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(Eds.)

CTE 2018

Cloud Technologies in Education

Proceedings of the 6th Workshop, CTE 2018

Kryvyi Rih, Ukraine
December 21, 2018

Kiv, A.E., Soloviev, V.N. (Eds.): Cloud Technologies in Education. Proceedings of the 6th Workshop CTE 2018, Kryvyi Rih, Ukraine, December 21, 2018, CEUR-WS.org, online

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CTE 2018 – How cloud technologies continues to transform education

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Abstract. This is an introductory text to a collection of papers from the CTE 2018: The 6th Workshop on Cloud Technologies in Education, which was held in Kryvyi Rih, Ukraine, on the December 21, 2018. 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 environments, cloud ontologies, cloud services for learning foreign language, cloud technologies in STEAM education.

1 CTE 2018 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:

- 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.

Fig. 1. CTE 2018 Local Organization Committee:
Iryna S. Mintii, Pavlo P. Nechypurenko,
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- 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 6th Workshop on Cloud Technologies in Education (CTE 2018), held in Kryvyi Rih, Ukraine, in December 21, 2018. It comprises 36 contributed papers that were carefully peer-reviewed and selected from 59 submissions. Each submission was reviewed by at least 3, and on the average 3.4, program committee members. The accepted papers present the state-of-the-art overview of successful cases and provides guidelines for future research.

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

2 Session 1: Digital transformation of learning

Elena H. Fedorenko, Vladyslav Ye. Velychko, Andrii V. Stopkin, Alona V. Chorna and Vladimir N. Soloviev [5] focuses on the special significance of education informatization as the main aspect of the existence and development of a modern higher education. The process of computerization of education is considered as the main basis of informatization in the historical aspect. This paper emphasizes the importance of implementing ICT in the learning process of free software and the interest of scientists in the field of education. The author’s focus is on the importance of the acquired skills and abilities as a result of informatization of education and implementation of the educational process of ICT. It is acknowledged that the practice of implementing ICT in the educational process of higher educational institutions are expanding every day and yields only positive results. It is noted that educational activity based on the use of ICT is a basis for changing the structure of the educational process for both teachers and students.

Andrey I. Kupin, Olena V. Tarasova, Tetiana S. Sulyma, Svitlana V. Sokolova, Ivan O. Muzyka and Vitaliy V. Tron [14] are analyzed the professional thinking issues. The authors pointed that the technical thought concepts, images and practical actions are in a complex and dynamic interaction with each other. The regression analysis of the students’ academic progress indicators who are trained by the traditional and innovative methodology with forming influence is conducted in the article. Analysis of thinking activity development levels in the process of professional tasks solving performed by the students of the control and experimental groups demonstrated the straight-line correlation dependence of the professional thinking development on the organization of professional activity in general and the training organization in particular.

Nataliia P. Volkova, Nina O. Rizun and Maryna V. Nehrey [35] concerns the issue of data science tools implementation, including the text mining and natural language processing algorithms for increasing the value of high education for development modern and technologically flexible society. Data science is the field of study that involves tools, algorithms, and knowledge of math and statistics to discover knowledge from the raw data. Data science is developing fast and penetrating all spheres of life. More people understand the importance of the science of data and the need for implementation in everyday life. Data science is used in business for business analytics and production, in sales for offerings and, for sales forecasting, in marketing for customizing customers, and recommendations on purchasing, digital marketing, in banking and insurance for risk assessment, fraud detection, scoring, and in medicine for disease forecasting, process automation and patient health monitoring, in tourism in the field of price analysis, flight safety, opinion mining etc. However, data science applications in education have been relatively limited, and many opportunities for advancing the fields still unexplored.

Anastasiia V. Tokarieva, Nataliia P. Volkova, Inesa V. Harkusha and Vladimir N. Soloviev [31] highlights the potential of social media, ICT, mobile technologies and applications as tools for communication, interaction, building up social skills and unique learning environments. One of the latest trends observed in education is an attempt to streamline the learning process by applying educational digital games. Despite numerous research data, that confirms the positive effects of digital games, their integration into formal educational contexts is still relatively low. The purpose of this article is to analyze, discuss and conclude what is necessary to start using games as an instructional tool in formal education. In order to achieve this aim, a complex of qualitative research methods, including semi-structured expert interviews was applied. As the result, the potential of educational digital games to give a unique and safe learning environment with a wide spectrum of build-in assistive features, be efficient in specific training contexts, help memorize studied material and incorporate different learning styles, as well as to be individually adaptable, was determined. At the same time, the need for complex approach affecting the administration, IT departments, educators, students, parents, a strong skill set and a wide spectrum of different roles and tasks a teacher carries out in a digital game-based learning class were outlined. In conclusion and as a vector for further research, the organization of Education Design Laboratory as an integral part of a contemporary educational institution was proposed.

Olga P. Pinchuk, Oleksandra M. Sokolyuk, Oleksandr Yu. Burov and Mariya P. Shyshkina [23] highlights the peculiar features of digital environment include: integration of ICTs; use of local and global networks and resources; support and development of qualitatively new technologies of information processing; active use of modern means, methods and forms of teaching in the educational process. Today, tools and technologies of the information and communication networks (ICNs), in particular the Internet, which custom and operational-procedural properties were changed at the initial stage from closed local to open ones at present, become widespread. The development of ICNs (from closed local to open ones) changes the typology of learning environments. The following models of learning environments, which widely use ICT and ICN tools (with basic features that characterize them) are distinguished: using the local communication network for presentation of educational information; using the local communication network and open network resources; using open network resources; for independent use of open network resources directly in the classroom by a student; for use of open network resources by a student in the process of independent learning activity; for use by a student educational resources, specially created by a teacher, as well as resources of an open networks in his independent learning activity.

Olena O. Lavrentieva, Lina M. Rybalko, Oleh O. Tsys and Aleksandr D. Uchitel [15] discovers the possibilities and classification of ICTs and tools that can be used in organizing students' independent study activities of higher education institutions has been explored. The analysis of the information and technological approaches to the organization of students' independent study activities made it possible to determine the means of realization of the leading forms of organization for this activity (independent and research work, lectures, consultations and non-formal education), to characterize and classify the ICTs and tools that support presentation of teaching materials, electronic communication, mastering of learning material, monitoring of students' learning and cognitive activity, such as ones that serve for the sake of development and support of automated training courses, systems of remote virtual education with elements of artificial intelligence, which implement the principle of adaptive management of learning and the organization of students' independent study activities. The paper provides the insight into the essence of the conducted investigation on the assesses of the effectiveness of ICTs and tools in the process of organizing students' independent study activities.

Oleksandra I. Yankovych, Volodymyr M. Chaika, Tetiana V. Ivanova, Kateryna M. Binytska, Iryna I. Kuzma, Oksana T. Pysarchuk and Halina I. Falfushynska [36] substantiates the technology of forming media literacy of senior preschool children in the establishments of preschool education of Ukraine. In the article, the features of preschool media education have been determined, the problems in implementation of media education in preschool establishments have been identified and the prospects for their solution have been determined. It has been proved that preschool age is sensitive for the formation of critical thinking. The concept of "preschool media education" as part of the educational process has been characterized by the three-component structure.

Hryhorii V. Tereshchuk, Iryna I. Kuzma, Oleksandra I. Yankovych and Halina I. Falfushynska [30] substantiates the relevance of implementing the technology of formation of a successful personality of a primary school age pupil during media education implementation at primary school. In the article, a technology model is developed; the necessity of solving problems of success simultaneously with increasing the level of media culture of a pupil, the formation of key competencies for life, preparation of a child for the life's self-realization on the basis of the partnership implementation of schoolchildren, parents and teachers is proved; the need of the embodiment of the pedagogy of heart and the pedagogy of success is shown; the diagnostic toolkit for determining the levels of formation of the successful personality of primary school pupils is specified.

3 Session 2: Cloud-based learning environments

Maiia V. Popel and Mariya P. Shyshkina [25] analyzes the current stage of educational studies of the cloud-based learning systems. The relationship between the notions of the cloud-based learning system and the cloud-based learning environment are investigated. It is shown that in the research literature there is no single interpretation of the concept of a cloud-based system for educational purposes. Still the number of basic approaches to the interpretation of the concept under investigation are revealed. The first approach is based on the understanding of the system, as a set of cloud services or cloud-based technologies. The second approach is to consider a separate cloud service as a cloud-based learning system. In this case, the cloud service tools should include such components that cover the content, the tools, the forms and the methods of learning. The structure of the cloud-based learning system within the interpretation of the latest works of Ukrainian researchers is considered.

The article of Yuliya H. Nosenko, Maiia V. Popel and Mariya P. Shyshkina [20] deals with the problems of using adaptive cloud-based learning systems in the modern high-tech educational environment and expanding access to them as tools of educational and research activity at higher education pedagogical institutions in Ukraine. The conceptual apparatus of cloud-based adaptive learning systems application and design is considered; their main characteristics are revealed; the ways of their pedagogical application are described. The experience of Institute of Information Technologies and Learning Tools of NAES of Ukraine on designing and applying of the cloud-based learning and research environment is outlined. The results of the survey on using adaptive cloud-based learning systems are presented. It is established that in the near future adaptive cloud-based learning systems will become the driving force behind the development of new pedagogy, new strategies for personalizing education, and expanding opportunities for active learning.

The article of Oleksandr H. Kolgatin, Larisa S. Kolgatina, Nadiia S. Ponomareva and Ekaterina O. Shmeltser [13] deals with the problem of out-of-class students' independent work in information and communication learning environment based on cloud technologies. Results of appropriate survey among students of pedagogical university are discussed. The students answered the questions about systematicity of their learning activity and propositions for its improving. It is determined that the leading problems are needs in more careful instruction according to features of the task completing, insufficient experience in self-management, the lack of internal motivation. Most of all, students recommend to provide the tasks with detail instruction (oral or written) and to pay attention to careful planning the time that is necessary for full completion of the task. It is pointed that such complicated requirements can be satisfied only by complex use of information and communication technologies as well as the automated system of pedagogical diagnostics. Some requirements for management of students' out-of-classroom independent work are formulated as a result of this discussion.

Anna V. Iatsyshyn, Valeriia O. Kovach, Yevhen O. Romanenko and Andrii V. Iatsyshyn [9] highlights the need to modernize preparation of future PhDs, caused by challenges of new information, globalized society and digital transformation of all spheres of life, including education and science. Concepts of "cloud computing", "cloud technologies", "cloud learning technologies", "cloud services", "cloud oriented environment" were analyzed. Experience of cloud technologies and their services application in educational and scientific space in researches of foreign and Ukrainian students was considered. Ukrainian experience in preparation of future PhD of various specialties with cloud services application was analyzed. It was emphasized that approaches improving to preparation of future PhDs based on cloud services application would increase their level of digital competence. It is recommended to include a separate course or module of specific discipline on work with cloud technologies and services during preparation of future PhDs. It is important to improve disciplines and tools content to support education process. It can be learning of disciplines using cloud technologies or services by future PhD's. Also, cloud services application to support scientific and scientific-organizational activities will increase level of organization and implementation of scientific research. It is important to create cloud-oriented environment for preparation of future PhDs in higher education and research institutions. Making cloud-oriented educational and scientific environment should be based on principles of open education. It is recommended to use cloud-based platforms and services (G Suite for Education; Microsoft Office 365; specialized SaaS (CoCalc or other)).

4 Session 3: Cloud ontologies

The article of Ivan M. Tsidylo, Hryhoriy V. Tereshchuk, Serhiy V. Kozibroda, Svitlana V. Kravets, Tetiana O. Savchyn, Iryna M. Naumuk, Darja A. Kassim [32] deals with the problem of the methodology of designing computer ontology of the subject discipline by the future teachers-engineers in the field of computer technologies. The scheme of ontology of the subject discipline is presented in which the set of concepts of the future computer ontology and the set of relations between them are represented. The main criteria of the choice of systems of computer ontologies for designing computer ontology of the subject discipline: software architecture and tools development; interoperability; intuitive interface are established. The selection of techniques for designing ontologies using computer ontology systems is carried out. The algorithm of designing computer ontology of the subject discipline by the future teachers-engineers in the field of computer technologies is proposed.

Yevhenii B. Shapovalov, Viktor B. Shapovalov and Vladimir I. Zaselskiy [28] investigates the approach to systematization of scientific information based on the ontological IT platform Transdisciplinary Ontological Dialogs of Object-Oriented Systems (TODOS). It has been proposed to select semantic characteristics of each work for their further introduction into the IT platform TODOS. An ontological graph with a ranking function for previous scientific research and for a system of selection of journals has been worked out. These systems provide high performance of information management of scientific information.

Viktor B. Shapovalov, Yevhenii B. Shapovalov, Zhanna I. Bilyk, Artem I. Atamas, Roman A. Tarasenko and Vitaliy V. Tron [27] propose to use graph-generators and graph-visualizers of the TODOS IT platform for taxonomization of educational materials. A separate aspect of the TODOS IT platform is the possibility of using a centralized web-oriented learning environment. Creation of the system and transdisciplinary knowledge is a problem of modern education, which can be solved by creating a centralized web-oriented educational environment. Using this approach is an important part of the learning process. Such a centralized web-oriented environment based on the ontological approach involves filling, adaptive educational services with information resources that reflect the conceptual system of a particular discipline. The paper presents specific developments of one centralized web-oriented educational environment can be used to teach different subjects such as biology, chemistry, Ukrainian language and literature, using the STEM approach.

5 Session 4: Cloud services for learning foreign language

Alona M. Prykhodko, Oksana O. Rezvan, Nataliia P. Volkova and Stanislav T. Tolmachev [26] discusses the use of a Web 2.0 technology tool – educational blog – in the system of teaching foreign languages for enhancement of teaching effectiveness and optimization of students' performance. The authors describe the content, characteristics and didactic properties of an educational blog as an alternative or auxiliary educational environment, define its methodological objectives and list a number of advantages of this approach versus conventional teaching model. The effectiveness of the above-mentioned Web 2.0 technology tool was confirmed by the experiment which showed that an educational blog integrated in a foreign language teaching system contributed to optimization of the process of teaching and learning, development of foreign language communicative competence of students and thereby allowed them to acquire not only communicative but also technological skills.

The article of Svitlana M. Amelina, Rostyslav O. Tarasenko and Albert A. Azaryan [1] deals with the innovative approach to the organization of the information training of translators. The proposed approach will ensure not only the formation of information competence of future translators, but also the formation of an individual information and technology case of the translator. The components of an individual information and technology case are determined. They may include electronic terminology databases, translation memory databases for use in automated translation systems, databases of electronic links to terminological resources network, databases of electronic links to corpora of parallel texts. The using information and technology case of the translator as one of the diagnostic tools for evaluating the information competence level of the translator is proposed. It was found that the creating information and technology case is effective in developing information literacy and improving information technology skills.

Olena O. Pavlenko, Oksana Ye. Bondar, Bae Gi Yon, Choi Kwangoon, Nataliia S. Tymchenko-Mikhailidi and Darja A. Kassim [22] presents an overview of free online resources, mobile apps, and other opportunities available for an independent study of a foreign language (based on the examples of English and Korean languages) in group and individual settings, geared towards increasing a foreign language competence. Initially, the authors formulated the criteria for selecting free online resources: the resource should be convenient for independent work; the resource should be available at any convenient time; it should be easy in navigation; it should provide opportunities for improving as many components of a foreign language competence as possible; preferably, the resource should have online as well as offline mobile apps. It is suggested to classify free online resources based on their functional characteristics. Various opportunities of the available resources are highlighted and the expediency of their utilization for specific objectives (i.e., advancement of foreign language competence in listening, reading, writing, speaking; the expansion of the vocabulary, etc.) is substantiated. The authors also emphasize free online opportunities of preparation for international examinations not only in the English language, such as TOEFL or IELTS, but also in the Korean language, such as TOPIK, by using online resources in English.

Olha V. Chorna, Vita A. Hamaniuk and Aleksandr D. Uchitel [4] highlights the use of YouTube on lessons of practical course of German language as the first and second language at the pedagogical university. The article represents the results of theoretical analysis of content on the subject of its personal- and didactic-definite orientation, as well as some aspects of the practical use of commonly used YouTube video materials in the process of teaching German as the first or second foreign language in higher education, namely at the pedagogical university. Taking into account the practical experience of using the materials of several relevant thematic YouTube channels with a fairly wide constant audience, a concise didactic analysis of their product is presented and recommendations on converting video content into methodological material in the framework of practical course of German language by future teachers are offered. Due to the suggested recommendations, the following tasks can be solved: enrichment of the vocabulary; semantization of phraseological units, constant figures of speech, cliché; development of pronunciation skills; expansion of linguistic competence; improving listening and speaking skills; increasing motivation to learn, etc.

Viktoriia O. Ustinova, Svitlana V. Shokaliuk, Iryna S. Mintii and Andrey V. Pikilnyak [33] discuss the modern techniques of organizing computer support for future teachers' independent work in German language. The article summarizes the experience of organizing computer support for future teachers' independent work and the substantive and methodological features of its implementation into the process of experimental introduction of the Moodle course "Foreign (German) Language" into the educational process carried out on the basis of Kryvyi Rih State Pedagogical University (Ukraine).

Rostyslav O. Tarasenko, Svitlana M. Amelina and Albert A. Azaryan [29] shows the current trends in the translator training, which reflect the orientation towards the use of cloud-based automated translation systems. The possibilities of studying cloud-based translation systems in the educational process of training the translator are considered. The role of mastering modern translation tools for forming information competence of translators, particularly technological component, was described. The definition of the list and type of basic translation tools that should be mastered in the studying process was discussed. These tools should include automated translation systems and terminological management systems. It is advisable to provide for the study of both desktop and cloud-based systems. The inclusion in the content of the training translators the study of cloud-based systems of automated translation after desktop systems is proposed. A number of advantages of cloud-based translation systems for the use in the process of training the translators is defined and substantiated. A comparative analysis of the functional of cloud-based automated translation systems (Wordfast Anywhere, XTM Cloud, and MemSource) with the aim of including them in the content of the training program for translators has been carried out.

6 Session 5: Cloud technologies in STEAM education

Liudmyla I. Bilousova, Liudmyla E. Gryzun, Daria H. Sherstiuk, Ekaterina O. Shmeltser [2] represents the authors' cloud-based complex of computer dynamic models and their transdisciplinary facilities. Proper theoretical background for the complex design is elaborated and the process of the computer models development is covered. The models in the complex are grouped in the sections according to the curriculum subjects (Physics, Algebra, Geometry, Biology, Geography, and Informatics). Each of the sections includes proper models along with their description and transdisciplinary didactic support. The paper also presents recommendations as for using of the complex to provide holistic learning of Mathematics, Science and Informatics at secondary school. The prospects of further research are outlined.

The article of Arnold E. Kiv, Olexandr V. Merzlykin, Yevhenii O. Modlo, Pavlo P. Nechypurenko and Iryna Yu. Topolova [12] deals with the possibilities of using specialized (virtual labs and simulators, software for natural process simulation) and general (programming languages and libraries, spreadsheets, CAS) software in school researches. Such software as virtual labs, software for natural process simulation, programming languages and libraries in school researches can be used to simulate phenomena that cannot be learned in a school lab (for example, for modeling a radioactive decay or for demonstrating the states of relativistic mechanics). Also, virtual labs in school practice are usually used in those cases where students cannot perform an experiment in real labs. For example, it is convenient for distance learning. The using of programming languages and libraries in physics learning research requires both students' physics research competencies and programming competencies. That is why using this software in physics classes can hardly be recommended. However, programming languages and libraries can become a powerful tool for the formation and development of research competencies of physics students in extracurricular learning activities.

Andriy I. Herts, Ivan M. Tsidylo, Nataliia V. Herts and Stanislav T. Tolmachev [7] describes the cloud service ThingSpeak as a tool for monitoring and estimates the atmospheric air pollution. The main components of open instruments of environmental monitoring were implemented via microcontroller development system – Teensy 3.2, sensor module (temperature, humidity, pressure) BME280, SenseAir S8 carbon dioxide sensor module, PMS3003 air pollution sensor, Wi-Fi module ESP-01 and online ThingSpeak platform for storing and processing data. The prototype of an open source software system is developed, which, due to its openness, integration capabilities, ease of design and informativeness, provides monitoring of the human respiratory zone in two districts of the city of Ternopil on the content of suspended particulate matter PM10 and PM2.5. The estimation of the influence of sources of pollution on the level of content suspended particulate matter in the atmospheric air was carried out with the help of multidimensional statistical methods, in particular using statistical procedure by principal component analysis, which allowed to process a large set of data and to obtain information on quantitative indicators and the nature of pollution. The analysis of particulate matter contents in the context of the cloud computing concept reflects the real-time monitoring metrics through the ThingSpeak services, which serves as a place not only for collecting, analyzing data, but also for discussing the results, thereby training students-biologists to monitor the quality of the surface layer of the atmosphere.

The article of Olga V. Bondarenko, Olena V. Pakhomova and Vladimir I. Zaselskiy [3] is devoted to the topical issue of the cloud technologies implementation in educational process in general and when studying geography, in particular. The authors offer a selection of online services which can contribute to the effective acquisition of geographical knowledge in higher school. The publication describes such cloud technologies as Gapminder, DESA, Datawrapper.de, Time.Graphics, HP Reveal, MOZAIK education, Settera Online, Click-that-hood, Canva, Paint Instant. It is also made some theoretical generalization of their economic, technical, technological, didactic advantages and disadvantages. Visual examples of application are provided in the article. The authors make notice that in the long run the technologies under study should become a valuable educational tool of creation virtual information and education environments connected into common national, and then global, educational space.

Ihor V. Kholoshyn, Iryna M. Varfolomyeyeva, Olena V. Hanchuk, Olga V. Bondarenko, Andrey V. Pikilnyak [11] discuss the Earth remote sensing data as one of the basic directions of Geo-Information Science, a unique source of information on processes and phenomena occurring in almost all spheres of the Earth geographic shell (atmosphere, hydrosphere, lithosphere, etc.). The authors argue that the use of aerospace images by means of the information and communication technologies involvement in the learning process allows not only to increase the information context value of learning, but also contributes to the formation of students' cognitive interest in such disciplines as geography, biology, history, physics, computer science, etc. It has been grounded that remote sensing data form students' spatial, temporal and qualitative concepts, sensory support for the perception, knowledge and explanation of the specifics of objects and phenomena of geographical reality, which, in its turn, provides an increase in the level of educational achievements. The techniques of aerospace images application into the modern school practice have been analyzed and illustrated in the examples: from using them as visual aids, to realization of practical and research orientation of training on the basis of remote sensing data. Particular attention is paid to the practical component of the Earth remote sensing implementation into the modern school practice with the help of information and communication technologies.

Ihor V. Kholoshyn, Olga V. Bondarenko, Olena V. Hanchuk and Ekaterina O. Shmeltser [10] outline the basic principles for implementing ArcGIS Online in the educational process (interdisciplinary integration, the sequence of individualization in training, communicability, distance education and regional studies), and provide an example of an interactive map created with the help of the specified cloud GIS, since this kind of map is the most popular a form of research by geography students. In the article it is noted that integration of ArcGIS Online into the educational process allows the teacher to follow a clear pedagogical strategy, taking into account possible variants of its use (demonstration, direct mastering of GIS in a computer class and independent work in an individual mode). Considering cloud GIS as a new stage in the development of geoinformational education, the authors emphasize their key benefits (round-the-clock access, work with GIS package in the cloud, the ability to use other maps as well as the creation of their own maps and web-applications) and disadvantages (monetization of services, underestimation of the GIS role in the curriculum of the higher school, the lack of Ukrainian content, etc.).

Yevhenii O. Modlo, Serhiy O. Semerikov, Pavlo P. Nechypurenko, Stanislav L. Bondarevskyi, Olena M. Bondarevska and Stanislav T. Tolmachev [19] discuss the use of mobile Internet devices (MID) in the formation of ICT component of bachelors in electromechanics competency in modeling of technical objects. It has been established that despite the fact that MID are actively used by electrical engineers, the methods of using them in the process of bachelor in electromechanics training is considered only in some domestic scientific studies. The article highlights the components of the methods of using MID in the formation of the ICT component of the competence of the bachelor in electromechanics in modeling of technical objects, providing for students to acquire basic knowledge in the field of Computer Science and modern ICT and skills to use programming systems, math packages, subroutine libraries, and the like. For processing tabular data, it is proposed to use various freely distributed tools that do not significantly differ in functionality, such as Google Sheets, Microsoft Excel, for processing text data – QuickEdit Text Editor, Google Docs, Microsoft Word. For 3D-modeling and viewing the design and technological documentation, the proposed comprehensive use of Autodesk tools in the training process.

Liudmyla H. Havrilova, Olena Ye. Ishutina, Valentyna V. Zamorotska, Darja A. Kassim [6] substantiates the scientific and methodological background of creation and development of the distance learning courses for the future music teachers is. The components and structure of future music teachers' instrumental performance competence are defined; the content of the course is revealed. The materials are based on the authors' teaching experience within the distance learning course "Basic Musical Instrument (Piano)". The main blocks of the distance course design and development are considered among them to be theoretical, practical, individual work, and control blocks. The specificity of distance learning methods in the future music teachers' instrumental and performance training is substantiated and three main methods are distinguished. The method of involving information and communication technologies, including multimedia; project method, and features of knowledge and skills controlling are elaborated. The results of implementation and experimental research of using distance learning courses for developing future music teachers' instrumental performance competence are described. The influence of different methods use on students' success is explored.

Nadiia V. Olefirenko, Ilona I. Kostikova, Nataliia O. Ponomarova, Liudmyla I. Bilousova and Andrey V. Pikilnyak [21] presents e-learning resources for successful math teaching to pupils of primary school. Primary schools are basically focused on development subject knowledge and general study skills. One of the ways of their developing is to use tools and apps. There are the examples of using interactive tools and apps for teaching Math for young learners by teachers-to-be in the article. The article presents as well the experimental data about training teachers-to-be to use tools and apps. Interactive tools and apps provide real task variability, uniqueness of exercises, operative assessment of correction, adjustment of task difficulty, a shade of competitiveness and gaming to the exercises. To create their own apps teachers-to be use the tools that are the part of the integrated Microsoft Office package using designing environments, and other simple and convenient programs. The article presents experimental data about the results of training teachers-to-be to create apps. A set of criteria for creation apps was made and checked at the experimental research such as ability to develop apps, knowledge and understanding the functional capabilities of apps, knowledge of tools for creating apps and their functional capabilities, ability to select and formulate tasks for young learners, ability to assess adequately the quality of the developed apps.

The article of Iryna V. Lovianova, Dmytro Ye. Bobyliev and Aleksandr D. Uchitel [16] deals with the problem of introducing cloud calculations into 10^{th}-11^{th} graders' training to solve optimization problems in the context of the STEM-education concept. After analyzing existing programmes of optional courses on optimization problems, the programme of the optional course "Optimization Problems" has been developed and substantiated implying solution of problems by the cloud environment CoCalc. It is a routine calculating operation and not a mathematical model that is accentuated in the programme. It allows considering more problems which are close to reality without adapting the material while training 10^{th}-11^{th} graders. Besides, the mathematical apparatus of the course which is partially known to students as the knowledge acquired from such mathematics sections as the theory of probability, mathematical statistics, mathematical analysis and linear algebra is enough to master the suggested course. The developed course deals with a whole class of problems of conventional optimization which vary greatly. They can be associated with designing devices and technological processes, distributing limited resources and planning business functioning as well as with everyday problems of people. Devices, processes and situations to which a model of optimization problem is applied are called optimization problems. Optimization methods enable optimal solutions for mathematical models. The developed course is noted for building mathematical models and defining a method to be applied to finding an efficient solution.

Oksana M. Hlushak, Volodymyr V. Proshkin, Oksana S. Lytvyn [8] describes the using of e-learning course "Analytic Geometry" in the process of training students majoring in Computer Science and Information Technology. As a result of analysis the expediency of free access of bachelors majoring in Computer Sciences and Information Technologies to modern information educational resources, in particular, e-learning courses in the process of studying mathematical disciplines is substantiated. It was established that the e-learning course is a complex of teaching materials and educational services created for the organization of individual and group training using information and communication technologies. Based on the outlined possibilities of applying the e-learning course, as well as its didactic functions, the structure of the certified e-learning course "Analytic Geometry" based on the Moodle platform was developed and described. Features of application of cloud-oriented resources are considered: Desmos, Geogebra, Wolfram|Alpha, Sage in the study of the discipline "Analytic Geometry".

The prospect of further scientific research is outlined through the effectiveness of the use of e-learning courses for the improvement of additional professional competences of students majoring in Computer Sciences and Information Technologies (specialization “Programming”, “Internet of Things”).

The article of Maryna M. Volikova, Tetiana S. Armash, Yuliia V. Yechkalo and Vladimir I. Zaselskiy [34] devoted to the peculiarities of the practical use of cloud services for the organization of qualitative professional training of future specialists. It is established that in order to implement state policy, there is an essential need for using various ICT, in particular cloud services, which are not only economically acceptable in the new educational environment, but also a powerful tools of obtaining new knowledge, skills and abilities. The advantages and disadvantages of using cloud services in the educational process of higher education are substantiated; the examples discuss the methods of using cloud services in the process of studying fundamental disciplines. It describes the use of the blog as a media-educational technology during the advent of pedagogical practice. The methods of using cloud-based services on the example of creation of a distance course “Linear algebra and analytic geometry” are considered. The prospects of research, which consist in getting acquainted with cloud technologies of the humanitarian profile future specialists at the second higher education, are determined. It has been established that the practical application of cloud technologies in the educational process will promote more qualitative and progressive learning; the formation of a close interaction between the teacher and student; development of professional skills and abilities of independent work.

The article of Oksana M. Markova, Serhiy O. Semerikov, Andrii M. Striuk, Hanna M. Shalatska, Pavlo P. Nechypurenko and Vitaliy V. Tron [17] deals to implementation of cloud service models in training of future information technology specialists. Leading research directions are defined on the basis of self-analysis of the study results on the use of cloud technologies in training by employees of joint research laboratory “Cloud technologies in education” of Kryvyi Rih National University and Institute of Information Technology and Learning Aids of the NAES of Ukraine in 2009-2018: cloud learning technologies, cloud technologies of blended learning, cloud-oriented learning environments, cloud-oriented methodological systems of training, the provision of cloud-based educational services. The ways of implementation SaaS, PaaS, IaaS cloud services models which are appropriate to use in the process of studying the academic disciplines of the cycles of mathematical, natural science and professional and practical training of future specialists in information technology are shown, based on the example of software engineering, computer science and computer engineering. The most significant advantages of using cloud technologies in training of future information technology specialists are definite, namely, the possibility of using modern parallel programming tools as the basis of cloud technologies. Conclusions are drawn; the direction of further research is indicated: designing a cloud-oriented learning environment for future specialists in computer engineering, identifying trends in the development of cloud technologies in the professional training and retraining of information technology specialists, developing a methodology for building the research competencies of future software engineering specialists by using cloud technologies.

The article of Dmytro A. Pokryshen, Evgeniy H. Prokofiev and Albert A. Azaryan [24] is devoted to the coverage of the course “Database management system Microsoft Access”, an educational blog review “The development of a creative child. ICT”, which is used as an auxiliary tool for promoting a course and teacher in the Internet, structural analysis of this blog is made. The channel location is set on YouTube video hosting and how it is used in the course on databases. Attention is drawn to the fact that theoretical and practical material is considered on real, implemented informational and analytical systems. To prepare students for the Olympiads and provide methodological help teachers of computer science are looking at tasks from databases that were offered at the All-Ukrainian Olympiads on Information Technologies, especially II, III and IV stages (online and online Olympiads), which are located in open access to the blog and YouTube channel. The main focus of the article is devoted to the practical side of teaching teachers of computer science, experience in using the above technologies.

Iryna S. Mintii, Svitlana V. Shokaliuk, Tetiana A. Vakaliuk, Mykhailo M. Mintii and Vladimir N. Soloviev [18] highlights the theoretical and methodological aspects of preparing the test questions of the most common types in the form of text files for further import into Moodle learning management system (LMS). The action algorithms for importing questions and instructions for submitting question files in such formats as Aiken, GIFT, Moodle XML, “True/False” questions, “Multiple Choice” (one of many and many of many), “Matching”, with an open answer – “Numerical” or “Short answer” and “Essay” are offered in this article. The formats for submitting questions, examples of its designing and developed questions were demonstrated in view mode in Moodle LMS.

7 Conclusion

The vision of the CTE 2018 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 Israel, Poland, Sweden, Ukraine have attended the workshop to share their significant contribution in research related to Cloud Technologies in Education.

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 2019.

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Informatization of education as a pledge of the existence and development of a modern higher education

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Abstract. This article focuses on the special significance of education informatization as the main aspect of the existence and development of a modern higher education. The process of computerization of education is considered as the main basis of informatization in the historical aspect. This paper emphasizes the importance of implementing information and communication technologies (ICT) in the learning process of free software and the interest of scientists in the field of education. The interest of modern scholars is analyzed in the consideration of such problems as the application of ICT in education; problems of informatization of education and goals of informatization of education; didactic and psychological aspects of application of ICT in the educational process; problems associated with the widespread introduction of ICT in higher education institutions and informatization of education in general. The article's focus is on the importance of the acquired skills and abilities as a result of informatization of education and implementation of the educational process of ICT. The goals of informatization of education at a modern higher educational establishment are determined. The primary goals of informatization of education are singled out. The types of education that are directly related to ICT are considered. It is acknowledged that the practice of implementing ICT in the educational process of higher educational institutions are expanding every day and yields only positive results. The conclusions highlight the relevance of this study. It is noted that educational activity based on the use of ICT is a basis for changing the structure of the educational process for both teachers and students.

Keywords: informatization, education, higher education, computerization, information and communication technologies.

1 Introduction

1.1 Research problem

Currently, informatization of education is the main factor in the existence and development of a modern higher education, because its primary objective is the development and growth of the potential of each individual. Informatization of education is a set of interrelated organizational and legal, socio-economic, educational, methodological, scientific-technical, industrial and management processes. These processes are aimed at providing information, computing and telecommunication needs (other needs related to the implementation of methods and tools of information and communication technologies – ICT) of participants of the educational process, as well as those who manage and maintain this process (including those who provide its scientific and methodological support and development) [2]. Informatization of education increases the efficiency and intensification of the educational process by using information technologies and implementation of new methodological developments in learning process [39, p. 34]. Informatization of education envisions and catalyzes the general processes of development of society and education. Basic components of education and education systems such as content of education, methods, tools and technology of training and education, organization of education and training systems are gaining essential specific features [2].

1.2 Problem statement

Considering the goals of informatization of the educational process of higher education, we identified a number of problems associated with legal, economic, educational, methodological, and scientific and technological processes. Implementation and application of ICT in the training of future professionals will play an important role not only as a tool for the disclosure and development of individual abilities of the individual, but also as a catalyst for comprehensive informatization of society. ICT in education are part of pedagogical technologies aimed at the establishment of knowledge and the acquisition of acquired skills and abilities that, under the slightest effort, can be adapted to the individualities of any person who wants to study.

According to Vladyslav Ye. Velychko, the use of information technologies in educational activities will enable future specialists to use a wide range of modern methodological approaches and technologies and will help to reveal their inner creative potential, become a “visual guide" to the skills and abilities of information technology use to achieve higher learning results [39, p. 75].

