not match.

You can confirm the registration by clicking the Registration button. Then there is a request for a PHP script that checks the repeatability of login and email, as well as adding a new profile in the database with the relevant data. If the registration was successful you will be automatically returned to the main menu. You can cancel the registration by using the left arrow button or by pressing the Back button on the phone, as a result you will be returned to the authorization window.

In order to log in to your profile and start completing tasks, you must enter your login and password, which we specified at registration and press the Authorization button. The client checks the fields and then sends a query to the database where the entered data is checked. If the login or password does not match, a corresponding message is displayed. If the login was successfully completed at least once, the application saves the login of the last login for more convenient use of the program.

If the login and password matches were found in the database and other errors did not occur then the menu for executing the tasks will automatically open.

The Task Scan button allows you to read assignments from the QR code provided by the teacher in the classroom. The Reply button allows you to view the last of the scanned task and send your answer to the teacher (if no task is read then the button is not active). The QR code button allows you to generate a QR code with a response and show it to the teacher. Consider each item separately.

Application Functionality:

"QR code". Opens a form to generate your own QR code. The task scans. Opens a form for reading QR code and sending to database. Sending result after scanning (if an error occurred).

In the QR code text box (Fig. 2) you need to enter the data that you want to encode in the QR code, and then you will get a mediocre result on the screen.

Fig. 2. The QR code text box

In our program we used byte coding for creating QR codes. The essence of this method is that any characters can be encoded using this encoding method. The input character stream is encoded in any encoding that is convenient for us (recommended in UTF-8), then converted to binary, and then combined into one-bit stream.

If you choose "Task scan" you can scan your task QR code using the camera of your phone (Fig. 3). QR codes prepared in advance by the teacher and attached to each specific student. After recognition and validation of the necessary QR code, the task condition will automatically open for you. Now you can start solving the task, after solving which click the "check" button, or postpone the decision by returning to the menu. In the second case, in order to send the work, you must click on the send response button on the main menu. In the end, the response form will open.

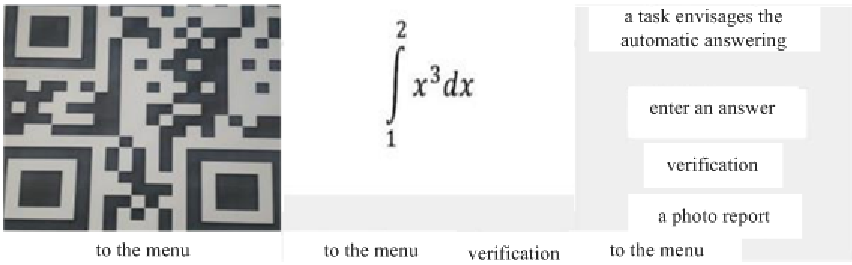

Fig. 3. The QR code detection algorithm

The QR code detection algorithm presented in this paper consists of several stages:

- Search for contours in the image;
- Approximation of the contours;
- Search for suitable quadrangles;
- Checking the ratio of FP blocks.

In the text box (Fig. 4) you need to enter your answer and press "check" button. If the answer matches the answer in the database, then you will receive the answer "success" (green letters) and the teacher will be notified of your result.

Fig. 4. The text box "true"

Otherwise, you will be notified of the negative result (in red letters) (Fig. 4) and will be able to send a response manually. To do this, write a solution on paper and take (Fig. 5) of it, then click the "photo report" button. An operating system file manager will open where you must select a previously created photo. Check the correctness of the selected photo and click "Check".

Fig. 5. The text box "false"

The main advantage of the Unity platform that we used to create this software product is its cross competency. This allows you to easily develop applications for Android, debugging it on a computer running Windows, and also without making any recent changes, port our product to other systems such as iOS. An obvious advantage is an easily accessible to ready-made as a set that allows us to optimize our work and speed up the development process. This platform allows auto directly access the hard ware capabilities of our device (such as a camera), which was necessary for our soft- ware product. Unity also has the ability to use the HTTP protocol to communicate with the database.

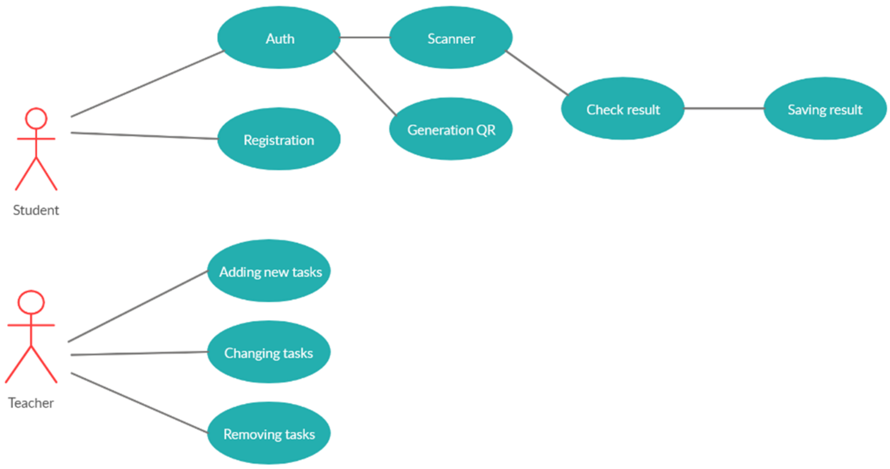

Fig. 6. The main steps of the teacher and student

4 Architecture of the application

Now we will show in block form how the program was created.

Based on the generation, reading and work with the database, we have created software to automate the verification of students' homework (Fig. 6). This flowchart describes the processes of recognition, decoding of QR code and displaying tasks (Fig. 7).

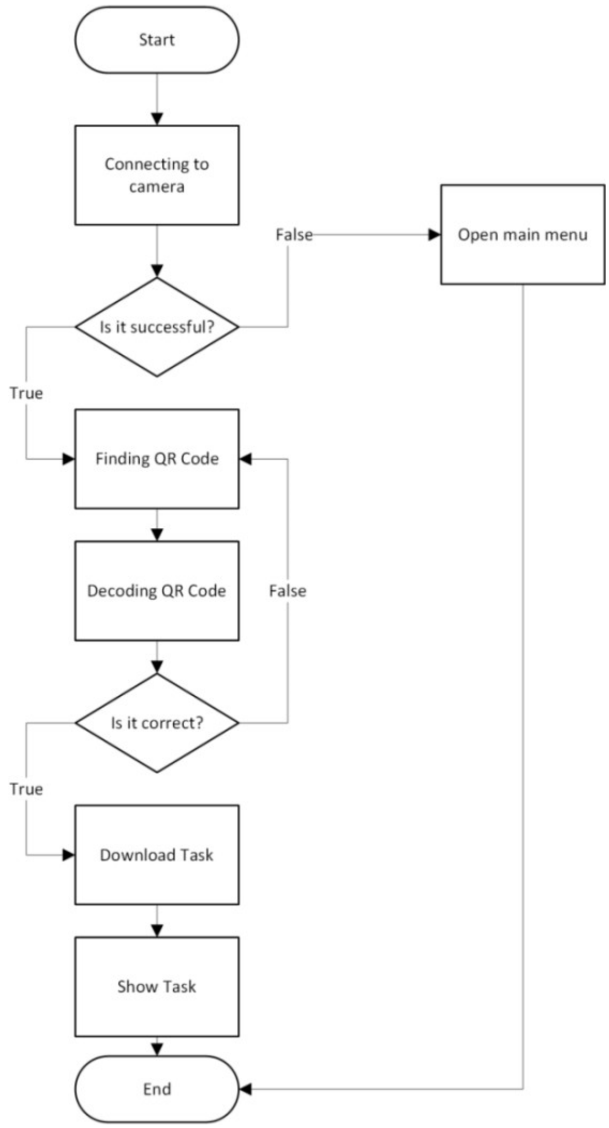

Fig. 7. QR Scanner

And in the next flowchart, a visualization of the process of generating the QR code is presented (Fig. 8).

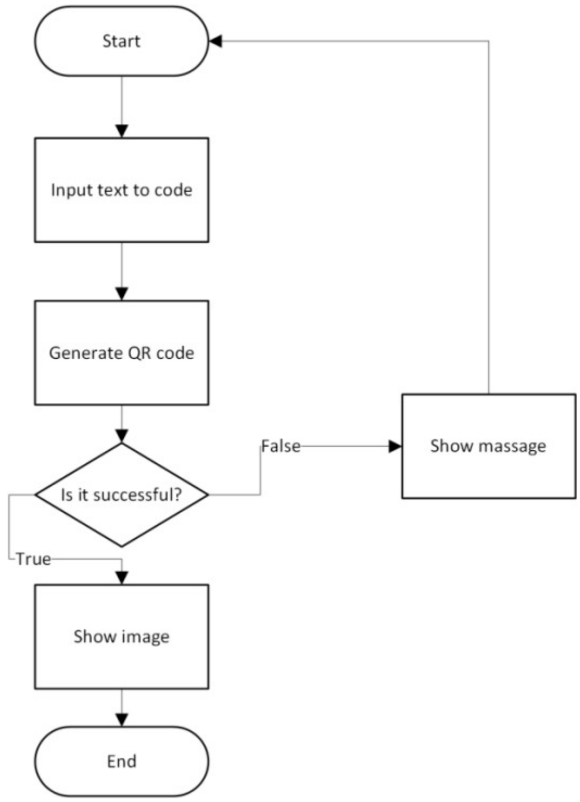

Fig. 8. QR Generator

5 Conclusions

The use of automated checks of tasks of a new type is an alternative to traditional methods. There is the possibility of personal training and self-examination of the results of such training.

Classes with this type of tasks and verification are interactive. The main advantage of using cloud technologies in this work is saving time on task verification, quick generation of options from the task bank. Such classes contribute to preparing students for life in the modern information society.

If students are working with this program they are faced with unplanned new information, in addition to the mathematical principles for solving integrals, as well as the ability to use a software product for working with the conversion of information into QR codes. This allows you to increase the student's interest, and thereby transforming the form of education from academic to personality-oriented and playful.

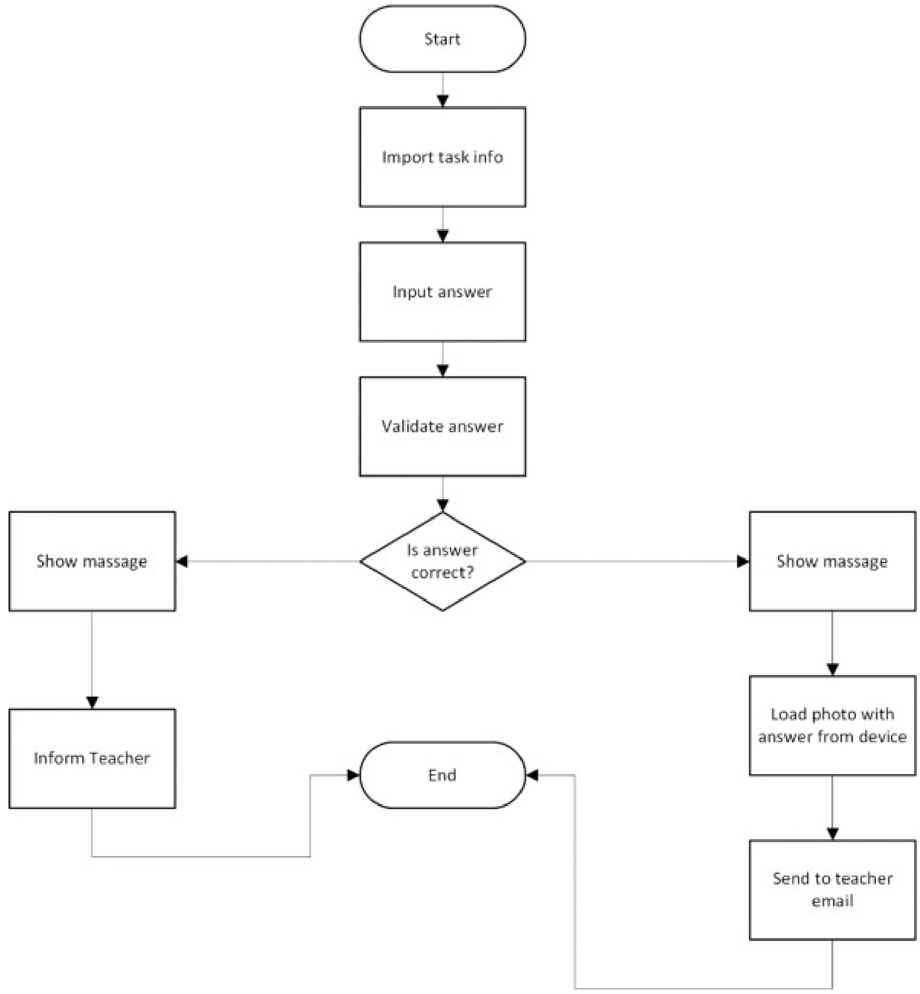

Fig. 9. Sending tasks

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E-learning as a mean of forming students' mathematical competence in a research-oriented educational process