Many studies are devoted to the problems of informatization of education and the purposes of informatization of education. The most significant of them belong to Valerii Yu. Bykov [2], Mikhail P. Lapchik [13], Serhii A. Rakov [25], Myroslav I. Zhaldak [42], etc. Theoretical aspects of the application of ICT in education are reflected in the writings of such researchers as Serhiy O. Semerikov [29], Vasilii I. Soldatkin [30], Oleh M. Spirin [31], Aleksander V. Spivakovsky [3], Myroslav I. Zhaldak [4] and others.

The problems associated with the widespread introduction of ICTs in higher education institutions and informatization of education are considered in the publications of Roman S. Hurevych [6], Andrii M. Hurzhii [7], Maiia Yu. Kademiia [6], Nataliia M. Kiianovska [9], Mariia A. Kyslova [12], Alla F. Manako [14], Oleksandr V. Merzlykin [17], Nataliia V. Morze [23], Andrii M. Striuk [16], Yurii V. Tryus [38], Vladyslav Ye. Velychko [39] and many others.

Modern education requires the variety of the forms, methods and techniques of the organization of educational activities. The preference should be given to the forms, methods and techniques that use information technology, which can personalize the process of learning, enrich the acquired knowledge and allow individuals to become effective in professional activities [39, p. 74]. The introduction of the latest ICT into the educational process will accelerate the realization of such an objective as informatization of education. Currently, it is possible to share the features of this process from the experience of other countries such as the United States, South Korea, England, Finland, Estonia, Ireland, Bulgaria, Germany, Switzerland and others [9]. Such experience gives modern scholars a clear understanding of the integrity of building a system of informatization of education through the introduction of ICT in the educational process of higher educational institutions.

1.3 Research aim

The purpose of the article is to emphasize the importance of introducing ICT into the educational process of higher educational institutions and emphasizing to highlight the special significance of informatization of education as the primary aspect of the existence and development of a modern higher education.

2 Theoretical bases of the study

Informatization of education is aimed not only at the formation of knowledge, but centered on the person who can apply the acquired knowledge and skills to work with information resources for successful activity in any sphere of public life and for the innovative development of society [2]. The level of innovation development of society directly depends on the level of informatization of education. Informatization of society is a process of education and establishment of each individual of a new generation in conditions of qualitative improvement of modern information and technical structures and processes created for the satisfaction of needs and the realization of life existing rights of a modern citizen [34; 35].

The basis of the process of informatization of education is the process of computerization of education, which started at the beginning of the XX century. In general, the process of computerization of education of scholars and researchers (Valerii Yu. Bykov [2], Nataliia V. Morze [23], Serhiy O. Semerikov [28], Illia O. Teplytskyi [27], Vladyslav Ye. Velychko [39] and others) is divided into three stages, but the initial date varies from the 20-ies XX century to the 50-ies of XX century. So, for example, Serhiy O. Semerikov, determined the beginning of the first stage is exactly the 20-ies of XX century. According to him, the first stage (20-50th years of the twentieth century) is described as the period of application of mechanical, electromechanical and electronic individualized devices [28; 20], with which the teaching material was provided and the control and self-control of knowledge were implemented – the technology of programmed learning. The second stage (50-80s of the twentieth century) is characterized by the wide introduction of computers into practical training activities. And the third stage (since the 80s of the last century) is specified as the stage of personal computers and computer networks [29].

Informatization of education is inextricably linked with existing learning models. In the 1950s and 1960s computer technologies were actively used in the implementation of the theory of behaviorism. The cognitive model of learning inherent in the 70-80s was used to develop critical thinking. Constructivism of the 90s with the use of computer technology solved the problem of changing personal relationships and building a social model. Modern information technologies have enabled the development of a new learning model – connectionism. Connectionism is evolving due to modern trends – distance education, mobile learning, mass open online courses, e-education and cloud technologies [37].

It is important that the entire initial stage of the development of informatization, which involves the development of computers and software related to universities. The development of computer technology needed highly skilled specialists who were trained directly at universities where the first computers were built [39, p. 62]. Informatization of education is definitely connected with the development of material and technical bases and the preparation of complexes of educational methods for their use. A significant factor in the delay of the development of informatization of education, as well as the informatization of society as a whole, is the lack of sufficient financing of these projects by the state. That is why groups of programmers created free distribution software [32]. Thanks to these software products, teachers have had more opportunities to use computers in the learning process, which gradually led to the widespread use of ICT in educational activities which resulted in the informatization of education [36]. The first software products used in university education belonged to open software as there was no global software commercialization. It should be noted that such software had limited scope and was used primarily for mathematical calculations [18; 26].

Lecturers of mathematical disciplines mastering software products of the indicated orientation and using this knowledge and their own developed techniques during the training of students of mathematical specialties became the first example of the introduction and application of information technologies in university education. These actions have shown that such implementation greatly facilitates availability teaching material and the interest of students. The experience of using mathematical software products while working with students proved to be invaluable and fundamental to lecturers of other disciplines. Understanding the benefits and needs of pedagogical workers in such educational products, programmers actively create and recycle existing computer programs that effectively begin to be used during lectures and laboratory and practical classes.

Further evolution of informatization of education, which took steps from equipping educational institutions with electronic computers of the first generation to the application of the most modern tools of ICT, reflects both the achievements of scientific and technical progress. Cybernetics, computer science, IT industry, and achievements in the appropriate training of teaching and management education, computer level oriented scientific and methodological support of the educational process, automated systems of education and training led to the widespread introduction of ICT in educational practice [2]. Consequently, ICT are rapidly being introduced into the educational activities of higher education institutions and step by step, with the help of graduates of higher education, mastering other branches of education such as secondary schools, technical schools, schools, etc.

ICT of teaching are a variety of pedagogical technologies used to optimize the construction of the educational process and represent a set of educational organization programs aimed at learning and acquisition of skills and abilities, the specificity of which is expressed in the emphasis on the development of students not only to perceive and use the knowledge provided, but to independently obtain knowledge from a variety of sources of information. These technologies can radically change the function of the teacher in the educational process, as well as the attitude and perception of the educational material by those who study. ICT are one of the major factors in implementing a personal approach to each individual. Due to the combination of traditional learning technologies and ICT, the efficiency of the development of individual abilities the educational process is improved, the quality of education increases, an understanding of the importance of creating its own educational path is formed.

Through the use of ICT in education, all those who had not previously been able to afford it were given the opportunity to study and gain knowledge and skills in a variety of categories and areas. For example, people with special needs for whom, having regard to their physical condition and state of health, previously, higher education was not an achievable dream, now due to existing technologies and developed methods, they are able not only to acquire knowledge, but also desired diplomas.

Over the last four decades, a large number of educational software products, both free and proprietary, have been developed and implemented in various educational areas. Prepared educational and methodical literature, which was done to emphasize the need to use ICT at all levels and in all areas of education. Vladyslav Ye. Velychko noted that the main directions of the use of ICT in the educational activity of higher educational institutions are [39, p. 124]:

- an element of the methodology of scientific research;
- an integral part of the education management system;
- object of studying;
- a learning tool.

Each of them is in close contact with others.

Currently, there are many types of education directly related to ICT. Such types of learning as distance learning, e-learning, mobile learning, blended training, etc., expand opportunities and choices for anyone who wants to study or improve their own qualifications or receive additional education. These opportunities are associated with the emergence of new, virtually unlimited pedagogical opportunities that have arisen as a result of the introduction of ICT in education and successfully used. For the individualization and differentiation of the educational process the use of additional information educational resources resulted in a wide range of pedagogical methods and technological training options. Changes in the nature of educational communications are increasing the procedural and multimedia characteristics of study and the expansion of the space of innovative pedagogical activity [2].

By scientists and researchers definition there is a classification of pedagogical software tools, based on which pedagogical orientation that is the realization of certain didactic functions in the learning process [39, p. 125]:

- demonstration programs (designed for a demonstration of the training material of a descriptive nature);
- training programs (aimed at the acquisition of new knowledge; implemented usually in the form of a dialogue);
- simulators (provide the formation and consolidation of practical skills, and also used in self-education activities);
- control programs (designed to control a certain level of knowledge and skills. Application of such programs enables to increase the efficiency of training, to intensify and increase the productivity of the teacher, provides the necessary stability and invariance and independence from subjective teacher settings);
- simulation and simulation programs (allowing to simulate objects, phenomena and processes of the real world. Their effectiveness is achieved when the process or the phenomenon cannot be practiced (micro and macro world). In the process of using such programs, abstract concepts become more specific and easier to perceive by those who learn);
- information and reference programs (intended for search and output the necessary information for educational, methodological and other purposes. Such programs include electronic encyclopedias, knowledge bases. Today the value of their application is to organize access to information through modern telecommunication networks;
- programs for problem learning (designed to activate cognitive activities of students through the formulation of various problems and tasks that need to be resolved through attempts and errors).

The practice of ICT implementing in the educational process of higher educational institutions is spreading every day. Many software products, techniques and technologies that were used at the beginning of the education informatization were subject to multiple changes and updates. Currently, ICT are rapidly being implemented in the educational process of higher education institutions. If the first introduction involved the use of software products for purely mathematical calculations and the teaching of disciplines in the mathematical cycle, then this range is almost limitless [15]. Educational software products are used during teaching of any discipline, from psychology and jurisprudence to philology, physical education and music. The wider the range of different software applications within a particular discipline, the more it benefits those who study, as they get new functional capabilities that significantly affects the learning process and is more beneficial in achieving the identified goals.

ICT are innovative pedagogical technologies of the education system used to create new opportunities. The transfer of knowledge (the activities of the teacher), the perception of knowledge (the activities of students), the assessment of the quality of education and the comprehensive development of personality during the educational process [41], makes the educational process more intense and productive through the use of multimedia capabilities, intersperses interpersonal communication provides the search for information from various sources, creates convenient circumstances for communication in the most appropriate form [33].

Scientists paid much attention to the use of ICT in education and described in their doctoral dissertations. So, for example, it is noticed that a computer science teacher with fundamental knowledge in the field of informatics is needed even in secondary school [13]; the main goal of computer science students is the formation of professional informational competencies, which are based on public order, state higher education standards and personal choice of a student, the function of fundamentalization of informatics education is the basis for the formation of new qualities of a future specialist [29, p. 68]; vocational guidance function of the fundamentalization of informatics education has the following structural components: target, content, technological and the final ones [23]; multimedia in education – a promising direction in the field information processing of human activity, integration of heterogeneous data computer systems in order to more fully present the results of intellectual production in science, art, education, industry etc. [1]; informative awareness – the ability to implement the systemic knowledge, skills and abilities of acquiring and transformation of information in various fields of human activity for the qualitative performance of professional functions and conscious prediction of the consequences of its activities [24]; informational competence includes the ability to independently search, analyze and select the necessary information, organize, transform, store and transfer it using real objects and information technologies [8]. Information competence is the main component of the information culture as part of the overall culture of the individual [4]; information culture is a collection of informational worldview, systems of value orientations, knowledge, skills, providing purposeful and effective independent activity with the purpose satisfaction of own and professional needs in information products [10]; informatization of education is one of the most important elements of culture in general, characterizing the material and spiritual development of society, the level of organization of information processes, the degree of satisfaction of the needs of people in informational communication, timely, reliable and exhaustive information and provides a coherent vision of the world [4]; the use of ICT in education includes skills and work skills in the information and communication pedagogical environment, the ability apply multimedia teaching aids for the tasks of professional activity, the ability to use knowledge control with the help of a computer, the ability to use ready-made electronic tools and independently develop their own multimedia teaching aids, forms Internet communication skills [10] and many other works devoted to informatization of education and the use of ICT in education [21; 22].

Informatization of education is stipulated by branch directions. Considering the goals of informatization of education Valerii Yu. Bykov noted that at the present stage of development of society and education the main goal is to prepare those who are studying for active and productive life in the information society, to provide high-quality, affordable and effective education, to create educational conditions for life-long learning at the expense of widespread introduction into the educational practice of methods and means of ICT and computer-based technologies [2]. Informational education provides two strategic goals. The first of these is to increase the efficiency of all types of educational activities through the use of ICT. The other is in elevation the quality of training specialists with a new type of thinking that meets the requirements of the information society [11].

In accordance with the current legislation, the Law of Ukraine on National program of informatization, the informatization means a set of interrelated organizational, legal, political, socio-economic, scientific and technical, production processes aimed at creating conditions for meeting the information needs of citizens and society through the creation, development and use of information systems, networks, resources and information technologies based on application of modern computing and communication technology [40].

3 Results of the study

Every teacher who works now and in the future should know that informatization of education is a modern resource getting answers to questions that are of interest to educators and students. Possessing skills using information resources is the major way of improving their own professional ability. And this is also one of the goals of education informatization.

For the primary goals of informatization of education we have to include the following components as:

- establishment of skills of self-education and self-realization;
- advancement of the potential of each person and its development;
- development of the educational spectrum of services for people with special needs;
- increase in the quality of education;
- formation of skills for building own educational trajectory;
- raising the fundamental level of general and education [2];
- creation of new special methods, tools and educational technologies [2];
- raising the level of pre-professional training of higher education students of general school [2];
- increasing the aptitude to analyze the extended knowledge and skills of students;
- expansion of methods and means of teaching using modern scientific and technical developments;
- providing favorable conditions for those wishing to upgrade their qualifications;
- development of postgraduate education and adult education;
- expansion of limits and possibilities of self-realization [2];
- establishment of the society with the informatively experienced population [39];

— development of the intellectual potential of the nation;
— enhancement and modernization of traditional forms of training curriculum.

The degree of informatization of education is a direct reflection of the level of informatization of society, which is why the information development of education becomes the major factor in the growth of the general level of training of students. Students develop skills to create and implement the latest technologies for future professional activity and form the theoretical basis of knowledge while studying at a pedagogical higher educational establishment.

4 Conclusions and prospects of future research

Based on the evidence mentioned above and on the fact that informatization of education is the main contributor of the existence and development of modern higher education and society as an intertwined entity, we can state that the informatization of education of all levels should become one of the major and important tasks of the state. As already noted, informatization of education is the foundation of the informatization of society as a whole, precisely because the problems of informatization of objects of education should be given the highest priority at both the local and state levels. Informatization of education directly influences the content of education and the methods of its organization. Educational informatization has pedagogical goals and objectives. It provides the necessary conditions for the integration of the educational system of Ukraine into the world information space. Educational activity based on the use of ICT becomes the foundation for change in the structure of the working process of teachers and forms a new perception of the educational material by those who learn. Educational activity affects the development of self-education through the use of information learning resources, thereby gaining experience in the use of ICT both in everyday life and future professional activity. The widespread introduction and application of ICT in the educational sector is a pillar of the development of scientific research and development. The educational software products are improving constantly. There is an ongoing development of pedagogical technologies based on ICT. New educational courses and methods are being developed and implemented in educational areas, as well as various forms and technologies of training. The attention paid to the education of informatization by scientists increases the introduction of ICT into the educational process at all levels and in all branches of education. We concluded that informatization of education is a constant process, which enhances the development of society, improving the quality of life and education and the expansion of new forms and methods of teaching.

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Defining and modeling of students' professional thinking development dependence on their training process organization

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Abstract. The professional thinking issues are analyzed in the research. The authors pointed that the technical thought concepts, images and practical actions are in a complex and dynamic interaction with each other. The components of professional thinking are considered in detail. The training method based on the implementation of forming influence is proposed. The regression analysis of the students' academic progress indicators who are trained by the traditional and innovative methodology with forming influence is conducted in the article. Analysis of thinking activity development levels in the process of professional tasks solving performed by the students of the control and experimental groups demonstrated the straight-line correlation dependence of the professional thinking development on the organization of professional activity in general and the training organization in particular.

Keywords: professional thinking development, education technology, training process.

1 Introduction

The issues of specialists' professional activity effective organization are getting urgent actualization under the current conditions of socio-economic development of industry in Ukraine. Scientific and technological progress in our country raises high requirements for the specialist' qualification and to his professional skills.

Modern young specialists need skills for solving tasks and problems productively and creatively using modern technologies when developing new models of equipment and demonstrate the ability to creative professional self-development for successful professional occupation in the new information society.

The proficiency of a qualified specialist requires active intellectual activity and continuous professional thinking development. That is why the problem of professional thinking investigation and psychological conditions of its development is highly topical issue.

2 Problem statement

General methodological and psychological aspects of thinking were studied in the scientific works of Andrei V. Brushlinskii [7], Lev S. Vygotskii [52], Petr Ia. Galperin [14], Serhii D. Maksymenko [33], Aleksei M. Matiushkin [35], Sergei L. Rubinshtein [44], Oleksandr V. Skrypchenko [45], Oleg K. Tikhomirov [48], and other scientists; nature and specialists' professional thinking development patterns in various aspects are disclosed in the researches of Vladimir P. Andronov [2], Anatolii A. Batalov [5], Larysa V. Zasiekina [53], Evgenii A. Klimov [21], Boris F. Lomov [32], Veniamin N. Pushkin [41], Maryna L. Smulson [46], Varvara V. Chebysheva [8] and others; the essence of technical thinking and technical creativity were studied in psychological researches of Viktor E. Alekseev [1], Anna M. Vasilevskaia [51], Sergei Iu. Gubenkov [15], Tovii V. Kudriatcev [27], Boris F. Lomov [32], Petro S. Perepelytsia [40], Valerii D. Putilin [42] and others; the theory of problems, in particular educational ones, is reasoned in scientific papers of Heorhii O. Ball [4], Anatolii F. Esaulov [11], Hryhoryi S. Kostiuk [25], Yukhym I. Mashbyts [34], Lev M. Fridman [13] and others; features and methods of structural and technical problems effective solution were considered in the studies of Alla B. Kovalenko [26], Natalia A. Menchinskaia [36], Lidiia A. Moiseienko [38], Iraida S. Iakimanskaia [28], Pavel M. Iakobson [18] and others.

Nowadays the professional thinking problem is one of the most important and less investigated issue in psychology. By now, national and foreign psychology collected scientific material which reveals variety and specific features of professional tasks range and the methods of its solving at any levels of professional activity, in particular, variants for solving professional tasks at information, algorithmic and heuristic levels are highlighted, certain approaches to learning optimization concerning the solution of professional-technological and managerial tasks are outlined, etc.

However, the holistic concept of the professional thinking development has not been developed yet. Both psychologists and teachers-practitioners of professional training do not have very clear conclusions about the role of thinking and function of each types of thinking in professional activity, about principles of classification and general means of professional tasks solving, about specific features of the solving process of such tasks and lessons organization training using the professional oriented tasks in the general system of professional training and the workforce retraining.

The task is to formalize the process of professional thinking development depending on the organization of professional activity in general and the learning organization in particular, to determine the dependence of students' academic progress for different teaching methods.

3 Innovative education approaches

The concept of "professional thinking" is widely used in the XXI century's psychology in connection with the labor intellectualization increase, the need for forming a specialist (a worker, an engineer, a doctor, a teacher, an agronomist, etc.) with the ability to update their knowledge, to think critically and find the original means of professional tasks solving, to orient within the stream of various information, to overcome “non-regular”, extreme situation. Profession for a person is a source of existence and personal self-realization; this is the social field of his possible labor actions, for realization of which he must have professional knowledge, skills and abilities, appropriate abilities and developed professional thinking. So, developed professional thinking is an important aspect of the personal mastery process and its precondition of successful professional activity.

Different approaches to the professional thinking characteristics are distinguished in modern psychology. Professional thinking is defined as a feature of the specialist thinking due to the nature of professional activity in relation to the object of labor (Hryhoryi S. Kostiuk [25], Tovii V. Kudriatcev [27], Boris M. Teplov [50], Varvara V. Chebysheva [8] and others) as a process of tasks solving in one or another area of activity (Iuvenalii N. Kuliutkin [29], Zoia A. Reshetova [43], Sergei L. Rubinshtein [44] and others).

Summarizing the experience of studying the notion “professional thinking” it is necessary to highlight that a number of scientific studies [16; 19; 20; 26] consider the professional thinking as a process of professional tasks solving in one or another area of activity and some studies [2; 55] consider professional thinking as the type of specialist orientation in the subject of his professional activity. However, more often the notion of “professional thinking” is used simultaneously in both these meanings. So, we used to discuss the “technical” thinking of an engineer, a worker in a particular industry, the “clinical” thinking of the doctor, “spatial” thinking of the architect, “economic” thinking of the economist and manager, “artistic” thinking of art workers, “mathematical” thinking, etc. [49].

Undoubtedly, the thinking processes of different specialists are manifested by the one and the same psychological laws but there is a specificity of the object, means, and the work results in respect to which mental operations are carried out. So, first of all, some features of specialist’ thinking that allow him to perform professional tasks at a high level of proficiency are quick, precise, original solution of both ordinary and extraordinary tasks in a certain subject area. Such specialists are usually characterized as people who are creative in their professional field, as people who are especially perceived the subject of their activity and are capable of rationalization, innovation, discovery. So, professional thinking is a thought-oriented activity that is directed to professional tasks solving in a certain subject area. If the specificity of professional thinking depends on the uniqueness of the tasks that are being solved by different specialists, then the quality of professional activity or the level of professionalism depends on the professional thinking development.

In our opinion, an acmeological approach is the most productive in the study of the professional thinking (Anatolii A. Batalov [5], Dinara N. Zavalishina [54], Evgenii A. Klimov [21], Iurii K. Kornilov [24], Aelita K. Markova [3]), that considers professional thinking as a structural component of professionalism. Professional thinking is explained as a system that is being developed in a structural and holistic formation education and includes cognitive, operational and personal components.

The operating component is considered as a system forming (thinking receptions, thinking actions and operations), on the basis of which the transformation is taken place within the cognitive component and certain professionally significant features of thinking are formed. The degree of general thinking actions forming and operations determine the level of professional thinking development in any sphere of activity [22].

Consequently, the peculiarity of professional thinking is related to specialist's orientation in the subject of his activity, as well as using equipment, methods, methods of influence on this subject that is with the psychological aspect of the professional activity.

Studying professional thinking, a number of scholars are paying a lot of attention to investigation of the peculiarities of professional thinking in the process of technical tasks solution indicating the importance of studying the problems of technical thinking. As Tovii V. Kudriatcev states, "... the problems of technical thinking as a specific type of intellectual activity of a person" [27, p. 184]. In particular, the problem of the person's professional technical thinking development has found reflection in fundamental psychological research: Tovii V. Kudriatcev [27], Iuvenalii N. Kuliutkin [29], Boris F. Lomov [32], Valentyn O. Moliako [39] and others, considered the issues of the technical thinking essence; Sergei Ia. Batyshev [6], Anna M. Vasilevskaia [51], Inna P. Kaloshina [19], Varvara V. Chebysheva [8], and others studied the technical thinking development in professional activity; Nikolai D. Levitov [31], Emiliia A. Faraponova [12], Pavel M. Iakobson [18], and others analyzed the constructive-technical activities; Anatolii F. Esaulov [11], Dinara N. Zavalishina [54], Hryhoryi S. Kostiuk [25], Oleg K. Tikhomirov [48] and others emphasized the operational-scientific direction of technical thinking, the ability to apply technical knowledge to solve tasks in a variety of conditions.

Characterizing professional technical thinking, Nikolai D. Levitov singled out the following [31]:

- it is distinguished by the clarity and accuracy of the thought-oriented operations directed to accurate calculations;
- it is practical (in the sense that it is aimed at practice) thinking (to understand the idea that is put in the technical device, it is to understand the principles of its design for certain practical purposes);
- this is flexible, unconventional thinking;
- technical thinking is realized through schemes, drawings. The language of people who are endowed with such thinking is concise and laconic.

The structure of technical thinking has specific features. Tovii V. Kudriatcev defined that any technical task which needs technical thinking is a task to a certain extent of uncertainty search and has multivariate solution. Such features of technical tasks are determined by many qualities and attitudes of technical objects as material-subject objects.

Tovii V. Kudriatcev distinguished three components of technical thinking:

1. Technical thinking always has theoretical and practical nature because the process of technical activity is the process of interaction of mental and practical components of work, therefore, the theory must be continuously tested by practice and practice

by theory. As the scientist states, “any theoretical technical thinking is usually tested by practice. New car, new the technological process ... will never begin to work at the production without preliminary verification of the design in practice” [27, p. 211].

2. Technical thinking is not only the operation of technical images but also of technical concepts that are very complex because they include knowledge from different sciences. Technical notions are the connection between the laws of abstract sciences, general laws of nature and technology and the laws of a particular type of production.
3. Technical thinking often requires efficiency. Tovii V. Kudriatcev emphasizes that the specialist in the field of technology often have to “solve production-technical tasks in a limited time ...”, his idea needs “instantaneous practical implementation” [27, p. 231]. That is the ability to orient quickly, to perceive and analyze information accurately and use existing knowledge properly, react to unforeseen situations.

Consequently, technical thought concepts, images and practical actions are in complex and dynamic interaction with each other. Well-developed professional technical thinking provides an opportunity for a person to transform verbal technical problems into images and diagrams quickly and easily, images and schemes into practical actions. Such thinking allows a designer, an engineer, a technician to change over internal, mental action plan to external, practical actions and operations with material objects of work without interference.

Professional technical thinking can be described as a set of consecutive thinking actions aimed at reflecting in the human consciousness technical processes and objects, the principles of their structure and the use of technical concepts and images. A certain performance of professional technical thinking is technique understanding: rapid assimilation of the technical device structure, the principle of its operation, the imperfections detection, imperfections in it, finding problems in technical objects and mechanisms, development of means to improve the technical devices, etc. Without technical thinking it is impossible to construct new and improve already existing machines and technological processes, so technical creativity is impossible.

Scientific and technological progress raises very high requirements for the qualification of a specialist to his professional skills in our country. Therefore, the proficiency of a highly skilled specialist requires an active intellectual activity and constant development of professional thinking. The process of professional thinking developing depends on many internal and external factors. The internal ones include: genetic predispositions, personal forces of thinking, individual peculiarities of analysis, synthesis and abstraction and others. External factors make up a wide range of objective factors that stimulate the development of individual professional thinking, in particular: social needs, incentives, requirements of scientific and technological progress in various spheres of production, taking into account environmental conditions and peculiarities of professional activity, etc.

To implement socio-economic transformations, to solve extremely complex and new tasks, it is not just desirable for the person of today and for the person of tomorrow to master creative skills, strategies and tactics as tools not only in professional but even in everyday activities. So, creativity should become the norm of professional activity and the standard of preparation for it, that is, each specialist has to be a creative specialist.

Modern psychology concerning the mental development problem study has formed approaches which indicate its dependence on:

- teach students to apply rational methods and methods of thinking activities (Natalia A. Menchinskaia [36], Lev B. Itelson [17], etc.). Representatives of this approach prove that students can learn knowledge if an explanation is carried out from specific to general;
- means of forming mental actions (Petr Ia. Galperin [14], Aleksei N. Leontev [30], Nina F. Talyzina [47], etc.);
- formation of generalized conceptual systems of students (Vasilii V. Davydov [9], Daniil B. Elkonin [10]). Representatives of this approach give special significance to the theoretical generalizations that can be designed by students in the form of the conclusion that is the assimilation of knowledge from the general to concrete.

Such factors as activity stimulation of the study subject, internal initiative and freedom of choice, creation of favorable conditions for personal growth influence on the students' intellectual abilities development.

Being formed in the process of a specific professional activity, professional as well as any highly developed, thinking assumes the presence of generalized concepts about the objects that are being investigated, the ability to conduct their mental analysis and synthesis, to make judgments, conclusions, evidence, etc.

Quality of professional activity or the level of professionalism depends on the type of thinking: a high level of professionalism is connected with creative thinking and developed practical intelligence. Thinking is aimed at solving professional tasks, therefore the training of a specialist requires a mandatory analysis of their specifics and strategies.

Investigating the general patterns of thinking, Hryhoryi S. Kostiuk [25] mentioned that thinking is being developed in the process of activity, respectively, professional thinking is being developed in the process of solving professional tasks. These are professional technical tasks for the specialists of technical area, as well as for the students of a vocational institution that simulate the situation of technical activity (it should be said more precisely about the "Educational" tasks). Ukrainian term "educational tasks", by Heorhii O. Ball covers the student's tasks solved by the student, and the tasks of managing the students solved by a teacher [4].

As professional thinking is an intellectual activity concerning the professional tasks solution it is necessary to reveal the specifics of the educational task of professional orientation because the thinking process is aimed at solving of certain tasks. In addition, the problem of studying the creative tasks nature of professional orientation becomes the special issue because, in our opinion, the training of a creative specialist in the system of vocational education is possible under the conditions of constant, systematic implementation in the educational process of diverse educational, in particular, educational and creative tasks of professional direction.

A number of studies (Iurii A. Kontcevoi [23], Tovii V. Kudriatcev [27], Natalia A. Menchinskaia [36], Evgenii A. Milerian [37], Ya. O. Ponomarov, Iraida S. Iakimanskaia [28], Pavel M. Iakobson [18], etc.) are devoted to the analysis of peculiarities of technical tasks, effective learning methods development to solve structural and technical tasks, the patterns of thinking in the process of solving technical and production problems are defined. So, Iurii A. Kontcevoi believes that in the process of technical tasks solving it is possible to identify the components of technical thinking by solving technical problems (the only conceptual-figurative and practical structure) and to evaluate the meaning and place of each component.

As we stated in our research that the professional thinking of future professionals will be successfully developed in the condition of the systematic involvement of students in active thinking in the process of solving complicated educational tasks of a professional direction, that's why we will try to reason the notion of "task of professional direction". The professional task can be considered the one that contains the subject of a professional task of specialist's certain profile. Additionally, if we compare the total specific features of production tasks (multidimensionality, continuity, dynamism, negligence, efficiency, irreversibility) with general features student problems, then it turns out that ordinary school tasks are characterized, first of all, by opposite signs (one-plan, interpretability, static, impractical, reversible). So, the organization of vocational training needs to implement the intermediate tasks (students' tasks of professional direction) which have the sequential transition from single-plan to multi-plan, from intermittence for continuity, etc. So, the organization of vocational training needs to implement intermediate tasks (student tasks of professional direction) which have sequential transition from single-plan to multi-plan, from intermittence for continuity, etc. In addition, the student's task of the professional orientation in the future specialists training should meet such requirements:

- be formulated for professionals in a professional language;
- be a verbal model of a real production situation;
- apply the acquired knowledge of special disciplines: special technology, mining, material science, technical drawing, etc. using computer.

Yukhym I. Mashbyts [34] who is one of the national scientists examined psychological and pedagogical aspects of computer training. The author characterizes the didactic capabilities of computing learning technology in his studies.

The scientist mentions that the teacher has never had so powerful means of learning that is a computer that no technical means which used up so far, with its didactic capabilities cannot be compared with the computer and its opportunities have not been revealed to the end. Among the most fruitful use of computer in training Yukhym I. Mashbyts [34] distinguishes the following:

- use it as a means of managing student activities;
- ability to provide individual training "in mass order";
- great opportunities in the implementation of problem education;
- forming of creative thinking of students, readiness for creative work in the conditions of scientific and technological progress and information society.

The professional thinking of future specialists in the study is considered as the only thought-based structure that contains motivational-purposeful, content, process-operational, creative, reflexive-evaluation components.

Each of the components of professional thinking are defined by the appropriate evaluation criteria.

The motivational-target component of professional thinking implies active interest in technology, the need to solve problems, the desire for success and the experience of joy because of the successful task solving.

The content component of professional thinking involves knowledge of the most important characteristics of the professionally meaningful objects functioning.

The process-operational component of professional thinking involves logic and analytical thinking, completeness of thinking operational composition.

The creative component of professional thinking involves finding the original the productive way of solving the mental problem, the flexibility of thinking, prone to visualization.

Reflective and evaluation component of professional thinking involves awareness of carried out activities, evaluation of oneself, their capabilities, self-criticism.

A set of research methods were tested in order to determine the level of professional thinking components development of future specialists and the adequacy of their use according to the set tasks is made. This allowed finding out the psychological features of professional thinking components manifestation of the future professionals and determining the level of their development. Experimental research was carried out in Kryvyi Rih National University. Students of I, II, III courses of specialties: “Software Engineering”, “Vocational Education (computer technology)”, “Computer Engineering” were involved in the research experiment.

Summarizing the peculiarities of the students’ professional thinking functioning that were discovered after the diagnosis we distinguished three levels of professional thinking development of future specialists (table 1).

Table 1. Peculiarities of functioning of students’ professional thinking that are elicited after the diagnostics

Development levels of professional thinking	Average value, %						Average index, %
	Research methods						
	Content component		Process-operational component	Creative component		Reflective and evaluation	
	V1	V2	V3	V4	V5	V6	
Low	50.5	46.7	50.07	16.6	48.33	39.7	42.0
Medium	37.9	41.5	38.33	44.8	34.6	41.8	39.8
High	11.6	11.8	11.6	38.6	17.07	18.5	18.2
Total	100	100	100	100	100	100	100

Notes:

V1 – test method “Mechanical wit” by Evgenii A. Klimov;

V2 – Bennett test of mechanical comprehension;

V3 – author’s educational tasks for the development of students’ professional technical thinking;

V4 – the method of detecting the determinant influence of the operating system on the process of problems solving (Abraham S. Luchins);

V5 – a methodology for evaluating Williams' divergent (creative) thinking;

V6 – the method "Self-assessment of individual personal characteristics" of Williams.

So, assessing the level of students' professional thinking development at the statement stage of the empirical study, we found that, unfortunately, the low level of students' professional thinking development is prevalent, and the least common is the high level.

The components of professional thinking do not function in isolation, they are interconnected. To confirm this position, we have decided to investigate the existing interrelationships between the individual components of the future specialists' professional thinking such as conceptual, process and operational and creative. For this purpose, a correlation analysis of data with the help of Spearman's rank correlation coefficient is carried out. Quantitative results are presented in table 2.

Table 2. Correlation matrix of connection between indicators of professional thinking (*N*=60)

Content component					**Process-operational component**		**Creative component**			
Changes	**V1**	**Significance level**	**V2**	**Significance level**	**V3**	**Significance level**	**V4**	**Significance level**	**V5**	**Significance level**
V1	1		0.67	0.001	0.57	0.001	0.59	0.001	0.63	0.001
V2	0.67	0.001	1		0.59	0.001	0.4	0.01	0.53	0.001
V3	0.57	0.001	0.59	0.001	1		0.37	0.01	0.61	0.001
V4	0.59	0.001	0.4	0.01	0.37	0.01	1		0.43	0.01
V5	0.63	0.001	0.53	0.001	0.61	0.001	0.43	0.01	1	

Notes:

V1 – test method "Mechanical wit" by Evgenii A. Klimov;

V2 – Bennett test of mechanical comprehension;

V3 – author's educational tasks for the development of students' professional technical thinking;

V4 – the method of detecting the determinant influence of the operating system on the process of problems solving (Abraham S. Luchins);

V5 – a methodology for evaluating Williams' divergent (creative) thinking.

The obtained correlation analysis data demonstrated that all components of the content component have high significant ($p \leq 0{,}01$) positive correlations with the constituents of process-operational and creative components of professional thinking. This confirms our standpoint that the stronger the students will understand technical objects, processes, ability to make conclusions, ability to further use of professional knowledge in practical activities, the better students will develop the ability to establish links between the main signs of technical issues, ability to analyze, synthesize technical concepts and images, to express their thoughts logically, to find analogies, to combine; the flexibility of thinking in search of the original creative approach, problem solving duration; the ability to put forward a variety of ideas, find the best variant of the solution of the thought task, origin and novelty of the associations, giving them a new functional value and vice versa.

Results of the final stage of the experimental study are presented in table 3 gives grounds to state:

1. In the process of professional oriented task solving (table 3) students of the control group received the first rank of reproductive level of thinking activity development (48.3%), the second – adaptive (26.7%), the third grade – locally-modeling (15.0%), the fourth rank – system-modeling (creative) (10.0%). The students of the experimental group received the first rank of locally-modeling level of thinking activity development (33.3%), the second – system-modeling (creative) (30,0%), the third – reproductive (20.0%), the fourth rank – adaptive level (16.7%). It confirms the efficiency of the proposed technology of future specialists' professional thinking development.
2. One of the main criteria of the technology effectiveness of our technology were changes in professional thinking development levels: content, process-operational, creative and reflexive-evaluation.

Table 3. Ranking of the development levels of mental activity in the process of professional oriented tasks solving of the students of control and experimental groups after the forming influence

No	Mental activity developed levels	Control group			Experimental group		
		Number of people	%	Rank	Number of people	%	Rank
1	Reproductive	29	48.3	1	12	20.0	3
2	Adaptive	16	26.7	2	10	16.7	4
3	Local-modeling	9	15.0	3	20	33.3	
4	System-modeling (creative)	6	10.0	4	18	30.0	2
Total		60	100	–	60	100	–

Research of dynamics of students' professional thinking components development of experimental groups demonstrated statistically significant positive changes in their indicators. These changes are manifested in the development of knowledge of the most important characteristics of the professionally meaningful objects functioning and the ability to further use this knowledge in practice; increasing the ability to establish links between the main features, analyze, synthesize technical concepts and images, logically express their own thoughts, to find analogies, to combine; the formation of the ability to generate creative ideas in the process of performing technical activity, inclination to search an original new approach to tasks solving; in the growth of courage to accept criticism, to assume possible failures, propensity to search alternatives and risk in solving complex tasks.

3. Statistically insignificant dynamics of changes in the students' thinking activity development in the process of professional tasks solving and the professional thinking components development in the control group states the lack of efficiency influence of the traditional vocational education system on the development of students' professional thinking.
4. The efficiency of our developed and tested program of the students' professional

thinking is evidenced by the positive dynamics of students' professional thinking development of the experimental group that is proved in a statistically significant increase in the level of all professional thinking components development and the lack of significant changes in the control group.

As a result of the conducted forming phase of the experiment in the experimental group there is a tendency to increase the rates of the content and reflective and evaluation components that is statistically confirmed developed and tested the program of the experiment has significantly increased the level of professional thinking development of the students of the experimental group.

In addition, statistically significant changes were recorded in the experimental according to the indexes of process-operational and creative components.

To confirm the efficiency of the developed and implemented technology of the professional thinking development of future specialists, we conducted a calculation of Student's statistical *t*-criterion to detect the changes in the students' professional thinking components development in control and experimental groups (before and after forming effect) (table 4).

Table 4. Calculation of statistical *t*-criterion of Student's for estimation of dynamics changes according to components of professional thinking (*N*=60 (CG), 60 (EG))

Components of professional thinking	Research methods	Experimental group (EG)					Control group (CG)				
		Arithmetic mean	Dispersion	Arithmetic mean	Dispersion	Student's *t*-criterion, significance level	Arithmetic mean	Dispersion	Arithmetic mean	Dispersion	Student's *t*-criterion, significance level
		before forming influence		after forming influence			at the beginning of the traditional system training		at the end of the traditional system training		
Content	V1	25.9	140.7	34.4	169.8	3.7	26.05	150.1	30.07	183.2	1.7
	V2	27.3	93.4	34.2	148.4	3.44	26.3	105.4	26.6	108.7	0.16
Process-operational	V3	10.45	13.2	12.87	14.63	3.55	10.02	13.85	11.18	11.4	1.8
Creative	V4	1.81	1.67	2.63	1.55	3.48	1.63	1.62	1.81	1.57	0.8
	V5	64.8	285.97	74.4	204.2	3.34	67.83	195.7	68.78	240.04	0.35
Reflective and evaluation	V6	46.08	492.6	56.3	508.3	2.5	43.6	338.9	44.7	327.9	0.32

Notes:
Student's t-criterion for 60 people $t = 2$ at the level of significance ($p \leq 0.05$)
V1 – Bennett test of mechanical comprehension;
V2 – test method "Mechanical wit" developed by Evgenii A. Klimov;
V3 – author's educational tasks for the development of students' professional technical thinking;
V4 – the method of detecting the determinant influence of the operating system on the process of problems solving (Abraham S. Luchins);
V5 – a methodology for evaluating Williams' divergent (creative) thinking;
V6 – questionnaire "Self-assessment of creative personality characteristics" developed by Williams.

Figure 1 shows the dependence of the learning success of the control and experimental group of students. The approximation was carried out using linear function while the determination coefficient was not less than 0.5. Trends demonstrate the learning quality improvement over time. Innovative training method based on forming influence allows achieving higher academic progress by 20% compared with traditional methods.

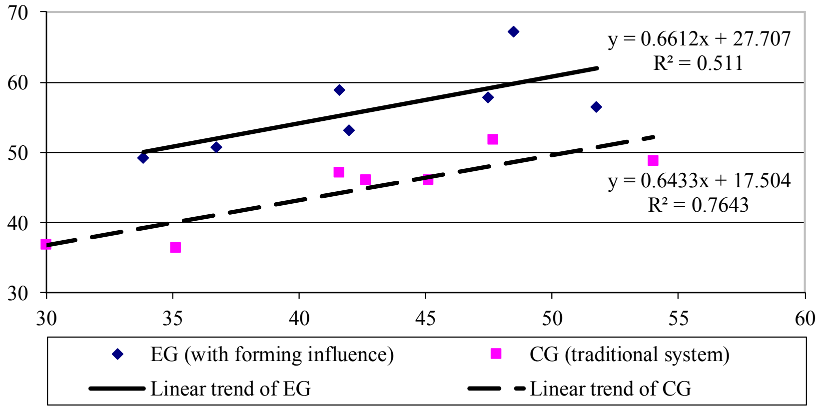

Fig. 1. Approximation of the dependencies of the academic progress for the control and experimental groups of students

4 Conclusions

So, to sum up, we need to state that there is a direct dependence of the professional thinking development on professional activity organization in general and on training organization in particular.

At the same time, it is not the spontaneous "maturation" of thought actions and operations but the search for techniques that promote intensive intellectual development of a person (problem learning organization, the tasks' complication method implementation, the phased formation of mental activities, the training orientation to the creative thinking development, etc.). Therefore, in our opinion, the problem of future specialists' training at different levels of education, in particular, in higher education institutions will be successfully realized if the students will solve the professional oriented tasks independently in the learning process that correspond to this specialization instead of learning standard solutions for separate technical tasks.

In addition, the ability to solve the professional tasks will enable the student to master the samples of new technology independently; it will enhance the practical experience of a future specialist and mastery of professional skills.

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Data science: opportunities to transform education

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Abstract. The article concerns the issue of data science tools implementation, including the text mining and natural language processing algorithms for increasing the value of high education for development modern and technologically flexible society. Data science is the field of study that involves tools, algorithms, and knowledge of math and statistics to discover knowledge from the raw data. Data science is developing fast and penetrating all spheres of life. More people understand the importance of the science of data and the need for implementation in everyday life. Data science is used in business for business analytics and production, in sales for offerings and, for sales forecasting, in marketing for customizing customers, and recommendations on purchasing, digital marketing, in banking and insurance for risk assessment, fraud detection, scoring, and in medicine for disease forecasting, process automation and patient health monitoring, in tourism in the field of price analysis, flight safety, opinion mining etc. However, data science applications in education have been relatively limited, and many opportunities for advancing the fields still unexplored.

Keywords: data science, high education, clustering, natural language processing, text mining.

1 Introduction

Nowadays the world is changing rapidly: globalization, digitalization, new technologies, etc. These processes are accompanied by the emergence of new types of data and increasing data. To effectively use the benefits of the modern world, you need to be able to use data correctly, model processes and make decisions using modern methods and technologies.

Data science is the field of study that involves tools, algorithms, and knowledge of math and statistics to discover knowledge from the raw data. Data science is developing fast and penetrating all spheres of life. More people understand the importance of the science of data and the need for implementation in everyday life. Data science is used in business for business analytics and production, in sales for offerings and, for sales forecasting, in marketing for customizing customers, and recommendations on purchasing, digital marketing, in banking and insurance for risk assessment, fraud detection, scoring, and in medicine for disease forecasting, process automation and patient health monitoring, in tourism in the field of price analysis, flight safety, etc. However, data science applications in education have been relatively limited, and many opportunities for advancing the fields still unexplored.

Data science should be used in education to solve science problems, for example, in behaviors research in economics, psychology, biology and so on, in predicting different processes, analyzing complex systems, etc.

2 Literature review

Data Science has a big list of tools: Linear Regression, Logistic Regression, Density Estimation, Confidence Interval, Test of Hypotheses, Pattern Recognition, Clustering, Supervised Learning, Time Series, Decision Trees, Monte-Carlo Simulation, Naive Bayes, Principal Component Analysis, Neural Networks, k-means, Recommendation Engine, Collaborative Filtering, Association Rules, Scoring Engine, Segmentation, Predictive Modeling, Graphs, Deep Learning, Game Theory, Arbitrage, Cross-Validation, Model Fitting, etc. Some of these tools were used in the next researches.

Teaching data science, for example, were introduced in [3], Big data and Data Science methods presented in [4], [8], [12], [23], [25], machine learning used [16], [11], Monte Carlo method presented [17], game theory and genetic algorithms combined [18], Artificial Intelligence presented in [19], [21], [22], etc. Data Science is fast developing. A large volume of information that grows with each passing year makes it possible to build high-precision models that simplify and partially automate the decision-making process. Models are being developed that implement the key data science algorithms for decision-making in business [9], [13].

3 Data Science: principles and tools

Data Science in education is a multidisciplinary approach to technologies, processes, and systems for extract knowledge, understanding of data, and supports decision-making under uncertainty. Data science deals with mathematics, statistics, statistical modeling, signal processing, computer science & programming, database technologies, data modeling, machine learning, natural language processing, predictive analytics, visualization, etc. Data Science in education has two aspects of the application: the management and processing of data and analytical methods for analysis and modeling. The first aspect includes data systems and their preparation, including databases facilities, data cleansing, engineering, visualization, monitoring, and reporting. The second aspect includes data analytics data mining, machine learning, text analytics, probability theory, optimization, and visualization.

The basis of the learning process is the availability of relevant data that is of sufficient quality, appropriately organized for the task. Primary data often requires pre-processing. First of all, it is necessary to investigate the availability of the necessary data and how they can be obtained. The data search ends with the creation of a data set in which data coexistence is to be provided.

Data science has a wide range of tools for data evaluation and preparation, in particular for data mining, data manipulation (value conversion, data aggregation and reordering, table aggregation, breakdown or merge of values, etc.) and validation of data (checking format, ranges of test values and search in legal values tables). The problem of missing values is solved by using different analytical methods: simulation, inserting default values, statistical simulation. Data science provides broad opportunities for text analytics. In addition, the use of data science tools facilitates work with big data. The main approaches in Data Science are Supervised learning models and Unsupervised learning models.

Data Science process includes next steps (Figure 1):

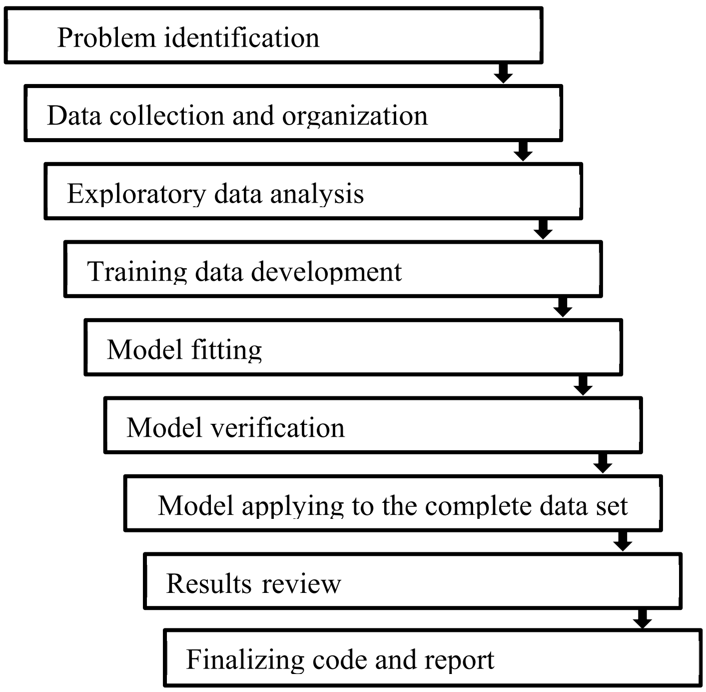

Fig. 1. Data Science process

3.1 Supervised learning models

Supervised learning is one of the methods of machine learning, in which the model learns on the basis of labeled data. Using Supervised learning is possible to decide on two types of tasks: regression and classification. The main difference between them is the type of variance that is predicted by the corresponding algorithm. In regression training, it is a continuous variable, in the classification, it is a categorical variable. To solve these problems, many algorithms have been developed. One of the most common is a linear and logistic regression, a decision tree.

Linear regression. Regression analysis can be considered as the basis of statistical research. This approach involves a wide range of algorithms for forecasting a dependent variable using one or more factors (independent variables). The relationship between variables is expressed by a linear function:

$$y = b_0 + b_1x_1 + b_2x_2 + \ldots + b_nx_n,$$

x_i – factor i, based on which the forecast is based,
b_i – parameter of the model, the influence of the factor,
y – dependent variable for which the forecast is constructed.

The advantage of applying such an approach to modeling is the simplicity and clarity of the results, the speed of learning and the release of the forecast. The disadvantage is not always sufficiently high precision (since in business processes, the linear relationship between changes is rare).

As the example, linear regression is trends for time series when time values or index values are taken for an independent variable (for example, from 1 to n, where n is the number of elements in the time series). Trend allows you to predict the value for the next period. For example, research on real climate change has been conducted based on the analysis of the average monthly temperature of soil and air in various areas for 1990-2011 (Figure 2) [9]. It is important to analyze this trend in order to model in the biology, geography, economics.

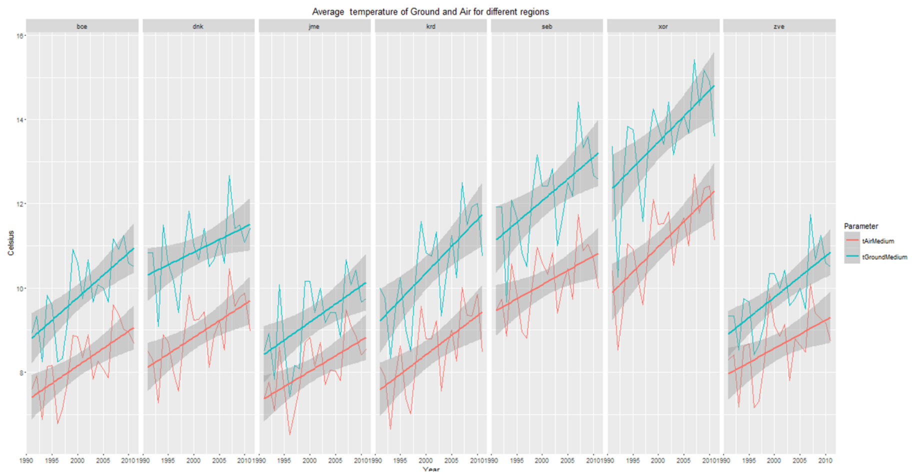

Fig. 2. Average monthly ground and air temperature in Ukraine

Another example of applying linear regression is the optimizing prices. Consider an example of optimizing tickets prices per week in one of the flights. Having historical data on price and demand, this task can be solved in several stages:

1. To forecast the demand for a product by analyzing the time series for the next period, taking into account seasonal characteristics and growth of consumers.
2. Estimate the linear function depending on demand from the price, first calculating the demand level for the next week based on the forecast. In addition, it is possible to add such dependent variables as the promotional product, the presence of ads in booklets/displays, on the Internet, etc. (Figure 3). In complex cases, such dependence can be expressed as a nonlinear function (for example, sigmoid).

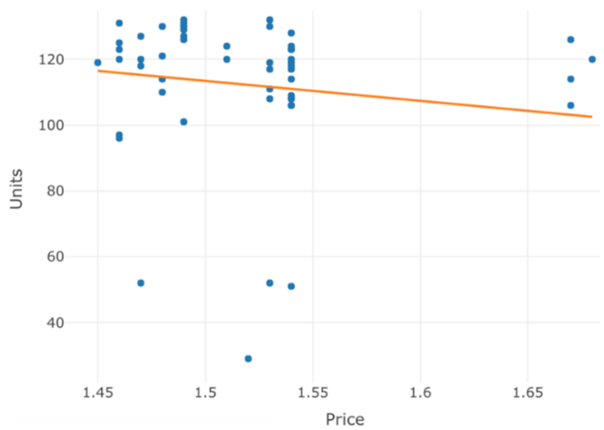

Fig. 3. Price – Demand function of tickets (thousand hryvnyas)

Taking into account the estimated function of demand, optimization of the quadratic function of revenue (Figure 4):

$$D = pu = p(a + bp) = bp^2 + ap,$$

where D – profit, p – price, u – demand.

Logistic regression is used when it is necessary to predict the release of a binary variable using a dataset of continuous or categorical variables. Situations, where the parent variable has more than 2 possible values, can be simulated by a one-vs-all approach when constructing a logistic classifier for a possible output, or one-vs-one when constructing logistic classifiers for each possible combinations of categories of the original variable.

The dependence between the independent and the logarithmic variable in logistic regression is linear, the only difference with linear regression is sigmoidal functions, which converts a linear result in the probability of belonging to a class within [0; 1]:

$$p = \frac{1}{1 + e^{-(b_0 + b_1 x_1 + b_2 x_2 + \ldots + b_n x_n)}},$$

x_i – i factor, a base for the forecast,
b_i – i parameter of the model,
p – a probability of belonging to the class “1”.

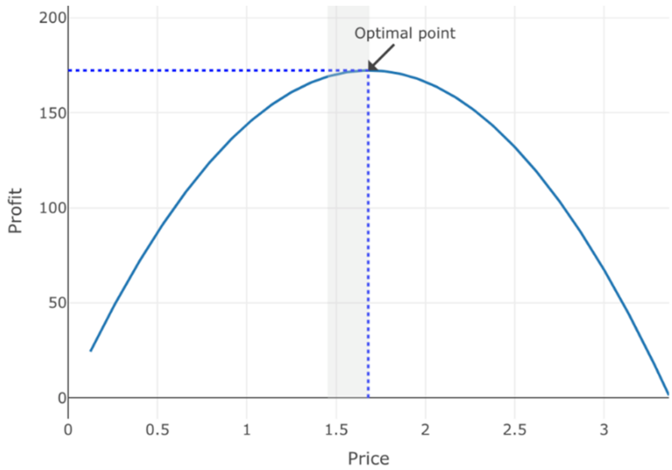

Fig. 4. The function of profit of the tickets

The advantages and disadvantages of logistic regression are due to the advantages and disadvantages of linear regression. This is the speed of the algorithm and the possible interpretation of the results, on the one hand, and a little accuracy – on the other.

Logistic regression is often used to construct vote counting models. An important factor in this is the interpretation of its results. The influence of each factor is clearly expressed by the magnitude of the coefficient *b*, which allows it to be clearly defined which of them positively and to what extent influence the decision. In Figure 4 shows a simple model of indicators, which predicts a loan client based on two factors: the age of clients and the term of the loan. This model is based on 1000 copies of the data set "German Credit Risk". As can be seen from the Figure 5, the model assumes higher creditworthiness of clients with a term of lending up to 2 years and at the age of 30–40 years. The accuracy of such a model is ~ 60%, the construction of logistic regression across all 20 attributes, can achieve the accuracy of up to 80%. The black line on the graph reflects the boundary of the model's decision: it has a greater probability of a positive response > 50%.

A decision tree is an approach to both regression and classification. It is widely used in intelligent data analysis. The decision tree consists of "nodes" and "branches"". The tree nodes have attributes that are used to make decisions. In order to make a decision, it is needed to go down to the bottom of the decision tree. The sequence of attributes in a tree, as well as the values that divide the leaves into branches, depends on such parameters as the amount of information or entropy that the attribute adds to the prediction variable.

The advantages of decision trees are the simplicity of interpretation, greater accuracy in decision-making simulation compared with regression models, the simplicity of visualization, natural modeling of categorical variables (in regression models it is needed to be coded by artificial variables). However, the decision trees have one significant drawback – low predictive accuracy [10].

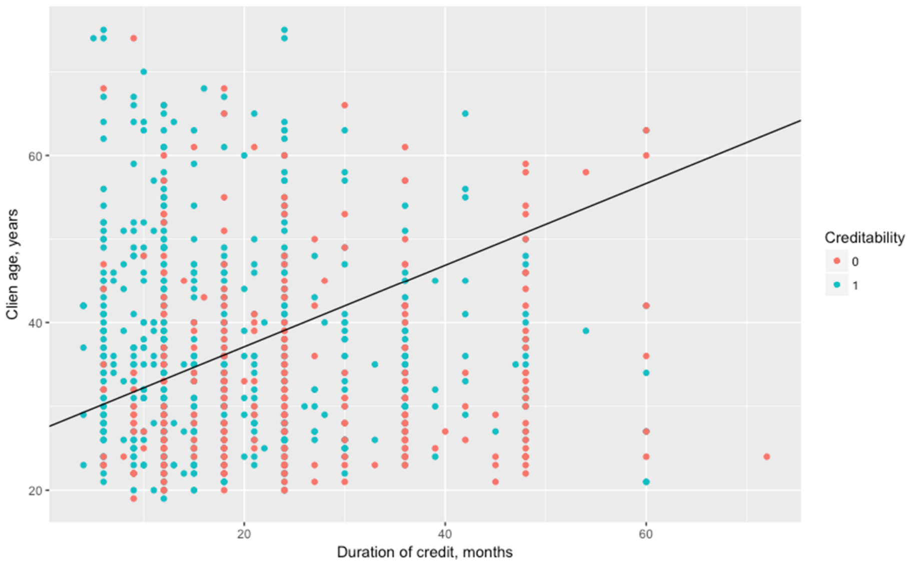

Fig. 5. Scoring model of the creditworthiness of clients

An example of applying a decision tree is the definition of the companies client classification algorithm – the construction of Loyalty Matrix. All clients are divided into 4 groups (TTruly Loyal, Accessible, Trapped, High risk) based on the answer to questions1 to 5 questions. In Figure 6 shows a tree that, based on three questions, allows us to predict the client's class with the accuracy of 98%.

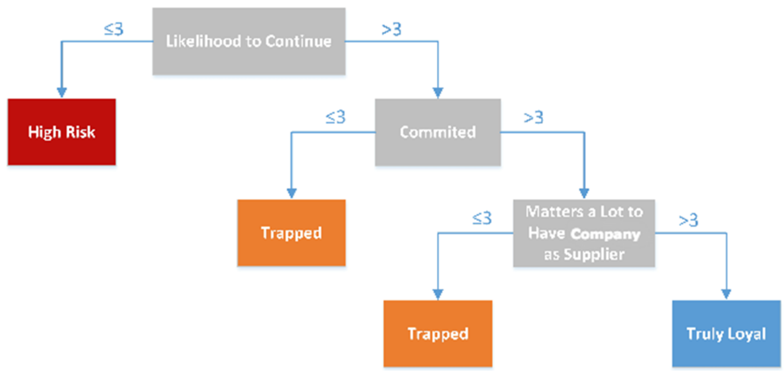

Fig. 6. Decision tree of the classification of company’s clients

3.2 Unsupervised learning

Unsupervised learning describes a more complex situation in which, for each observation $i = 1, ..., n$, observation of the measurement vector x_i, but without any variables in the output y_i. In such data, the construction of linear or logistic regression models is impossible, since there are no predictive variables. In such a situation, a so-called "blind" analysis is conducted. Such a task belongs to the class of tasks of unsupervised learning, due to the absence of an output variable that guided the analysis. Unsupervised learning algorithms can be divided into algorithms for space reduction and clustering algorithms. The main task of clustering is to find patterns in the data that allow you to divide the data into groups and then in a certain way analyze them and give them an interpretation.

K-means is one of the most popular clustering algorithms, whose main task is to divide n observations into k clusters. The minimum sum of squares is the distance of each observation to the center of the corresponding cluster. This algorithm is iterative, at each step the cluster centers are re-indexed and redistributed observation between them until a stable result is achieved.

The benefits of such an algorithm of clustering are the simplicity, speed, and the ability to process large amounts of data. But the user must specify the number of clusters he wants to use for clustering before computing; the instability of the result (it depends on the initial separation of points between the clusters).

Figure 7 shows an example of using k-means for clustering users of the Internet service by coordinates [13]. It allows you to split them into groups and form a delivery zone.

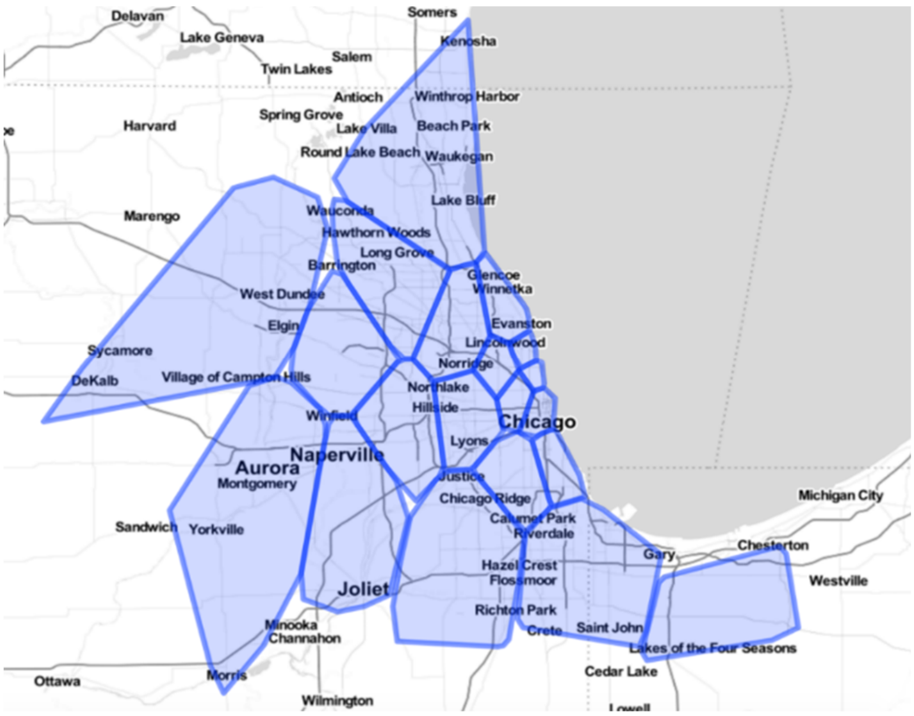

Fig. 7. Clustering of Internet clients based on their coordinates

Hierarchical clustering is an alternative approach to clustering, which does not require a preliminary determination of the number of clusters. Moreover, the hierarchical clustering ensures the stability of the result and gives the output an attractive visualization based on the tree-like structure of observations/clusters – dendrogram. This clustering algorithm uses different distance metrics and cluster agglomeration cluster criteria, which makes it very flexible to the data on which clustering is performed. However, the disadvantage of hierarchical clustering is the need to calculate the matrices of the distance between observations before agglomeration, which complicates the application of this algorithm for large data and data with many dimensions.

Figure 8 shows a dendrogram of customer segmentation based on features such as the number of weekends/weekdays transactions, the average number of purchases per week, and so on. Segmentation allows you to select groups of "similar" clients, for example, those who make purchases only on the weekend; those who buy mostly discounted goods, etc. This algorithm allows improving targeted marketing.

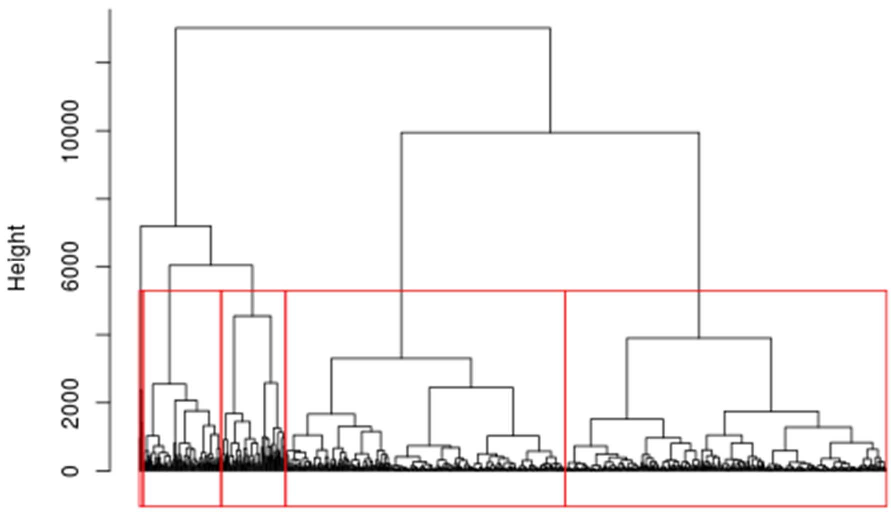

Fig. 8. Dendrogram of customer segmentation

Time series analysis. A time series is built by observations that have been collected with a fixed interval. It could be daily demand, or monthly profit growth rates, number of flights, etc. The time series analysis takes an important part in the analysis of data that covers the region, from the analysis of exchange rates to sales forecasting [14]. One of the tasks of time series analysis is the allocation of trend and seasonal components and the construction of the forecast. There are many algorithms have been developed, and we consider models such as ARIMA and Prophet.

The **ARIMA** algorithm is one of the most common algorithms for forecasting time series. The basic idea is to use the previous time series values to predict the future. This can use any number of lags, which makes such an approach difficult in setting because it is necessary to select the parameter so as to minimize the error and not override the model. ARIMA is often used for short-term forecasting. A disadvantage is a complexity of learning a model in many seasonal conditions.

Figure 9 shows an example of forecasting for 1 week the number of orders in a restaurant [9]. One can clearly see seasonality in one day, which is inherent in the series of this kind.

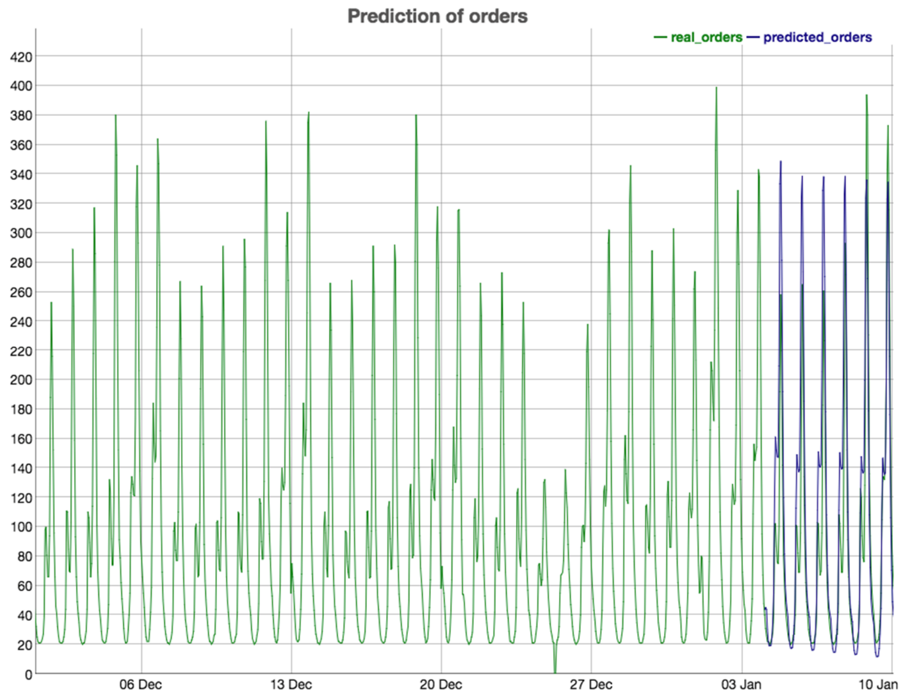

Fig. 9. ARIMA for forecasting tickets demand

Algorithm **Prophet** was developed by Facebook in the beginning of 2017 for forecasting based on time series [14]. It is based on an additive model in which nonlinear trends are of annual and weekly seasonality. This approach also allows to model holidays and weekends, thereby allowing to predict residuals in a time series. Also, the Prophet is insensitive to missed values, bias in the trend and significant residuals, which is an important advantage over ARIMA. Another advantage is the rather high speed of training, as well as the ability to use large-scale time series.

Figures 10, 11 shows an example of prediction with the Prophet. On the first of the charts – forecasting the entire category of goods, on the second – those products that are bought for Christmas. In the second case, only the seasonal components are taken into account and the "holiday" component is not modeled.

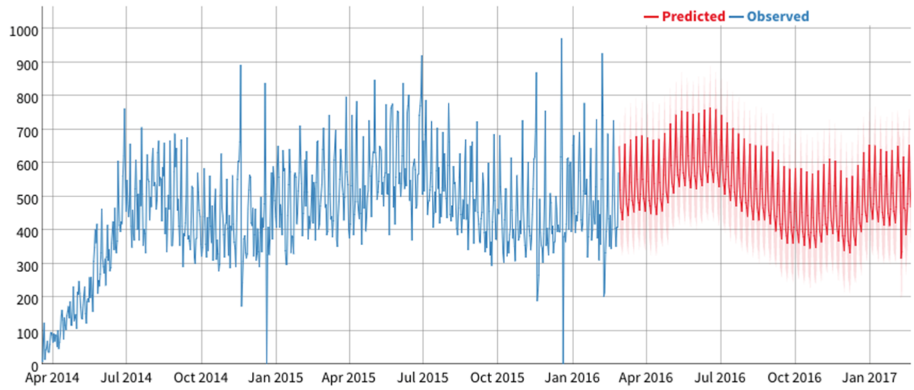

Fig. 10. Forecasting the entire category of goods using the Prophet

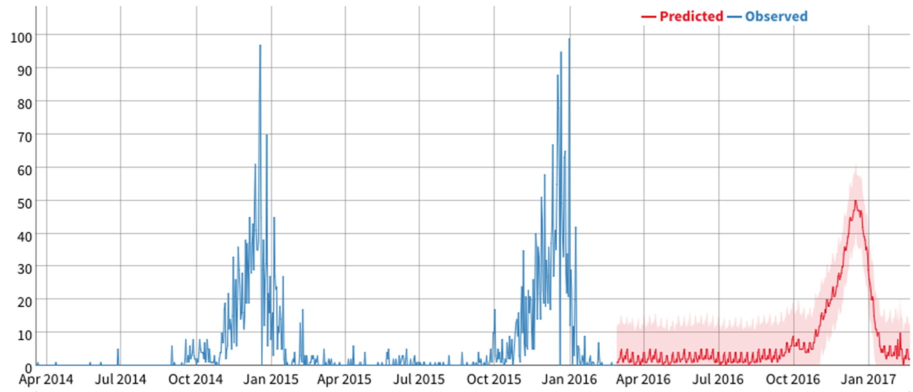

Fig. 11. Time series analysis using the Prophet

3.3 Text mining algorithms

Under the notion of texts mining in natural language we understand the application of methods of texts computer analysis and presentation in order to achieve the quality, which corresponds to the “manual” processing for further usage in various tasks and applications. One of the actual tasks of automatic texts mining is their clustering (definition of groups of the similar documents). More and more often statistical topical methods are being applied [24].