Mariia M. Astafieva[0000-0002-2198-4614], Oleksii B. Zhyltsov[0000-0002-7253-5990], Volodymyr V. Proshkin[0000-0002-9785-0612] and Oksana S. Lytvyn[0000-0002-5118-1003]

Borys Grinchenko Kyiv University, 18/2 Bulvarno-Kudriavska Str., Kyiv, 04053, Ukraine
m.astafieva@kubg.edu.ua, o.zhyltsov@kubg.edu.ua,
v.proshkin@kubg.edu.ua, o.lytvyn@kubg.edu.ua

Abstract. The article is devoted to the substantiation of approaches to the effective use of advantages and minimization of disadvantages and losses of e-learning as a mean of forming mathematical competence of students in the conditions of research-oriented educational process. As a result of the ascertaining experiment, e-learning has certain disadvantages besides its obvious advantages (adaptability, possibility of individualization, absence of geographical barriers, ensuring social equality, unlimited number of listeners, etc.). However, the nature of these drawbacks lies not as much in the plane of opportunity itself as in the ability to use them effectively. On the example of the e-learning course (ELC) "Mathematical Analysis" (Calculus) of Borys Grinchenko Kyiv University, which is developed on the basis of the Moodle platform, didactic and methodical approaches to content preparation and organization of activities in the ELC in mathematics are offered. Given the specifics of mathematics as a discipline, the possibility of using ELCs to support the traditional learning process with full-time learning is revealed, introducing a partially mixed (combined) model. It is emphasized that effective formation of mathematical competence of students by means of e-learning is possible only in the conditions of research-oriented educational environment with active and concerned participation of students and partnership interaction. The prospect of further research in the analysis of e-learning opportunities for the formation of students' mathematical competence, in particular, research and investigation tools, and the development of recommendations for the advanced training programs of teachers of mathematical disciplines of universities are outlined.

Keywords: e-learning, e-learning course, mathematical competence, research-oriented learning.

1 Introduction

Today's innovative society needs professionals of a new type who are able to act responsibly, actively and productively in the face of dynamic change, with a high degree of interdisciplinarity and adaptability, ready to learn quickly and effectively. This is why the EU Council and the European Parliament, as one of the key competences for lifelong learning, define mathematical competence as the ability to develop and apply mathematical thinking to solve problems in different situations and contexts, the willingness to trace cause and effect relationships, the ability to make and evaluate arguments, prove [1]. At the same time, the problems of our day require the specialists of mathematical competence not only in the above, general understanding, but also at the subject level, which is caused by the intensive development of the mathematical science itself, as well as the penetration of mathematics, its methods into other, non-mathematical, spheres. Training of such a specialist is possible only in the conditions of research-oriented teaching of mathematics (in particular inquiry-based learning), with active and concerned student's participation and partnership interaction. Obligatory components of such training are: asking questions, identifying problems, finding ways of solving, investigating, discussing, thinking about alternatives, rethinking and evaluating the result.

Recently, the effectiveness of mathematical training has been linked to the intensity of the implementation of various forms, methods and tools of e-learning in the educational process. Distance learning is a solid part of university education due to its advantages, including, among others, technological adaptability, the possibility of individualization (own pace and educational trajectory), lack of geographical barriers, ensuring social equality (access to training for persons with special needs, for example), unlimited number of listeners, etc. [18]

In modern scientific researches theoretical and methodological foundations of informatization of education have been revealed (Viacheslav V. Osadchyi [13], Liubov F. Panchenko [7], Serhiy O. Semerikov [6], Aleksander V. Spivakovsky [11], Vladyslav Ye. Velychko [2] etc.). The aforementioned scientific reconnaissance outlines the actual problems of the essential characteristics of informatization of education, components and structure of methodical systems of open education, information technologies of training, psychological and pedagogical substantiation of the nature of electronic educational resources [4], valeological aspects of the use of ICT, readiness of teachers and students to work in the system of open learning [9].

As practice shows, one of the most widespread innovative means of teaching mathematics is e-learning courses (ELCs) – complexes of educational-methodical materials created for the organization of individual and group study by students of mathematical disciplines using technologies of distance learning.

The use of ELCs in the study of mathematical disciplines has become the subject of research by a number of scholars. Thus, Andrii O. Vorokh [17] researched the structure of an e-learning course in descriptive geometry, Oksana V. Zaika [19] presented an electronic educational and methodological support for the course of projective geometry. Serhii A. Rakov [8] explored the process of forming mathematical competences of a mathematics teacher on the ground of a research approach in teaching using information technologies, etc.

Also noteworthy are the works [14; 15] aimed at improving the quality of the implementation of mathematical distance education using ELC. Thus, Oksana A. Zhernovnykova [22] considered the psychological aspects of the implementation of distance education technologies in the process of training future mathematics teachers, Kateryna V. Vlasenko et al. [16] presents the characteristics common to online courses, principles of providing a functioning and physical placement of online systems in webspace and make a conclusion about the expediency of promoting online courses, the purpose of which is to get mathematics teachers acquainted with the technical capabilities of creating educational content developed on Web 2.0 technology, Oksana M. Hlushak et al. [3] revealed the theoretical and methodological bases of using e-learning course "Analytical geometry" in the process of professional training of bachelors in computer science, etc.

There is a rich foreign practice of distance and blended higher mathematics teaching with the use of various packages and different platforms, a detailed review of which was given by Nataliia M. Kiianovska et al. [5]. Interesting and useful in the context of our research is the experience of the Latvian University of Agriculture on the organization of e-learning mathematics for students of engineering specialties. Didactic approaches to the construction of e-courses on the Moodle platform, grounded and tested by the academic staff of this university, allow to strengthen the practical orientation and professional direction of mathematical learning courses, which positively affects the quality of students' mathematical preparation to the future professional activity [21].

Most researchers consider the use of ELCs to improve the quality of students' mathematical training and the formation of their mathematical competence. At the same time, many years of experience in the use of the ELC also allow us to highlight a specific problem area related to various methodological, didactic, ethical, psychological and other aspects of e-learning.

2 The objective of research

The aim of the article is substantiation of approaches to the effective use of the advantages and minimize the disadvantages and losses of e-learning as a mean of forming the mathematical competence of students in the context of a research-oriented educational process.

3 Research methodology

The achievement of the goal of the research was facilitated by the use of a set of appropriate methods: analysis of scientific literature in order to establish the state of elaboration of the problem under study, determination of the categorical and conceptual apparatus of the research; synthesis, generalization, systematization for theoretical substantiation of approaches to minimizing the disadvantages of e-learning as a mean of forming students' mathematical competence; empirical: diagnostic (talk, survey, testing) to track the dynamics of e-learning implementation; ascertaining experiment to prove the advantages and disadvantages of e-learning as a mean of forming students' mathematical competence; mathematical methods (Pearson's) for assessing students' perceptions of e-learning courses.

The research was carried out within the framework of the "Partnership for Teaching and Teaching Mathematics at the University" (PLATINUM) program of the EU

Erasmus + KA203 – Strategic Partnership for Higher Education, 2018-1-NO01-KA203-038887 and corresponds to the complex scientific theme of the Department of Computer Science and of Mathematics of Borys Grinchenko Kyiv University “Theoretical and practical aspects of the use of mathematical methods and information technologies in education and science”, DR No 0116U004625. The experimental base of the research is the Faculty of Information Technology and Management of Borys Grinchenko Kyiv University.

4 Results and discussion

The guideline in our research is the Regulation on the ELC in the Borys Grinchenko Kyiv University [10]. This provision sets out the basic requirements for the ELCs, the compliance of which should contribute to the achievement of the learning outcomes declared in the work program of the discipline. These include:

- structured teaching materials;
- adherence to the logical sequence of study of the discipline;
- a clear timetable for the implementation of the curriculum;
- system of interactive interaction between teacher and student, students among themselves;
- high quality of the offered educational materials, resources;
- system of control and evaluation of all types of student’s educational activity.

In Fig. 1 a fragment of the title page of the ELC for mathematical analysis is shown.

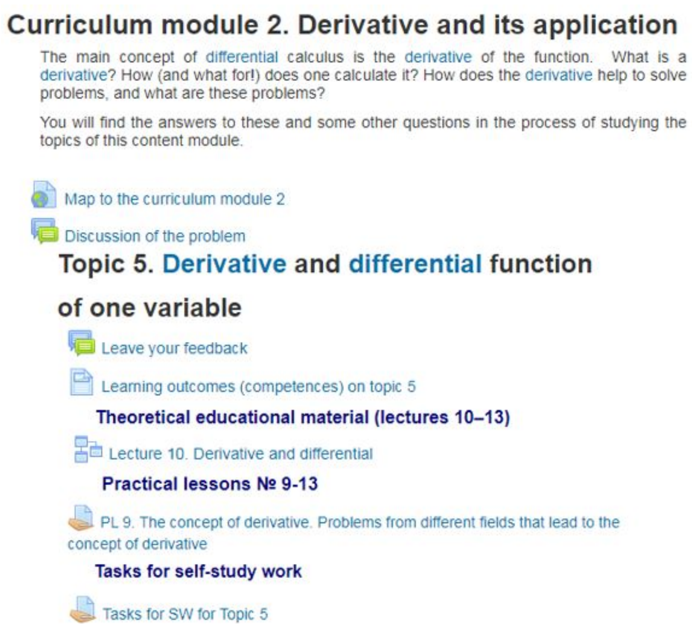


Fig. 1. Fragment of the cover page of the ELC “Mathematical Analysis”

This fragment illustrates the structure of teaching and didactic materials, in particular, the curriculum module "Derivative and its application". Here is a brief motivational appeal to students, a map (diagram) of the module, a forum "Discuss the problem", outlined the structure of the first topic of this module "Derivative and differential function of one variable", consisting of four lectures and five practical sessions. Independent work assignments are also suggested, and the learning outcomes to be achieved as a result of learning of the topic are determined. It is worth noting that ELC was created in Ukrainian, and a part of the course was translated into English for the article.

To find out the real state of implementation of ELC in the educational process and their usefulness for forming mathematical competence of students, we conducted an ascertaining experiment during March – May 2019. The basis of the experiment was the Faculty of Information Technology and Management of Borys Grinchenko Kyiv University (BGKU). A total of 155 Mathematics, Computer Science, Finance, Banking and Insurance students and Management students took part in the survey. In addition, 25 teachers were involved in the experiment as experts.

A benchmark for the student survey was taken "The Perception Questionnaire" ELC in higher mathematics in the Moodle system, conducted at University Kebangsaan in Malaysia [20]. "The Perception Questionnaire" contained 20 indicators grouped into 4 groups: a) Usefulness; b) Computer Self-Efficacy; c) Simplicity; d) General Attitude. Rating scale – four-point (from 1 to 4); the higher the score, the more positive the perception.

Our students were asked to evaluate the ELC generally on the same four scores and on the same four-point scale. The results of the questionnaire are shown in the Table 1.

Table 1. Results of a survey of students' perceptions of ELC

No	Indicator	Rating students BGKU	Rating students Malaysia
1.	Usefulness of ELC (how much it helps me in learning, makes learning more effective, improves success; enhances material understanding, facilitates material perception, and alike)	2.09	3.76
2.	Computer Self-Efficacy (whether there is access to the content, can I use all the elements and resources of the ELC without further explanation, or can I fix the problems on my own if they arise during the use of the ELC)	3.26	3.48
3.	Simplicity in use (whether there is a convenient interface, whether it's easy to communicate with the teacher, students, report on tasks, ask questions, etc.)	3.02	3.38
4.	General Attitude (how do they find using the ELC: interesting, exciting to learn in such a way, other positive emotional feelings or not interesting, boring and other negative feelings)	2.84	3.71

We compared the statistics obtained using Pearson's criteria χ^2**.** It is established that for the number of degrees of freedom $\nu = 1$ the empirical value of the criterion $\chi^2_{emp} = 2.424$. The critical value of the criterion, $\chi^2_{cr} = \begin{cases} 7.815, & p \leq 0.05, \\ 11.345, & p \leq 0.01 \end{cases}$, $\chi^2_{emp} < \chi^2_{cr}$, that is, in total, the differences between these distributions (the views of

Ukrainian and Malaysian students on the problem of using ELCs in the educational process) are not statistically significant. At the same time, comparing the survey results of our and Malaysian students clearly shows that the biggest differences are in assessing the usefulness of the ELC and the overall emotional perception. This suggests that our ELCs, for the most part, do not provide interactive learning and do not create positive internal motivation for students, that is, they do not justify the philosophy of the Moodle educational environment – the pedagogy of social constructivism, which involves active, research-based learning in partnership interaction [12].