The topics are presented as discrete distributions on a number of words, and the documents – as discrete distribution on a number of topics [24]. Topical methods perform a “non-precise” clustering of words and documents, which means that a word or a document can be referred to a few topics with different probabilities simultaneously. The synonyms with higher probability will appear in the same topics since they are frequently used in the same documents. At the same time, the homonyms (words different in meaning, but similar in writing) will be placed in different topics because they are used in different contexts [7].

Vector Space Model

Topical methods, as a rule, apply the method of a "bad of words", where each document is considered as a set of words not connected to each other. Before the topics are defined, the text is processed – its morphologic analysis is conducted with the objective to define the initial form of words and their meanings in the speech context. The method of processing words in a machine-readable natural language, as a rule, is based on the vector-space method of data description (Vector Space Model) [15], suggested by Gerard A. Salton, Andy Wong, Chung-Shu Yang in [20]. Within the framework of the method each word in a document has its particular weight. Thus, each document is presented as a vector and its dimension is equal to the total number of words in the document.

Similarity of a document and a topic is evaluated as a scalar product of a few information vectors. The weight of separate words (terms) can be calculated both applying the absolute frequency of a word appearing in the text and the relative (normalized) frequency:

$$tf(w,t) = \frac{k(w,t)}{df}, \tag{1}$$

where $k(w, L_t)$ is the number of w-word occurrences in the text t; df – total number of words in the text t.

The weight of a word, calculated by the formula (1), in documents is usually put as TF (Term Frequency).

However, this approach does not take into consideration the frequency, with which the word is used in the whole massive of documents – i.e. the so-called discrimination strength of the word. That is why, in case when the statistics for word usage in the whole document is available, it is more efficient to use the other method:

$$TF \times IDF = tf(w,t) \cdot \log_2 \cdot {}^{D}\!/_{df}$$

where D – total number of documents in the collection.

TF×IDF method of weighting words shows not the frequency of words appearing in the document, but the measure, inverse to the number of documents in the massive containing this particular word (inverse document frequency).

The Vector Space Model of data presentation provides the systems, which are based on it, with the following functions: creation of professional systems and databases; increase of the level of specialists' competence by means of obtaining an effective possibility of directed search and filtration of text documents; automatic summarization of documents' texts.

Latent Semantic Analysis

In "soft" clustering each word and document refer to a few topics with particular probabilities simultaneously. Semantic description of a word or a document is a probability distribution on a number of topics. The process of finding these distributions is called "topical modelling".

One of the best methods of "soft" clustering is the Latent Semantic Analysis (LSA), which reflects documents and separate words in the so-called "semantic space", where all the further comparisons are conducted [7].

In this process, the following assumptions are made: documents are a set of words, the order of which is ignored; it is only important how many times a word appears in the text; semantic meaning of a document is defined by the set of words, which, as a rule, go together; each word has a single meaning.

LSA is the method of processing information in natural language, analyzing interconnections between massifs of documents and words, appearing in them, as well as associates topics with documents (words).

The LSA method is based on principles of revealing latent connections of the studied phenomena and objects. In classification/clustering of documents this method is applied to extract context-dependent meanings of lexical units by means of statistical processing of very large text massifs. As the initial information in LSA the matrix "word-document" is used, which describes the set of data, used for system's training.

Elements of this matrix contain weights that consider frequencies of using every word in every document and participation of a word in all documents ($TF \times IDF$). The most widely-used variant of LSA is based on using decomposition of a diagonal matrix by singular values (SVD – Singular Value Decomposition).

With the help of SVD any matrix can be decomposed on many orthogonal matrices, the linear combination of which is a rather precise approximation to the initial matrix.

Mathematical basis of the method is as follows:

Formally let A be a $m \times n$ words-document matrix of a documents collection. Each column of A corresponds to a document. The values of the matrix elements $A[i, j]$ represent the frequency identifications $tf(w, t)$ of the word occurrence w_i in the document t_j: $A[i, j] = tf(w, t)$. The dimensions of A, m and n correspond to the number of words and documents, respectively, in the collection.

In this case $B = A^TA$ is the document-document matrix. If the documents i and j have b words in common, then $B[i, j] = b$. On the other hand, $C = AA^T$ is the word-word matrix. If the words i and j occur together in c documents, then $C[i, j] = c$. Clearly, both B and C are square and symmetric; B is a $m \times m$ matrix, whereas C is an $n \times n$ matrix. Now, we perform the Singular Value Decomposition on A using matrices B and C as described in the previous section:

$$A = U \Sigma V^T,$$

where U is the matrix of the eigenvectors of B; V is the matrix of the eigenvectors of C; Σ is the diagonal matrix of singular values obtained as square roots of the eigenvalues of B.

In LSA we ignore these small singular values and replace them by 0. Let us say that we only keep k singular values in Σ. Then Σ will be all zeros except the first k entries along its diagonal. We can reduce the matrix Σ into Σ_k which is a $k \times k$ matrix containing only the k singular values that we keep, and also reduce U and V^T, into U_K and V_k^T, to have k columns and rows, respectively. Of course, all these matrix parts that we throw out would have been zeroed anyway by the zeros in Σ. Matrix *A* is now approximated by:

$$X_{t\times d} \approx X_{K_{t\times d}} = U_{K_{t\times d}} \Sigma_{K_{t\times d}} \left(V_{K_{t\times d}}\right)^T$$

Intuitively, the *k* remaining ingredients of the eigenvectors in *U* and *V* could be interpreted as a k “hidden concepts” where the words and documents participate. The words and documents now have a new representation in words of these hidden concepts. The results of the LSA method are following:

Document comparison: $Z_k = \Sigma_{K_{t\times d}} \left(V_{K_{t\times d}}\right)^T$ represents docs (cols) in semantic space (scaling with singular values). Documents d_i and d_j can be compared using cosine distance on *i* and *j* columns of Z_k.

Word comparison $Y_k = U_{K_{t\times d}} \Sigma_{K_{t\times d}}$ represents words (cols) in semantic space. Words t_i and t_j can be compared as cosine distance on *i* and *j* columns of Y_k.

Topic analysis. Left singular vectors $U_{K_{t\times d}}$ map between *k* words and “semantic dimensions” (topics). Then column k of this vector “describes” topic by giving strength of association with each word. Right singular vectors $V_{K_{t\times d}}$ map between topics and documents could in principle tell us what a document was “about”. As with words, one document can be associated with many topics.

Latent Dirichlet Allocation

To get rid of the above-mentioned disadvantages the probability LSA is conducted, based on the multinomial distribution – in particular, on the algorithm of Latent Dirichlet allocation (LDA) (David M. Blei [1; 2], Andrew Y. Ng [2], Michael I. Jordan [2]).

The LDA presupposes that each word in a document is created by a certain latent topic; at the same time distribution of words in each of them is used in a clear form, as well as the prior distribution of words in the document. Topics of all the words in the document are supposed to be independent. In LDA, as well as in LSA, a document can correspond to a few topics. However, LSA sets the algorithm of generation of both words and documents, that is why there appears an additional possibility to evaluate probabilities of documents outside text massive using the algorithm of variation Gibbs sampling.

Unlike LSA, in the LDA the number of parameters does not increase with the growth of number of documents in the studied massive. The applied extensions of the LDA algorithm eliminate some of its limitations and improve productivity for particular tasks. LSA is generating algorithm only for words, but not for documents. The LDA algorithm overcomes this limitation.

The main idea of LDA consists in the fact that the documents are presented as a mix of distributions of latent topics, where each topic is defined by a probability distribution on the set of words. LDA reflects hidden connections between the words by means of topics; it also allows to set probabilities for new documents, which were not included into the training set, applying the algorithm of Variational Bayesian method.

In fact, LDA is a three-stage Bayesian network, which generates a document from a mix of topics. At the first stage for each document d a random vector with the parameter α (usually α is taken as $50/T$) is selected from the Dirichlet distribution. At the second stage a topic z_{di} is selected form the multinomial distribution with the parameter θ_d. Finally, in accordance with the selected topic z a word w_{di} is chosen from the distribution Φ_{zdi}, which is the Dirichlet distribution with the parameter β (usually the parameter β is 0.1; its increase leads to more sparse topics).

4 Example of text mining tools application in education

The printed newspaper becomes a rarity. At the same time, that does not mean that there is less written news, but on the contrary, with the strong online growth of recent decades, more and more people have switched from the classic newspaper to online news. Every written online word can be read and interpreted by a machine. There are numerous application examples in which a machine could improve the news world. Today, everyone wants to read the news, but only the shortest summarized news if possible, as less and less time remains to read long texts. Also, pre-sorting of certain texts in areas has its appeal to news companies because they could then focus entirely on writing messages rather than being biased in the category. On top of that, it would also be great to see a sentiment analysis of each news which will be released, because it would show the reader what kind of news center they are dealing with. It could be that the news center is manipulating its "customers" by choosing certain words, and with a neutral system, which would show the political sorting or sentiment, the user could easily choose what kind of text with the same content he is willing to read. Some of these approaches are already live and some are still future talk. Coming back to the categorization, it is not only a topic for news center but for a variety of businesses or even for the private user, who wants to classify some of his personal texts.

The aim of exemple of text mining tools application in Education could be identification and assigning the news article into categories.

Research Questions

Users gain more power when it comes to advertising a product by reviewing them. A company should therefore carefully watch all the reviews they get. However, if they have too many products and getting too many reviews it is impossible to check every review one by one. So, with the help of text mining techniques it should support the companies to give them a better overview whether a review is important or not. In our opinion companies should not only check for the rating itself but for the written text, because there could be a hidden bug or feature which they could promote better afterwards. Also, we recommend not only looking at the negative reviews, but also at the positive ones, to even strengthen the good quality. So the research question is, whether it is possible to cluster reviews and gain a new insight.

Research Plan

This term paper is based on the programming language R. R is an open source development environment for statistical analysis comparable to other statistical software packages such as MATLAB, the SAS Enterprise Miner or SPSS Statistics. It is based on its own scripting language, which is optimized for mathematical calculations. R allows you to load records from many data sources, transform them, and then examine them. Insights gained in this way are valuable and can often be developed into predictive models. R also provides a set of domain-specific extensions for special statistical methods or visualizations.

The steps of Research plan are following:

1. Find/Get reliable data for processing our text mining techniques. We gathered data from the BBC is a (online) news center. We decided to take 2225 news, which are categorized into 5 categories. We will go into more detail about the data in the result chapter.
2. Our second step is to preprocess the gathered data in Excel.
3. The next step is to gather more information about the corpus, which we get with the frequency of words. These are defined by the document term matrix (DTM) and the term document matrix (TDM). With this technique we can get an idea of high frequently words and words which are only used rarely. Also, the TF-IDF Transformation is giving us more information about the importance of terms within the corpus.
4. The fourth step is to cluster the news with several algorithms. We will describe the steps more detailed in the results of the experiment chapter and compare each algorithm by their results and mention their advantages and disadvantages.
5. At the end we will give a conclusion.

Results of the experiment

For providing the experiment were took news articles from BBC, which are already labeled into five categories. The following five categories are listed: business; entertainment; politics; sports; tech.

The dataset consists of 2225 documents from the BBC news website corresponding to stories in five topical areas from 2004-2005. Source: http://mlg.ucd.ie/files/datasets/bbc-fulltext.zip.

Firstly, it is possible to split the files into 300 files per class label, which results in a total dataset of 1500 files which we will cluster with all the learned cluster algorithms. After that we renamed all the files to each of the label (to have a better visual comprehension of the clustering plotted images). For example, all the labeled text files have a name like “business (1)”, “business (2)”, “business (3)” etc. (Figure 12)

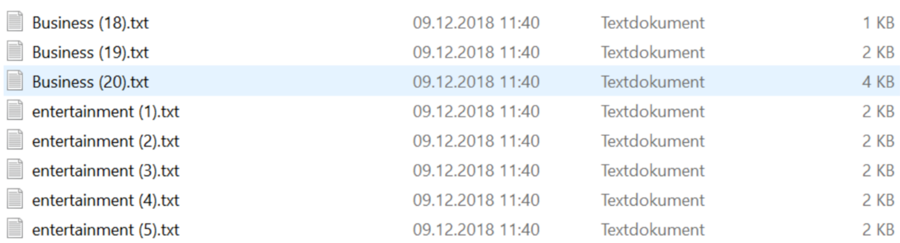

Fig. 12. File names

The corpus has a 100×4346 dimension matrix with a sparsity of 97%, which means that 409476 rows have zeros. This means that the files are not very similar in their content (choice of words), which can be seen in the extract in Figure 12. There you can see an example of the zeros for each row.

Just from that data, we cannot really say something about the corpus, but we are eager to see where this will take us. The tail means, that these words are only used once. We also tried to check the association between some words (Figure 13), we picked some words, which we would take as a representation for the label:

- world – politics;
- music – entertainment;
- sport – sport.

```
> findAssocs(dtmr,"world",0.5)
$`world`
 champion medallist      mark    indoor    silver   finland  helsinki   lewisfr
     0.60      0.60      0.57      0.53      0.53      0.52      0.52      0.52
    relay   fastest     olymp
     0.52      0.51      0.50

> findAssocs(dtmr,"music",0.5)
$`music`
   wonder     spend     stori     frank     opera treatment     stage      turn
     0.68      0.64      0.63      0.60      0.60      0.60      0.55      0.52

> findAssocs(dtmr,"sport",0.5)
$`sport`
  iaaf athlet   dope
  0.60   0.54   0.53
```

Fig. 13. Association of words

The word "world" is most associated with "champion" which comes from "world champion" which would be classified into the sport sector not the politics sector, how we "predicted". However, the word "world" is mostly a universal word, which occur in most of the labels, that is why, it is the second most frequent word in the corpus. To get a better visual, immediate understanding of the used words in the corpus, we plotted a world cloud with three colors. "Year" is the most frequently used word. The same explanation like for the word "world" it is a universal word, which will be used for all of the categories.

A dendrogram shows a hierarchical clustering, it illustrates the arrangement of the clusters produced by the corresponding analyses. Well, as one can see in Figure 14, we clustered the corpus into 5 parts, but we do not get a good result, because in our example there is no hierarchical possibility to cluster the files. It is not like some files are built on others. So, that is why we get a bad result. The advantage of the dendrogram is to see some hierarchical cluster, mostly the cluster algorithm is used for chemical or biological studies to see the relationship between some elements or species. For clustering "similarities" the algorithm is not very effective.

We chose to create a table with the clustered values (Table 1), because just from the Figure 14 it is very difficult to see which files are in which cluster.

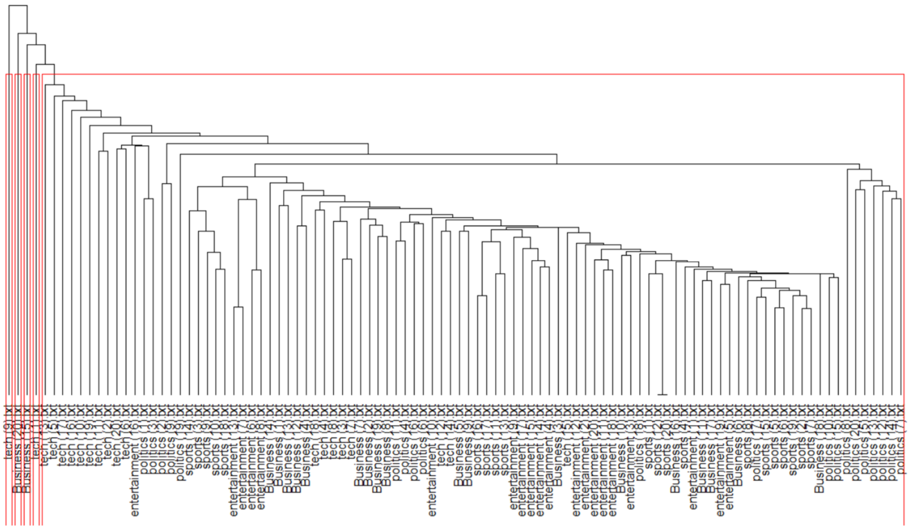

Fig. 14. Cluster dendrogram

Table 1. Clastering results table

	1	2	3	4	5
Business	1	11	0	0	8
entertainment	0	14	0	0	6
politics	0	6	0	7	7
sports	0	16	0	0	4
tech	0	5	4	8	3

The table shows that most of the files are located into the second cluster, followed by cluster 5. All the topics are scrambled into all the cluster (Figure 15). So, the k-means algorithm is also not a good algorithm for our case. The disadvantage for the k-means algorithm is that it is not good with outliers, and if there are some outlier, they will be put into one cluster like business 20, or some of the tech articles in cluster 3. However, the other texts are likely to be "too similar" to distinguish them from the others.

Community Detection

Since we have a lot of files, it is not our goal to see the "biggest" influenceable hub for every sub community but see how the communities are detected. First, we have built the communities itself, like seen in Figure 16. Alone from that one can see a clear cluster like the sport-cluster in the bottom left corner or entertainment in the upper right corner. The community detection is based on the cosine similarity, as we described in the topic Document similarity.

Now we can build the community detection, which is based on the algorithm greedy optimization of modularity. Figure 17 shows clearly that there are more than 5 sub-communities. There is already the first disadvantage, it is very difficult to find the best attributes in order to get exactly 5 cluster. However, in our opinion the community detection did cluster the files very good. We added 5 numbers for every cluster, we will focus on.

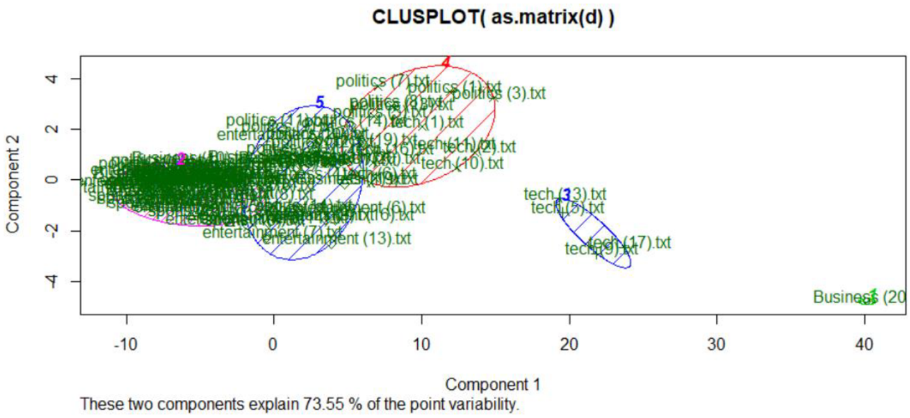

Fig. 15. K-Means plot

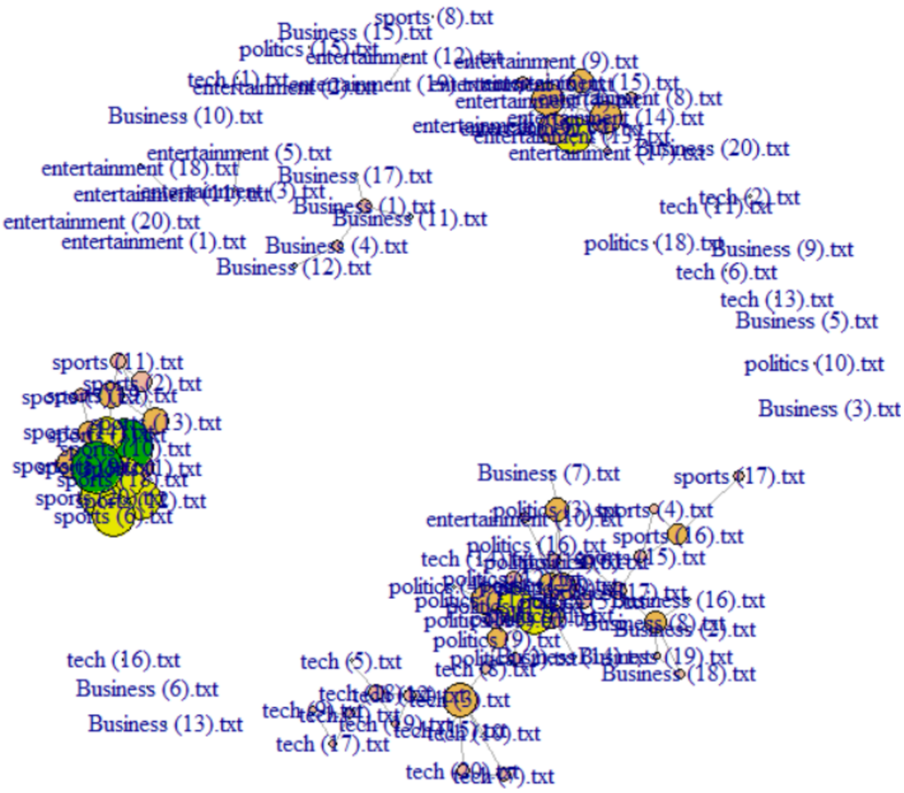

Fig. 16. Cosine similarity-based graph

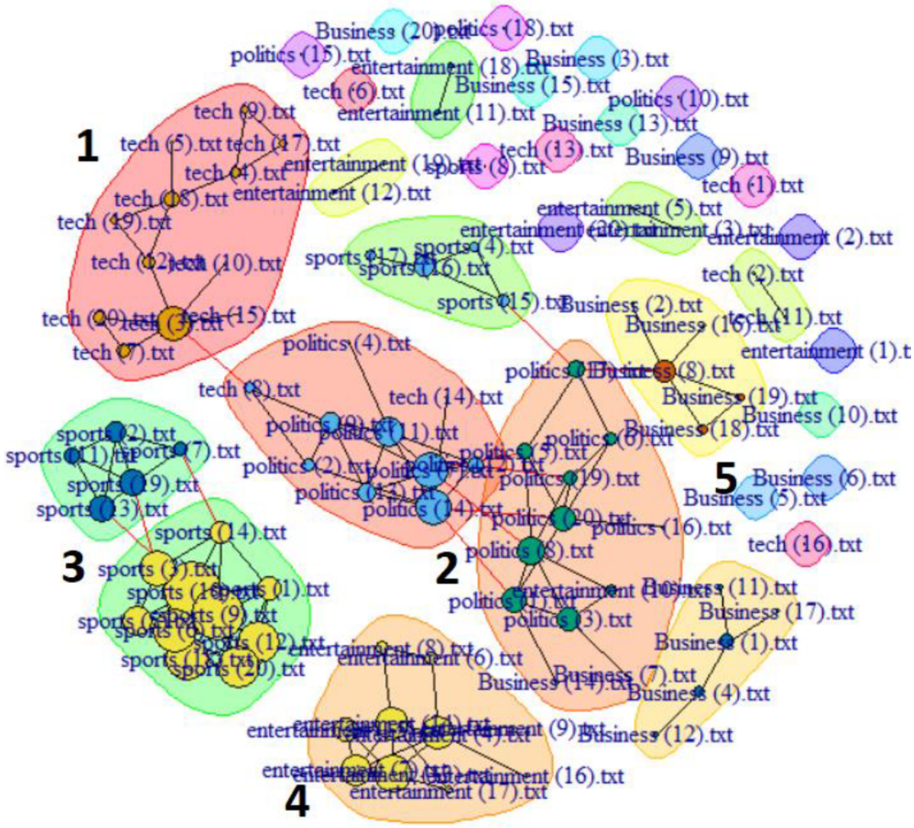

Fig. 17. Community detection results

Cluster 1 is mostly having tech files in them. Cluster 2 is politics and a little business and tech; they are definitely in a relationship. Business and politics are areas which are not that different, so it is obvious that they have a connection to each other. Sports on the other hand, cluster 3, is not in a relationship with other news areas, but it is split into 2 and a half sub communities (green). Only two of them are having a strong tie. Entertainment (cluster 4) is similar to sports, they don't have a strong bond to other news categories, but not all of the entertainment news are within this sub-community. The last cluster (5) is business, which only has a low number of files in them. Also, there are several files which have a "single"-degree number, they must be outliers or do not have much in common with other files.

Latent Semantic Analysis (LSA)

As one can already see in the two-dimensional graph in Figures 18 and 19 LSA, the clustering is not very good, even when using the k-means to get a better visual understanding, the results are not getting better.

We only made some file names visible, because otherwise it would get too chaotic. We predefined 5 cluster, as always, but won't get a good result. We processed the data in Excel and got the Table 2. There you can clearly see that most of the files are clustered into community 5 and 4, there is no real distinguish. Only some outliers are into another category. We assume that it is difficult to predefine 5 clusters, if we test the attributes with a lower cluster size, we assume that the algorithm is getting better. However, the result is useless for our case.

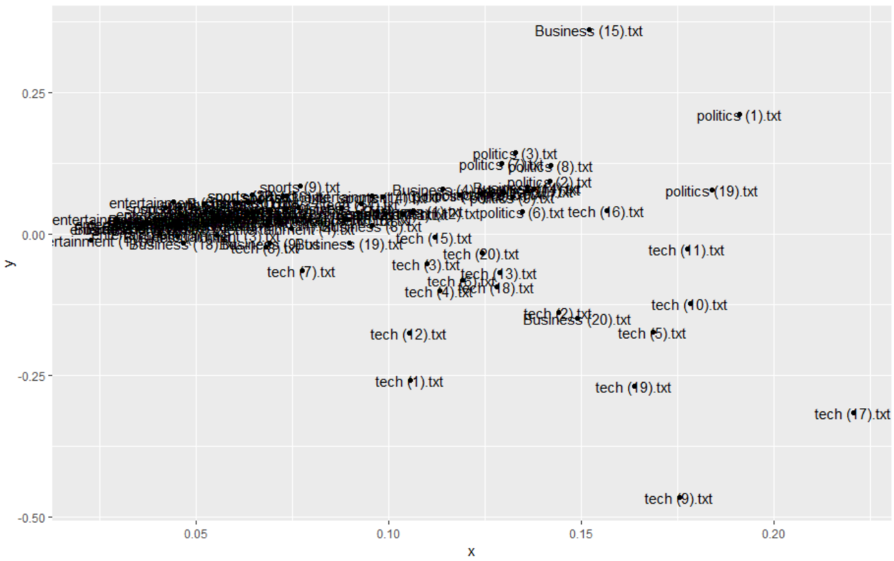

Fig. 18. LSA results

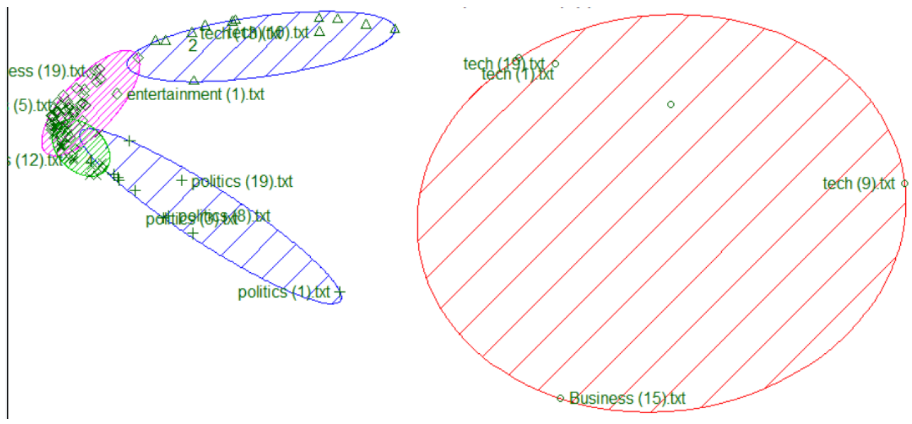

Fig. 19. LSA clustering results

Topic Modeling

Like the other algorithm, we predefined 5 categories, and try to assign the topics, which are seen in Figure 20, based on the most important words for each news category.

Table 2. LSA Result Table

	1	2	3	4	5
Business	1	1	1	6	11
entertainment	0	0	0	2	18
politics	0	0	8	6	6
sports	0	0	0	10	10
tech	4	11	1	1	3

1. Topic 1 is most likely to be the tech category, because we have "phone", "user" "call" those words are most likely to be used when writing a news article in the tech sector.
2. As already seen before the word "world" in topic 2 is most associated with champion which is only relevant for the category sport, also time and last could be very clear terms for sport.
3. Topic 3 is easy, because we have terms like "book", "film", "award" which clearly matches with entertainment.
4. Topic 4 and 5 are not so easy to separate because business and politics are also quite similar when using specific terms. In topic 5 we have words like "elect" and "parti" which is relevant for the election and can only be matched with politics, so topic 4 must be the business category.

```
> ldaOut.terms
     Topic 1 Topic 2    Topic 3  Topic 4   Topic 5
[1,] "call"  "world"    "includ" "month"   "new"
[2,] "peopl" "last"     "book"   "govern"  "women"
[3,] "now"   "time"     "film"   "year"    "elect"
[4,] "make"  "take"     "award"  "compani" "parti"
[5,] "phone" "european" "year"   "plan"    "blair"
[6,] "user"  "set"      "show"   "expect"  "email"
>
```

Fig. 20. Topic model terms

After processing the values in excel, we get Table 3. We can clearly see that our prediction is quite similar to the outcome. Even our trouble with topic 4 and topic 5 is seen here, some of the politics files are assigned to topic 4 (in the politics category). Apart from that difficulty the algorithm did a great job clustering all the files in the exact appropriate category.

We also created an error rate table, where one can see that the algorithm is quite accuracy, if we exclude the politics/business similarity (Table 4).

Table 3. Topic model result table

	1	2	3	4	5
Business	1	0	0	18	1
entertainment	0	0	19	0	1
politics	0	1	0	6	13
sports	0	20	0	0	0
tech	16	0	1	0	3

Table 4. Topic model error rate

	Business	entertainment	politics	sports	tech
Errors	2	1	7	0	4
Error Rate	10%	5%	35%	0%	20%

Comparison

Like already described in each algorithm, we saw that there is a great difference in the accuracy for each algorithm. Some resulted in a not so good cluster, but others were quite good. The Table 5 shows a summary of the results with some disadvantages and advantages for our case. For other cases it could be that there are other advantages and disadvantages.

Table 5. Summary of the research results

Algorithm	Result	Advantages	Disadvantages
Dendrogram	Not good	• Easy to understand/ read when having few files	• no existing hierarchical files, unsuitable • when having a lot of files, hard to read
K-Means	Not good	• Easy to understand/ read • Fast algorithm • efficient	• Starting configuration is crucial • not good with outliers • different size of cluster
Community Detection	Quite good	• easy visualization • easy to read • good for specific clustering	• cannot specify the cluster size • difficult to change attributes • no breakdown in R for every cluster
LSA	Not good	• fast algorithm • not sensitive for starting configuration	• Representation is dense • distributional model, not efficient
Topic Modeling	Very good	• NLP-model • tailored for text mining	• only good for large texts • static

Topic Model and Community detection were the best algorithm for our case. For the Topic Modelling it is not surprising because it is a machine learning and natural language processing mode, which cluster the document with the help of statistical model for discovering the abstract “topics” that occur in them. This is the only model which is tailored for text mining usages.

5 Conclusions

Machine Learning techniques are getting more popular in the recent year, even artificial intelligence is getting more attention each year. Governments and businesses investing billions into the area. However, text mining and NLP which are both a part of the area seem to get overlooked. We want to emphasize that text mining is a powerful field, which is far from perfect, and could bear more attention than artificial intelligence. With the growing online news turnover reducing the normal paper, mostly every news will be written online, which means that they are easily analyzed by text mining algorithms. So even news centers are forced to deal with text mining when it comes to learning something about their writing style. Although the results are still taking a lot of human interaction, and the cluster algorithm are still not the best, it is necessary of the companies to invest more in that area, so they get an advantage towards their competition. Our clustering model was partly successful but could be even better. However, we are still in a learning phase and think, with more time and a better model we would be able to get a better accuracy than guessing.

As mentioned in the comparison it is crucial to use a suitable algorithm for the given case. We cannot use a dendrogram to cluster the category, because the purpose is not relevant for that issue. However, if we take the topic model, we can definitely come to a great cluster. The topic model is very good with large texts, but not very good with small texts like reviews or tweets, so you also have to be careful what kind of texts you have. When the texts are quite similar it is always difficult for a machine to differentiate them, at least for now. We think that the NLP model will become better and better, because there are a lot of possible application for text mining. When we look at the impact on social media, before an election or when a company wants to check their reviews by users, there are plenty of application possibilities for text mining, therefore algorithms are getting better and more precise.

6 Future research directions

Described approaches and algorithms are just some basic for business processes modeling, which could be applied to solve the different decision-making problems. There are multiple examples of how all these methods could be used in education. For example, with time series analysis we could predict future demand for tickets, using regression models we could determine the loyalty of the customers and so on.

Nowadays there are much more algorithms, which could be applied in this area. Like complicated non-liners algorithm for regression predictions. As an example, it could be a random forest, XGBoost, neural networks. With such method, we could build models for maintenance prediction, what is very crucial in education.

Education should correspond to the modern development of the digital economy, digital society, innovation, and creative entrepreneurship. The use of data science in education should be of a multiplatform nature, that is, to be used not only in the study of a subject, but in the training of all subjects, the interaction of students with each other and with teachers, real experts, research, and individual learning.

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Educational digital games: models and implementation

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Abstract. Nowadays, social media, ICT, mobile technologies and applications are increasingly used as tools for communication, interaction, building up social skills and unique learning environments. One of the latest trends observed in education is an attempt to streamline the learning process by applying educational digital games. Despite numerous research data, that confirms the positive effects of digital games, their integration into formal educational contexts is still relatively low. The purpose of this article is to analyze, discuss and conclude what is necessary to start using games as an instructional tool in formal education. In order to achieve this aim, a complex of qualitative research methods, including semi-structured expert interviews was applied. As the result, the potential of educational digital games to give a unique and safe learning environment with a wide spectrum of build-in assistive features, be efficient in specific training contexts, help memorize studied material and incorporate different learning styles, as well as to be individually adaptable, was determined. At the same time, the need for complex approach affecting the administration, IT departments, educators, students, parents, a strong skill set and a wide spectrum of different roles and tasks a teacher carries out in a digital game-based learning class were outlined. In conclusion and as a vector for further research, the organization of Education Design Laboratory as an integral part of a contemporary educational institution was proposed.

Keywords: educational digital games, game-based learning, advantages and challenges of educational games, Education Design Laboratory model.