In addition, the survey revealed that the vast majority of students have the following problems in studying mathematics disciplines using ELC:

- lack of (or limited) personal communication between the teacher and the student, and stated interaction in theory is poorly implemented in practice;
- insufficient interest of students themselves, especially junior students, in mastering mathematical knowledge independently due to poor mathematical preparation and lack of general educational skills;
- the inability to practice the mathematical knowledge obtained with further discussion of possible errors;
- health problems (such as vision defects) that prevent you from working at your computer for a long time;
- most of the lectures of the ELC are presented in the form of boring textual information with a minimal number of examples, graphics and videos, and without any feedback.

Expert teachers also outline a number of problems in the use of ELC in teaching mathematics:

- only in the teaching audience does the teacher feel how students understand the material (by their questions, answers, emotions, etc.), which allows to make corrective changes in the course of study (to emphasize the students on a certain theoretical or practical aspect, to give additional explanations, to pay additional explanations, certain subtleties of proof, etc.);
- students who are used to communicate in a virtual environment often have poorly formed communication skills, which leads to seclusion, uncertainty, fear of communication. Students lack experience in public speaking, discussion, formulation, and finding answers to study tasks;
- the problem of identifying students' personalities when performing tasks, for example, tests, homework assignments, etc. is also relevant.

Teachers of mathematical subjects also point out the difficulties associated with the creation of the ELC. In particular, the development of mathematical content (lectures, assignments, test questions, glossary articles, etc.) requires a large number of formulas, and Moodle does not support formula editor in Word; so, you have to save and paste formulas or type in LaTeX. But formulas in the form of pictures are non-editable. In addition, they require a large amount of memory, which significantly slows down the download of training material when working with Moodle. And not everyone knows

LaTeX. This circumstance also complicates communication in the ELC “student – teacher”, “student – student”, in particular, the exchange of information containing mathematical texts.

Without going into the technical issues of creating and working with the ELC structural units in Moodle, we will focus on content preparation issues (filling lectures, practical tasks, tests, etc.) and selecting activities to effectively take advantage of and minimize the losses of computer learning compared to traditional.

As known, the didactic purpose of the lecture on mathematics is to introduce students to the scientific problem, to reveal the main issues of the topic, to solve the problem, justify the method, focusing on the most difficult (problematic, contradictory) points, the possibility of applying theoretical knowledge, and preparing students for further self-work. Properly organized lecture makes passive learning impossible.

Virtual lecture (in e-course) is deprived of this important factor – direct communication of the lecturer with students, in which the lecturer has the opportunity to conduct a “Socratic dialogue”, ask questions, prompt the listeners to answer and formulate questions, oppose, stimulate imaginary experimentation, encourages and provokes discussion, give students the opportunity to make mistakes “safely”, to choose their own way, even if it is a dead end, to formulate hypotheses, to draw conclusions, and most importantly – to be able to respond to answers, considerations, students’ questions in time, to make necessary corrections in their explanations, if necessary, to improvise.

Let’s illustrate by examples of lectures of the author’s e-learning course on mathematical analysis in Moodle environment [3] – how it is possible to compensate the direct “live” communication of the lecturer with the students, implementing the principle of interactivity, in the e-learning course.

It is suggested to use the “Book” resource or the “Lesson” activity to create an e-learning course in Moodle. The “Book” module allows the teacher to create multi-page resources in book format, from chapters and subdivisions. Books can contain content in the form of text, pictures or media files. However, a lecture in the “Book” format does not stimulate the student to research and search activity, does not create conditions for interactive interaction of the student with the teacher, but rather similar to a regular paper book, which the student passively reads. Therefore, this resource is barely suitable for lecture. It should be used to summarize a particular topic (concepts, theorems, formulas, methods, etc.), or to create a reference book. It is best to use the “Lesson” activity to design the lecture. The “Lesson” module not only provides some theoretical material, but also predicting the student’s activity and feedback (interaction) and the possibility of providing the student with the necessary assistance in the process of its development.

To do this, at first, all lecture material should be broken down into short, meaningful blocks; after each of them, ask questions (or tasks) to test understanding of the theoretical material presented. Depending on the answer to the question (task), the student goes to the next page (if the answer is correct) or (if the answer is incorrect) goes back to the previous page; the commentary on his incorrect answer explains the essence of the error or a hint or pointing to the relevant theoretical material whose ignorance led to the error. In such a way, the teacher is able to monitor the entire process of the student’s development of the lecture, providing the necessary assistance at each stage. The student will give a lecture to the end, if he will correctly answer all the questions due to the course, that is, if he will actively work (analyze, compare, argue, prove, ask questions, express hypotheses, etc.), and not just passively read the text.

Secondly, the presentation of the material (proof of the theorem, for example) should be in the form of an imaginary dialogue (the author asks the question and answers himself), so that the student has the feeling that he is thinking. While giving a lecture, a student should see an example of a research-based way of knowing and learn from this example to ask the question: Why? And what if ...? What are the restrictions? How to find out? and so on (Fig. 2) Similarly, the presentation should be interspersed with the objections (by the imaginary opponent) and the answers to those objections.

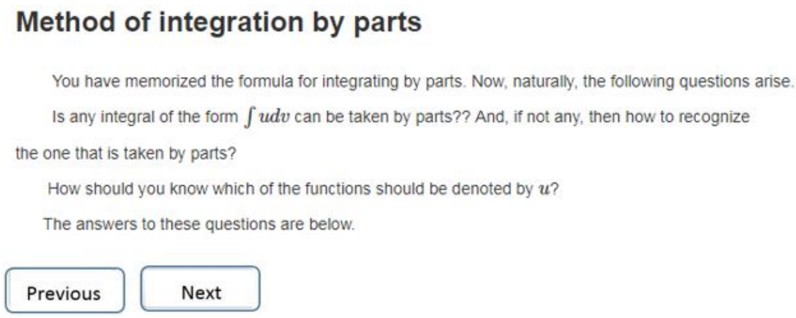


Fig. 2. A fragment of a lecture with questions

Thirdly. Just like in a real lecture, the course author does not rush to report the finished fact, but encourages the student to experiment (real, using a certain resource, such as Go-lab, GeoGebra or imaginary) and formulate a hypothesis, as well as describe (as if he is conducting) this experiment either formulates a hypothesis or prompts the student to do so (Fig. 3).

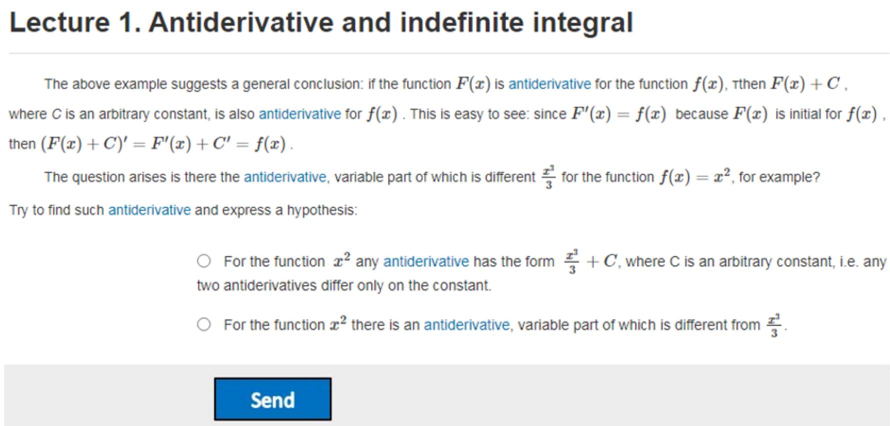


Fig. 3. Fragment of the lecture with the task of expressing a hypothesis

Fourth. Remembering that on an e-lecture the teacher does not see the student and cannot visually evaluate how closely he or she listens to and understands the material, the ELC author should find an opportunity to encourage the reader to make a conscious perception of the virtual lecture. For this purpose, one should ask from time to time questions such as: “What follows from this condition?”, “What are these restrictions?”, “Where is the condition of the theorem used?” etc. For example, after a fragment of a lecture on mathematical analysis of integration by the method of substituting a variable, where the integral $\int \sqrt{a^2 - x^2} dx$ is calculated by substitution $x = a \sin t, t \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$, students are asked to indicate where the condition $t \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ is used in the above considerations (Fig. 4).

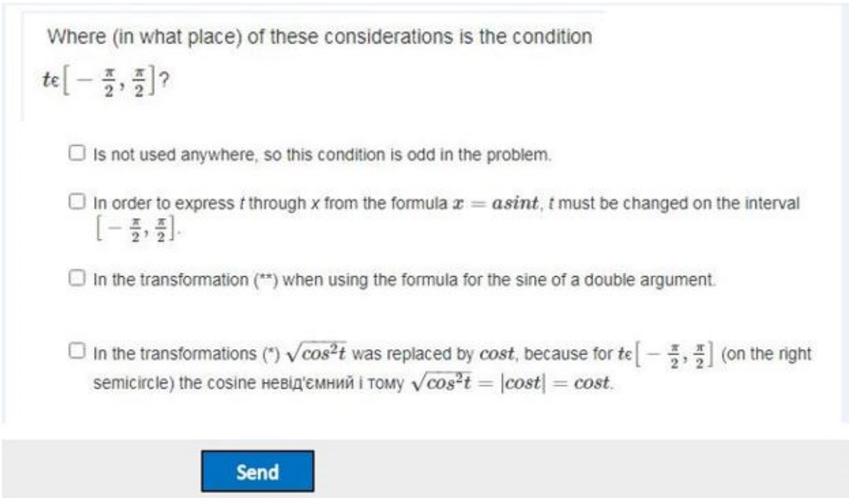


Fig. 4. A fragment of a lecture on the theme: “Integration methods” with a test task

Fifth. Preference is given to open-ended test tasks; when designing a test task, it is necessary to program (predict) errors in order to be able to adjust the student’s educational trajectory.

And finally, the language of presentation should not be a stationery book, but “live”, personalized, close to direct communication during the face-to-face lecture.

Here is an example of a fragment of lecture 4: “The concept of the limit of the numerical sequence” in the form of “live” dialogue, during which the student is induced to an imaginary experiment and thus summed up the definition of a new (for the student) concept:

“Previously, we have already formed on a sensory level the concept of convergent sequence and the limit of sequence. So, observing the behavior of the sequence $x_n = \frac{1}{n}$ members, we notice that they accumulate around the point 0. Mathematicians say that the specified sequence tends to 0 or that it has limit of 0.

Let’s try now to give a rigorous mathematical definition of this concept.

What does "members of the sequence accumulate, thicken near the point" mean?

Obviously, they are approaching this point anyway close; that is, differ from this number arbitrarily little. Well, let's take, for example, the sequence of $x_n = \frac{1}{n}$. Its members accumulate at zero. Let's imagine that on a number line of the monitor the flashlight lights up every second at a coordinate point $x_1 = 1$, $x_2 = \frac{1}{2}$, $x_3 = \frac{1}{3}$ etc, approaching, as was already mentioned, to point 0. We want to stop this movement. To do this, lets surround the point 0 with barriers: $\pm\frac{1}{10}$. Does this stop the members of the sequence from closing to zero? Obviously not. Already on the eleventh second, the next (eleventh) member of the sequence, followed by all the following, will overcome the barrier (the flashlights will be lighting up one after the other on the left of our barrier, ignorantly approaching zero).

What if point 0 is surrounded by new barriers: $\pm\frac{1}{100}$? Will we stop the movement of the members of the sequence? Obviously not. Already the 101st member, followed by all the following, will overcome our new barrier.

What if we are building these barriers not close enough around zero?

Not really. No matter how tight we surround the barrier point 0, we will not be able to "protect" it from the "invasion" of the members of the sequence. Right?

Therefore, it is quite logical to have the following definition of the convergent sequence.

Definition. It is said that the sequence x_n "tends to" a or that number a is limit of sequence x_n if **all** the members of a sequence **starting with some** get in **any** circle of point a".

Since mathematical competence means the ability to act, it is obvious that its formation is possible only in the process of active search and research activities (and it manifests itself in the actual behavior of the individual in a particular situation). An organic and tested field for such activities is mathematical problems.

In the structure of mathematical disciplines, much of the study time is devoted to practical classes, where, in particular, the ability and practical application of theoretical knowledge are formed in the process of solving problems. Virtual (distance) training of any practical skill is ineffective. Therefore, in our practice, we use ELC in the Moodle system to support the traditional full-time learning process by implementing a partially blended (combined) model.

However, the limited ability of the ELC to undertake a practical training can and should be transformed into an advantage. The fact is that during practical class, there is no time to think long about the task, and most non-reproductive tasks require slow thinking. Therefore, in a practical auditorium class, it is advisable to unleash mainly training exercises on the direct learning of concepts, theorems, standard problems, the acquisition of certain mathematical methods and techniques. Non-standard tasks and tasks for modeling real processes, creative tasks to find a solution, analysis, research of the result, etc., which create favorable conditions for engaging higher levels of cognitive processes, but require more time to solve, the same "slow thinking", it is better to offer for work outside the auditorium. A productive idea, the right or optimal solution, is most often born of discussion, debate. And the platform for such communication in the ELC is forum and chat.

Mathematical solving of applied problems inevitably raises the problem of adequately understanding of the content of a real problem to translate it into a mathematical language and then interpreting the mathematical result in the context of a real problem. A glossary auto-linking filter, created by a mathematics teacher in conjunction with a particular subject teacher or practitioner, helps solve this problem effectively. The idea is borrowed from [21]. The glossary contains terms, laws, descriptions of processes, etc. of a specific discipline or industry that may not be known or misinterpreted by mathematics students, as well as students of other specialties, because they study higher mathematics in junior courses and do not yet have sufficient knowledge in their subject industry.

Another type of activity that can be used effectively for students to accomplish specific tasks is to work on collaborative projects is the wiki. Wiki allows participants to add and edit a set of web pages, both editable by all members and modified only by their wiki. The history of previous versions of each page in the wiki is saved with a list of changes made by each participant. And it is very convenient, because it allows the teacher to track the trajectory of each student in the process of completing the task and, if necessary, to respond in a timely manner. Examples of the use of wiki in the ELC are students' creation of short notes, directories of theoretical material in preparation for practical classes (Figs. 5, 6) and the implementation of a collective project for the development of dynamic models to problems of projective geometry in the GeoGebra system [2; 1].

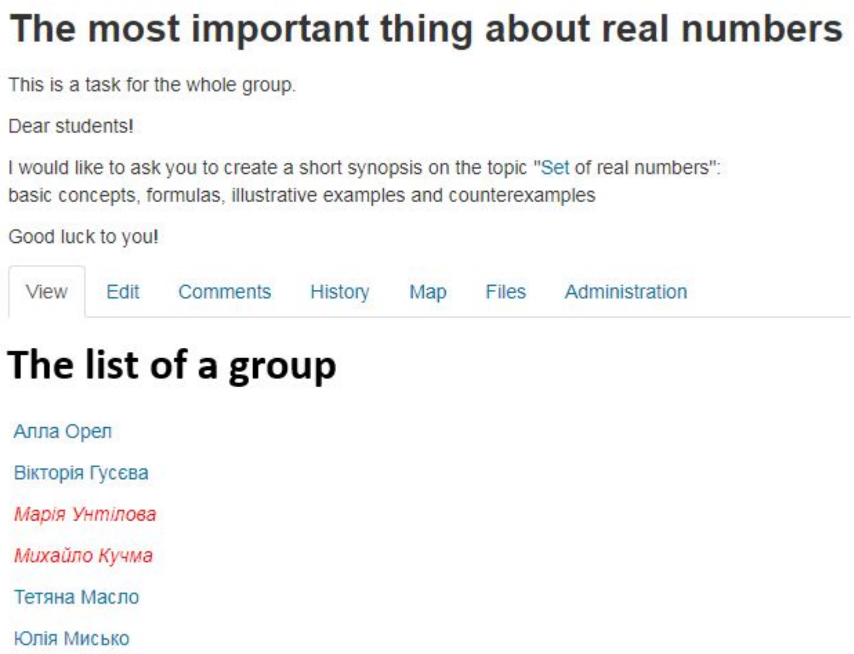
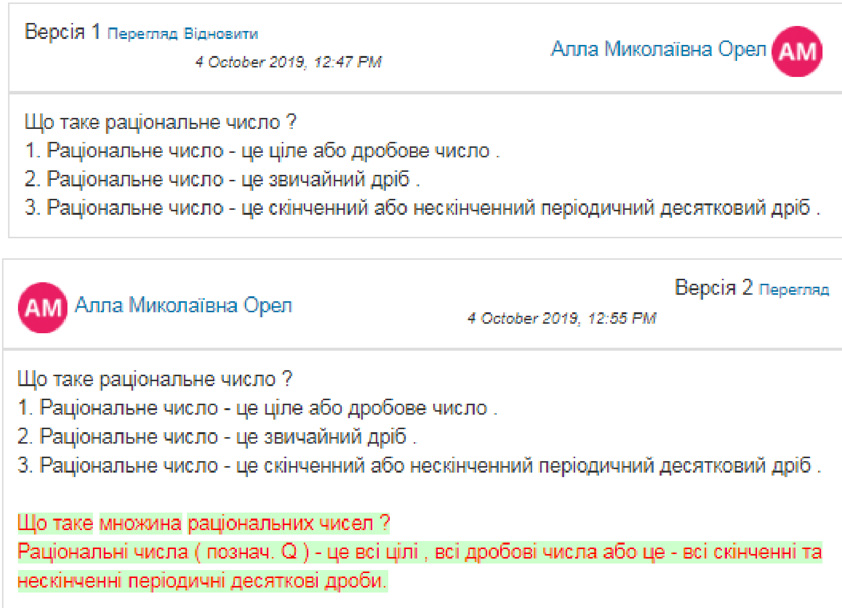


Fig. 5. A task for a group of students to create a short note on the topic "Set of real numbers"

In fig. 6, in particular, we see two versions of the wiki page about rational numbers, created by student A. O. The first version (where three different interpretations of the rational number are given, fig. 6a), she complements the definition of the set of rational numbers (second version, fig. 6b).



(a) (b)

Fig. 6. History of creation of a Wiki by the student A. O.

An important element of any training is the diagnosis and monitoring of results. Since e-learning is dominated by automated proficiency testing, testing is the most common form of assessment and evaluation. With quick feedback, the test can be an important tool for students to evaluate their own performance and help them become more successful. Properly selected test provides the necessary information for the teacher on the degree of mastering the educational material by students.

The effectiveness of knowledge control by testing is determined by the quality of the test tasks. Moodle has powerful tools for creating quizzes with different types of questions. To assess the level of mathematical knowledge and the ability to apply it in practice, which is an indispensable indicator of mathematical competence, the most appropriate are tests of the open type, with a freely constructed answer (Fig. 7).

In test tasks with choices, there is a temptation simply to guess the answer. And, even if you exclude guessing, there is a big difference between finding the right answer and formulating it yourself. For example, if an open-ended problem proposes to find the root of an equation, then the student will need to solve the equation; if the answer to this problem is one of the correct ones, then the student can find it directly in the equation. Obviously, in the second version, we will not have any information about whether the student has methods of solving certain types of equations.

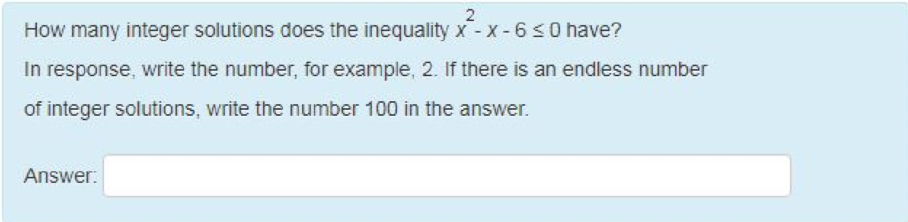


Fig. 7. Test of an open type

In addition, developing a test that meets the criteria of validity requires specific expertise in the field of testology. And to a greater extent this applies to tests with closed test questions. As a rule, the ELC author/teacher does not have such special knowledge. Therefore, often a set of questions with the choice of one or more correct answers, similar in appearance to the test, isn't in fact a test and doesn't give an adequate information about the knowledge neither to the student nor to the teacher.

Finally, it should be remembered when designing test tasks, that the answer to any reproductive question is easy to find in the Internet today. Therefore, it makes no sense to ask such questions in control tests.

5 Conclusions

1. As a result of the analysis of the scientific literature, it is found that the effectiveness of forming mathematical competence of students is related to the intensity of implementation of various forms, methods and means of e-learning in the educational process. The conducted research also proves that e-learning, besides the obvious advantages (adaptability, possibility of individualization, absence of geographical barriers, ensuring social equality, unlimited number of listeners, etc.) also has certain disadvantages. However, the nature of these shortcomings lies not so much in the plane of opportunity itself as in the ability to use them effectively.
2. The results of the ascertaining experiment indicated students' willingness to use ELC – on the one hand, and low assessment of their usefulness, and not quite positive general emotional perception – on the other. This leads to the assumption of poor quality and, therefore, the inefficiency of the majority of ELCs, which do not provide interactive learning and do not create positive internal motivation for students, i.e. do not justify the philosophy of the educational environment Moodle – pedagogy of social constructivism and active, research-oriented learning in partnership interaction).
3. Considering that effective formation of students' mathematical competence is possible only in the conditions of research-oriented learning with active and concerned student participation and partnership interaction, didactic and methodical approaches to content preparation and organization of activities in ELC in mathematics are proposed. Also, given the specifics of mathematics as a discipline, it is proposed to use the ELC to support the traditional learning process with a full-time form of education, introducing a partially mixed (combined) model.

The prospect of further research is seen in a more detailed analysis of e-learning opportunities for the formation of students' mathematical competence, in particular, research and development tools, and the development of recommendations for advanced training programs for teachers of mathematical disciplines of universities.

Gratitude. The research findings of this article were conducted within the framework of the "Partnership for Learning and Teaching in University Mathematics" (PLATINUM) program of the EU Erasmus + KA203 – Strategic Partnership for Higher Education, 2018-1-NO01-KA203-038887. This article reflects only the views of the authors, and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

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The use of the cloud services to support the math teachers training

Mariya P. Shyshkina[0000-0001-5569-2700] and Maiia V. Marienko[0000-0002-8087-962X]

Institute of Information Technologies and Learning Tools of the NAES of Ukraine,
9 M. Berlynskoho Str., Kyiv, 04060, Ukraine
{shyshkina, popel}@iitlt.gov.ua

Abstract. The development of the information society and technological progress are significantly influenced by the learning tools. Therefore, to the variety of tools that could be used to support the study of any discipline new ones emerging lately are continuously being added. Along with the great deal of systems of computer mathematics (SCM), web-oriented versions of SCM mathematical applications and other math learning tools the cloud-based versions of mathematical software such as MapleNet, MATLAB web-server, WebMathematica and others are now being used. These tools accomplishment becomes the essential part of training mathematics teachers. Domestic and foreign experiences of using cloud services for forming professional competences of mathematics teachers are analyzed. The place of the CoCalc within the system of mathematical disciplines learning tools is investigated. The task of improving the math teachers' ICT competence by means of cloud services use in the process of training is considered. Among the new forms of learning rising along with the cloud services dissemination are such as collaborative learning, inquiry-based learning, person-oriented learning. At the same time, the use of the appropriate cloud service in the study of some mathematical discipline improves the assimilation of the learning material and improves the knowledge acquisition process on most topics. The analysis of current research of Ukrainian scientists on the problem in question shows that the progress is underway as for further elaboration and implementation of new learning methods and techniques of using cloud services in the higher education institutions.

Keywords: cloud services; mathematics teachers; mathematical software; learning tools.

1 Introduction

The study of mathematical disciplines, as a rule, combines deep understanding of theory and practice. Within the framework of the Bologna Process and in the context of a single educational space, it would be advisable to use the best experience of the educational practice of European countries in combination with the domestic achievements to raise math education to a new level. In this context, there are a number of unresolved issues.