1 Introduction

Modern media that come in many different formats, including books, magazines, newspapers, television, movies, video games, music, cell phones, various kinds of software and Internet, can be viewed as an important form of pedagogic influence and socialization, as they not only spread information but also form our cultural values and behavioral norms.

In recent years, when contemporary high-tech enterprises require their employees to demonstrate the good level of mathematics, sciences, engineering, be computer literate and solve complex tasks creatively, the training of a new, competitive generation depends, primarily, on innovative technologies and teaching approaches that would enhance students' potential and, at the same time, would be cost effective.

Taking into consideration that the young generation of today is growing up in networked interactive media world where high-speed information acquisition, graphic images, instant rewards and multi-tasking are omnipresent, educational landscape reacts by introducing social media, ICT and mobile technologies to reach new student audience and apply these media as an educational tool on a preschool, elementary, secondary, and higher levels. Most recently, instructional designers have been examining how best use digital games.

Literature review lets us state that on the international level the scope of scholarly works about digital games is wide. For example, the focus of queries of Katie Salen Tekinbas, Eric Zimmerman [27] and Pavel Zemliansky, Diane M. Wilcox [36] falls on game design. Mark Prensky investigates D-generation and argues for partnering pedagogy [23]. Several studies, including papers by Glenda A. Gunter, Robert F. Kenny and Erik Henry Vick [15] discuss the formal design paradigm for serious games. Pieter Wouters, Christof van Nimwegen, Herre van Oostendorp and Erik D. van der Spek [35] presents the analysis of motivational and cognitive effects of video games. The description of frameworks for design and analysis of digital games can be found in the works of Sylvester Arnab, Sara de Freitas, Francesco Bellotti, Theodore Lim, Sandy Louchart, Neil Suttie, Riccardo Berta, Alessandro De Gloria [3] and Christian Sebastian Loh, Yanyan Sheng, Dirk Ifenthaler [21]. Questions related to the game-based curriculum are analyzed in article of Björn Berg Marklund and Anna-Sofia Alklind Taylor [4].

There are a number of projects that exemplify the gamification process and digital games' application to different contexts, including educational. Among them are Beaconing – Breaking Educational Barriers with Contextualised Pervasive and Gameful Learning (Horizon 2020, EU Program); Nutriciencia – a research project to increase food and nutritional literacy of high-risk populations (the University of Porto, EEA Grants Program, Ministry of Health, Portugal); Serious Games in Higher Education: Impacts, Experiences and Potential (Research Center CIIE, the University of Porto, Portugal); KidCOG' – Prevention of Online Sexual Grooming of Children' project (the University of Skövde, the Change Attitude Foundation, Sweden).

The research results report a number of successful educational video games' and commercial off the shelf games' uses [14], and confirm that digital games have a potential to increase students' motivation, provide a more authentic learning experience, teach system thinking, facilitate collaborative problem-based learning, and influence social sphere.

Despite these examples, the integration of digital games into formal education is still relatively low. This can be partially explained by the fact that many educators see video games as a leisure time activity with no pedagogic value; many are not familiar with games' interfaces as well as the game based learning concepts and process. Even those teachers who use video games face a wide range of issues to be addressed to, which makes implementing digital games into educational context highly challenging.

In other words, what we observe today is the high popularity of video games and the increase in their production and research importance. At the same time, there is an obvious gap between theoretical claims and practical implementation of digital games into a formal educational context.

Given this, the purpose of this article is to analyze the path of educational digital games from theory to a real-life educational context and to look into what it takes to use games as an instructional tool.

2 Research methods

In order to achieve our aim, a complex of qualitative research methods, including synthesis, comparison and generalization of theoretical material was applied, which helped identify the main topics for the analysis. Theoretical analysis was in large part informed by the material related to pedagogical aspects and based on the study of such works as "Digital games in schools: A handbook for teachers" (by Patrick Felicia [10]), "Supporting Teachers in the Process of Adoption of Game Based Learning Pedagogy" (by Valérie Emin-Martinez, Muriel Ney [9]), "Learning with Digital Games: A Practical Guide to Engaging Students in Higher Education" (by Nicola Whitton [33]), "Production of Creative Game-Based Learning Scenarios: A Handbook for Teachers" (ProActive Project [24]), "Best Practices For Using Games and Simulations In The Classroom: Guidelines for K-12 Educators" (Software & Information Industry Association Education Division [34]), "Poverty is not a Game: A Handbook for Teachers" (by Caroline Kearney [19]). After the theoretical analysis was completed, the most frequently raised topics were identified:

1. game-based learning, its characteristics and distinctive features;
2. advantages of digital games as an instructional tool: cognitive, motivational and social aspects; characteristics of a good game;
3. possible ways of digital games' integration into formal educational context;
4. teacher's role(s) in a digital game-based learning class.

Our analysis is also based on interviews (within interview guide approach) with a selected group of experts from The School of Informatics, University of Skövde. Six people were interviewed, with some people interviewed twice. Each interview lasted from forty to eighty minutes. The detailed notes were taken and/or the recording was done. The group of experts was selected from the lecturers, senior lecturers and the researchers in Serious Games of the School and included the Associate Professor in Educational Game Design and Game-Based Learning and the Researcher in Game Studies; the Lecturer in Media Arts and the Researcher in Virtual Reality; the Lecturer in IT and Game Design and the Researcher in Educational Games; the Senior Lecturer in Informatics and the Researcher in Serious Gaming; the Associate Professor in Media Arts, Aesthetics and Narration, and a Serious Game Designer from ZCOOLY company.

On the later stage, theoretical claims as described in research articles, projects' accounts and web resources were compared and contrasted with the discoveries from the expert interviews, therewith a more all-round view on what digital games can offer, their strengths and weaknesses, as well as what is necessary to start using games as an instructional tool was constructed. Final conclusions were made.

3 Results and discussion

We consider it necessary to begin our analysis from defining educational digital games. Educational digital games or EduGames are also known as "video games for learning", "computer games", "applied games", "games for education", "learning games", "electronic educational game resource" (a term recently introduced by the Ukrainian scientific community) [6], "serious games", with the last term as a recent years' *mainstream* term that describes games for learning, training, healthcare and social change [28]. If video games are considered an activity that includes one or more players, has definite goals, rules, limitations, rewards and outcomes, is artificial with the element of a competition, then serious video games are those that are built on game-based learning principles, include basic elements of video games and are used not only for the entertainment.

In order to clarify the term, we asked the experts the following question, "Is Serious Video Games the best term for the phenomenon and what is your definition of it?"

When comparing two terms – "serious video games" and "educational digital games" (EduGames), all the informants pointed to the broadness of the first term, which, according to their opinion, incorporates educational games, as well as games for health and different types of simulators. In order to designate games used for educational instruction, they prefer "educational games", "game-based learning" or "game-based discussion" terms.

Therefore, further in the article, we choose to use "educational digital games" or "educational games" when speaking about educational context, "serious video games" (SVGs) when analyzing other contests as well, "digital/video games" – to describe a type of a contemporary artifact.

Now we move on to the detailed discussion of the selected themes.

Referring to the first topic, which is game-based learning, we should note that it is considered the context of educational games' application. This, in turn, leads us to a brief description of its main characteristics and distinctive features.

Game-based learning (GBL) – is a type of game-play with defined learning outcomes [29]. The origin of game-based learning (also known as educational gaming) can be traced back as early as the 1980's to the works of Alan Amory [2], Detlev Leutner [20], Thomas W. Malone [22] that described new technology of computers and their unique possibilities for fantasy, sensory effects, individual adaptability and the potential for creating motivation and engagement.

At the beginning of the 21st century, the increased interest in the positive impacts and outcomes of games expressed by Clark Aldrich [12], James Paul Gee [11], Mark Prensky [23], led to a dramatic growth of the academic field that argues for the application of the game-based approach in education. Therefore, the argument is no longer whether games should be used, but how they should be used, how they should be designed and how they should be integrated into the curriculum.

In the process of GBL, learners use games as a tool to study a topic or related topics. They work individually or in teams. It is expected that in this process, the use of games will enhance the learning experience through challenge, exploration, interaction, reflection and decision-making, while maintaining a balance between the content, gaming and its application to the real world.

The main features of GBL are that it is interdisciplinary and multimodal (it combines images, sounds, texts, kinesthetic manipulation). It uses such game elements as a rapid pace, a random selection, different roles, presence of rivals and rewards. GBL is supported by the following learning principles: learning by doing or experiential learning; the authenticity of the tasks; motivation; independence and autonomy; team-working and/or competition; playfulness.

It is important to point out that game-based learning is not gamification. If the former is the use of games/digital games with serious goals (i.e. educational objectives) as tools that support learning processes in a significant way, the latter takes game elements (points, badges, leaderboards, competition, achievements) and applies them to a non-game setting with the aim to turn routine tasks into more refreshing, motivating experiences [8].

To understand game-based learning processes in depth, we asked the informants the following questions: 1) how would you describe game-based learning and what learning principles is it backed up with? 2) Is it important to differentiate gamification and game-based learning (GBL)?

As a result, we got the answers that GBL is, first of all, an approach to teaching and learning based on a constructivist pedagogy (one answer). It can be used as an extension to other traditional teaching methods but cannot serve as a substitute for a teacher, because stand-alone games never provide learning (all the interviewees). It is also important to understand that just a few games offer a real picture of the world (principle of authenticity and life skills' development) (one answer). It is the educators' role to transform a game into a meaningful activity via its contextualization, thus making real learning occur (all interviewees).

According to the experts' views, it is very important to differentiate gamification from GBL, as gamification is the use of game elements and their application to non-entertaining activities and contexts with the aim to increase motivation. GBL, to the contrary, is full exploitation of a game with the aim to reach specific learning objectives (all the experts).

To further our discussion of educational digital games, we come to the second topic, which is the advantages of digital games as an instructional tool: cognitive, motivational and social aspects and the characteristics of a good game.

Nowadays, it is the established view that educational digital games create a unique learning environment in which students interact, experiment with their ideas, discover, research, analyze and reflect on the gained experience. Many agree that games affect learning by influencing cognitive processes, motivation, by shaping and advancing social component [9; 10; 14; 19; 24; 33; 34].

Video games as a change in cognitive processes.

Up to now, there is a sufficient amount of experimental work that confirms that the material studied in SVGs is stored longer in the memory of students and is more structured [35]. Memorization in the process of video gaming takes place when the tasks are repeated and rewards are given. The analysis and understanding of the studied material are achieved through direct interaction with the game elements, free experimentation and the study of the relationship between different phenomena within the problem tasks. Evaluation skills are developed when students model game objects and processes and change them in order to achieve better results [3]. Among others, not less important cognitive qualities that are formed in video gaming are movements' coordination and spatial sensation.

Video games as a change of motivation.

Beginning from the second half of the 20th-century play became the interest of scientific studies. One of the first fundamental works on the game theory and the play element in culture was the book by a Dutch historian and cultural theorist Johan Huizinga, "Homo Ludens: a study of the play-element in culture" published in 1938. According to his views, the play is not just a pastime. It is the primary category of life and the structural component of culture, as culture is born as a play and never leaves it. The scientist puts emphasis on the indispensable ability of a person to play and speaks about "Homo Ludens" [17].

Alan M. Rubin [25], Jay G. Blumler [18], Thomas E. Ruggiero [26], Bradley S. Greenberg [13], John L. Sherry [30], Michael Gurevitch [18] is another group of researchers who traced connections between video games and motivation. What makes people play video games? The scientists underline seven main motifs: 1) control – over the game character and the game context; 2) challenge – desire to attain a higher level of skill; 3) competition – to win or surpass others; 4) fantasy – to engage in a variety of acts that will be difficult to perform in our everyday lives; 5) interest – to explore the game and gather information about it; 6) distraction – to take minds off usual concerns by doing something completely different; 7) social interaction – to play with each other and against each other [32].

In addition, the ability of video games to offer participants the choice of icons or the names of the players transforms it into a personally significant, increases the pleasure of participation, creates a space for self-realization, leads to the increase in motivation.

Video games as a participatory culture builder.

Except building up cognitive skills and the increase in motivation, the game-play lets participants share their knowledge with other players who, very often, have various sociocultural origin. This allows the creation of player communities. The key features, describing such game communities, are: a) open participation for any player; b) common game environment that is shared by novices as well as mature players; c) participants have the right to form and transform the game environment; d) knowledge and expertise are divided between the players; e) there are different ways to achieve the goals of the game, different ways to participate in the game and get a new status. Such communities generate their own practices, social and cultural norms, values and goals, as well as identities of their members [11].

To clarify the above-presented points, we asked the informants the following questions, “What is the advantage of video games as an educational tool?” “Do you agree that video games influence cognitive processes, motivation and social sphere of players?” “What do you think motivates people to play a video game?” “Would you agree that unique game communities are born around a game?” “What is a good educational game for you?”

Related to the first question, the most significant characteristics outlined by the informants were the cost-effectiveness, efficiency and safety of games in military, firefighters and pilots’ training (in four answers). Next, video games are good at helping learners remember and grind studied material (in all the answers). Video games stimulate active participation, reflection, and discussion (in five answers). They present complex systems, and let learners experiment, make mistakes without negative consequences (in five answers). They are a visual tool with many build-in features, such as checking the answers, logging, scenario replaying (in two answers).

The second question was, “Do you agree that video games influence cognitive processes, motivation and social sphere of players?”

The informants pointed out that firstly, games per se do not teach or influence anything. They should be contextualized, i.e. tied in with target learning group, curriculum and learning environment (all the experts). Secondly, there are studies that say about players’ good results in remembering the content of the game. Games are good at “drilling” the material in many fun activities (four answers). Thirdly, the social aspect of games is important and can be used and elaborated on more than it is done today (three answers).

The next question, “What do you think motivates people to play a video game?” brought the following results – to play is a basic human nature activity (one answer). Among other motifs are the feeling of “empowerment” – that a player is becoming better in the course of gameplay (one answer), a challenge, wish to create, identity-making (four answers).

The important aspect that came up in the interviews was the necessity to differentiate formal and informal contexts where motifs to play are significantly different (in one expert’s comments).

There is a unanimous agreement of the informants as to the question, “Would you agree that unique game communities are born around a game?” The examples given included Dota 2, Minecraft, Counter-Strike, EVE, World of Warcraft.

As for “What is a good educational game for you?” question – a good game should be adaptable, short and focused on one main theme (one answer). Its mechanics should follow the learning experience (one answer). Concerning the “fun” component in games, we got two opposite views. The first is that the “fun” part and learning should not be separated. Another one is that “stealthy” approach to learning (when learning is disguised as a fun game-play) never leads to learning outcomes. The “flow” state of a player has to be broken and the educational component should be brought in.

The importance to understand ways of digital games’ integration into formal educational context, leads us to the third topic of our discussion.

As an educational instrument, educational digital games require a complex approach in order to be integrated into the teaching/learning process. Recent projects, related to the studies of favorable environments' creation to integrate educational digital games into a particular educational setting, state that the main "stakeholders" in this process are administration, IT departments, educators, students, their parents and the community [34].

To persuade all stakeholders to support game-based learning requires much more time and energy than to develop traditional educational and methodologic materials, as the course of establishing and carrying out game-based learning is accompanied by a lot of preliminary work, such as surveying educational organization and preparing it for implementing educational games. Preliminary analysis of the organization may comprise questions, connected with organizational culture, teachers' attitude, parents' attitude, students' experiences with game-playing, teachers' computer and technology literacy, teachers' gaming literacy, availability of devices (PCs, tablets, etc.), information storage and access, classroom size, number of students, schedule and curriculum, management and support, etc.

It is highly important to develop teachers' understanding of educational games as an innovative tool. This can be done through the initiatives that facilitate a few teachers in developing their competencies with educational games, rather than having a universal training for the entire staff. Top-down initiatives, where new techniques and tools are "pushed onto" teachers, ran the risk of being expensive and alienate teachers by limiting their involvement in decision-making [5, p. 112].

Another important factor in applying video games is the knowledge of possible integration scenarios into the educational context. We maintain that the most comprehensive analysis was made by Nicola Whitton, Professor of Education at the University of Manchester, Faculty of Pedagogy, who suggested six possible models.

Model one – application of one game per session, which involves using a game in one lesson to achieve a specific goal. Model two – one game per several session that can be used as a direct replacement for two or more lessons. Model three – use of a separate element of a game as an additional task, which involves the application of some game element as an auxiliary tool. In this case, a game does not replace a lesson. Model four – integration of a complete game into the curriculum when a digital game is used as an alternative means of presenting the material, which, in turn, leads to the reorganization of teaching, learning and evaluation process, i.e. to the redevelopment of the course. Model five – use of online games as a part of blended learning or online course. In this case, students do not necessarily meet each other, because the game runs online – synchronously, or asynchronously. Model six – implementation of a game as a "mixed reality" type [31] – the use of the elements of online environment and personal interaction, often involving mobile technologies, such as mobile phones or other portable devices [33, pp. 85–88].

The questions we asked the informants to support this discussion were: 1) should educators take a game and try to tie it in with the curriculum or should they follow the curriculum trying to pick up the right game? 2) Are there two different approaches to implement Educational Games and Commercial Games (COTS) into educational context? 3) What are possible scenarios to integrate video games into a classroom? 4) Do you think it is a viable idea to teach teachers to design their own games for their specific purposes?

The interview data related to the first question tell that this choice may depend on the level of schooling. For example, if it is an elementary school – it is easier to find a ready-made game and to use it in class, building up a lesson with specific learning outcomes around it. At the same time, this approach may not work in higher education, where teachers have to follow the curriculum to let students master a particular subject. Games take many hours to play, which may not comply with the time frame of the course (one informant).

There is, though, another opinion, stating that teachers know the curriculum and have enough traditional material to achieve its goals. However, sometimes there may be parts of it that are not quite successfully presented by a traditional material. In such cases, teachers may opt for finding a game that would explain or help master this part. It is the example when a teacher follows the curriculum and chooses a game that may enhance a particular element (three answers).

As for the second question, many answers underlined that entertainment games are time-consuming, unlike educational games that are usually small, replayable and are directed at a specific learning objective (all the interviewees). When COTS are used, most probably a teacher has to design his/her lesson plan around it. With EduGames that are not easily re-interpreted, a teacher has to adapt the working process to the game (one answer). Another difference between COTS and EduGames is the time one learns how to play them. With EduGames it is shorter, which makes the process of a game's integration into educational context faster. At the same time, with both COTS and EduGames there are the same issues of finding the right game, understanding how it can be used for a specific subject, issues of licensing and technical support (three answers).

As for the third question about possible scenarios to integrate educational digital games into a classroom, there is no one universal way to do it. The right way is the one that works best for the educator (all the answers).

Because of the time issue, many educators may prefer to use a mini-game as a complementary means to enhance learning. To the contrary, as the time that takes to find, contextualize and start playing a game is relatively long, it may be sensible to use the same game for a longer period. Whatever choice is, a game should be an integral part of a bigger educational process.

As for the idea to teach teachers to design their own games for their specific purposes (question four), all informants agreed that it is a good one. To start from analog games and move on to digital tools with the aim to help teachers understand how games work. It is also reasonable to provide teachers with courses in programming to get such experience. For example, simple programming languages, like SCRATCH or online courses on game design. At the same time, it is rather challenging to teach an educator to think like a game designer.

Now, we come to the discussion of the last topic on the teacher's role(s) in a digital game-based learning class.

Here we have to say that knowledge acquisition is possible in many different ways, which depends on learners' characteristics, material to be studied, the situation where learning takes place. The same is true about teaching styles that differ depending on a particular educational context.

For the present discussion, we use five metaphors of learning and the accompanying teaching styles as described in ProActive: Fostering Teachers' Creativity through Game-Based Learning project. These are learning through knowledge transfer, learning though imitation, learning though experimentation, learning through participation and learning through discovery [24].

The way of knowledge transfer is the information pass from one person who possesses it (a teacher) to another one who acts as a receiver (a student). Learning is targeted at memorization of facts and concepts' acquisition and is rooted in repetition and replication. In this context, the teacher acts as an expert who conveys information. The way of imitation is when learners model behaviors or make a copy of the proposed model. Learning is targeted at improving practical skills. Here, the teacher acts as a coach. The way of experimentation takes place when teachers provide a task and let learners experience it. Here, the teacher acts as a facilitator. The way of participation is targeted at social aspects of learning. To encourage learners to be a part of the community, teachers stimulate interaction between peers, organize discussions, view-exchange and collaboration. Teacher's role is also of a facilitator. The way of discovery is aimed at establishing new relations between objects and concepts. Here the teacher acts as a facilitator who organizes guiding activities for the learners to discover and construct new meaning.

Thus, within the five metaphors, the teacher may come as a knowledge expert, a coach, a facilitator, an evaluator.

In the context of digital game-based learning, an instructor carries out all the roles listed above, guiding learners into their specific task and experimentations within the game, reflection, consolidation, and reinforcement of the gained experience (Figure 1).

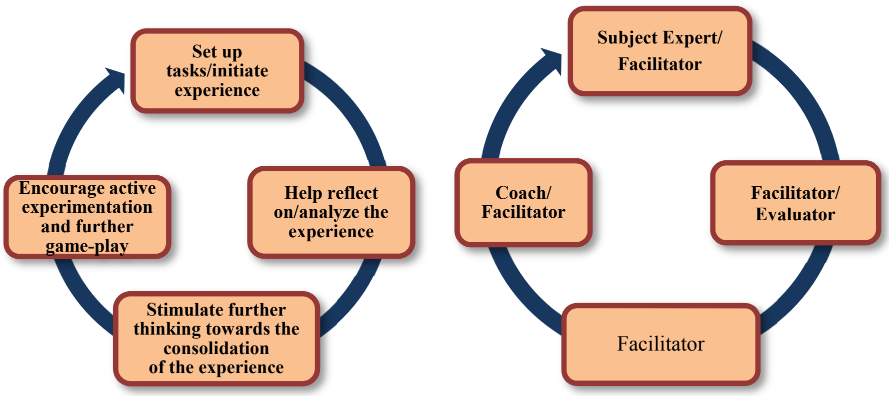

Fig. 1. Example of educators' tasks and roles in experiential learning cycle

Research carried out on game-based learning confirms that when conducting game-based classroom activities, teachers take on a wide range of roles in order to successfully and significantly integrate the educational game into their classrooms. During a typical game-based exercise, teachers act as game administrators, lecturers, game tutors, subject matter anchors and authority figures that keep students in an educational mode of play. This, in turn, requires a diverse skill set, including technology expertise, gaming literacy, subject matter knowledge, and a strong pedagogical foundation [5, p. 206].

Another important principle outlined in many research works states that for a game to have positive educational value, briefing before the game and reflection after the game (known as a debriefing or after-action review AAR) are a must. Debriefing – is a meeting that takes place in order to get information about a particular piece of work that has been finished, for example about what was done successfully and what was not [7]. Debriefing after the game facilitates reflection and serves to check whether participants learned what was intended to learn. It also allows the participants to reflect upon the training experience and make connections between game events and real-world events [16].

Therefore, a digital game-based lesson passes three distinct stages: 1) before the game-play stage (organized as a briefing); 2) during the game-play stage (the game-play itself); 3) after the game-play stage (in a form of a debriefing or after-action review).

The model of "a coaching cycle" (Figure 2) developed by Anna-Sofia Alklind Taylor serves as a good illustration of a digital game-based session [1, p. 193].

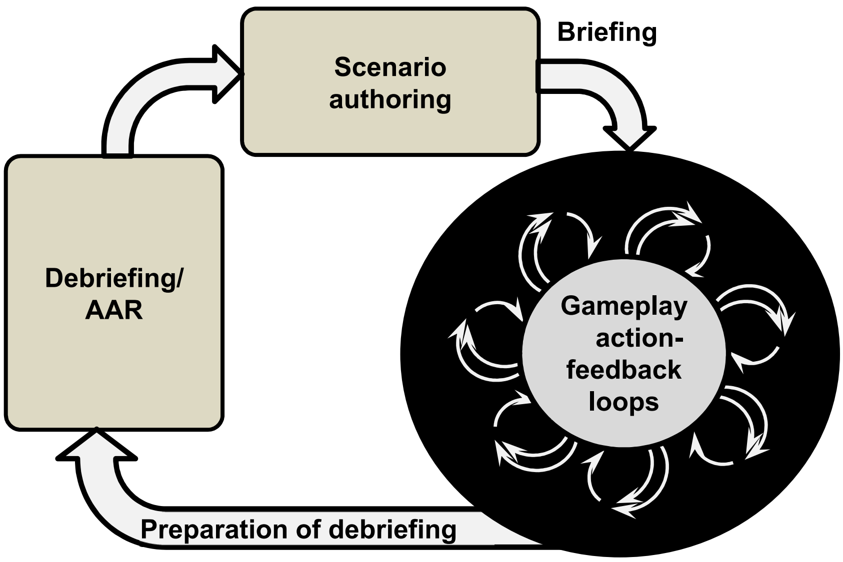

Fig. 2. Game-based session coaching cycle (used with permission)

Consequently, in preparing and conducting a digital game-based lesson, a teacher follows the path from making up a lesson plan targeted at a specific learning group and a syllabus (scenario authoring), setting up the gameplay (briefing), guiding learners in the game-play process (gameplay) and finalizing the experience afterwards (debriefing).

To reinforce the discussion, we asked the experts these questions: 1) how are the roles between a teacher and a student distributed when digital games are used in educational context? What roles does a teacher carry out? 2) What are possible ways to transfer knowledge from a game-play to real-life situations?

Answering the first question, all our informants confirmed that a teacher carries out different roles, including a facilitator, a knowledge expert, a de-briefer, etc. At the same time, and what is very important, in digital game-based learning the teacher also acts as tech support, a moderator who explains how the game works, as an IT administrator. These extra functions often distract teachers from their immediate tasks (four answers).

Situations may occur when students who often play games outside school help teachers during the game-play and become facilitators of the learning process, and this changes lesson's dynamics (one comment).

The teacher also may act as an active player involved in the game along with students. Assuming this role, a teacher can give feedback from "inside" the game by responding to students' actions (Figure 2). In this case, the game flow and the students' engagement are not broken (one comment).

The teacher may act as a game developer, which requires good experience with games (four answers).

Concerning the second question, it is a hard task to transfer knowledge gained in the game-play to real-life situations (all the experts). One way to do it is to pause the game and to highlight a specific learning point. Conversations and discussions around the game build up the knowledge and help make connections with the real world. One way to get students into conversations is to sit two of them at a computer. Another way to transfer knowledge from a game-play to real-life situations is to carry out a debriefing. Here, it is important to explain the difference between the game and the real life, reflect on practices inside the game and outside it. Reflection is the way to transfer the knowledge and the experience into real life contexts. As in a game it is hard to simulate all possible real-life scenarios, it is the teacher's role to help students make these connections and that is one more reason why games cannot replace teachers.

4 Conclusions and prospects for further research

Having conducted theoretical analysis and expert interviews and having compared and contrasted the obtained data, we may come to the following conclusions:

- although "Serious Video Games" is considered the recent years' mainstream term to describe games used not for entertainment, the experts' practical opinion states that "Educational Games" is a better term for the phenomenon;
- game-based learning (GBL) is one possible approach to teaching/learning that is supported by a constructivist experiential pedagogy. It uses educational games as a tool of instruction. GBL is an extension to other traditional methods but not a substitute for them or a teacher. In the process of GBL the game is fully used to reach specific learning objectives and the teacher is the key actor to make learning happen;
- educational digital games (EduGames) are complex systems that provide a unique and safe learning environment for experimentation. In reality, there are only a few

games that provide authentic material and real-world tasks. To get the most of learning out of games a teacher should help students make connections between the knowledge and experience from the game with real-life scenarios;
- content studied in game-play is stored longer and is better structured in learners' memory. There are different motifs why people play but it is important to remember that motivation to play in formal and informal contexts differ. Games stimulate active participation and create communities around them;
- there are two different views on "fun" component of games. The first is that fun and learning should not be separated. The second is that to achieve a desired learning outcome, the "flow" state of a play should be regularly broken and a reflection and discussion brought in;
- to integrate video games into educational context requires a complex approach. It includes cooperation between administration, IT department, educators, learners, community. In this process, it is highly recommended to survey and to prepare the target organization to work with EduGames, as well as to help teachers understand EduGames as an innovative tool. It is better to start from a small group of teachers, rather than to facilitate the whole staff;
- if a teacher chooses a game to use in the class, he/she should build up the entire lesson and lesson materials around it by tying it in with the curriculum. To the contrary, a teacher may follow the curriculum and try to find a game to enhance a particular part of it. Whether COTS or EduGames are used, the issues of finding the right game, understanding how it works for a specific purpose, licensing and technical issues are the same. There is no one universal scenario of how to integrate EduGames into an educational context. Some may opt for a mini-game or a bigger game for a longer period of time. It's important that the chosen game fits right into a general educational process;
- in the context of digital game-based learning, a teacher carries out the roles of a facilitator, a knowledge expert, a coach, an evaluator. The teacher also acts as tech support, IT administrator, a moderator, a de-briefer, which may distract from exercising immediate teaching tasks. The teacher may act as an active player and provide feedback from "inside" a game. In addition, a teacher may be a game developer. These roles require good experience with games;
- the positive educational effect is achieved if briefings and debriefings become a part of a game-based learning process. Properly organized debriefing is the way to transfer knowledge and experience from a game to a real-life context. As games cannot simulate all possible real-life scenarios, a teacher, as a de-briefer, cannot be replaced by games.

The implications of the study presented in this paper are that what educational digital games may give as an instructional tool is a unique and safe learning environment with a wide spectrum of build-in assistive features. They are very cost-effective and efficient in specific training contexts. Digital games are good at helping learners memorize studied material, appeal to different learning styles (visual, audio, kinesthetic) and individually adaptable. As a novel educational instrument, they increase motivation, stimulate players' interaction, active participation, discussion, and reflection.

At the same time, the path of digital games to formal educational context requires complex approach that may affect administration, IT departments, educators, students, parents, community and is accompanied by many preliminary arrangements, starting from the analysis of the target organization to the choice of the most appropriate scenario of a game's application. The key figure in the process of transforming a game into a meaningful activity is an educator. This demands a strong skillset of gaming literacy, technical skills, knowledge of the taught subject, pedagogy, psychology, etc., as in the process of digital game-based learning a teacher exercises different roles of a subject expert, a facilitator, a coach, an evaluator, a game moderator, a tech support, a de-briefer, a co-player, a co-designer. Teachers build up lesson plans, conduct the lesson and debriefing, follow the quickly changing market of digital games, play games to be able to choose the right one for the class.

If we place the results of this brief study into a broader context, we may state that digital games as a contemporary cultural artifact are here to stay with no turning point, as well as other modern digital tools, gadgets and applications. They may not revolutionize education but it is highly possible that a new generation of teachers will come that are used to playing video games and who will be ready to put their knowledge of a game-play into learning in the attempt to get to the present and future generation of learners.

Therewith, the importance of information dimension in the development of the 21st-century skills as well as the digitalization of education will stay as important elements. This will lead to the re-evaluation of the teaching process in terms of how to teach with modern digital tools, including digital games.

We conclude this article with the idea (and the prospect for further research) of building up Education Design Laboratory as an integrative part of a contemporary educational institution. This laboratory may stream its work into Contemporary Multimedia in Education Unit, Educational Game Design Unit, Teacher Training in Multimedia and EduGames Unit, Gamification Unit, etc. This, as we see it now, may help teachers gain and/or upgrade their competences and get support in implementing cutting-edge instructional tools, assist the administration in building up a contemporary technologically rich research model of an educational institution and students – to develop the 21st-century skills.

5 Acknowledgement

This publication is part of the research work carried at the University of Skövde, funded by a Swedish Institute scholarship.

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Digital transformation of learning environment: aspect of cognitive activity of students

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Abstract. Peculiar features of digital environment include: integration of ICTs; use of local and global networks and resources; support and development of qualitatively new technologies of information processing; active use of modern means, methods and forms of teaching in the educational process. The organization of activities in terms of digital learning environment provides appropriate changes in the interaction between subjects of the educational process.

Today, means and technologies of the information and communication networks (ICNs), in particular the Internet, which custom and operational-procedural properties were changed at the initial stage from closed local to open ones at present, become widespread. The development of ICNs (from closed local to open ones) changes the typology of learning environments. The following models of learning environments, which widely use ICT and ICN tools (with basic features that characterize them) are distinguished: using the local communication network for presentation of educational information; using the local communication network and open network resources; using open network resources; for independent use of open network resources directly in the classroom by a student; for use of open network resources by a student in the process of independent learning activity; for use by a student educational resources, specially created by a teacher, as well as resources of an open networks in his independent learning activity.

Keywords: cognitive activity, learning, learning (academic) environment, digital transformation, competencies, ICT.

1 Introduction

According to experts in the field of Economics 4.0 and modern production [8], consumer trends as a reaction of progressive groups of society to social challenges, leading to changes in the culture of behaviour, in 2019 will increasingly focus on various aspects of consumer and technology interaction. A modern person watches changes in technology and is forced to adapt to them both at the workplace and in everyday life. The most noticeable are: evolution of customer interface, integration of devices, provision of access to software products, services and resources in the cloud. The speed of life leads to the gradual replacement of human labor with bots or programs. Robotics in mass production, processing and use of large volumes of data, rapid updating of knowledge, availability of information and, at the same time, the difficulty of converting it into knowledge – these and other signs of the information age lead to the need to make self-education a necessary element of every person's life.

Technologies are crucial in routine problems solving. Internet of things should ensure compatibility between all devices and provide mobility. However, the experience of typical tasks solving does not help to find effective solutions. Progressive ideas are born in the man's learning process of the world at the intersection of disciplines. Consequently, in our opinion, in modern conditions, a person armed with skills of rapid adaptation, working with data, productive communication, which is characterized by flexibility of thinking, the ability to concentrate, analyse, make conclusions, is able to create its own product, is ahead.

Here are some examples that we think, illustrate the rapid growth rate of transition in all areas of human life to digital technologies:

The number of people on the planet using the Internet is rapidly increasing.

So, according to [29] over the past 5 years, this growth is 6–9% per year.

Moreover, according to results of long-term study of consumer trends of Ericsson, based on an online survey of 5097 primarily Internet users, almost half of the respondents in the survey think that, for better or worse, the Internet of skills (AR/VR experience [30]) has replaced many of the simple pleasures of daily life, and as many as 42% say the Internet needs to be changed fundamentally if it is going to be a force for good in society again. 60% would like glasses with on-screen instructions that help you repair almost anything, and 56% even want to learn how to dance using an instructive AR experience [8].

Growth is the tempo of digital communication between people. So, the number of e-mail accounts in the world is about 5 billion, mostly at the expense of private ones. As of January 2019, the number of Facebook users, one of the most popular electronic social networks, is 2.320 billion people and has been steadily increasing ever since. By the way, as of December 2018, already 30.95% of Ukrainians use a social network. According to the company "Vhaschno" (https://vchasno.com.ua), which provides business services in docflow, storage and exchange of documents online appeared to be 70% cheaper than paper ones.

For example, in Ukraine, the official participant of the public procurement system ZAKUPKI.PROM.UA sent 316,100 documents per year, saving UAH 5,057,400.

At the beginning of 2019 (according to the site populationpyramid.net), with a total population of about 7.678 billion people, we have the following (Fig. 1).