Analysis of recent research and publications. Some experience of using cloud services and cloud technologies in Ukrainian higher education already has been accumulated [5]. For example, the cloud infrastructure is reported to be used at the Kryvyi Rih State Pedagogical University [12], Google Apps cloud services are integrated into the educational environment of the Faculty of Physics and Mathematics of the Ternopil Volodymyr Hnatiuk National Pedagogical University [17]. Most studies are focused on the principles, approaches, and design of a higher education environment including cloud services [9].

Volodymyr P. Serhiienko and Igor S. Voitovich [23] consider the experience of integrating Moodle training courses with one or more cloud services. Particular attention is paid to the use of the cloud services in the process of distance learning of higher mathematics, which was studied by Oksana M. Markova [10], Natalya V. Rashevska [21], Svitlana V. Shokaliuk [11], Kateryna V. Vlasenko [33], Tetiana I. Zhylenko [35].

Usually, cloud services can be used to visualize data and calculations [3], in particular to solve problems and organize individual [18] or team work [25], to control students' knowledge [24]. According to Kateryna I. Slovak research [30], the role of cloud-based math software in particular CoCalc [8] is growing significantly.

Keith J. O'Hara, Douglas S. Blank and James Marshall explored four ways to use cloud services in the learning process: within the lectures (discussions); seminars; homework (individual) tasks; exams [16].

In Spain, the project "New Free Software Tools for the Automatic Correction of Complex Exercises" was carried out at the University of Madrid of Complutense, with the use of CoCalc service [1; 2]. In particular, it has been found that CoCalc is chosen by more students than other cloud services. This is due to the fact that, in most cases, that this tool is widely used for learning support, in particular math disciplines. Still students also do not have significant difficulties taking up other cloud services.

David I. Ketcheson [4] described the experience of teaching school subjects (ranging from short to 2-3 classes and ending with several semesters) using the CoCalc service. Due to this research CoCalc may be used as a complement to the basic manuals of the subject discipline.

The purpose of the article is to consider the advisable ways of using cloud services to support mathematics teachers training.

2 Research results

The problem of training skilled education management staff as well as ICT-skilled teachers can hardly be considered today separately from the processes of innovative development of the educational space created in a school, region and in the educational system of a country or a world. In this regard, there is a need for basic research with a focus on advisable ways to develop the learning environment of educational institutions. Trends in the improvement of ICT tools searching for new technological solutions and new pedagogical and organizational models should be taken into account [15]. The main focus is on the transition from the mass deployment of individual software products to a complex and integrative environment that supports distributed network services and cross-platform solutions.

2.1 The formation of professional competences of a mathematics teacher

The main feature of the competency approach is that during the training process students are gaining competences necessary for leaving and professional realization in the information society [14]. It would be false to assume that at the beginning the students have no competence at all, since the process of its formation can be quite long and fall under the influence of various factors: training in educational institutions, professional activity, interpersonal communication and so on. Therefore, saying that students acquire certain competencies implies the formation of their competence at the particular level.

Within the Tuning project, the specific competencies for the following subject areas have been considered: Business and Management, European Studies, History, Mathematics, Earth Sciences, Education, Nursing, Physics, Chemistry. In this project there are 42 subject areas: the main 9 are located on the Tuning site, the other 33 can be found on the Internet sites on the pages of the Tuning project [34].

The work was carried out by different groups of scholars, reflecting the specific traditions and development and implementation of educational programs in the field of each subject area. But at the same time, each group took into account the Tuning methodology, with further opportunities to create educational programs. By this way the project was developed using the same language (vocabulary, components), recommendations (learning outcomes and competencies, approaches to both learning and evaluating its results, etc.).

Another source on professional competencies is the UK Quality Assurance Agency for Higher Education (QAA, UK). The Agency has approved Subject benchmark statements for 60 Bachelor's degree programs with honors (in some approximation – Bachelor's Degree in Ukraine), 17 Master's programs and 16 programs for Healthcare professions [32].

As for the classification of professional competences, they are generally divided into three categories: domain knowledge, cognitive and domain skills, subject domain practical skills.

Considering mathematical competence, which is a component of professional competence Ianina G. Stelmakh [31] treats it as a property inherent for a personality, which is ready to use mathematical tools independently and responsibly as confirmation of the theoretical and practical readiness of graduates for further professional activity.

Svitalna O. Skvortsova [29] proposes her own classification of the professional competences of a future mathematics teacher. The basis is the generally accepted separation of competencies into key, special and basic competencies. At the same time, each competency is characterized by separate components: communicative, personal and professional.

The professional component has two competencies:

- information competence (ability to process mathematical facts, work with mathematical data, organize a systematic search and generalize available mathematical material),
- subject (presence of a comprehensive system of complex mathematical knowledge and willingness to use them in their professional activities; ability to solve typical professional problems with the involvement of mathematical apparatus).

The communicative component consists of communicative competence (knowledge of mathematical terminology; willingness to transmit mathematical information; ability to use verbal and non-verbal means of transmitting mathematical data and information).

The personal component contains: reflexive competence (desire to improve the use of mathematical tools in professional activity); creative competence (use of innovative mathematical methods in professional activity).

Sometimes, among professional competencies consider: general professional [13] and specially professional. In this case, the specially professional competencies include:

- ability to use professionally profiled knowledge in the field of mathematics (mathematical statistics), for the statistical processing of experimental data and mathematical modeling of natural phenomena and processes;
- ability to use mathematical apparatus for modeling various processes;
- ability to use professionally profiled knowledge and practical skills in algebra and number theory;
- ability to use professionally profiled knowledge and practical skills to master the basics of theory and methods of theoretical research;
- ability to use professionally profiled knowledge and practical skills in mathematical analysis;
- ability to use knowledge and skills in analytical and differential geometry;
- ability to use professionally profiled knowledge in discrete mathematics;
- ability to use knowledge and skills in the theory of probabilities;
- ability to use professionally profiled knowledge and skills in mathematical logic and theory of algorithms;
- ability to use knowledge and skills in differential equations;
- professionally profiled knowledge and skills in the theoretical foundations of computer science and practical use of computer technologies;
- ability to use computer and ICT skills;
- ability to use professional knowledge and practical skills in teaching mathematics in primary school.

The above competences allow solving the typical problems that the graduates are facing at the pedagogical university, in particular the teachers of mathematics, in the performance of their professional functions.

Analyzing professional functions, typical tasks of activity and content part of skills, it is expedient to distinguish a certain group of professional functions (Table 1) taking into account the properties and qualities (specialized professional competences) of graduates of pedagogical high school, namely teachers of mathematics of school mathematics.

Table 1. Professional functions, typical tasks of the activity, which should be possessed by mathematics teachers

Content of function	The name of a typical activity task	Content of the skill
Conducting all forms of classes in secondary schools	Class planning	Draw up a plan and a synopsis of lessons using educational and methodical documents and educational and methodical literature
	Conducting classes	Use special knowledge in conducting classes
	To control the knowledge acquired by the students	Obtain and use scientific and technical professional information for conducting classes
		Use a computer to perform control measures
Educational activity	Provision of independent methodological level of knowledge	Use mathematics and informatics teaching methods to conduct different forms of classes
	Methodical support of independent work of students	To draw up and prepare for printing methodical instructions, manuals for mathematics and informatics with the use of educational literature, educational-methodical and other instructive documents

As shown in Table 1, specially professional competences do not relate only to such professional function as educational and public education of students. In these professional functions, due to specialized professional competencies, it is possible to solve all typical tasks of the activity, which are disclosed in the cells that characterize the content of the skill.

If we consider specialized professional competences in terms of the system of skills that reflect them, we obtain the following correspondence (Table 2) between the specialized professional competences and the content of skills.

In the Guidelines for the Development of Higher Education Standards, specific (professional, subject) competencies are defined as subject-area competencies and are important for successful professional activity in a particular specialty.

2.2 CoCalc in the system of teaching mathematical disciplines

New technologies, information and communication networks create the basis for the implementation of a holistic approach to education and training [26]. The holistic approach focuses on the integration of science and practice, training and production, fundamental and applied knowledge and technological competences. First and foremost, it aims to develop management skills in education that should be based on a unified approach to learning, design and management. This is a promising area for developing the staff potential of the education system. Therefore, new approaches and models are needed to organize and develop the learning and training environment for qualified teaching staff.

Table 2. Specialized professional competencies and a system of skills that reflects them

Competence in solving problems and problems of social activity, instrumental, general scientific and professional problems	Content of the skill
Use of modern information technologies	Be able to use existing and learn new information technologies
Search for new data	In professional activity, using keywords in a specific industry based on professionally oriented (print and electronic) sources, with the help of appropriate methods, to search for new textual data (work with sources of educational, scientific and reference data); search for new graphic, audio and video data
To apply the laws of formal logic in the process of intellectual activity	Use formal logical procedures to analyze the available data for their compliance with the conditions of necessity and sufficiency to ensure efficient operation
	Use formal logical procedures analyze existing data for compliance with internal consistency requirements
	Use formal logic procedures to structure the data
	According to the results of structural and logical processing of the work data, the conclusion about their suitability for the implementation of the given functions
	Based on the results of the activities carried out using certain criteria to determine the quality of the previously performed logical operations
	In case of negative result of activity to find errors in structure of logical operations

There is a problem of accessibility and ways of learning and supplying resources for better pedagogical effect of their use. This problem can be partially solved by using cloud computing tools. The main benefit of this technology is to improve access to qualitative resources (and sometimes the only way to access the resources you need). The idea is to identify approaches to modeling and evaluating cloud components and computing capacity using the knowledge about the design of the learning environment and its different tools.

Thus, Mariia A. Kyslova, Serhiy O. Semerikov and Kateryna I. Slovak includes in the mobile educational environment of higher mathematics:

- mobile tools of supporting educational and, in particular, mathematical activities,
- mobile tools of educational communication,
- mobile tools of supporting the process of teaching higher mathematics, to support interaction between students and the teacher [6].

In addition to mobile learning tools, researchers in recent publications have taken the cloud services as learning tools. Mariia A. Kyslova and Kateryna I. Slovak [7] analyzed a number of cloud services that they propose to use in the learning process in combination with traditional learning tools: Google Apps for Education, Office 365, ThinkFree Online. In particular, each cloud service is characterized, its characteristics, components and the advantages of its use as a tool for teaching mathematical disciplines are highlighted.

The following selection criteria can be used to select a cloud service [1]:

- compare computing resources (RAM, number of available kernels), the amount of data that can be computed by a cloud service, without affecting these characteristics by the computing power of the user-operated device and provided free of charge;
- the availability of tools for the organization of training and its control (it is necessary to take into account whether there is an existing distribution of exercises at the level, the ability to collect completed tasks and evaluate them);
- the possibility of increasing the computing resources for a small fee, comparing tariff plans;
- openness of the program code, possibility of setting of own settings and applications (special libraries), except for those provided by default (to individualize the work and settings of cloud service for an individual student or teacher);
- possibility of joint editing, simultaneous work on one problem (project) of a group of students, resources of different formats.

The advantages of cloud services include the following items (according to Natalya V. Rashevska and Viktoriia V. Tkachuk) [22]:

- the data are accessible to the user from any device having access to the Internet;
- the user is able to work with all educational material, without installing additional software;
- the ability to work anywhere, not just within the audience;
- the organization of the learning process is of a mixed type.

But Mariia A. Kyslova and Kateryna I. Slovak [7] consider the use of only cloud services as teaching aids to be inadequate. In the process of studying mathematical disciplines, it is appropriate to pay attention to the specialized web-oriented versions of SCM (the principle of operation of which is based on cloud technologies), which are referred to by Sage. In addition to Sage, in [7] considered GeoGebra, MathCAD

Calculation Server, MapleNet, Web-Mathematica. Each software tool is presented as a short feature that can be used as a learning tool.

At the same time, there is a tendency for the development of computer mathematics systems, which were still operating in a network environment (the so-called Web-SCM [20]) with respect to their gradual transformation into cloud-oriented systems. The main differences between Web-SCM and cloud-oriented SCM are covered in more detail in [27]. A variation of this type of system namely the cloud-oriented Web-SCM is CoCalc, the cloud-oriented version of Web-SCM Sage [27].

Modern SCM can be divided into seven main types, but despite the fact that each of these SCM has some differences in its purpose and architecture, it is considered that they have a similar structure [28]:

- the computing core of the system occupies a central place;
- codes for a large number of compiled functions and procedures that need to be performed fairly quickly, so the kernel volume is usually minimized;
- user-friendly interface through which the user can easily access the kernel and get the result directly on the monitor screen;
- powerful graphical toolkit extends the use of SCM not only for mathematical calculations, but also thanks to it can illustrate most non-mathematical processes;
- extension packages that increase SCM capabilities by increasing the number of user-assigned tasks;
- libraries of procedures and functions that allow the use of less commonly used, but equally important, rare procedures that are simply not included in the kernel due to its size limitations;
- a help system through which the user can at any time refer to each section regarding the correct use of a particular function, syntax and examples of use.