Technological changes in science, economics and society lead to social, political and cultural changes. These changes cause new problems, the solution of which takes time. Social systems unavoidably experience periods of economic decline and growth while educational systems go through reforms. Changes in education, among other things, cause some contradictions. The following should be identified:

1. At the level of *the global information space:* between innovative updates of information and communications technologies as well as networking technologies from one side and the slow reaction of the state and the educational system to these trends on the other side.
2. At the level of *the national educational system:* between the emergence of the latest technology, technology and the new generation of means for training, management and scientific research and late response of education managers to the choice, implementation and spread of innovation.
3. At the level of *the educational institution:* between the need to develop a modern educational environment and the conservatism of leaders and pedagogical staff in the period of innovation transformations.

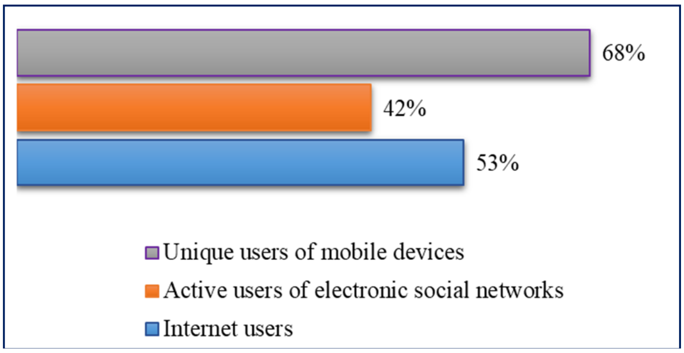

Fig. 1. The share of users from the total population by selected groups

The dynamics of factors' development of external and internal environment directly affects the development of the innovative capacity of educational institutions and its implementation in the educational process. This requires a substantial transformation of the education system based on:

— psychological, pedagogical and didactic principles of digital education;
— new approaches to the selection of educational content;
— principles of flexibility and adaptability of pedagogical systems;
— principles of equal opportunities for all parties of the educational process;
— new forms, methods, technologies and means of teaching and learning that are implemented in modern educational environments.

We have analysed demographic trends, namely of world (PopulationPyramid.net): proportion of so-called millennials (age from 20 to 40 years old) – the most productive population, teenagers and young people (from 10 to 19 years old) who will take jobs in a few years. Millennials make up 30% of the world's population. Despite some differences in distribution, in Ukraine, the proportion of the Millennials does not have any statistical difference (28.7%). The proportion of people aged 10–19 years to 16.1%. For Ukraine, this percentage is much lower – 9%. Among the features the Millennials obtain, psychologists mention: short-term concentration, pragmatic thinking, intelligibility in information, orientation on trends and social networks, extra-territorial activity (want to act "here and now").

The next generation will live and work under somewhat different conditions, including: high level of automation for production processes, job cuts, competition in design of things, machine intelligence and 5G networks, rapid loss of actuality of acquired skills, etc. Transformation of society, primarily, will be associated with the development of new technologies. Information and communication technologies change the nature of relations within society, including within the sphere of education. These technologies cause a lot of changes in the economic, political, social and cultural spheres and, as a result, form new requirements for the field of education, laying the foundations of its new architecture. These bases include the results of the MEP-revolution in education (Ronald M. Harden [4]); virtualization and gamemization of education (Elizabeth Corcoran [7], Jane McGonigal [12]); The new achievements of cognitive psychology (Robert L. Solso, M. Kimberly MacLin, Otto H. MacLin [28]) and the possibility of their use for the formation and development of cognitive skills and abilities.

Global Education Futures Initiative connects the development of new education practices with active use in the educational process:

- unique approaches and access to carriers of key competencies;
- modern educational, in particular a digital, environment that supports the whole education / learning process, as well as the development of courses, interaction with communities, etc.;
- individual educational trajectory of each student (with possibility of full asynchronous education, with combination of educational process and extracurricular activities, with tutoring of this trajectory by mentors);
- flexible assessment system focused on supporting student's motivation;
- resources (students and teachers) for individual and group learning experiments;
- flexible architecture of educational institutions, which allows to realize a large number of educational formats for independent and group activities of students;
- horizontal education in communities, including the use of electronic networks;
- joint learning processes with real-life carriers.

Due to widespread use of mobile devices with access to the Internet there are changes in the organization of training. The boundaries between formal and informal education become less clear.

2 Related work

In previous studies, we analysed and compared new technologies, educational models, their impact on formation of learning environments, that are increasingly used in general education institutions, allowing us to address the issue of expanding student access to learning resources, and expanding opportunities for collaboration and cooperation [27]. In order to organise approaches to formation of learning environment in which ICTs and the Internet are actively used, a comparative analysis of different models of learning environments has been conducted on the main features that characterize these models [17].

Problems of use of network technologies for conducting educational studies on natural sciences course in general secondary educational establishments, formation of system of knowledge by means of network technologies are studied [32].

Problems of projecting of informational and educational environment for the education of high school students on the basis of technologies of electronic social networks are investigated. The possibilities of using information and communication technologies and technologies of electronic social networks in the system of general secondary education are revealed [26]. The scientific and methodological foundations of formation of subject competences taking into account the basic principles of practical and personally oriented learning are proved. Forms and methods of studying which promote increase of formation level of pupils' subject competence are elicited [18]. The problems of increasing information and communication competence of all participants of the educational process are looked into. Possible changes in the teaching method, when new objects appear in the system of learning tools – services of electronic social networks, are analysed. It is paid attention to change of emphasis from communication network to organization of productive discussion and collaboration with cooperative learning methods for students [16], [19].

The authors of the article revealed results of research on solving the current psychological and pedagogical problems of designing information and educational environment, different models of using electronic social networks in teaching senior students, development of certain elements of computer-oriented methodological systems, evaluation of educational process results in the open information and educational environment of training students and the critical problem of users' safety on the Internet, the formation and development of information and communication competencies of all participants of the educational process. A number of methods, related to: the formation of safe and responsible use of social networks and critical evaluation of Internet content; using electronic social networks to provide group interaction; organization of independent work of pupils (on an example of physics) and design and research activity of students (on an example of mathematics); prediction of aggressive behaviour of pupils; support for the education of disable children; the organization of informal education of youth are suggested. Much attention is paid to changing the emphasis from network communication to productive discussions creation, as well as from collaboration to cooperative learning methods [20].

3 Research methodology

Currently, the Cabinet of Ministers of Ukraine approved the Concept of development of digital economy and society in Ukraine in 2018–2020 [5]. In fact, this is a roadmap for digital transformation of Ukrainian economy. The document defines key policies, priority areas, initiatives and projects of "digitalization" of Ukraine for the next 3 years. In particular, this is "digitization of educational processes and stimulation of digital transformations in the education system".

The release of revised wording of key competencies for lifelong education coincided with the adoption of the Concept [10]. Mathematical competence and competence in science, technology and engineering (mathematical competence and competence in science, technology and engineering) and digital competence are determined as key. [9].

The formation of above key competencies is possible on the basis of modern educational technologies using ICT tools, electronic educational resources, electronic social networks, which allow to reduce the educational load and simultaneously to intensify the educational process, in particular, from natural and mathematical disciplines, providing learning and cognitive activity with creative, research orientation.

Futhermore, opportunities for individualization and differentiation of training increase, opportunities for self-education skills form, metasubject and subject skills, ability to put the knowledge into practice through the wide introduction into the interactive process of studying individual work of students are developed.

The means and technologies of the ICN, including the Internet, forming a computer-technological platform of educational, in particular learning environment of modern education, primarily open, transform the traditional educational environment into "an environment of computer-mediated communication – an integrated education and information environment with distributed educational resources and a communicative infrastructure of supporting educational communities of different types" [23].

It is understood that a considerable part of the didactically grounded and specially organized educational and cognitive activity of students is carried out on the Internet, has specific features [22], transforming into a modern form of training due to a number of factors:

1. The Internet is a network of information environment of modern society, and its role as a source of scientific and educational information is obvious.
2. A new generation of students takes the Internet not just as a social cultural phenomenon of our time, as well as parallel, often leading environment. Any activity in such environment, including an independent educational and cognitive, is taken by a young person with an interest, that increases the motivation for this type of activity. The Internet is becoming an informational environment for training and self-education.
3. Internet environment as an informational and informational and educational environment has a significant potential for self-development of the individual.
4. Thanks to its unique properties (virtuality, turnover of operations, plurality of spaces, etc.), the Internet creates a comfortable environment of life that completes the internal and external space of an individual, and can act as a space of experiment.

From the didactic point of view, the logic of the learning process also changes. The traditional structure of learning process consists of the following steps: "getting information – understanding – memorization – reproduction – application (mostly by model)".

The modern structure is different: "getting information – understanding – application (creative) – analysis – evaluation – creation". It is this logic and structure of the process of educational and cognitive activity that underlies the system-activity and competence approaches and ensures dynamic activity of students.

Having agreed with the researchers [25], [2] we define cognitive activity as an element of the holistic process of learning, which is a purposeful, systematically organized, managed external or independent interaction of a student with the surrounding reality, which results in mastering, on the level of reproduction or creativity, a system of scientific knowledge and ways of activity.

Cognitive activity is carried out throughout the life of a person, in all types of activities and social relationships, in particular, when students perform various subject-practical actions in educational process. However, only in the process of learning the cognition gets a clear form in a special, particular only for person, educational and cognitive activity.

Basic components of cognitive activity:

- content (knowledge, expressed in concepts or images of perception and conceptualisation);
- operational (various actions, operation of skills, techniques);
- resultative (new knowledge, methods of decision making, new social experience, ideas, views, abilities and personal features).

The main types of educational and cognitive activity of students in the Internet-oriented informational and educational environment include: search activity; practical development of new technologies; creating new content; Internet communication for cognitive purposes; learning using Internet resources.

Forms of educational and cognitive activity in the informational and educational environment are determined by the organization and / or self-organization of information and communication interaction and informative and cognitive activity of students. Formation and sustainable development of cognitive abilities of a person throughout his life is an indispensable element of any educational process.

4 Results and discussion

From the perspective of the revised Bloom's taxonomy [1], during the study we systematized the types of educational and cognitive activity of students [17] in the Internet environment in accordance with the categories of cognitive processes (Table 1).

Criteria, levels and other indicators of productivity of educational and cognitive activity in modern conditions are determined by the new paradigm of education of the information society. All the tools that make it possible to evaluate and control educational and cognitive activity get disturbed. The combination of information and communication technologies and means of communication networks form new solutions that can affect the basic processes in the educational system: the formation and development of competencies, fixing achievements, assessing the quality of learning, creating a positive motivation and promoting self-dependence in educational and cognitive activities. On the basis of such technologies, new educational instruments are offered [11].

Table 1. Types of educational and cognitive activity

Cognitive processes	Educational and cognitive activity of students in the Internet environment
Remember	**Research activity with use of Internet resources**: *identification;* *recognition.*
Comprehend	**Mastering of new technologies:** *mastering communication technologies based on non-verbal forms of communication;* *feedback on the results of the activity.*
Apply	**Practical use Internet resources:** *work with different sources of information;* *independent study of new material;* *training and testing process learning.*
Analyze	**Development of critical thinking:** *self-control and self-correction;* *formation of skills of classification.*
Evaluate	**Internet communication for cognitive purposes:** *feedback in the process of peer assessment;* *ranking;* *verification; reviewing.*
Design	**Creating of new content:** *publication;* *formation of a portfolio;* *production of a new solution;* *implementation of a new process.*

The effectiveness of educational and cognitive activity of students is determined by the new paradigm of education of the information society. It recognizes all the tools that make it possible to carry out the educational and cognitive activity of the students, its evaluation and control.

- *Translation of reference experience or practice* – transfer of verbal knowledge (or self-studying), the transfer of non-verbal knowledge through communication with the carrier, the transfer of non-verbal knowledge through training skills. The tools include online multimedia libraries, multi-user online courses, e-books, YouTube educational channels [6], subject blogs [21], virtual mentors, simulators [14], virtual simulators [13], and robot-mentors.
- *Independent getting of experience* through testing, research / experiment implementation, creative individual or group project. They are implemented in gaming environments, quests, in alternate reality, work-competitions, virtual laboratories [15], discussion scientific communities, social networks, and others.

- *Fixation and assessment of students' learning achievements* – testing, prognosis of educational trajectory based on the profile of achievements [3], end-to-end continuous monitoring (in particular, monitoring behaviour in the game forms within the alternate reality).
- *Tools*: personal competency profile, personal virtual portfolio, creation and stress test of the virtual world or digital model.
- *Encouragement and motivation* of students for educational activities is carried out through: competitive gaming models (gamification), reputational capital management system, preventive outcome management (achievement prognosing systems), gaming adaptive models [24], state monitoring systems (which control the quality of experiences in the educational process).

5 Concluding remarks and future work

The transformation of modern society and education, particularly related to the development of new technologies, especially information and communications and networking. The digital transformation of education covers the creation of a modern computer-based environment that supports learning and self-education, creation of a system of informational and educational and game resources, flexible structure of educational institutions, which allows to fulfil a large number of educational formats and supports the advancement of students with individual educational trajectories, development of mechanisms of education in communities, including the use of electronic networks, formation of unique approaches to formation of key competencies, in particular digital one.

Formation of key competencies for lifelong education, including mathematical competence and competence in science, technology and engineering, is possible on the basis of modern educational technologies using ICT tools, electronic educational resources, electronic social networks, which allow to reduce the training load and, at the same time, to intensify the training the process, in particular, from science and mathematic disciplines, providing educational and cognitive activities with creative, research orientation.

The Internet environment as an informational as well as informational and educational environment has a significant potential for self-development of a personality due to peculiarities such as virtuality, turnover of operations, plurality of spaces, etc. It creates a comfortable environment for cognitive activity and can act as a space for an educational experiment.

The main types of educational and cognitive activity of students in the Internet-oriented informational and educational environment include: search activity; practical development of new technologies; creating new content; Internet communication for cognitive purposes; use of Internet resource for educational purposes.

From the perspective of the revised Bloom's taxonomy, during the study we systematized the types of educational and cognitive activity of students in the Internet environment in accordance with the categories of cognitive processes: remember, comprehend, apply, analyse, evaluate, design.

The revolution in digital content complicates separation of academically meaningful, scientifically grounded, truthful from false and, at times, dangerous. Individual training extends to new features. At the same time, the essence of the educational process and its quality survive little changes. According to the authors, there are approaches to change this state, in particular, learning related to real life; training in projects; free choice of training tools; reflection and a two-way evaluation of the result (for example, parents and teachers, teachers and students). We consider further research in solving the problems of using digital simulations in the educational and cognitive activity of students to be relevant.

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Theoretical and methodical aspects of the organization of students' independent study activities together with the use of ICT and tools

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Abstract. In the article the possibilities and classification of ICTs and tools that can be used in organizing students' independent study activities of higher education institutions has been explored.

It is determined the students' independent study activities is individual, group, collective activity and is implemented within the process of education under the condition of no pedagogy's direct involvement. It complies with the requirements of the curriculum and syllabus and is aimed at students' acquisition of some social experiences in line with the learning objectives of vocational training.

The analysis of the latest information and technological approaches to the organization of students' independent study activities made it possible to determine the means of realization of the leading forms of organization for this activity (independent and research work, lectures, consultations and non-formal education), to characterize and classify the ICTs and tools that support presentation of teaching materials, electronic communication, mastering of learning material, monitoring of students' learning and cognitive activity, such as ones that serve for the sake of development and support of automated training courses, systems of remote virtual education with elements of artificial intelligence, which implement the principle of adaptive management of learning and the organization of students' independent study activities.

The paper provides the insight into the essence of the conducted investigation on the assesses of the effectiveness of ICTs and tools in the process of organizing students' independent study activities.

Keywords: students' independent study activity, process of activity's organization, ICT, ICTs and tools.

1 Introduction

1.1 Statement of the problem

The globalization and informatization processes are widely recognized to have led to a steady increase in the volume of information, have significantly raised the intensity and power of information flows, have highlighted the problem of content, volume, logic, means and ways of organizing the mastering of knowledge and experience of humans in the higher education institutions. The problem of organizing the students' independent study activities has become a matter of importance and significance in the conditions of changes in educational paradigms from the concept of knowledge-oriented education "for life" to education through life, that is, continuous education, that is mainly carried out on the basis of person's self-initiative and activism.

Obviously, the nominal increase in the volume of students' independent work without introducing changes in the structure and content of the educational process has resulted in most cases in a decrease in cognitive motivation among students, impedes the development of important personality traits and characteristics, impacts on the specialists' competitiveness and their professional mobility, doesn't ensure appropriate evolution of students' abilities in learning throughout their life and doesn't allow them to master new technologies. In terms of information society researchers are seeing new wide perspectives in the active introduction of modern information and communication and network technologies, computer based technology, tools of transfer and exchange of information. At the same time the development and mass application of ICTs is seem to have caused significant changes in the informational and educational spheres of a higher education institution.

Therefore, the introduction of a new structure, the latest ICT tools into the administration and self-management of the students' independent study activities requires investigation and research.

1.2 Analysis of recent research and publications

By the thorough researches of the scientists in the past and present days (Anatolii M. Aleksiuk [1], Ivan M. Bendera [3], Volodymyr I. Bondar [6], Volodymyr K. Buriak [51], Oleksandr H. Kolgatin [20], Vitalii A. Kozakov [22], Oleksandr V. Malykhin [28], Aleksandr G. Molibog [33], Pavel I. Pidkasistyi [38], Serhii V. Sharov [43], Mykola M. Soldatenko [46], Nataliia P. Volkova [36], Viktor I. Yevdokymov [40], etc.) it was found that the independent study activities are not only a continuation of the student's study work, but it is also conditioned and is means of forming the personality traits that are especially valuable for specialist-and-experts in their personal and professional self-improvement such as e.g. self-organization, self-actualization, self-identification, self-evaluation, self-control, self-reflection, etc. [3; 28].

Evidently, in the context of reforming the system of higher education in Ukraine, due to the need to bring it in line with the best world standards the problem of effective designing and organization of independent study activities is acquired of particular significance. The documents of the Bologna process, international research projects as well as the adoption of the "National Qualifications Framework" (2011), the Laws of Ukraine "On Higher Education" (2014) and "On Education" (2017), etc. have become a powerful foundation for the conceptual changes in national educational system. It caused the revision of the traditionally formed basis of students' study activities in the direction of increasing their personal and competent orientation, activity and independence in the choice of goals and priorities, orientation towards the construction of individual educational trajectories [5; 12; 13; 16; 39].

According to Yurii O. Zhuk, the mass ICT implementation in the educational process has required the development of special tools, which, according to the pedagogical situation, offer a certain set of options and means that extend the spectrum and enrich the students' study activity [59, p. 40].

Over and above, and also more extensive opportunities for academic mobility of teachers and students, the increasing role and importance of non-formal, distance and dual education [48], have led to the development of qualitatively new educational standards and programs as well as integrated and hybrid academic disciplines, which cannot be high-quality learnt without use of the modern ICT (Aleksandr A. Andreev [2], Valerii Yu. Bykov [9], Roman S. Hurevych [19], Maiia Yu. Kademiia [19], Petrus A. M. Kommers [21], Mykhailo M. Koziar [19], Volodymyr M. Kukharenko [23], Olekasndr V. Merzlykin [30], Natalia V. Morze [21], Serhiy O. Semerikov [42], Eugenia M. Smyrnova-Trybulska [21], Yurii V. Tryus [51], Ivan M. Tsidylo [8] and etc. [8]).

It should be noted, nowadays in higher education institutions the gradual abandonment takes place to the widespread use of traditional non-electronic study technologies whereas the ICTs continuous implementation in all forms and types of students' independent study activities. However, a significant amount of information resources that has developed and is used by lecturers is usually applied unsystematically, and this fact does not contribute to the proper performance of vocational training's tasks.

1.3 The purpose of the article

The purpose of the article is to explore the possibilities and classification of ICTs and tools, as well as to analyze the degree of productivity of their application in organizing students' independent study activities in higher education institutions.

2 The theoretical backgrounds

Due to the results of the analysis of the primary sources, it has been established the *independent study activity* is such activity, which is a logical continuation of study work, it embodies the educational and cognitive minimum ensuring the autonomously mastery of students by determined level of professional competences. In line with its content, it is individual, group, collective activity and is implemented within the process of education under the condition of no lecturer's direct involvement. It complies with the requirements of the curriculum and syllabus and are aimed at students' acquisition of some societal practices in accordance with the learning objectives of vocational training (Anatolii M. Aleksiuk [1], Ivan M. Bendera [3], Nataliia I. Boiko [4], Volodymyr I. Bondar [6], Volodymyr K. Buriak [51], Vitalii A. Kozakov [22], Serhii M. Kustovskyi [24], Anatolii I. Kuzminskyi [25], Oleksandr V. Malykhin [28], Aleksandr G. Molibog [33], Pavel I. Pidkasistyi [38], Iia M. Shymko [44], Mykola M. Soldatenko [46], Oleh O. Tsys [52], Svitlana H. Zaskalieta [58], etc.).

By virtue of the content analysis of initial categories, such as "information technologies", "computer based technologies", "communication technologies", as well as existing numerous researches, in the context of the investigated problem of organizing students' independent study activities we consider the *ICTs* as a systematic range of techniques and forms of knowledge acquisition and ways of learning on the basis of lecturer-student and ICT tools interaction aimed at the achievement of expected accomplishments of the educational process (Svitlana M. Hryshchenko [34], Yevhenii O. Modlo [31], Yurii L. Novikov [50], Polina A. Novikova [50], Ivan O. Petrytsyn [37], Tatiana V. Rudenko [41], Andrii M. Striuk [29], Valentyn M. Tomashevskyi [50], Ivan M. Tsidylo [8], Serhii M. Yashanov [56], Elena V. Zakharova [57], etc.).

The conducted our own research of the content and essence of organization of students' independent study activities with the use of ICT has made it possible to identify and characterize the *leading forms of its organization*: independent and research work, lectures (electronic, multimedia, video, audio ones), consultations (synchronous, asynchronous, delayed, remote, network, local, online, offline ones) and non-formal learning (electronic, user, distance learning courses) [52].

The essence of ICTs is represented as a system which includes: technical, methodological, substantive environment and software and hardware which accompany and support different aspects of the organization of students' independent study activities via appropriate ICT and tools (see Fig. 1).

Useful ICTs in the organization of students' independent study activities are multimedia, interactive, hypertext, cloud computing, telecommunication, Internet technologies, SMART technologies, web technologies, as well as technologies of virtual information space and automated library-and-information systems [52].

3 Findings

Nowadays there are many software products, widely available open author's apps, cloud and local services that offer a variety of ICT and tools. They can be embedded in existing forms and what's more caused perfect methods of students' self-learning without any significant additional time expenditures. In our study, we consider ICT and tools in the scope of minimal, desirable and predictive ones. First of all, the basic ICT and tools include the software and hardware part of multimedia. There are PC, the input, output and communication devices, the devices of storage and transmission of large amounts of information and their software, and over and above the tools of mobile ICT. Additionally, we take into account such ICT and tools that enable the recognition and synthesis of human speech together with multilingual support.

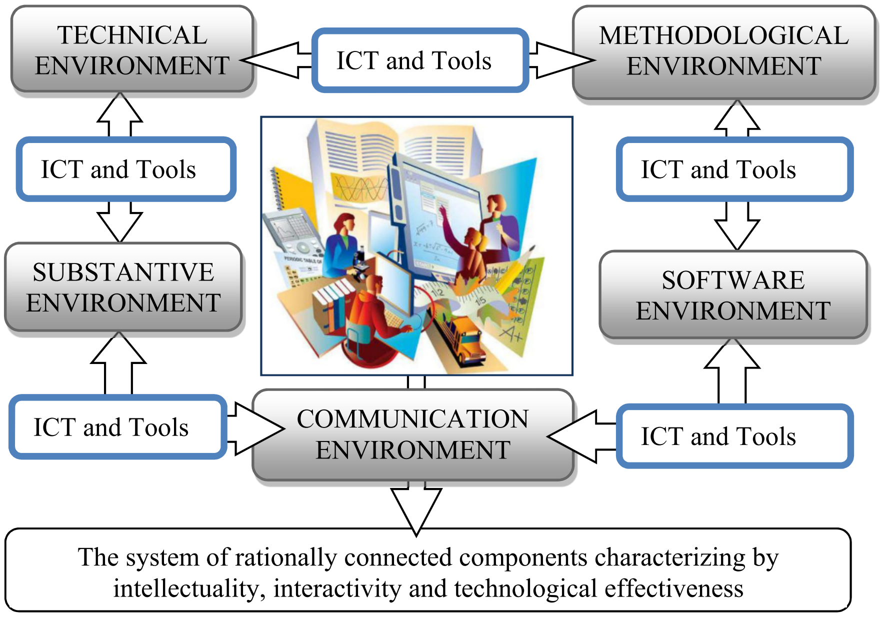

Fig. 1. Contents of information and communication technologies

Consideration the specifics students' independent study activities in institutions of higher education, we present the ICT and tools' classification (see Fig. 2).

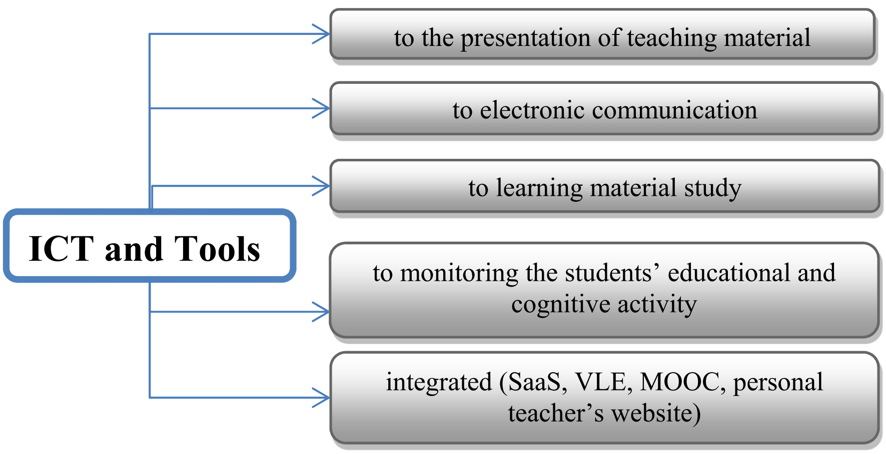

Fig. 2. The classification the ICTs and tools for organizing students' independent study activities

Offer you to consider further each group of ICT and tools in more detail.

3.1 ICT and tools for the presentation of teaching material

The all existing diversity of software and hardware tools for creating and presenting certain educational content and general methodological support that students could use in their own autonomous learning may be united in *ICT and tools for the presentation of teaching material*.

As just before computer occurrence and its widespread distribution now lecturer both creates a methodological support for leaning the discipline or its separate sections and develops educational content. With the use of ICT this process slowly but surely gets more automation and flexibility. The author's software products, prepared by the lecturer, are the result of processing a certain technology with using office packages, text and graphic editors, automated design tools. In fact, today the lecturer's relevant information competence is not only desirable, but is considered as demands of the times [55]. At the same time, the most trained in this regard, scientific-and-pedagogical personnel represents their educational and methodological text-books in the form of electronic lectures, study presentations, electronic teaching aids, they place educational information on the pages of personal websites and use thematic blogs of social networks.

To prepare the multimedia presentation today, the Microsoft PowerPoint product could be used, as well as applications for creating animated video presentations in the format of "hand drawn" (Algodoo, Sparcol VideoScribe, and PowToon), cloud services GoAnimate, Prezi, Google Slides, Zoho Show, Haiku Deck, Visme and many others that allow not only to make presentations but also receive real-time help to improve them [47].

It is generally accepted that a learning book remains the most important source of knowledge. Theoretically, an e-book can be prepared using a text editor and, by means of hypertext technology, it can be structured for the benefit of quick navigation on it. At the same time, modern ICT and tools enable the creation of full-time didactic means for students' self-learning activities. There are both the simple HTML documents (HTML Help Workshop, HTML Help ActiveX control, HTML Help Viewer, Microsoft HTML Help Image Editor, HTML Help Java applet, HTML Help compiler, HelpMaker) and full-fledged textbooks in such formats as html, chm, pdf and exe that support speech, animation, video and simulation (SunRav BookOffice, eBooksWriter LITE, Help & Manual, Sophie, ExeBook, Maestro STANDARD, HTML Book Maker, Document X), as well as other leaning materials, trainings, courses, demonstrations, help manuals (Adobe Captivate), etc. [2].

With the object of teaching materials' granting there are the repositories for data sharing and knowledge sharing, the educational resources, the electronic libraries, the file sharing networks (Usenet, Citrix), the knowledge bases, the distributed knowledge bases, the cloud storages (Dropbox, Google Drive, 4shared, Amazon S3, CloudMe, etc.) on the Internet [42].

The stream multimedia is far and away a great opportunity for students to organize their independent study activities by themselves. It means the information in a multimedia format that is continuously received by the user from the provider which offering streaming broadcasts (Internet radio, Internet-TV, video collections, educational programs, etc.) [42].

Significant advantages for the organization of student's independent study activities are next:

- thematic channels of YouTube, where there are collections of video tutorials, presentations, educational videos, multimedia lectures, created directly by teachers and individual training centers (https://www.youtube.com);
- TED (Technology Entertainment Design) presentations, they are lectures collection on topics of science, art, design, politics, culture, business, global issues, technology and entertainment industry (https://www.ted.com);
- the Khan Academy, it is open online platform featuring short video tutorials (5-15 minutes) on various subjects as well as tests helping visitors to measure the level consciousness of leaning information (https://www.khanacademy.org);
- Wolfram|Alpha, it is knowledge base, a set of computational knowledge engine and a question-based system, containing, in particular, the necessary information for the mastery of engineering, technical, technological, computer knowledge (http://www.wolframalpha.com);
- the services of corporate social networks (Podio, Yammer, Chatter, SocialCast, Bitrix24) that allow users to centrally store all working materials in one place, attach files and add comments;
- the services and tools for creating thematic websites for the demands of teachers and students (WordPress, Ucoz, Strikingly, Imcreator, etc.). They can build a site using a template set and in any case, they don't need web programming knowledge.

3.2 ICT and tools for electronic communication

The next step in organizing students' independent study activities is to establish feedback, planning and carrying out consultations. This process can be provided by *tools of electronic communication*.

The leading direction of consulting is the use of electronic network communicators and IP-telephony. The actual state of the development of network technologies allows to apply the free features of Skype, Viber, WhatsApp, Google Talk, Facebook Messenger, iMessages for the organization of study work both individually and in chat, as well as thanks to email and cellular communication.

Webinars, web-forums, web-conferences, teleconferences, which are implemented in both synchronous and asynchronous regimes, are effective means of communication organization; in particular within the framework of students' research work. It enables students to organize the communication on a specific topic of their interest in a convenient time. Such platforms as BigBlueButton, V-Class, GoToMeeting, iMind, WebEx [23] can be used for technical support of web-conferences.

It should be taken into account that the virtual boards (Padlet) are fairly well-approved in organizing students' independent study activities. These are web sites allowing to communicate with other students via text messages, photos, links, etc., that placed on such a virtual message board. This tool enables to set up equal access for multiple users who can view and add their materials.

What's more with the development of the Internet technologies, feedback and counseling in the system of students' independent study activities can be provided in thematic groups of social networks namely Facebook, Twitter, Instagram, etc.

3.3 ICT and tools for learning material study

It is well known ICTs provide exceptional opportunities for autonomous student learning. This quality is supported by *ICT and tools for learning material study*.

It should be noted the hardware and software capabilities of ICT can effectively organize independent carry out by students of multilevel educational tasks in virtual (digital) laboratories in a number of academic subjects, both technical and humanitarian [51].

In fact, the virtual lab has a complete set of properties typical of the traditional organization of scientific research. Its application in the learning process allows to expand the range of solved tasks, helps students to create mathematical models of devices, to test different modes of their work, to explore a wide range of phenomena and processes, to carry out an instrumental diagnostics and detailed analysis of the results with together using computer software – electronic calculators, graphs, summary tables, diagrams, models and others. In this case, the advantage of virtual laboratories is the possibility of independent and remote conducting of researches with significant saving of material equipment and training means, observance of the requirements of protection and occupational health [35].

Among the virtual labs, one can identify those that function on the basis of software emulators reproducing software or hardware, or a combination of the work of other programs or devices, and simulation programs simulating the state of the modeled system for executing the original machine code [37].

It is supposed the examples of ICT and tools for the creation of virtual research and teaching laboratories are STAR (Software Tools for Academics and Researchers), VirtualLab, Algodoo, PhET, Wolfram Demonstrations Project, there are also many cloud services that enable users to directly conduct both virtual laboratory researches and to process mathematical statistics with applying their results (MATLAB, Statistics). It should be noted that these tools let to development and functionate full-fledged pedagogical software means for the methodological provision of students' independent study activities [35].

An important place in the system of training specialists in technical area is engineering, design and technological activities. Their formation covers the assimilation and application of modern automatic designing systems, and not only during the study of certain academic subjects, but also in terms of supporting coursework and qualification design (drawing, sketching, animation of processes, preparation of sketches) [18].

CAD system is a program for designing and issuance of working project documentation allowing to study project ideas and visualize concepts through photorealistic visualization, as well as to model the behavior of products in real-world conditions [31]. There are the most commonly used CAD tools – AutoCAD, NanoCAD, Compass 3D, FreeCAD, T-FLEX CAD, SolidWorks, Simulink, on top of the animation programs – Maya, 3ds Max, Corel Draw, CorelCAD, University MD Motion Bundle, etc.

The students' supervision from the direction of lecturers can be provided through a project management system. The service enables the reproduction of a complete design cycle: objectives and results trees, project life structure phases, organizational structure of the project, matrix of distribution of responsibility and allocation of works between the performers (if the project is collective), network model of the sequence of project execution, resource tree, cost tree, description of project risks, etc. Among the ICT and tools supporting project management are Microsoft Project, Casual, Bullet Journal, Evernote, Trello, SCIM.ru and others [54].

Implementation of learning projects, conducting research in the network is being supported by Web 2.0 technology, through which such systems operate, that, by accounting for network interactions, they become the better, a lot of people use them [49]. These technologies, including the wiki, Google, Flickr, Digg.com, and blogging services, allow students to engage in self-search research on specialized sites as contributors, copywriters, critics, bloggers, commentators, etc. Therefore, together with the acquisition of educational information, this kind of independent study activity contributes to the formation of self-esteem, broadens the horizons, and develops students' communication skills.

3.4 ICT and tools for monitoring the students' educational and cognitive activity

The scientific based organization of students' independent study activity involves systematic control, self-control and correction. For this purpose the special means with ICTs for *monitoring the students' educational and cognitive activity* are being used.

Predictably the most successful and effective is test control appreciating the knowledge that students mastered by themselves, since it enables to objectively, impartially and promptly find out the quality of assimilation of learning information. The software market provides a wide range of ICT and tools for computer testing that let the user to select different test presentation formats, the test structure, and how to evaluate its execution (tempo, time, use of tips), styles of input and choice of answers, type of organization under time of testing knowledge (number of attempts, time limit, arbitrary choice of questions for the answer, the possibility to randomly select a certain number of questions from the general database of tasks, the introduction of statistics), the ways giving of the test results (in general, for each task with the demonstration of the correct answers, the formation of group information) [52].

The study-and-control programs of linear and branched-off character are considered to have the most widespread. The programmed learning's concept founded their expediency and optimality. The purpose of such programs is to prevent students' errors. If branched-off study-and-control programs are being used, after the test the student is provided with the analysis of the results, as appropriate the correct answers are shown, explanation to the assumed errors is given, the references to those aspects of the learning material that need to be finalized is pointed out. In that case the student has the opportunity to independently determine both the order of passing the test and studying portions of the learning material. In our opinion, such a variant of study-and-control programs is more adapted to the individual characteristics of students, but there is danger of losing control over the performance of independent work. So, each type of study control program must find its place in the system of students' independent study activities [55].

In a nutshell we would like to cite the ICTs and tools as an example that could be used to build testing control of students' knowledge. These are MyTest, MiniTest-SL, ExeTest-SL, OpenTEST, Quick Exam, FreeXTest, Assistant, Test Designer, etc.

Furthermore, the Internet offers a number of cloud-based services that create on-line quizzes by virtue of the principle of gamification. The quite professional and versatile services in this respect are Kahoot (https://getkahoot.com) and Quizizz (https://quizizz.com) that contribute to build and conduct quizzes and surveys, with the use of mobile devices. The tool lets the test organizer adjust the tempo, speed, time limits for each task, and add additional marks for the estimation of speed or sequence of tasks performed by each student [14].

Certainly, above we considered the most well-known and promising ICTs and tools in terms of organization of students' independent study activity.

3.5 Integrated ICT and tools

At the same time, we would like to emphasize specially created ICTs with educational purposes, they are *integrated ICT and tools* that cover all of the above listed aspects of organization students' independent study activities.

These include Internet technologies and SaaS (software as a service) cloud-based technologies [17]. They allow storing data and associated applications on specialist servers that let solving the tasks of organizing students' independent study activities. The most common are Microsoft Office 365 Education and Google Apps for Education, as well as cloud-based services have been made on their basis. Their benefits are next: they are either full or in a practical manner free as well as availability and widespread [23].

In particular, the Google Apps for Education cloud platform offers the following ICTs and tools: text, voice, and video, chat, email; Google Drive – a data warehouse (15 to 30 Gb) for storing files, setting access rights to them with the possibility to post to the Internet; as well as a number of tools – Google Docs for making documents, spreadsheets and presentations; Google Group to create mailing lists and discussion groups; Google Calendar – a calendar for planning and managing meetings, tasks, and event sharing; Google Forms for surveys and tests, Google Sites – for generation sites using templates. It should be taken into account the fact that the list of tools is constantly expanding.

According to experts, the use of ICT in the organization of study activities was based on general-purpose services. Then special services appeared and integrated the individual functions of e-learning (for example, the "virtual class" model); their evolution led to the creation of the concept of Virtual Learning Environments (VLE) [23]. Its main representatives are:

1. Learning Content Management System (LCMS) enabling the placement and manipulation of electronic teaching materials in various formats. This system is convenient in the case when the created system of educational courses uses a lot of common fragments of educational information;
2. Learning Management System (LMS) is mainly applied in distance learning.

In the educational process today, various platforms for managing integral training courses are being actively used, including Moodle, Claronline, ATutor, SharePointLMS, Live@EDU, eFront, Prometheus, Dokeos, etc. Their advantages and disadvantages are considered in detail in their publications of Bohdan A. Demyda [11], Halyna I. Haidur [55], Andrii I. Hladyr [11], Mykola P. Hnidenko [55], Oleh O. Ilin [55], Polina A. Novikova [50], Yurii L. Novikov [50], Serhii O. Sahaydak [11], Valentyn M. Tomashevskyi [50], Viktor V. Vyshnivskyi [55], Nataliia V. Zachepa [15] and many others [23].

Among the principles of social constructivism [49], which is the basis of the LMS project, we emphasize one very important for our study, it is the opinion that the learning environment should be flexible and should provide a simple tool for the participants in the educational process to fulfill their learning needs [55]. This certainly makes LMS a powerful tool for organizing students' independent study activities.

Any distance learning system is being based on the context-modular principle and covers, as indicated by Bohdan A. Demyda, Serhii O. Sahaydak and Irena Kopyl, such modules as: administration of the system; organization and support of the educational process; development and maintenance of testing; design and presentation of all kinds of learning materials in the system; export-import of their various formats; interactive user cooperation; user potency registry [11]. These sections, blocks and modules can be applied separately and together in line with specific goals and tasks of studying those or other subjects.

The analysis of the functional capabilities of these interactive modules makes it possible to identify their essential advantages for the organization of students' independent study activities in all its forms – independent and research work, types of consultations, as well as to build on its basis a functional electronic resource that reflects and supports academic discipline.

What's more, there are commercial Blackboard, WebCT, Microsoft Learning Gateway, Prometheus, WebTutor, Virtual University, and freeware ATutor, ILIAS, Sakai among widespread virtual learning environments [55]. The distance education functions on these platforms and creates chances for organizing students' non-formal education.

It is a peculiarity of online education that students and lecturers are separated in space and time, and the interaction between them takes place in a virtual environment [42]. Online Educational institutions are commonly referred to as "virtual universities". Their functioning is being based on the four systemic principles of open education: they are formulated by Valerii Yu. Bykov, namely: mobility of subjects of the educational process; equal access to educational systems; providing quality education; formation of the structure and implementation of educational services [9, p. 55–56].

Massive open online courses (MOOC) allow students to be taught by lecturers from leading world universities, to join a multinational student community, and to receive a document confirming the successful completion of the entire course. The largest online platforms offer electronic lessons with subtitles and printed learning material; video materials; enable conduct a meaningful evaluation of the knowledge gained. To help the student methodical and reference material is given, the opportunity to discuss learning issues and tasks at the forum is added, credit for regulate the speed, the pace of training are taken. They are Coursera, Khan Academy, EdX, Udacity, Canvas Network, Udemy, FutureLearn, FUN, Prometheus on-line platforms that provide such user-friendly courses [42; 11].

When all's said and done above we mark that the processes of ICTs' unification and universalization of eventually ensured the development of various types' separate universal training modules. Ones could be part of several technologies for the organization of students' independent study activities [45, p. 85].

The personal teacher's website is a means of interactive distance cooperation between participants in the educational process. It could be considered as the holistic ICTs that capable of providing pedagogical management to the organization of students' independent study activities [26, p. 66]. It is an interactive didactic tool through which the cooperation between all participants in the pedagogical process – teachers, lecturers, students, potential entrants, employers, graduates, etc., is organized. An equally important aspect of such interaction is the possibility of individualization of independent study in the view of student's cognitive or professional perspective.

On their content there are several types of teachers' websites, in particular:

- the *business card site* presents the image of the teacher, his scientific interests, the most profound scientific and methodological works, photo-collections, it contains general information about him/her and the courses that he teaches. In addition, such a type of site enables the implementation of operative feedback with students for consulting and organizing their research work;
- *portfolio site* that usually includes general information about person, results of scientific and pedagogical activities, scientific and methodological works, lecture notes, electronic textbooks, examples, reference samples, and tasks for students' independent work, multimedia collections, leaning models, etc.;
- the *subjective site* that is a specialized online resource for the organization and control of students' independent study activities for a fixed educational discipline. Typically, the structure of such type of site is determined either by thematic lines of the course, or by types and forms of students' independent work (section for ongoing work, for conducting a study project, preparation of term paper, web-quest, for laboratory and practical classes, lead-up for exams or credits, etc.). The quality of subject site is determined by the presence in its structure of information relevant to students, dynamic and multimedia models of investigated phenomena, video materials, references to digital educational resources, cloud services; presentations, automated tools for self-control;

- the *educational site* is considered to have wider possibilities, in comparison with the above presented one, in the organization of students' independent study activities. Its main purpose is to help students build their own educational trajectories, to promote deepening and expanding knowledge in the chosen specialty. Here could will be found top news and announcements, latest video materials, links to educational, scientific, library and other resources, will be introduced to holistic self-education electronic courses, it will be possible to organize interest communication in specialized chats;
- the *combined site* that has two or more of the above types of sites in its structure [26].

The technological basis of such websites can serve as specially developed platforms for distance learning that are provided to the user almost for free: they are Moodle, Google services, Edmodo, Studyboard, etc., and moreover ordinary social networks. In their structure, the main features of management of students' independent study activities are laid.

When creating a site, a specialist programmer uses specially designed programming languages (PHP, HTML, JavaScript, etc.). However, a website builder tools can generate a site applying user-friendly simple settings. There is the possibility of making sites, both on the basis of Content Management Systems (CMS) and applying SaaS platforms, although in this case, the service is paid [55].

3.6 Criteria for the effectiveness organizing of students' independent study activities via the use of ICTs and tools

It is observed that the organizing of independent study activities with the use ICTs tools is considered an effective one if the students gain a certain amount of knowledge at the appropriate general scientific and professional level, forming the important features of their personality, necessary for further intellectual and professional development. At the same time, the independent study activities has been carried out on the basis of self-management by students and the systemic indirect mediated management by lecturers as well as rates of mental labor, sanitary and hygienic and ergonomic requirements in the application of ICTs have been taken into account.

The effectiveness of the organization of students' independent study activities can be assessed by a number of criteria. Obviously, the students' motives and motivation determine their personal meaning, are the main factors of one's effectiveness, especially in terms when the classroom training has been reducing. Starting independently, based on their needs, the student has put forward a specific goal. Therefore, the goal is being defined as a conscious need, as a marking of a desired result that is being directed the student's activity towards achievement it [53]. Thus, activating the students' cognitive interests, initiating their creative initiative, and the desire to perform the proposed learning tasks in a qualitative and timely manner, to master and apply for the sake of these newest ICTs is the first urgent step in organizing an effective students' independent study activity [3]. The next step is to build a content and instrumental basis for independent study activities. This involves, firstly, the formation of students' teaching and methodological knowledge for the organization of autonomous learning, as well as methods, techniques and skills for solving the set of educational tasks with the wide application of ICTs. In the end, the effectiveness of the functioning of such a system is assessed by educational, cognitive and personally significant products of students' independent study activities.

In that way, based by the structure and content of the system of students' independent study activities, *criteria for its effective organizing* are: *motivational, substantive, organizational and productive* one. At the same time, considering the general state of the effectiveness of the organization of the studied activities, one requires a separate study and investigates the *technological ability criterion* of the educational process. Thanks to it we could be estimate the motivational provision of the students' and lecturers' functioning in the organization of independent study activities together with the use ICTs and tools; make diagnostic and appreciate efficiency of the investigated process; design the content of independent study activity by way of a system of cognitive and practical tasks as well as an indicative basis and methods of their solution; achieve algorithmicity, optimality, integrity and controllability of the process organizing students' independent study activity with the use of ICT and tools; amount the effectiveness and developmental nature of students' self-study and whatever (Dmitrii V. Chernilevskii [10, p. 18–25] and others).

Describing the level of efficiency organizing of students' independent study activity via the use of ICTs and tools we proceed from the features of educational activity as a process that can have different degrees of implementation and the subject of management. Therefore, taking into account the above-mentioned, we distinguish four levels, these are insufficient, critical, sufficient and proficiency one.

3.7 Brief description of the content of the pilot-and-experimental study of the effectiveness the use of ICTs and tools in the organizing of students' independent study activities

Pilot work has been carrying out for the years 2016-2017 and has covered 240 students of 2-3-courses of technological and pedagogical area of expertise of 2 HEI of Ukraine; they were Kryvyi Rih State Pedagogical University and Poltava National Technical Yuri Kondratyuk University [27].

After a theoretical justification the components of the informational and educational environment of higher educational establishments aimed at satisfying the educational needs of students in the organizing of independent study activities have been defined and specified. They cover:

- the website of the institution, which includes presentation and teaching materials of the institution and individual specialties, library repository, automated library frames, built-in platforms for the use the Learning Management Systems (in particular, Moodle), systems for automated learning inspection;
- the departments' educational-methodical complexes;
- the specialized web-sites of departments and personal lecturers' web-sites for organizing students' independent study activities from disciplines of curriculum;

- the open electronic educational resources.

In the framework of the forming experiment, the selection of ICTs and tools as well as the corresponding technological models that described above has been carried out. The criteria for their choice were as follows:

- *the general didactical* ones providing scientific, professional orientation, systemic, consistency, connexion a theory with a practice, computer and “traditional” visualization of the educational information, consciousness, activeness and independence of students in knowledge acquisition;
- *the general psychological* ones that allow for friendly dialogue interface, quality of screen design (color, contrast, clarity, size, speed of change of information, etc.), taking into account the students’ age and individual characteristics, bring in both of motivation means for their independent study activities, and pedagogical and computer support in organizing their autonomous learning;
- *the methodical* ones providing planned, algorithmic, staged and sequence in the study of learning information, as well as feedback between the lecturer and student, last and not least the unified approach to the organizing independent study activities in any learning environment;
- *the technical* ones, these are accordance hardware tools with software and operational documentation, the ability to create a seamless learning environment, produce a synchronous and asynchronous training communication mode, provide software stability for incorrect users actions;
- *the ergonomic* ones by virtue of them the functional comfort in work, correspondence of aesthetic design of certain learning objects to their functional purpose are being guaranteed [55].

We also took into account such specific requirements as the ability to use ICTs and tools on portable mobile and media devices without software interference in their content.

For the scientifically grounded management by students’ independent study activities of technological and pedagogical area of expertise the steps to distribute the ICTs and tools according to the leading forms its organization have been taken; we means the independent and research work, lectures, consultations and non-formal learning (see Table 1).

In addition, the didactic supply of the organization of students’ independent study activities of technological and pedagogical area of expertise with the use of ICTs and tools have been created and adapted. They were the electronic educational content, if in a nutshell – electronic lectures, electronic educational books, electronic educational kits and whatever. At last the electronic, mobile, combined, mixed learning technologies as well as ones of training, coaching, gaming, design, test, rating have been tested and endorsed.

It has been tested the models of blended learning. First of all, it was the stream model that via an educational web-site has concentrated in itself an invariant core of students’ independent study activities and has integrated with traditional technologies through so called model “Flipped classroom”. The potentials of axial model that included user's custom electronic courses of curriculum disciplines as interactive educational modules on the Moodle platform has been studied. The variety of ways for mixed self-study learning has also been implemented.

Table 1. Ways of implementation the forms organizing the students' independent study activity via the use of ICTs and tools

The forms organizing the students' independent study activity				
Independent work	**Research work**	**Lectures**	**Consultations**	**Non-formal learning**
• Lecturer's Website • Web-quest • Portfolio • Training project • Virtual Laboratory Classes • Training simulators • Study-and-control programs • Electronic educational resource • CAD • Systems for automatic control of objects and models • Knowledge bases • Databases **ICTs and tools:** for the presentation and learning of teaching material, for monitoring the students' educational and cognitive activity	• Service projects • Presentation portfolio • Project's portfolio • Web-forum • Web-conference • Webinars • Network publications • Wiki-projects • Web-based programming • Multi-design **ICTs and tools:** for providing an electronic communication, for virtual education with elements of artificial intelligence	• Multimedia lectures • E-lectures • Lecture-and-visualization • Video tutorials • Micro-lessons • Thematic blogs • EBook • Electronic library • E-learning resources • Useful educational resources • Thematic library collections • Knowledge bases • Databases • Infographics • Virtual museum • Video channels **ICTs and tools:** for the presentation of teaching material	• Video tutorials • Workshops • IP telephony • Interactive counseling • Network consulting • Correspondence • Work in the list of links • Chat • Blog • Video-chat • Virtual bulletin board • Useful educational resources • Administration and management as a service • Webinars • Gamification (web-quests) • SMART Table Training Center **ICTs and tools:** for provide electronic communication	• User e-course • On-line course • Distant education • Thematic educational channel • Virtual universities • Planetary classes • MOOC **ICTs and tools:** for creating and managing automated learning courses, remote virtual education systems with elements of artificial intelligence

3.8 Analysis of the effectiveness of the use of ICTs and tools in the organization of students' independent study activities

Focusing on this task we have investigated the changes that occurred in the levels organizing of students' independent study activities with the use of ICTs and tools on the grounds of productive and technological ability criteria. Such work meant the study of the quality of mastered by students the knowledge about disciplines of the curriculum, the specific types their professional activity in the system of independent work, research work and non-formal learning, as well as the degree of technological efficiency of these processes.

Diagnostics on a productive criterion has carried out on the basis of “Rating card of the student’s self-study activities”. In this mean we have included such following positions: the standardized components of the basic level of organization of independent study activities (current student’s learning progress, systematic independent work, accorded independent work (educational projects), work in the informational educational environment of higher educational establishments); components of an in-depth and professionally oriented level (student’s research work, work with electronic educational resources of subjects); non-formal learning (study in user and additional electronic courses developed by both the lecturers and in the system of open distance education).

While the experimental research, we have been able to determine thanks to such the card, the degree of activity, autonomy and systematic, effectiveness and productive performance of each student’s individual study activities. Due to this card we have standardized the performance of each type of work by virtue of addition to basic students’ result both supplementary and penalty marks.

The obtained results are presented in the Table 2 as well as on Fig. 3.

Table 2. Comparative dynamics of levels organizing the students' independent study activities with use of ICTs and tools in line with productive criterion (%)

Levels	Experimental group		Control group	
	Output Stage	Final Stage	Output Stage	Final Stage
Insufficient	15.0	3.3	13.3	11.6
Critical	25.0	13.3	23.3	20.0
Sufficient	43.3	55.0	45.1	48.4
Proficiency	16.7	28.4	18.3	20.0
Pierson χ^2-criterion	25.9>11.3, ρ = 0.001		1.1<11.3, ρ = 0.001	

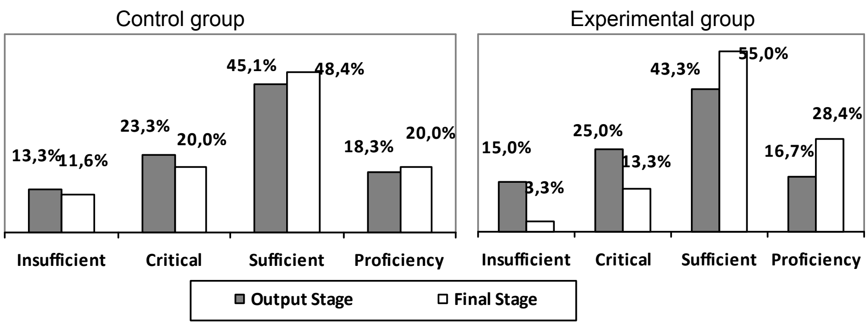

Fig. 3. Dynamics of the levels organization the students’ independent study activity with the use of ICTs and tools according to productive criteria

As you can see the quantitative data analysis of Table 2 reflects the changes in the attitude of students in the experimental group to independent study activities with together use of ICTs and tools in its organization. Predictably, the introduction of special control and diagnostic procedures, systematic differentiated inspection and evaluation have contributed to increasing the level of students’ activity in research work, as well as the application of qualitative new forms of its organization into the system of the students' independent study activities. We mean the webinars, workshops, video tutorials, thematic websites, user courses, electronic educational resources, whatever.

The students have noted the expediency of developing a department's thematic website, the variety of offered courses for the acquisition of knowledge about ICTs and tools for educational and professional purposes, as well as orientation to opened online e-courses.

As you can see for data of Fig. 3, there is a positive, statistically significant dynamics in the levels organizing independent study activity for students in the experimental group in contrast to the students of the control group: 11.6% more students have shown the proficiency and sufficient levels of organization of the investigated activity via the use ICTs and tools.

The level of productivity of the organizing the students' independent study activities with together use of ICTs and tools has been estimated by the coefficient of efficiency:

$$K_t = \frac{K_c}{K_p}, \quad (1)$$

where K_c and K_p are in respectively coefficients of completeness of the fulfilled tasks by students with the used ICT and non-computer pedagogical technologies.

The data obtained are summarized in Table 3. We must notice, evaluating the efficiency, we did not take into account the use of ICT by students for text editing, automatic calculation, etc.

Table 3. The coefficient of effectiveness the use of ICTs and tools in the process of organizing students' independent study activities of technological and pedagogical area of expertise

Types of tasks	**The coefficient**	
	Output stage	**Final stage**
Organization of educational communication in the "lecturer-student" system	1.5	1.8
Information search	1.2	1.8
Graphic, computational and practical tasks	0.7	1.2
Educational projects	0.8	1.3
Preparation of plans-synopsis of lessons for labor training and technologies	0.6	1.1
Laboratory and experimental research	0.6	1.5
Creation of portfolio	0.5	1.1
Creation of schemes, technological cards, consolidated tables, charts and diagrams	0.7	1.5
Self-monitoring, test control	0.9	2.0
Solving the technical creativity tasks	0.6	1.1
Working with the library catalog	0.7	1.5
Participation in the quest	0.7	1.1

As you can see, in experimental groups there has been a significant increase in the use of ICTs and tools by students for solving educational problems. Such results were made possible by introducing into the educational process the varieties of ICTs and their technological models that have made it possible to integrate traditional and electronic tools into blended and mixed learning systems.

For the control group statistical analysis shows the changes in the level organizing students' independent study activities are being random and related to the general evolution of the individual students in the vocation training process.

4 Conclusions and prospects for further research

Consequently, the analysis of the latest information and technological approaches to the organization of students' independent study activities made it possible to determine the means of realization of the leading forms of organization for this activity (independent and research work, lectures, consultations and non-formal education).

In the current context, when the development and replication of educational software products becomes a business, the market is being filled with quite diverse and multiple products. Identification of the criteria for their quality and selection is getting increasingly issue of the day. Often, the criteria for such an assessment are the technical characteristics of software products that not directly related to the pedagogical and methodical terms for their creation. The quality of graphic design, reliability, availability and quality of documentation, etc. – all these criteria are definitely important, but in our opinion, they do not determine the main characteristics of educational software products. Therefore, the programmatic and methodological support of students' independent study activities based on ICT should include both software tools for teaching support and means that enable the lecturer to manage the learning process, its rational organization.

As for result of this study, the ICTs and tools for the organization of students' independent study activities have been characterized and classified. It was shown and described the ICTs and tools that support presentation of teaching materials, electronic communication, mastering of learning material, monitoring of students' learning and cognitive activity, such as ones that serve for the sake of development and support of automated training courses, systems of remote virtual education with elements of artificial intelligence, which implement the principle of adaptive management of learning and the organization of students' independent study activities.

In this publications the elements of the system of pedagogical work on the creation of informational educational environment of higher educational establishments functioning on the basis of the same educational principles in the process of organizing students' independent study activities with the use of ICTs and tools have been presented. The content and functional components of such a medium have been developed and tested in the framework of pilot-and-experimental work. They have enabled to effectively implement the leading forms and technologies via appropriate ICTs and tools, as well as have given statistically significant dynamics in the levels of organizing students' independent study activities in line with for productive and technological ability criteria.

Summarizing the analysis of the possibilities of integrating traditional and newest ICT into the organization of students' independent study activities, take credit that not only ICTs are important, but how their use serves the achievement of educational goals. Usually, the best educational result is being provided by a feasible combination of well-proven time traditional and innovative means of organizing students' self-study. Expediently, when ICT are being selected one should take into account their maximum compliance with the specifics of the students' training in a particular area of expertise.

Perspective in the development of this area, we consider the research content of students' independent study activities in the distance, dual and e-learning educational systems.

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Technology of forming media literacy of children of the senior preschool age of Ukraine

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Abstract. The article substantiates the technology of forming media literacy of senior preschool children in the establishments of preschool education of Ukraine.

The features of preschool media education have been determined. Its relevance has been shown. The focus is on conducting the all-Ukrainian experiment on media education for 2017–2022.

The problems in implementation of media education in preschool establishments have been identified and the prospects for their solution have been determined. The psychological factors of forming media literacy of children of the senior preschool age have been highlighted. It has been proved that preschool age is sensitive for the formation of critical thinking. The concept of "preschool media education" as part of the educational process has been characterized by the three-component structure.

The peculiarities of conducting ascertaining and forming experiments in the establishments of preschool education of Ternopil, Khmelnytskyi have been shown.

The expediency of media education for educators of the establishments of preschool education of Ukraine has been proved.

Keywords: media education in preschool establishments, technology, media education, critical thinking.

1 Introduction

1.1 Problem statement

Media threats as manipulations of consciousness, fake messages, dangerous acquaintances, the emergence of dependence on new media, provoking aggression, cruelty, violence, etc. are increasing in the modern Ukrainian society. Information wars with the use of manipulations and fakes appeared to be no less devastating than the ones using the latest firearms. In such conditions, media education is becoming increasingly relevant, primarily for children, since the age of a child is constantly decreasing when child first contacts the mass media. It is necessary to begin to form media literacy as early as older preschool age. There are several reasons for this. Media literacy in preschool is not perceived as a subject, but as a way of life. Later, teenagers have to be re-educated, changing skills and style of behavior in the media environment. It is much more difficult to do that than to organize properly media education from the very beginning.

Despite the relevance of the media education problem for preschoolers, it is poorly researched; in addition, a number of contradictions are not resolved, moreover at the level of conceptual documents.

For example, the Concept of Implementation of Media Education in Ukraine (new edition) indicates the appropriateness of preschool media education, which is fundamentally integrated and aimed at balanced aesthetic and intellectual development of a child's personality (including various forms of intelligence: emotional, social and practical), provides child's protection against aggressive media environment (also from the information "garbage", inappropriate to the age capabilities of child's psyche information influences, containing the elements of violence, horror, erotics), the ability to navigate, choose and use media products adapted to the age norms [21]. However, in the Basic component of preschool education, the issue of media coverage is not given significant attention. Only in the variative part of the standard, in the "Computer Literacy" educational strategy in particular, is stated that a child should be familiar with computer, acquire basic techniques of work with it, adhere to the rules of safe behaviour while working with a computer [6]. But these skills are not essential to a child, who we call a media literate one.

Given the relevance of media education in the modern society, the Ministry of Education and Science of Ukraine approved an all-Ukrainian experiment on media education for 2017–2022, which involves 153 educational institutions, not only schools, gymnasiums, lyceums, regional institutes of postgraduate education, but also preschool educational institutions [11], [33]. However, the question concerning the format of the media education implementation remains controversial, as well as whether preschool age is sensitive to the formation of critical thinking. The creation of teaching and methodological support for media education in preschool is a problem. The level of media literacy of older preschoolers depends largely on its quality.

1.2 Analysis of recent researches and publications

Problems of the children and youth's media literacy formation are the subject of the research of Ukrainian scholars, namely: Kateryna M. Binytska [59], Tetiana V. Ivanova [17], Valerii F. Ivanov [17], Iryna Ya. Myshchyshyn [34], Liubov A. Naidonova [17], Iryna M. Nosachenko [36], Hanna V. Onkovych [38], Leonid V. Orshanskyi [39], Svitlana P. Shumaieva [49], Oksana V. Volosheniuk [17], Alla K. Voloshyna [58], and others, as well as foreign scientists – Anna Andrzejewska [1], Cary Bazalgette [3], Józef Bednarek [4], Ewelina Brzyszcz [8], Alexander V. Fedorov [13], Cecilia von Feilitzen [14], Janusz Gajda [15], George Gerbner [51], Henry A. Giroux [16], Luc Giroux [41], Robert Kubey [23], Adam Lepa [26], Len Masterman [32], Jacques Piette [41], W. James Potter [45], Bronisław Siemieniecki [27], Dorota Siemieniecka [50], Maciej Tanaś [54], etc. The interpretation of the basic concepts was carried out in the works of the abovementioned researchers; goals, tasks, concepts, functions, directions, the main factors of media education genesis, etc. are defined. The influence of the mass media on the development of a child is reflected in the works of Vasyl O. Sukhomlynskyi [53], the classic of pedagogy, as well as in the numerous researches of Ukrainian scholars, in particular, Lidiia H. Chorna [9], Ruslana Z. Danyliak [10], Vasyl V. Lyzanchuk [30], Olena V. Nevmerzhytska [35], Tamara B. Poiasok [42], Diana A. Popova [44], Svitlana I. Shandruk [47], Petro M. Shcherban [48], Valerii H. Skotnyi [57], Nataliia D. Temekh [55], Anastasiia V. Zaitseva [60], and others. The works of these scholars focus on the insufficient use of media potential, print media in particular, for the upbringing of children; on the necessity to eliminate the low-end media products.

The issues of the preschoolers' media education are investigated by Ukrainian scientists, namely: Nadiia I. Ashytok [2], Nataliia V. Havrysh [6], Olena S. Kachura [18], Ruslana V. Kondratenko [20], Olena O. Kravchyshyna [19], Kateryna L. Krutii [22], Olena M. Oliinyk [37], Olha B. Polievikova [43], Yuliia B. Semeniako [46], Olena P. Sotska [52] and others. The scientists pointed to the positive functions of the modern media in preschool education: didactic, educational, diagnostic, entertaining, etc. At the same time, they focus on the threats of the modern media to a child and the relevance of media education precisely in preschool, particularly in this context, Olena S. Kachura notes: "The average child is already from two years under the influence of the information flow coming from the TV, at the age of three a child shows fairly stable preferences in the choice of cartoons, and to five years, begins to master computer skills. These resources carry so much information that it is difficult to master even for an adult, what to say then about a child. The key to the formation of a person capable of active and safe functioning in the modern media space is media education" [18].

However, the technology of the media literacy formation of older preschoolers is not described. Older preschoolers are meant in particular, because at this very age they actively begin to contact with the latest technology, not being fully aware of its threats. In preschool age (5–6 years) all mental operations are actively developing in children, the development of cognitive activity and constant cognitive interest as a foundation for future learning motivation takes place. Such preschoolers are ready to begin to form the ability of conscious, critical, responsible perception of information. Given the psychological factors: the development of only visual and figurative thinking, it is impractical to do that earlier.

The problem of the low level of parents and educators' media literacy, who have to help children to become literate, remains in preschool educational institution. It is obvious that it is impossible to form competence in a child, if you do not possess it yourself. Parents often do not know what media, media education, media literacy are and they associate them with the mass media – radio, television, the Internet. Educators also feel the need to improve their own media culture. They note that there aren't any methodological materials for the formation of children's media literacy. Such developments are intensively created abroad, in Poland in particular, where the "Media Education" (Edukacja Medialna) web-site operates, with scripts, exercises and additional information for conducting classes in preschools, schools, houses of culture and libraries [24].

The materials are elaborated in accordance with the Catalogue of Media and Information Competences defined within the framework of the "Digital Future" project. In addition, other interesting developments for conducting workshops, media education classes for preschoolers and their parents were created [5]. The systematic work on creating such resources has only begun in Ukraine.

The relevance of the problem of implementing media education in preschool institutions, its lack of development in scientific sources, the need to resolve these controversies led to the definition of the *purpose of the study*: to prove and experimentally test the technology of media literacy formation of older preschoolers in preschool institutions of Ukraine.

The object of the research is institutions of preschool education of Ukraine; the subject is the media education of older preschoolers.

2 Material and methods

Theoretical and empirical methods were used to realize the purpose of the study.

Among the theoretical ones, primarily are such as functional and structural, interpretive and analytical, comparative analysis of literary and informational sources, through which the investigated problem was studied, forms, methods, means of realization of media education and formation of children's media literacy in Ukrainian pedagogy were revealed. An interview method was used in order to determine modern problems and ways to solve them in a preschool educational institution in relation to the implementation of media education. During the research, the specialists of the Academy of Ukrainian Press (founded in 2001, one of its tasks is the promotion of media education in Ukraine) were interviewed: Oksana V. Volosheniuk – a manager of media education programs of AUP; Yuliia O. Huza – an editor of the "Media Education and Media Literacy" site.

One of the leading methods of the research is modelling – to develop a model of the formation technology of children's media literacy.

In the process of scientific research, empirical methods were used: testing, observation, interviews, experts' assessments, questionnaires, polls to measure the level of media literacy of the experiment participants, as well as pedagogical experiment to verify the efficiency of the technology of media literacy formation of the preschoolers in preschool educational institutions of Ukraine.

Scientific research was carried out in preschool educational institutions of Ukraine in Ternopil (Establishments of Preschool Education No. 3, 6, 19) and Khmelnytskyi (Establishments of Preschool Education No. 28, 29, 46).

3 The peculiarities of the implementation of media education in the preschool educational institution

A comprehensive study on the formation of media literacy of older preschoolers involves the definition of "preschool media education". Often, the very different interpretation of the concepts leads to differences among educators, teachers regarding the forms and methods of media education.

In our opinion, preschool media education is a part of the educational process characterized by a three-component structure (education about media, education through media and for media) that is implemented through the partnership of educators, parents and children, involves the formation of critical, conscious, responsible perception of information to all members in the partnership.

Surely, preschool media education has its own characteristics and is fundamentally different from media education of a student or an adult. This difference lies in the specificity of mental activity, thinking, insufficiency of life experience in preschooler. It is characteristic for a preschooler to thoughtlessly absorb information, which is transmitted from TV screens, computer monitors, radio receivers. Immersing into the informational and virtual world, a child is often not even thinking about the content of what child sees and hears, if they are not prepared for the critical, conscious, responsible perception of information. However, such abilities are difficult to form. There are factors that become an obstacle, but there are those that are favorable.

Thus, the problems will be highlighted at the beginning.

1. According to the periodization of the intellectual development of children by Jean Piaget [40], a child aged 5–6 years (2–7 years old period) is at the stage of preoperative representations, during which intuitive, visual-effective and visual-imagery thinking develops [12]. Psychologists say that "thinking specifically, preschoolers tend to literally understand a lot. Therefore, they often misunderstand the words used in abstract and figurative meanings" [7, p. 15].

Since older preschoolers are characterized by weak abilities to perform abstract mental operations, their thoughts often turn out to be very naïve and unrealistic. Therefore, media literacy formation is problematic.

2. Children have limited life experience, they are easily exposed to, and therefore do not realize when it is worth checking information and whether it is true. The main

criterion still remains: "familiar-strange" (one can believe a familiar person); authoritative and non-authoritative (parents and educators are authoritative, peers, and often somewhat younger or elder brothers and sisters are non-authoritative). To find errors in the media is an unreal task for an average child to perform.

3. Media education involves its implementation through the media (including TV and computer). At the same time, a child should spend little time at the TV, and as far as a computer is concerned, then obviously child should not use it preferably before joining the school. Although it is stated in the "Computer Literacy" educational strategy that a child should be aware of a computer, acquire the basic techniques of its work, adhere to the rules of safe conduct while working with a computer [6].

At the same time, the potential of preschool age for the formation of media literacy should not be underestimated. In this context, the works of Tetiana B. Brailko [7] are of great interest, who found out that cognitive activity and constant cognitive interest as the foundation of future educational motivation in preschool age (5-6 years) develop. All mental operations actively develop in children.

Numerous researches (Aleksandr V. Zaporozhetc [61], Aleksei N. Leontev [25], Anna A. Liublinskaia [29], and others) show that when children are taught with a kind of purpose (even for a short period of time), the mental process changes very quickly. If 5–6-year-old preschoolers are taught to observe and draw conclusions (for example, to differentiate which things float and which sink, under which conditions leaves appear earlier on the cut brunches of poplars, to compare the shape of a tool with the conditions of its use), significant changes in their mental development occur.

Children learn to search for and identify the most peculiar features of things and phenomena, to find significant dependencies, relationships between them, and thus logical forms of thinking develop rapidly in children [28, pp. 213–214].