SCM has implemented a significant number of special mathematical operations, functions and methods [28]:

- opening of brackets in symbolic expressions;
- calculating the value of a numerical expression;
- schedule of polynomials on factors;
- calculating the value of a symbolic expression, but provided that the values of the variables are known;
- erection of such additions without opening the brackets;
- solving algebraic equations or a system of equations;
- solving transcendental equations, or the approximate value of the roots of the equations;
- performing mathematical analysis operations: calculating integrals, multiple integrals, finding primitives, boundaries of functions and numerical sequences; solving differential equations (analytically);
- plotting functions on a plane and in space, constructing vectors; calculations from the section of linear algebra (multiplication of matrices, calculations of determinants, raising a square matrix to any natural degree) and many others.

The first stage of SCM development (60's – 90's of XX century) is characterized by the fact that SCM was distributed locally – it was necessary to install the software on the user's computer and then it could be used in accordance with the license conditions.

The second stage of SCM development (90-ies of XX century – the first decade of XXI century) was marked by the emergence of Web-SCM, in which one of the main characteristics was equipped with Web-interface. Web-SCMs have the following properties:

- no need to install the system computing kernel on the client machine;
- all calculations are performed directly on the Web server;
- query execution and results are calculated using a Web browser.
- In addition, the following features of Web-SCM stand out:
- undemanding to the hardware component of the computer system;
- indifference to the browser used;
- ease of administration;
- mobile access to training resources, programs and data, etc. [28].

Today, the most usual Web-SCMs include MathCAD Application Server (MAS), MapleNet, Matlab Web Server (MWS), webMathematica, wxMaxima and Sage. Web-SCMs are equipped with a user-friendly interface, powerful graphical tools, and they implement a significant amount of mathematical calculations, functions and methods.

Among the specific characteristics of modern SCM there are:

- availability of programming languages inherent in these systems;
- importing data from other software;
- tools for printing mathematical texts.

There are several advantages to using CoCalc Web-SCM. Among them is the largest arsenal of tools for the development and research of various mathematical models within the mathematical disciplines. The first version of Sage (former SAGE) was released in February 2006.

Using Sage in the process of teaching mathematical disciplines provides the opportunity [28]:

1. Perform calculations: both analytical and numerical.
2. Submit calculation results in natural, mathematical language using symbolism.
3. Build two- and three-dimensional graphs of curves and surfaces, histograms and any other images (excluding animations).
4. Combine calculations, text and graphics within a single worksheet, printing, publishing and collaborating on them.
5. Create models using Python's built-in Sage language for practical work, educational research.
6. Create new features and classes in Python.

The third stage of SCM development (since 2009) is related to the emergence of cloud oriented systems. CoCalc is a free service supported by the University of Washington, the National Science Foundation and Google. CoCalc was specifically designed to help you use mathematical computing on the Android platform. CoCalc implements all the features of Sage, but there are some differences [28].

Strictly speaking, Sage is a console program. And all the calculations can be done in the console. Another issue is that this is inconvenient, which is why Sage Notebook and CoCalc were created. Historically, the first was the Sage Notebook. This is a graphical shell with a slightly outdated but user-friendly interface that is more suitable for working with Sage on a local computer. The Sage Notebook comes bundled with Sage and has the ability to perform calculations right in the browser. The Sage Notebook supports virtually every feature of the Sage console (except for code debugging commands), except you can: design sheets, add images, videos, 2d and 3d graphics, and create interactive applications.

By making certain adjustments, you can make it work with the Sage Notebook over the Internet. There are sites that provide access to the Sage Notebook, but they use an older version of Sage. It is recommended to use CoCalc to work with Sage online.

The idea behind the creation of CoCalc belongs to the professor of mathematics at the University of Washington, William Stein. Most servers are located in the US at the University of Washington. There are several servers in Europe. The servers are running the Ubuntu 14.04.1 LTS (Trusty) operating system with the Sage web-SCM kernel. Google App Engine is also used.

For Linux applications, this feature is distinctive: they can clearly distinguish the console part, which contains all the features of the program, and the graphical part of which the user usually works. It’s easy to make the program work on one computer and its graphics part on another.

Currently, various graphical environments are used to work with Sage. The Sage console is typically used for a variety of narrow tasks, such as: building your own mathematical web applications, debugging code, converting files to different formats.

The main source of data and communication resource is the SMC User Forum. A developer forum has recently opened after SMC’s final transition to open projects. Active communication occurs in the Gitter chat; created a FAQ on Github.

The principle of working at CoCalc is to create individual or group projects, fill them with training resources and work with individual resources or a group of resources at the same time. The system also preserves user actions, which are displayed in chronological order. It is possible to display the history of work with a particular learning resource (or project) of both a specific user and a group of users. Making certain changes to each project leads to a backup of the structure of the project itself. All copies are stored in chronological order, indicating the author of the changes.

Considering the aforementioned advantages of cloud services in teaching mathematical disciplines, as well as the prospects of introducing into the learning process of the free-running CoCalc cloud service, unlike most varieties of mathematical software of other manufacturers, at the same time, it is powerful enough to provide these processes, the application of this system was selected as the subject of experimental study.

2.3 Organization and results of the experimental research

The control and experimental groups of the experimental study were formed as follows: the control groups (CG) included the students trained according to the traditional method of mathematics teachers' professional competencies formation; the experimental groups (EG) included students trained according to the author's technique for using CoCalc as a training tool for mathematics teachers' pre-service training [19].

The following components of the subject, technological and professional-practical competencies were examined: subject-pedagogical, informational-technological and mathematical competencies [19]. Each component was considered separately, and the values were calculated according to the levels: high, sufficient, average and low. For data analysis, matches (at the initial stage of the experiment) and differences (after the forming stage of the experiment) of the experimental and control group characteristics were determined according to Fisher's criterion. For this purpose, statistical hypotheses were formulated: the absence of differences between the levels of formation of the individual components of the system of professional competencies and the significance of differences between the levels of formation of selected components.

Analyzing the obtained results at the summarising stage of the experiment, it can be concluded that the levels of formation of professional competences of mathematics trainee teachers in control and experimental groups [19] coincide with the level of significance $\alpha=0,05$.

Comparing the levels of the formation of professional competencies in the control and experimental groups at the beginning of the formative stage and at the end of the experiment, one can observe an increase in the proportion of students with high and average levels of professional competence.

The analysis of the results of the forming stage of the pedagogical experiment showed that the distribution of the levels of the formation of professional competencies in the experimental and control groups of mathematics trainee teachers has statistically significant differences due to the implementation of the developed method of using the cloud service CoCalc, which confirms the hypothesis of the study.

3 Conclusions and prospects of further research

1. In the study, the key concept is substantiated: the professional competence of a mathematics teacher is the ability of a person to perform professional activities in teaching mathematics of students and to achieve certain results on the basis of knowledge, skills and personal attitude.
2. According to the results of the research, special professional competencies were identified, the formation of which is expedient with the use of cloud services, namely: ability to use professionally profiled knowledge in the field of mathematics, for the statistical processing of experimental data and mathematical modeling of natural phenomena and processes; ability to use mathematical apparatus for modeling various processes; ability to work with a computer at the level of the user and the expert in the field of ICT.

3. During the study of domestic and foreign experience, the following advantages of using cloud services of mathematical purpose were revealed: saving resources (reducing the burden on the auditor's fund, the environment, the cost of acquiring and upgrading computer hardware, software, staff salaries); mobility of access (employment as the assimilation of material at a convenient time and in a convenient place); elasticity (provision of additional computing resources at the user's request). Given the aforementioned advantages of cloud-oriented learning tools in mathematical disciplines, as well as the prospects of implementing a CoCalc cloud service in the learning process, which is freely distributed and yet powerful enough to deliver the learning goals, it is advisable to use it to support mathematics teacher competencies formation.
4. The use of cloud services leads to the emergence and development of innovative forms of learning organization focused on collaborative learning activities on the Internet. It is shown that cloud services in teaching future mathematics teachers should be used as a tools for: communication (synchronous – chats, voice and video and asynchronous – mail, forums); collaboration (accessing, sharing, and collaborating with other users); data storage and processing.
5. The areas of use of CoCalc in training math teachers are: organization of educational communication; support of individual and group forms of organization of educational activities (classroom and extra-classroom); supporting learning management; providing clarity by constructing different interpretations of mathematical models, visualization of mathematical abstractions, etc.; providing accessibility through the use of a shared interface for access to environmental assets and reliable open source software; increasing temporal and spatial mobility; formation of a unified learning environment, the content of which is developed in the learning process.

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Application of GeoGebra in Stereometry teaching

Tetiana H. Kramarenko[1[0000-0003-2125-2242]], Olha S. Pylypenko[2[0000-0003-0493-8429]] and Ivan O. Muzyka[3[0000-0002-9202-2973]]

[1] Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine
kramarenko.tetyana@kdpu.edu.ua
[2] State University of Economics and Technologies,
37A Vatutin Str., Kryvyi Rih, 50096, Ukraine
banadaolga96@gmail.com
[3] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
musicvano@gmail.com

Abstract. The purpose of the paper is to improve methodology of teaching Mathematics via the use of cloud technology. The task of the paper is to identify the issues that require a theoretical and experimental solution. The objective of the paper is the educational process in the higher education institution, the subject of the paper is modern ICT. The result of the study is the learning tools of pedagogically considered and adequate bending of conventional and modern learning environment implemented into the educational process. The possibilities of using cloud technologies and Dynamic Mathematics system GeoGebra in the educational process through Stereometry specialized training have been revealed. The use of GeoGebra Dynamic Mathematics in Stereometry teaching will favourably influence the formation of students' STEM competencies. In order to encourage Mathematics and Computer Science teachers to implement effectively the elements of STEM education, it is suggested that cloud-based learning tools such as GeoGebra be used in the teaching process.

Keywords: GeoGebra 3D Graphing Calculator, Geometry, STEM competencies, Stereometry teaching, methodology of teaching Mathematics, cloud technologies in education.

1 Introduction

Emiliya Velikova and Magdalena Petkova [5] point out that every society needs STEM professionals, talented people who design new technologies, materials, constructions and processes. One of STEM training related fields is an integrated problem-based Mathematics training.

The results of the research study regarding the development of teachers' STEM competencies have shown that most of them are not aware of the peculiarities of students' STEM competencies formation. And some contradictions between the necessity to form the students' STEM competencies and insufficient attention to the training of future teachers of Mathematics occur.

One of the most effective tools for STEM-based Mathematics teaching is the system of dynamic mathematics, e.g. GRAN 2D tool [29] and cloud-based GeoGebra [7; 11].

Zsolt Lavicza, Theodosia Prodromou, Kristof Fenyvesi, Markus Hohenwarter, Istvan Juhos, Balazs Koren and Jose Manuel Diego-Mantecón [15] claim that GeoGebra was designed to integrate arithmetic, algebra, geometry, calculus, statistics. In recent times it is supposed to support STEM subjects as a single, integrated system available on most technology platforms. Moreover, teachers and students are offered free access to it all over the world. GeoGebra was originally created to integrate Algebra and Geometry into a single environment. GeoGebra enables to use such new technologies as Augmented [27] and Virtual Reality [16], 3D Printing [9] and mobile learning [18] in the learning Mathematics.

The use of GeoGebra Dynamic Mathematics in Stereometry teaching will enhance the formation of students' STEM competencies. It can also be helpful in the formation of key mathematical and digital competences [1], self-study competences, as well as in the development of spatial thinking.

In order to encourage Mathematics and Computer Science teachers to implement the elements of STEM education, it is suggested the cloud-based learning tools [17], such as GeoGebra, be used in the learning process.

2 Materials and methods

According to the recommendation of the European Commission [3, p. 7], competence is defined as a combination of knowledge, skills and attitudes. In the updated list of key competences of a personality eight major ones are emphasized [3]. We are keen to foster the development of students' STEM competencies: mathematical competence and competence in science, technology and engineering.

Serhiy A. Rakov explores the possibilities of mastering mathematical competencies in the learning by future teachers through the research approach using the system of dynamic mathematics DG [19]. The scientist distinguishes procedural, logical, technological, research and methodological competencies of Mathematics teacher. In particular, methodological competence implies the ability to assess the appropriateness of using mathematical methods to solve individual and social issues.

Consider in detail the opportunities which GeoGebra gives to a teacher. Markus Hohenwarter, Judith Hohenwarter, Yves Kreis and Zsolt Lavicza [10] emphasize a significantly important role of free open-source software for teaching mathematics world-wide. Open-source software do not only offer opportunities for teachers and students to use them both at home and in the classroom without any restrictions, but they also provide the tools for developing support and user communities reaching across borders. Such collaboration as well contributes to the equal access to technological resources and democratization of learning and teaching mathematics.

GeoGebra is available in multiple languages. Using GeoGebra a teacher can create interactive materials to solve the main tasks of teaching Geometry – the development of spatial imagination, practical understanding and logical thinking.

GeoGebra can be used both in standalone and online modes on mobile Internet devices (MID) which offer new opportunities to improve learning and teaching either inside or outside of classrooms [28]. Further advantage of GeoGebra is the Resources tab containing a number of teaching materials: textbooks, articles, instructions, and illustrations. Also, a registered users can share their own educational materials on the official website via GeoGebraTube (this is a kind of file-sharing site). Its essential feature is that the created dynamic constructions can be accessed online via the use of View Sheet tool. Any user is allowed to comment on GeoGebraTube content.

A user is provided with a possibility to create their own GeoGebraBook, a folder where selected materials can be added and subfolders can be created. A user can publish a game, a collection of visuals, lesson workbook that may include text messages, GeoGebra models, web pages, questions, videos, images and manuals public to anyone. GeoGebraTube content can be shared via social networks Facebook, Twitter, emailed and uploaded to Google Drive. Cloud-based tools affect favourably teacher-student interactions in an informal learning environment.

Ljubica Diković statistically confirms the fact that the use of GeoGebra applications in learning calculus had a positive effect on the development of students' reasoning and visualization skills [4].

The issues of using GeoGebra are highlighted in the research studies of Olena V. Semenikhina [24], Maryna H. Drushliak [23], Natalya V. Rashevska [20] and others. Application of GeoGebra 5.0 to the solution of solid geometry problems has been analyzed in the article [23]. Examples of solid geometry problems with detailed solution and learning clues have been presented. Among them there are problems on auxiliary section, polyhedron net, locus problems, space transformations etc. The article [24] discusses the relevance of the study of the dynamic Mathematics software for future teachers of Mathematics in Ukraine.

Modelling implies simplifying thus providing the model with its own characteristics, independent from the original reality. Consequently, geometry, in its interpretation and processing, acts like a new reality both abstract in its logic and concrete in its representation modes.

In the article [21] the authors begin with classical theories of modelling representation processes in order to apply them to 3D dynamic geometry software, GeoGebra3D, computing development seeking to bring geometric models closer to the reality of a school setting. The authors introduce three key notions, developed from Mathematics teaching, in order to support the exploration of two interaction situations between mathematics and their teaching. Finally, they finish on a few general considerations for the teaching of mathematics.

In teaching Stereometry, the assignment worksheets on the construction of sections through the trace method, internal projection and combination method by Volodymyr A. Sydoruk [25] should be taken into consideration. Each of the assignments is provided with the possibility of step-by-step procedure of the construction building. Thus, students are given an opportunity to develop both mathematical competence and the ability to learn independently. Some assignments include constructions created on a 3D canvas.

N. F. Fariha and H. P. Lestari [6] describe in detail how to realize the Dandelin Sphere more realistically, using GeoGebra Classic 5, which supports the creation of 3D images.

At a profound methodological level, a number of assignments on combinations of geometrical solid shapes was created by Mykhailo Y. Rykovskyi [22]. These models are designed as constructions of plane geometric shapes through the use of parallel projection properties. They are intended to be used to visualize the properties of geometrical shapes. However, students might face a challenge with reproducing models as the algorithm of the construction and details of the construction are not available for them.

The models are designed as constructions of plane geometric shapes with the use of the properties of parallel projection. In particular, a book / collection of visuals covering the topic "Prism" is recommended. There is a number of visuals that represents combinations of stereometric shapes: sphere and pyramid, sphere and prism, sphere and cylinder etc. Consider the visual "There is a cone inscribed in the sphere. And there is the right triangular pyramid inscribed into the cone. A pyramid is inscribed in the sphere". Even the name itself suggests that integrity is inherent to visuals. It can be used in the process of teaching Stereometry in school or teaching Methodology of Mathematics on various topics. While using visual aids, users are advised to study the properties of shapes inscribed into the sphere, to look into the relationship between the sphere radius, radius of cone base, the height of the cone and element of the cone.

These visuals are equipped with the Checkbox tool which allows a user to do the revision and answer to the questions: Which cone is called inscribed into the sphere? What element of the cone is the center of the sphere? Which pyramid is called inscribed in the cone? Which pyramid is called inscribed into the sphere? How to find the axial section of the cone? Which circle of the sphere is called a great circle? Which properties of the diameter of the sphere perpendicular to its great circle?

3 Setting a task

Mobile applications such as Geometry, Graphing Calculator, 3D Graphing Calculator have been relatively recently launched and now they are available on the official GeoGebra website. These applications are still undergoing improvements. However, the methodology of their use, and especially in teaching Stereometry, is not yet well developed. Therefore, this paper aims at elucidating the features of creating visuals with GeoGebra and their use in teaching how to solve stereometric problems.

4 Results

4.1 GeoGebraBook "Models for Stereometric problems" as training manual on the methodology of teaching mathematics

The methodical materials of the paper authors related to the use of the GRAN software are presented in the manual "Innovative information and communication technologies of teaching Mathematics". The issue of GeoGebra use has been considered in an updated version of the manual [12]. On the GeoGebra site, users can find the materials which contain relevant visuals at GeoGebraBook “Models for stereometric tasks” [14]. One can find here problem situations to be solved by students independently, self-assessment tests.

The study of the effectiveness of the use of GeoGebra mobile applications in the process of teaching Stereometry was conducted by us within the preparation of future teachers of Mathematics during Mathematics teaching methodology classes, advanced training courses at Kryvyi Rih State Pedagogical University, in teaching students of Kryvyi Rih State College of Economics and Technologies, and students of classes with mathematical specialization of Kryvyi Rih schools.

Particular interest in using GeoGebra was shown during the advanced training courses by Kryvyi Rih teachers of Mathematics who have been working at school for a considerable time. The study was also conducted on the effectiveness of the use of GeoGebra applications by students in order to enhance students’ motivation during extra-curricular vocational activities at the university. And it was studied as well during the course of Sereometry lessons conducted by masters majoring in Mathematics education completing professional practice in secondary education institutions.

When using applications, it is useful for a student to be able to reproduce the construction in the browser window, open other temporarily hidden drawing elements in case of necessity, and receive text notifications. However, a considerable number of constructions should be created later or simultaneously with the viewing via the mobile application.

Consider the peculiarities of the implementation of specific constructions and provide recommendations concerning their use.

One of the main issues that school students and students of higher education establishments face is the recognition of a 2D drawing representing the image of a 3D shapes. In order to develop the spatial imagination of students at schools and universities it is necessary to provide them with the assignments on constructing sections of polyhedron by planes.

4.2 Construction of sections of polyhedron with plane via the applications GeoGebra Geometry and 3D graphics

Consider examples of problems for constructing a section of a polyhedron with a plane passing through three given points that are not on the same line; through a straight line and a point that does not belong to it etc. It is necessary to construct a linear angle of a dihedral angle and measure them; the angle between the straight line and the plane.

Look into what four approaches to constructing a section of a polyhedron in a plane which should be distinguished by a teacher in order to be able to provide their students with the most appropriate one for their educational trajectory.

If a student has not fully mastered GeoGebra tools, it is advisable to provide them with a sheet of paper guiding the algorithm to follow in order to build a construction. Moreover, a student should be supplied with information regarding the icons that correspond to the tools in question. It is appropriate to place QR codes on printable worksheets for demonstrations.

1. The construction on a 2D canvas is rather cumbersome and requires logically justified steps for the construction. At first, it is necessary to follow step-by-step construction procedures to build several drawings, created via "the trace method" on a 2D canvas. To intensify the material dissemination, students may be at once provided with a constructed polyhedron. However, in the course of the study, there were cases when the students constructed the polyhedron wrongly. That is, after its construction on the plane, they were not able to change it dynamically. For example, to build a prism image on a 2D canvas made of an *n*-sided polygonal base (*n*>3), it is necessary to follow the following steps. Firstly one should build an n-sided polygon via the use of the appropriate tool. Then it is preferable to build a vector along one of the edges of the prism. Further, one should apply a parallel translation of the n-sided polygon to the constructed vector. The given vertexes are connected. Such a construction is represented taking into account the properties of the parallel projection.
2. Next it is necessary to compare the previous drawing with the one presented according to the same problem situation but on the 3D canvas. In this case, all straight lines for the construction of the section can be presented step by step. The advantages of such a construction include the possibility to change the constructed polyhedron dynamically and the location of points which the secant plane passes through. Via the GeoGebra 3D Geometry [8] app, one can simulate external actions aimed at geometrical solid shapes which are necessary for a student to be able to apply internal thinking regarding them and as a result develop spatial thinking. In our opinion, this approach is the most appropriate for the development of students' spatial imagination, logical thinking. In Fig. 1 the construction of the section of the pyramid with a secant plane which passes through the point on the lateral edge and a straight line drawn in the plane of the base is presented.

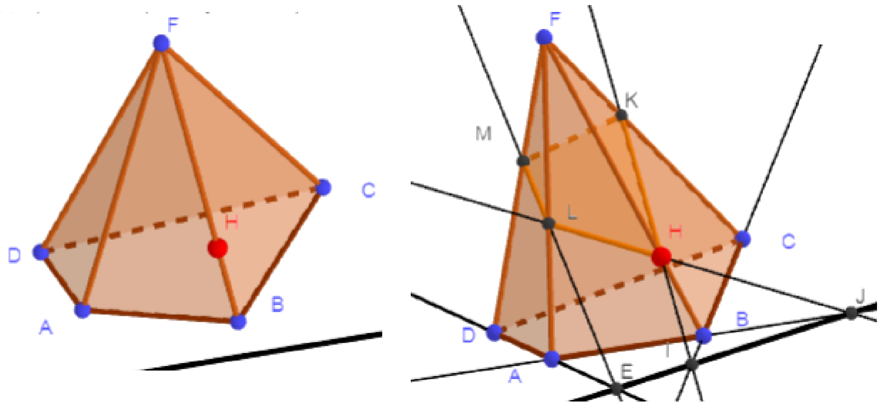

Fig. 1. Construction of a section of the pyramid with a plane.

3. The third option for constructing a section on the 3D canvas. Firstly, a polyhedron, and a secant plane should be built, and then the tool "Intersection of two surfaces" should be applied. A student, by "turning" the polyhedron, will have an opportunity

for the better perception and understanding of the construction. The approach in question is appropriate when augmented reality tools are used enabling to align the drawings with the image of a real object [13]. It is advisable to encourage students to find examples of such sections among the surrounding objects, in architecture etc.

4. The use of both 2D and 3D canvases simultaneously. Such a combination is advisable if there is some kind of difficulty in constructing a polygon that is for a base of the pyramid or specifying the position of the vertex of the pyramid, etc. For instance, if a trapezoid, in particular, a rectangular or equilateral one, is for a base of the pyramid or prism. Or, for example, the vertex of a pyramid is projected into one of the top of the base or to the side of the base (see Fig. 2).

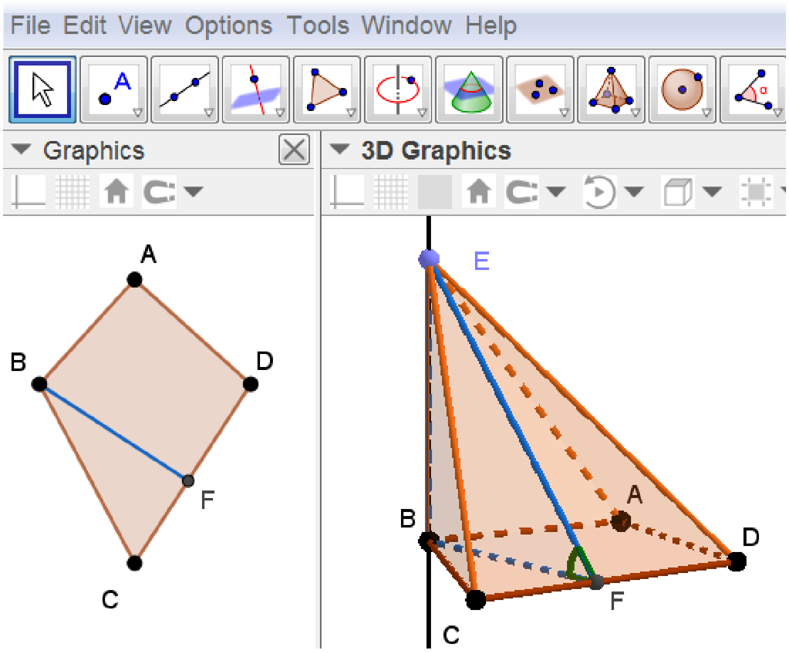

Fig. 2. Pyramid, two faces of which are perpendicular to the plane of the base.

It is worth pointing out that such constructions can only be built in the classic version of GeoGebra, and the construction preview may also be available via MID after uploading the file to the GeoGebra cloud repository.

4.3 The peculiarities of the definition and angle construction between planes and linear angle of the dihedral angle

Via the assistant of GeoGebra (3D canvas) it is possible to build the base of the pyramid (OXY) on the canvas, and in the process the constructions can be synchronously displayed on the 3D canvas (see Fig. 2, Fig. 3).

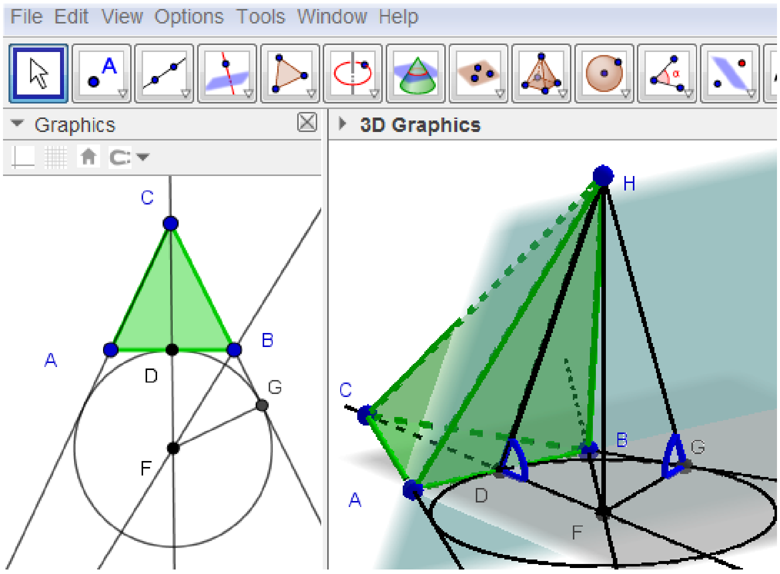

Fig. 3. Image of the pyramid and linear angles.

Attention should be drawn to the convenience and ease of the construction with the help of the linear angle of the dihedral angle at the base. According to the definition, to determine the linear angle of the dihedral angle at the base a plane perpendicular to the edge of the dihedral angle should be drawn. Then the angle between the rays formed as a result of the intersection of this plane with the edges of the dihedral angle will determine its linear angle (see Fig. 2) [2].

It should be stated that the measure of the angle between the planes varies from 0˚ to 90˚. While the measure of the dihedral angle can vary from 0˚ to 360˚ [22]. Here is an example of the problem from the textbook with major in Mathematics (No. 836, [2, p. 162]).

At the base of the pyramid there is an isosceles triangle with angle β at the vertex and radius R of the circle described. The plane of each face of the pyramid forms an angle α with the plane of the base. Find the area of the side surface.

It is recommended to use 2D and 3D canvases simultaneously to represent the drawing corresponding to the set problem [14].

The reason why mistakes are often made is that only one case is under consideration. Whereas the concept of "angle between the plane of the lateral face and the plane of the base" is substituted by "dihedral angle at the base". If the problem situation said that "dihedral angles at the base were congruent", then we would consider the pyramid the vertex of which is projected into the center of the circle inscribed into the triangle of the base (Pyramid of Type 1).

Since it concerns only congruent angles between planes, the problem will have two solutions. It is also necessary to take under consideration the case when one of the dihedral angles at the edge of the base is obtuse (Pyramid of Type 2). In this case, the vertex of the pyramid is projected into the center of the inscribed circle lying outside (see Fig. 3).

Using the problem mentioned above and similar ones we have conducted a research on the basis of the two 11th grade classes specialized in Mathematics, and in particular with the teachers of Mathematics Svitlana Shahmatova and Ruslan Kaluhin [12, p. 439-445]. 16 students of the experimental group (EG students) and 18 students of the control group (CG) have participated in the research. The similar research has also been conducted at the advanced training courses among the teachers of Mathematics in Kryvyi Rih State Pedagogical University (group 1 – 22 teachers, group 2 – 26 teachers). Some teachers among the participants of the courses did not teach students in high school that is why they do not deal with solving these very problems in their teaching.

The suggested questionnaire consisted of several questions and corresponded mainly to the Pyramid of Type 2. The participants were supposed to deal with the questions during the problem solving. Alongside the questionnaire we present the results of the survey.

1. On reading the problem situation, have you distinguished two types of the Pyramid?

A positive answer: EG – 1 student (6%), CG – no students (0%), group 1 – 5 teachers (23%), group 2 – 6 teachers (23%).

2. The participants received a clue about the way it is possible to construct the Pyramid with the obtuse dihedral angle at the base (Pyramid of type 2). The question was the following: Is it possible to construct the vertex of the pyramid projection on the plane base and in fact the Pyramid itself?

A positive answer: EG – 6 students (28%), CG – 5 students (28%), group 1 – 12 teachers (55%), group 2 – 13 teachers (50%).

3. First, a dynamic model, constructed with GeoGebra, was demonstrated to the participants. The algorithm of the Pyramid construction via the use of the tool GeoGebra Construction Steps was displayed. The task was to construct the Pyramid of Type 2 and create a problem solving algorithm individually. Next, a paper Pyramid model was demonstrated to the participants. The algorithm of the construction was discussed. The task was to construct the Pyramid of Type 2 and create a problem solving algorithm.

A positive answer: EG – 12 students (75%), CG – 8 students (44%), group 1 – 19 teachers (86%), group 2 – 17 teachers (65%).

Fisher's angular transformation [26] was used for the research results processing. For this purpose, the task performance proportions in the groups during the first and second stages were compared.

φ(EG, CG) = 0,61 < 1,64; φ(group1, group2) = 0,31 < 1,64: the received results do not differ considerably both in the groups of students and teachers.

After stage 3, the proportions of successful task performance in groups were compared one more time. φ(EG, CG) = 1,85 > 1,64; φ(group1, group2) = 1,73 > 1,64: the results differ significantly this time.

It has been defined that the use of dynamic models created with GeoGebra was more effective in comparison with the static paper ones.

On discussing the use of dynamic models created with GeoGebra, participants pointed out the following advantages: variability; dynamic visuals which enhance the development of spatial imagination; multiple reproducibility of the construction, which will contribute to the development of algorithmic thinking.

4.4 Tasks on combinations of polyhedron and solids of revolution

Consider the way it is possible to inscribe a sphere into the right rectangular pyramid via the use of 3D Geometry. In order to construct the base of the pyramid, it is necessary to use the Right Polygon tool, by pointing two points on the 3D canvas – adjacent vertexes of the base, and indicating that the right polygon has 4 vertexes. Then one should construct the diagonals of the square (the Segment tool) and define the center (Intersection point). Then through the center of the square, which is also the center of the circle inscribed in the square, one draws a straight line perpendicular to the plane of the square. On this straight line, one chooses an arbitrary point (Point on the object) and constructs a polyhedron (Pyramid). The perpendicular to the plane of the square straight line is the geometric location of points, equidistant from the sides of the base of the right pyramid.

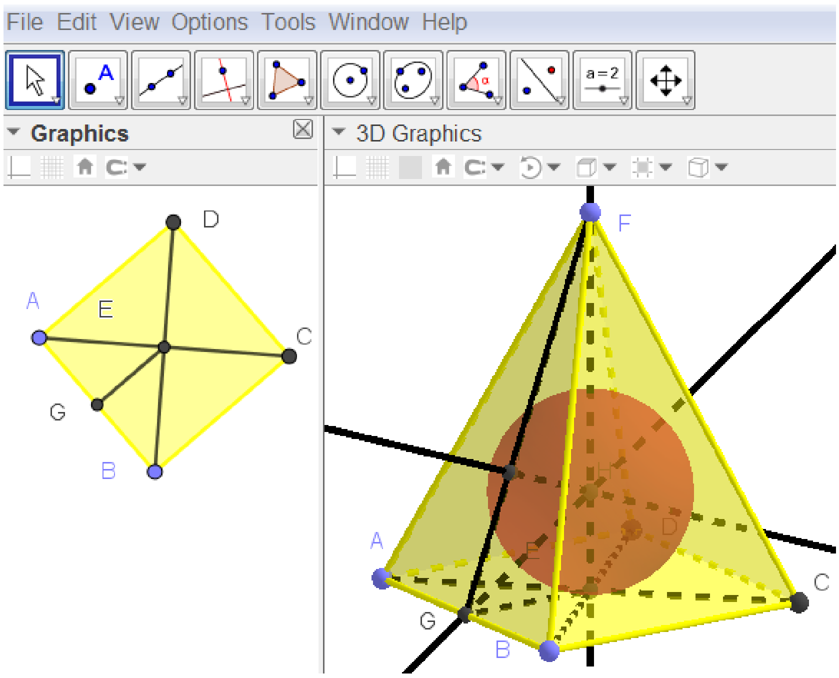

Fig. 4. The sphere inscribed in the pyramid.

To determine the position of the center inscribed sphere in the pyramid, one constructs a geometric location of points that are equidistant from the edges of the dihedral angle at the base of the pyramid. Since there is no construction of the bisector plane in the GeoGebra tools, it is necessary to construct a linear angle of the dihedral angle at the base and then bisector of the very angle. The plane passing through the vertex of the pyramid perpendicular to the edge of the base is built (Plane through the point perpendicular to the straight line; Intersection point). Instead of a plane, it is possible to draw a straight line from the vertex of the pyramid perpendicular to the edge of the base (straight, perpendicular to straight). Next, one should find the intersection point of the constructed plane / perpendicular with the edge of the base (Intersection point of the straight line and the plane / Intersection point of two straight lines). Then one builds the bisector of the obtained linear angle.

The point of its intersection with the perpendicular to the base of the pyramid, drawn from the top of the pyramid, will determine the center of the inscribed sphere (Point of intersection). Finally, one constructs the inscribed sphere (Sphere outside the center and radius) (see Fig. 4), specifying in sequence the center of the sphere and the point of intersection of the diagonals of the square.

For better understanding and mastering of the algorithm the construction of the sphere inscribed around the pyramid the students setting of the canvas are adjusted to be able to show the step-by-step procedure of the construction.

5 Conclusions and prospects for further research

1. The use of dynamic geometry software GeoGebra as a modeling tool makes it possible for scientific experimental logic to engage students in discovering new mathematical facts. Teachers who are concerned by the issues of instrumented learning help to create activities which imply that the main students' motivation is in the understanding of mathematical concepts.
2. In the process of Stereometry teaching, it necessary to divide the students into subgroups according to the type of spatial thinking. This will contribute to the implementation of the individual approach to the development of the spatial imagination, taking into account individual peculiarities, gradually complicating the task, supplementing the teaching material with visual aids, focusing on the practical application of knowledge. Actions with the models created with GeoGebra serve as an intermediate link between external actions with geometrical solid shapes and internal mental processes. Thinking must precede the external ones to engage and develop a person's imagination.
3. In order to increase the efficiency of the perception and assimilation of stereometric material, to overcome the difficulties in transcoding the symbols of a spatial body and to create an adequate spatial image, it is necessary to supplement the theoretical material with multimedia demonstration models created by the means of ICT, to encourage students and to engage them in the process of creating such models for classes independently. After all, the acquisition of mathematical competence depends not on memory, but on the activity in which the person is involved, on the system of mental operations that they perform in the process of knowledge acquisition.

4. In general, the result of the research study is the improvement of teaching methods of Mathematics via the use of cloud technologies, the implementation in the educational process of methodological materials of pedagogically balanced and appropriate blending of traditional and innovative learning tools, which contribute to the intensification of teachers' readiness for the use of STEM training in teaching.

In the future, it is necessary to explore the conditions for the effective use of other GeoGebra mobile applications in STEM learning.

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