The criticality of mind is characteristic for older preschoolers, that lies in the ability to objectively evaluate their own and others' opinions, to thoroughly prove and comprehensively check all the hypotheses put forward. Children who have developed this feature tend to check everything thoroughly before doing anything, and if one opinion does not pass the test, they reject it without hesitation and look for a new, more correct, one [7, p. 10].

Studying the work of psychologists on the development of mental activity of preschoolers indicates that the formation of critical thinking can only be started in preschool institution, and it is necessary to continue this work at school age. At the same time it is necessary to implement the pedagogy of partnership (without the help of parents and educators children will not become media literate).

On the basis of study of the works of domestic and foreign authors on the problems of diagnosing the formation of the older preschool children personal qualities, the implementation of media education, analysis of media education competencies of preschool children, identified in Poland in the framework of the "Digital Future" project (Cyfrowa przyszłość, 2010), empirical studies, we presented the ideal result ideal result *high level* of media literacy formation), that we expect to achieve in preschoolers, as a result of media education. An older preschooler with the formed media literacy is aware of the importance of learning about media and education through media and for media, responds positively to the announcements about media education classes, computer as a media means, is aware of the diversity of media, knows how to receive information, how to distinguish truth from untruth in media messages, how to verify information authenticity, existing media threats; knows what property is that responsibility ensues for assigning the work of another author; critically analyses the media products for children is familiar with a computer, acquires basic techniques of working with it; is able to create media means (pictures, photo galleries, comics), showing creativity, analyzing it adheres to the rules of safe media usage.

Children of a sufficient level of media literacy formation, although not aware of the diversity of media, do not know how to receive information, how to distinguish truth from misrepresentation in media reports, how to verify the authenticity of information, that liability is incurred for the appropriation of the work of another author, but they are aware of the importance of learning about the media and education through media and for media. Their only media product, created independently, is a picture. They are experiencing positive emotions when using media products, critically analyzing with their parents the media, adhere to the rules for the safe use of the media.

Without special educational influence the low level of media literacy prevails in children (misunderstanding of the importance of media education lessons, its benefits to the child, ignorance of the types of media, their functions, the choice of the source of information, ways of verifying the truth of the source, the ways of distinguishing the truth and lies in the media. Such children use mobile phones, tablets, gadgets without permission from parents, experiencing positive emotions when using media products, but do not want to analyze it, or analyze superficially. They do not show creativity while drawing (pictures are the only media work).

Formation of media literacy of older preschoolers is a complex process that involves a certain algorithm of actions for children, educators, parents, the implementation of special forms, methods, media education activities, diagnostic tools for checking whether the result corresponds to the aim. These actions and components are inherent to educational technologies. Thus, the actual task is to reflect the technology of media literacy formation of older preschoolers in the model.

4 The model of media literacy formation technology of older preschoolers in preschool educational institutions of Ukraine

The research on the development and experimental verification of the technology of media literacy formation of the older preschool age children took place during 2017–2018 at the preschool education institutions in Ternopil (No. 3, 16, 18) and Khmelnitsky (No. 28, 29, 46). Totally 384 respondents (200 boys, 184 girls) participated in the experiment, of which 180 children (95 boys and 85 girls) were involved in the formation phase of the experiment: 4 control and 4 experimental groups. The control groups consisted of 88 children (46 boys and 42 girls), experimental – 92 children (49 boys and 43 girls). The characteristics of the participants in the experiment are presented in Table 1.

Table 1. Characteristics of the experiment participants

Name of the experiment stage	Totally respondents		
	Boys	Girls	Total
Confirmatory stage	200	184	384
Formation phase of the experiment	95	85	180
control group	*46*	*42*	*88*
experimental group	*49*	*43*	*92*

Some provisions of the study of media literacy of preschool children were verified at Ternopil Volodymyr Hnatiuk National Pedagogical University at the Department of Pedagogy and Methods of Primary and Preschool Education and Khmelnytskyi Humanitarian Pedagogical Academy at the Department of Preschool Pedagogy, Psychology and Methods of Professional Disciplines.

A number of questions were asked to the children at the stage of the confirmatory experiment. The list of questions and answers to them is given in Table 2.

On the basis of the analysis of answers to the first question “Do you know the word “media”? What do you think it is?” we concluded that the essence of the word is incomprehensible to children. 37 preschoolers out of 384 answered that the media is a TV, other 12 added that this is also a computer. (But not a children’s magazine, book or theater).

Older preschoolers were asked: “If you want to learn about something how would you do it?” However, they could not answer this question without help. And only after the prompts “From the TV show ...”, “From the children's magazine”, the answers were “from the computer”, “from the mobile phone”.

All children are aware that TVs often display distorted information. Especially when it comes to advertising. However, they could not answer how to distinguish truth from untruth.

When asked how to check out whether what happens in life is described in fairy tales, children did not immediately answer that you need to ask your dad, mom, teacher. There was also such an answer: “One has to go with a mother or a father to the forest and check there, for example, whether a fox is talking to a hare”. What is said by a child is vivid confirmation of the fact that children have developed visual and effective thinking. Consequently, no child independently gave the correct answer to this question.

During the experiment, educators were asking: “Should children know that unusual events are reflected in fairy tales? Maybe, it is better for them to grow up with faith in the reality of the fair world”. We were answering that stereotypes formed in childhood often accompany people throughout their lives. For example, in adulthood, many adults are convinced that hedgehogs are wearing apples on their thorns. Such pictures were seen in books and magazines in childhood and remained in their memories as such that correspond to reality. Who defined the age when it comes to finding out the truth?”

During the experiment, we found that there is a direction in the field of media education, which educators give a lot of attention to in preschool education: child safety in the media and during contact with the media. Educators in preschool institutions talk about the threats of the modern digital means for the child’s organism. However, preschoolers often do not want to perceive and respond positively to such information, share it with their parents, who also prohibit the use of mobile phones, gadgets, tablets, etc. However, such devices increasingly attract children's attention.

Table 2. Survey results of preschoolers during the confirmatory experiment

Content of the question	**Number of positive responses and % of general quantity**	**Number of negative responses and % of general quantity**	**Note**
1. Do you know the word "media"? What do you think it is?	0 0 %	384 100 %	49 (13 %) answered inaccurately, incompletely
2. Do you know what are the ways to learn something, to get information?	0 0%	384 100 %	(children with the help of tips partially answered the question)
3. Have you ever heard that what is written in newspapers, magazines, books, or shown on TV screens (for example, advertising) is not always true, and the authors of books, articles can make errors?	322 84 %	62 16 %	Only from television screens, mostly advertising
4. Do you know how to check the truth of what is written in children's books, magazines, is shown on TV screens?	0 0 %	384 100 %	
5. How to check if what is described in fairy tales happens in life?	0 0 %	384 100 %	
6. Do you have a mobile phone? For what purpose do you use a mobile phone?	200 52 %	184 48 %	Phones are used for communication and entertainment
7. Do you know that you can use a computer, tablet, mobile phone to watch TV following certain safety rules?	384 100 %	0 0 %	
8. Do you play a mobile phone, do you use a computer, a tablet, watching TV violating security rules?	257 67 %	127 33 %	
9. Do you read children's books, magazines?	384 100 %	0 0 %	
10. Do you love talking with your parents about fairy tales, their acts, what they do well, and what is wrong?	384 100 %	0 0 %	

During the survey, all children answered that they like to read children's books, magazines, watch TV and could not give preference to any single media product. Similarly, everyone answered that they like to talk about fairy-tale heroes, their acts, what they do well and what is wrong, but we have found in individual conversations that there is a need for a deeper critical analysis of such works, for example, whether the reflected events, in children's opinion, are reliable.

Unfortunately, the only media product of preschoolers is the drawings, but they did not set the goal of using them to transmit information. In addition, the children did not create together with their parents or educator's newspapers, comics, as a means of conveying information.

During the experimental study, a group of experts was created: a methodologist of an educational institution, a teacher and one of the parents who distributed the children by levels.

According to the results of the confimatory experiment, it was found that 246 (64%) children (in control and experimental groups) are at a low level of the media literacy formation; 138 children (36%) – at a sufficient level. Preschoolers of a sufficient level of media literacy had several advantages over low-level children: they followed the rules studied while using the media, showed creativity when creating pictures as a means of transmitting information, and critically analyze the media. However, in order to obtain a high level of media literacy, they lacked knowledge about the variety of media, how to distinguish truth from lie, how to verify the authenticity of information, the inadmissibility of appropriating the work of another author, lacking the ability to create newspapers, comic books and other media products, analyze them, and also realize the necessity of organizing special classes for the formation of such knowledge and skills. The results obtained during the confirmatory experiment determined the relevance of the development and implementation of the technology of media literacy formation.

As under technology, first of all, we understand a system, which has a clear algorithm of actions, we have identified the stages of it: diagnostic-target (setting the goals), integrational (work on the implementation of goals), and analytical (analysis of the results of the experiment on the implementation of technology).

The technology model is depicted in figure. It demonstrated the process of forming media literacy of preschoolers in partnership with parents and educators from the goals to the result, using forms, methods, and means of media education activities (Fig. 1).

One of the main elements of the substantiated technology is the cycle of classes "Grains of Media Education", which is a part of the procedural component.

At the first stage, according to the diagnostics of the formation of media literacy among older preschoolers, the goals of media education were set.

At the second stage – integrational – the integration of actions of all the subjects of the educational process of preschool educational institution took place, the inseparability of the processes of motivation formation to media education, knowledge about media, their functions, a computer as the latest media tool, danger of the modern technical devices; skills of critical thinking and creation of the simplest media together with parents and educators.

At this stage, media education classes were conducted for children: "Where do we get information from?", "Truth and untruth: how to distinguish", "Does Little Red Riding Hood really exist?", "What do you know about the copyright of the authors of books?".

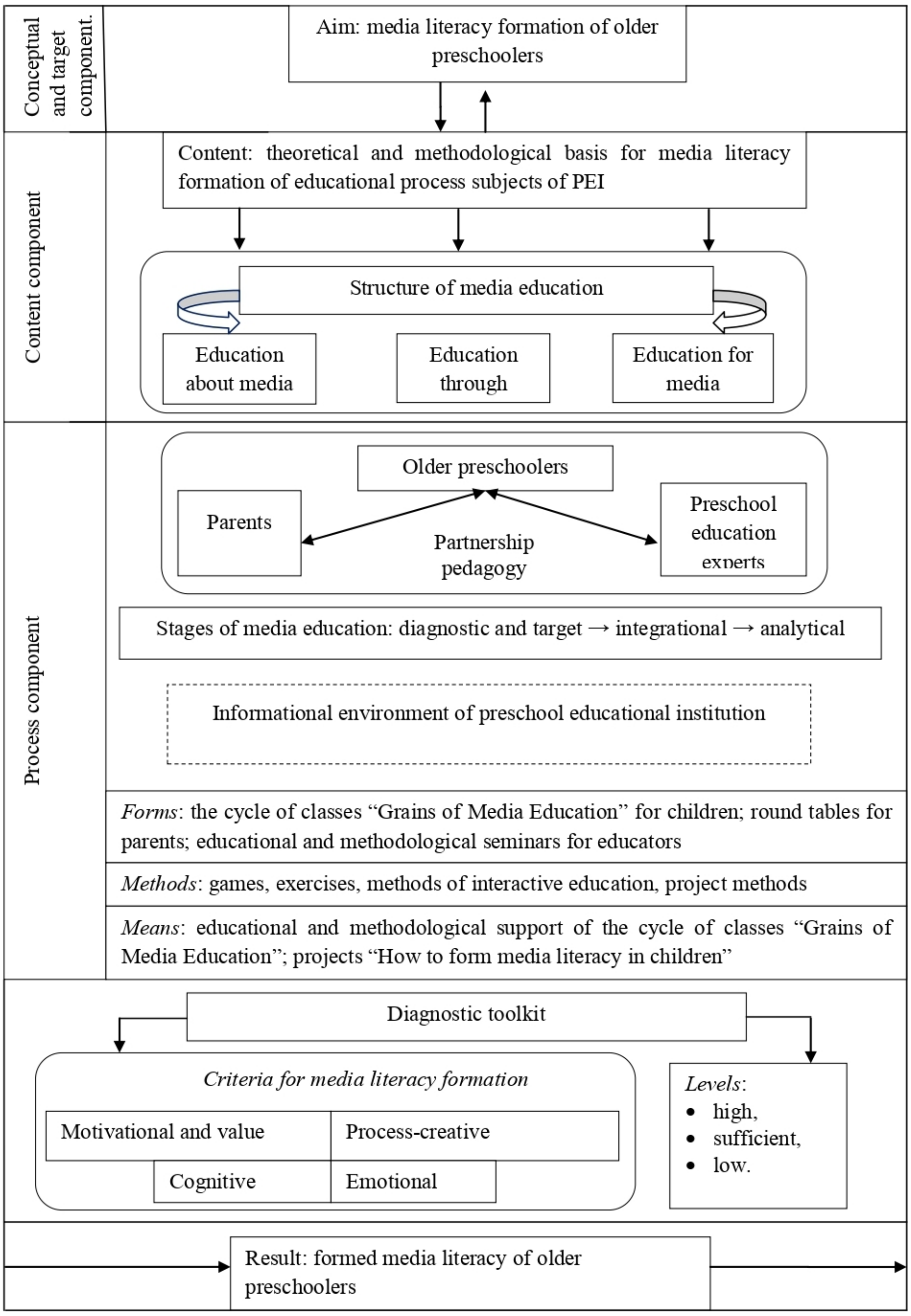

Fig. 1. The technology of media literacy formation in older preschoolers

The organization of the experiment to test the model of technology provided for the methodical training of educators. For this purpose, special methodological guidelines and recommendations for educators were developed and used, in which both theoretical principles and practical approaches to the organization of the process of media literacy formation of children of the older preschool age in preschool institutions were developed and used. Educators, involved in the experiment, were instructed in detail about the essence of the experimental work in control and experimental groups. Traditional methods and programs were used in control groups used; experimental groups implemented the developed technology model.

At the first stage, the diagnostics of the formation of children's media literacy in the control and experimental groups was carried out. In control groups and in experimental groups, no child was at the high level of media literacy. In control groups, 32 children (36%) out of 88 were at a sufficient level, 56 (64%) – at a low level of media literacy. In the experimental groups – 33 (36%) out of 92 children were at a sufficient level, 59 (64%) – at a low level of media literacy.

During the media education class “Where do we get information from?” preschoolers found out about the essence of media, its types; how beneficial they are to a child, realized that there are many sources of information; learned to choose the source of information according to their needs; tried to find another source of information than from an older person. Since preschoolers are thinking specifically, it is not necessary to demand from them to remember the meaning of the word media.

Therefore, the knowledge of the essence of the concept of media was not tested during the experiment. However, as a result of experimental work, preschoolers have learned that not only TV, but children’s magazines, booklets, theater is also media. Every day a preschooler is receiving a variety of new information. The educators told children that they could learn a lot, not only by asking parents or adults, but also flipping children's magazines, watching television programs. The class helped to find out what are the ways to find information.

The media education class “Truth and Untruth: How to Make a Difference?” was difficult for older preschoolers. Its goal was to get the children to know: not all that we learn is true; therefore, one has to learn to check information. After completing the training, preschoolers developed the ability to formulate simple questions to verify the accuracy of information; knew whom to contact to verify truthfulness of information; critically perceived information.

The media education class “Does Little Red Riding Hood really exist?” was an interesting one for the children. The educators told the children that not everything described in the fairy tale is true. After the class, the children knew that the actors from TV screens or magazines and books with whom they got acquainted could be fictional; heroes of fairy tales are also fictionalized.

Children can often distinguish between truth and untruth in fairy tales. But they do not always succeed. During the class, they become convinced that the author of fairy tales is inspired by the real world, for example, the world of animals. Preschoolers can create their own hero through their imagination.

When the experiment began, we thought that the main problem in implementing media education in preschool is the lack of interesting educational and methodological support. Therefore, by substantiating the technology of media literacy formation, we developed it and named as “Grains of Media Education”.

The name of the methodological support “Grains of Media Education” itself testifies that children develop elementary knowledge and skills that will become the basis for media education in elementary school. We implemented various media education trends, borrowing the experience of Polish pedagogy: using information, relations and communication in the media environment, media language, creative use of media, ethics and values, legal and economic aspects of media use [19].

It has already been pointed out that the problems of media education are challenging not only for children, but also for parents. When reading the methodological development “Grains of Media Education”, parents had possibility to find out what media education is. Parents together with children and educators acted on the principles of pedagogy partnership, using the information environment of a preschool educational institution.

During the experiment, promising ideas of the experience of the children’s media literacy formation in preschool institutions of Ukraine were realized, in particular, the creation of a photo-paper “My Family Tree”, a comic book “One day from my child’s life” [31].

Children not only acted as the authors of comic books, but also as their characters. For example, one of the preschoolers performed as a doctor, and the educator (his father) was taking photos of him during his work. Then a series of comics was created from the photos.

A child, due to the comics, learned to distinguish between two types of text information: language and thought.

One of the comics topics was: “A TV is My Friend”. At the same time, children found out that the TV is not only a medium that transmits information and affects children. It was illustrated as the following: a father calls his child to eat, or to read a book, to wash, but the child had the only answer: “No, let’s watch the cartoons”. In the end, the children saw the result of such behavior: a pale, frustrated face, poor eyesight, headaches, distorted spine. In the picture the child is yelling: “OK, let’s turn off the TV and go to the garden”.

During the experiment, we trained preschoolers to avoid extremes: not to consider everything seen on the TV as untruth, and not to believe everything entirely what they saw or heard in the media; to choose elder people (parents, educators, etc.) to verify the correctness of the information.

At the analytical stage, the media education activities of the subjects of the educational process of the preschool educational institution were analyzed. After the experiment was carried out, the positive changes in the dynamics of levels of media literacy formation were observed: in experimental groups, 15 children (16%) were at a high level of media literacy, 51 children (56%) were at a sufficient level; 26 children (28%) were at a low level of media literacy. In control groups, 36 children (41%) were at a sufficient level, 52 children (59%) had low levels of media literacy.

In the control groups, the distribution of children in the groups, which was recorded during the confirmatory experiment, has almost not changed.

The dynamics of the formation of media literacy levels is presented in Table 3.

Thus, the research has proved the effectiveness of implementing the technology of media literacy formation of older preschool children in preschool institutions.

Table 3. The dynamics of the formation of media literacy levels of the older preschool children

Levels	Control group		Experimental group	
	Before experiment	After experiment	Before experiment	After experiment
High				15 (16%)
Sufficient	32 (36%)	36 (41%)	33 (36%)	51 (56%)
Low	56 (64%)	52 (59%)	59 (64%)	26 (28%)

After the experiment we came to the conclusion that children are more likely to analyze media production with their parents and educators, they are more interested in magazines, booklets, and have desire to create their own newspapers.

Organizing the experiment, we believed that the most difficult task was to develop perfect methodological support, to write a booklet "Grains of Media Education", as well as to form skills of conscious and critical perception of information.

However, during the experiment, we realized that there were also problems of another kind. First of all, it is the formation of motivation of educators for media education activities with preschoolers. Educators are primarily trying to implement the State Standard for Preschool Education, and also do everything to meet the expectations of parents. Traditionally, parents want their children learn to read, write and count in preschool educational institution. Consequently, it is precisely for this purpose that their main efforts are directed. The obstacle for media education is the high level of groups filling (up to 35 children in a group) in the preschool educational institution. Tired of the difficult work, during which it is necessary to constantly meet the requirements of parents, methodologists, managers, educators often do not want to assume additional responsibilities for the implementation of media education. And after that we look forward to enthusiasts, especially those who were trained, attended the courses at the Academy of Ukrainian Press.

Studies conducted in higher education pedagogical institutions among undergraduate part-time students (more than 90% of them are educators) have shown that they do not know what media and media education are. Only 2% of the polled masters are familiar with the Concept of Media Education Implementation in Ukraine. Approximately 50% of the masters-educators who are part-time students are convinced that media education is education with the help of the state-of-the-art computer technology [56; 59].

All the students we have interviewed were women aged 23 to 46. Studies were conducted only in absentia, since more than 90% of the students of this form of study work as educators and must implement media education. But in reality, they have a very low awareness of media literacy.

Consequently, on the one hand, educators need to increase media literacy, on the other hand – they have insufficient motivation for this. The exception is such a direction of media education as the prevention of threats of the modern computer equipment for a child, which is not surprising, because this is one of the tasks of an educator, defined by the State Standard for Preschool Education.

Thus, the research has shown, on the one hand, the feasibility of implementing a technology for the formation of media literacy of older preschoolers in preschool institutions, on the other – the need for further education of future educators; creating better working environment for them. However, the fulfillment of the latter task depends on the economic development of Ukraine; of the funds that will be invested in the educational sector.

5 Conclusions

The manipulation of the consumers' media consciousness, the saturation of television programs by the scenes of aggression and violence, the uncontrolled use of modern technical devices by children already at preschool age, determine the relevance of media education, which results in the formation of media literacy (preschooler's awareness of the feasibility of media education classes and their positive attitude towards their realization, knowledge of media diversity, its functions, computer as the latest media tool, awareness of the threats of modern technology, the ability to choose sources of information, create photo papers, comics, drawings, fairy tales, critically, consciously and responsibly perceive information).

The research has proved the necessity of implementing the technology of media literacy formation of older preschoolers, the cycle of classes "Grains of Media Education", which is confirmed by the positive dynamics of the levels of media literacy formation: Before the experiment, 64% of children were at a low level of media literacy, 36% – at a sufficient level. No child was at a high level of the media literacy formation. Due to the implementation of the developed technology, 15% of children achieved a high level of media literacy development (56% were at middle and only 28% – at low levels). The number of children at low levels decreased by 36%. The analysis of the results of experimental work confirms the necessity of raising the level of media literacy of the educators themselves who need to improve the conditions of professional activity.

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The formation of a successful personality of a pupil in Ukrainian primary school during media education implementation

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Abstract. The article substantiates the relevance of implementing the technology of formation of a successful personality of a primary school age pupil during media education implementation at primary school. A technology model is developed. The necessity of solving problems of success simultaneously with increasing the level of media culture of a pupil, the formation of key competencies for life, preparation of a child for the life's self-realization on the basis of the partnership implementation of schoolchildren, parents and teachers is proved. The need of the embodiment of the pedagogy of heart and the pedagogy of success is shown. The diagnostic toolkit for determining the levels of formation of the successful personality of primary school pupils is specified. The effective forms and methods of the schoolchildren education are substantiated: the creation of electronic books, projects "Rules of Success Achievement", "Stories of Success", watching movies about successful people with special needs, analysis of media products on the topic of success. The ways of educating parents about the problems of children's success are determined. The results of experimental research are analyzed. The necessity of improving the content of textbooks in the context of achieving success, increasing interest to children's periodicals is revealed. The formation of a successful pupil is considered as one of the ways to strengthen the Ukrainian state. The necessity of raising the authority of the teaching profession is proved.

Keywords: successful personality, primary school age pupil, technology, media literacy, media education.

1 Introduction

1.1 The problem setting

In the last decade in the pedagogy of primary education, the problem of success and successfulness has become rather actual. There exist a few reasons for the interest in these issues. Usually, success is associated with financial independence or wealth. It is known that in Ukraine the standard of living of the population is steadily deteriorating. One of the ways to overcome poverty lies in developing children's successful personality features. Such education should begin at primary school. The success of a primary schoolchild serves as a start for achievements in high school and a basis for life-long self-realization in the future. In addition, the interest in the success development is due to the introduction of the Concept of a New Ukrainian School [7], the New State Standard of Primary Education [15], which focus school teachers of the first degree to develop students' initiative and entrepreneurship as key competencies, skills to think critically and creatively, solve problems, organize own activities, which are through skills. The implementation of media education is another important problem of the primary school, the relevance of which in the educational sphere is reflected in the Concept of Media Education Implementation in Ukraine [10]. The formation of a successful pupil by means of the Concept enables to solve tasks on the way to success through the development of media culture, information and digital competence. The analysis of scientific sources proves that media is a powerful instrument of influencing personality, but their role in educating a successful pupil is underestimated. The imperfection or lack of patterns for imitation in the Ukrainian media, in particular, literary texts, can be one of the weighty reasons for the acute need of the society in the intellectual elite, effective managers, who would lead Ukraine to the central positions among the states with a high index of human development.

1.2 Analysis of the publications as to the problem of the research

Scientific researches of the problems of forming a successful personality are carried out in several planes: the formation of a successful personality in primary school; the factors to achieve success; the role of the media in forming a successful personality. The significance of childhood success for life self-realization, ways of preventing a loser complex are highlighted by William Glasser, who wrote in particular: "It is here [in the primary school classroom] that the child most often forms the lifelong concept of himself as a successful or a failing person. That's why the impact of school failure is so devastating: it attacks and destroys the child's initial identity as a successful person" [5, p. 39].

Scientists Lisa Wagner and Willibald Ruch in [19] have shown the interconnection between character strengths (such as perseverance, self-regulation, prudence, love of learning, hope, gratitude, perspective, teamwork, and social intelligence), positive classroom behavior, school achievements, because "being the nice student" will make the grade in just any subject. "It seems rather that character strengths facilitate achievement-related behavior that then may lead to better school achievements" [19].

Based on the results of this research we can affirm that character strengths directly influence on the achieving success in school. But these qualities should be formed and developed.

Important to our research are the ideas of John MacBeath on the necessity of gaining experience by a pupil to overcome difficulties as a factor of achieving success in the future. In this context, John MacBeath states: "The experience to deal with failure is a hugely telling indicator of school success and success in later life, the seeds of which are planted early. That every failure is a learning opportunity has gained the status of a cliché, but can only become a classroom reality when failure no longer carries high stakes penalties" [13, p. 61].

A thorough analysis of the problem of the six-year-old children's success was conducted by Olena O. Maksymova [14]. The scientist substantiated the pedagogical conditions for the achievement of success by pupils in the first grade in their productive activities in the process of subject-subject interaction and identified the diagnostic tools for the development of success.

On the basis of literature analysis, our own research, we have interpreted the concept of "successful personality of the primary school age pupil". It is a pupil whose *activity results correspond to the specified goals; which he/she and his/her surrounding consider successful, based on modern social norms, customs, values and standards*.

Given the relevance of media education, the researchers investigate the role of the media in forming a successful personality. The reflection of stereotypes about human success in media is the subject of scientific research of Magdalena Kolber [9], Ewa Grzeszczyk [8], Amelia Carr [3] and others. Magdalena Kolber hereby argues that comparing himself with the ideal created in the media leads to negative consequences (the appearance of low self-esteem, such a person does not feel happy) [9, p. 79–80]. The positive role of the media in forming a successful pupil is reflected in the works of Timirkhan B. Alishev [1], Svitlana P. Hryniuk [6], Albert Kh. Gilmutdinov [1], Tetiana Ye. Krystopchuk [11] and others, who, studying the factors of success of schoolchildren in Finland and Singapore, found that the positive ideas of the experience of these countries is the dissemination in the media of the stories of success in the diligent and disciplined study and work environment, systematic reading of books, periodicals [1, p. 245], [6, p. 2].

1.3 Unresolved aspects of the problem

As the resource base analysis shows, the problem of forming a successful personality of a primary school pupil during media education implementation in the Ukrainian primary school was not the subject of a separate study.

1.4 The purpose

The purpose of the article is to substantiate the technology of forming a successful personality of a primary school age pupil during media education implementation.

1.5 Methods of scientific research

A number of research methods have been used for the achievement of the goal:

- theoretical – functional and structural, interpretive and analytical, contrastive and comparative analysis of literary and informational sources, textbooks for pupils of the first-degree school, through which the researched problem was studied, forms, methods and means of formation of successful pupils were revealed; modeling (for the development of a model of technology for the formation of a successful personality of a primary school age pupil during media education implementation);
- empirical – observation, questionnaire, survey, confirmatory and forming experiment (children of the second and third grades of comprehensive schools No 16 of Ternopil, No 30 of Khmelnytskyi, Mukachevo Educational Complex "Preschool educational institution – secondary school of the I degree – gymnasium" were involved in the experiment) to check the effectiveness of the technology of forming a successful personality of primary school age children.

2 The results of the research

2.1 Media education tools for the formation of a successful personality of primary school age pupils

In primary school, due to the relevance of media education, children now know what media is and which media are. Traditional media used by the pupils of the first-degree schools include visual (fiction, textbooks, newspapers, magazines, pictures, photographs), audio (radio), audiovisual (theater, television programs). Innovative ones include a computer, a tablet, a mobile phone, a gadget, the Internet, etc. But, unfortunately, as evidenced by the analysis of scientific sources, empirical studies, their ability to form a successful pupil is used only partially.

The textbooks for primary school ("Literary Reading", "Ukrainian Language", "Mathematics", "I am in the World", "I Explore the World") were analyzed in terms of the success problems reflected in them. Of all the educational books, only in the textbook by Nadiia M. Bibik "I am in the world" for the 3rd grade various aspects of successful activities are sufficiently thoroughly presented. In particular, the social and value orientation of certain goals (the story "What to be?"), the formation of the qualities of successful person ("Human virtues", "How to succeed") is reflected. After reading these stories, primary school pupils learn that a person is born to leave a trace behind himself/herself — in memory, in the hearts of other people; need to learn to live for people; to achieve success in life one needs to be hard-working, persistent, not postpone what can be done today, and even anger and rudeness prevent you from achieving a desirable [2, p. 26, 29, 33, 70]. Here is an example of the inventor Edison, who was an extremely hard-working man. There was a ninety (!) per cent of work in the sweat of his brow reflected in his inventions. The rest relate to talent, inspiration, intuition, and other coincidences [2, p. 29]. In this textbook, the economic aspects of success (economy, thrift) are reflected [2, p. 74]. However, in general, in educational books for the primary school, the problem of success is reflected rarely, fragmentarily without respect to the principle of continuity. We did not detect the texts where the children were taught the art of defining goals and analyzing their achievements, overcoming obstacles, how to communicate properly, to treat time with cautious, to create their own hero (a pattern of behavior), although such knowledge is essential for the formation of a key competence for life – the ability to study.

The fragments of the materials on success are partially presented in fiction, children's periodicals. It should be noted that there are more than 140 periodicals in Ukraine, among them the children's magazines "Angel's Lessons", "Barvinok", "Piznaiko", "Vodohray", "Zerniatko", "Kolosok", "Little Brainiac", "Sunflower", "Posnayko" (Eng.); cognitive and developing newspapers "Bunny", "The Alphabet of Fairy Tales", etc.) [4, p. 4]. However, according to research by Ruslana Z. Danyliak, 62% of the polled primary school teachers do not use children's periodicals either in their classes or in extra-curricular activities [4, p. 141]. The analysis of children's publications shows that they do not pay attention to success issues.

In periodicals and books, Ukrainian folk art is presented, in particular, the proverbs, sayings, acting on the development of a child completely opposite. On the one hand, they warn against ambitious plans: "Who flies high, falls low", and on the other, they call for persistent work that suits the vocation. In proverbs and sayings, the emphasis falls on the importance of motivation for an activity, "There is no work without eagerness", hard work in the achievement of success: "There is no fruit without labor". It is necessary to focus attention on the harmful influence on the formation of a child of certain proverbs like "My sweet peace, I feel good with you", "Neither move forward, nor leg behind, stay only in the very medium, like a periwinkle in the field". After all, such education aims at staying in the comfort zone, does not allow us to form a national elite, while in Ukraine there is an acute shortage of those people who can lead Ukraine out of the economic and social crisis. There are extremely few stories that would form the winner, the builder of the Ukrainian state.

In Ukraine (and this is proved by researches of Ruslana Z. Danyliak [4], Yuliia B. Semeniako [16], etc.) periodicals, fiction give way in the struggle for a little user to television, a computer, a tablet, a mobile phone. Unfortunately, there are not so many examples of success. In addition, there is no substantiated system of work for the formation of the success of a primary school pupil by media tools.

2.2 Model of the technology of forming a successful personality of a primary school pupil during media education implementation

To determine the level of formation of a successful personality of primary school pupils, to prove the work system in this direction, using media education, a study involving 160 pupils of schools in the cities of Ternopil, Khmelnytskyi, and Mukachevo was conducted. They were asked to answer the questionnaire.

A list of questions and answers to them (children could choose several answers to questions 2, 4, 5) is shown in Table 1.

Therefore, it was found that 85.6% of children consider themselves successful (almost the same number consider their parents to be successful, since for 73% of the respondents their parents themselves serve as examples of success), but only a third of the respondents properly understand the concept of "success" (achievement of the planned result), and another third is mistaken in the interpretation of "success", considering that a successful person is one who has many activities, regardless of the result they get. According to the respondents, the leading qualities necessary to succeed are self-confidence, diligence and persistence. Positive aspect may be found in the fact that mom and dad serve as an example in achieving success to their children. But, unfortunately, rarely (for 6.9% of children) it is a teacher. Children receive information about their success mainly from television programs, the Internet and from teachers. This result is not surprising since television and the Internet are the most popular media among pupils. However, in the context of achieving success, the need to improve the content of textbooks, increasing interest in children's periodicals, as well as system work of parents and teachers, aimed at creating media production by children, which would aim them at success.

The analysis of educational and methodological publications, scientific literature, children's media, empirical research has shown the need for modeling *the technology of formation of a successful personality of the primary school age pupil during media education implementation*. It ensures systemic work, the relevance of which is revealed at the stage of the survey of children. In modern science, technology is usually referred to as information and communication and media education technologies. However, it is also advisable to call technology as such a learning process, which has the characteristics of technological feasibility: systemic, diagnostic, algorithmic, reproducible, predictive (the results of an activity match a certain goal), as well as the following structural components: conceptual and target, content, procedural and result-analytical.

To substantiate the diagnostic tools of the investigated technology, which allows us to check whether a high and sufficient level of formation of a successful personality of a primary school pupil is ensured, the work of scientists on diagnostics of competences of primary school pupils have been analyzed, in particular media literacy, as well as the results of empirical research.

In the technology under study, the criteria for the formation of a successful personality of a primary school pupil during media education implementation are determined the value-oriented, cognitive and communicative, activity and creative, evaluative and analytical. Characteristics of the indicators of the levels (high, sufficient, low) of the formation of a successful personality of primary school pupils during media education implementation in accordance with the justified criteria are reflected in Table 2.

The pupil of a high level of formation of a successful personality can set goals, establishes the relationship between the success of the heroes and their values; is aware of the main concepts of success, the stages of successful activity, communicates well on the topic of media success, demonstrates the positive dynamics of educational achievements; models successful heroes, writes small and creative works on his/her own, creates projects and drawings, worries about his/her health, without abusing the length of contacts with the media, uses media innovations to improve the level of success; adequately determining the level of success, determines the prospects of self-development using the ideas of media education.

Table 1. List of questions and answers of the pupils to a questionnaire

Question content	a)	b)	c)	d)	e)	f)	g)	h)	i)
1. Who do you consider as successful person?	earning a lot of money **16**	achieving what was planned **50**	respected by other people **36**	has a lot of different activities **58**	other variants				
2. What features are inherent in successful person?	self-confidence **95**	persistence **92**	diligence **90**	sociability **23**	other features (write them)				
3. Do you consider yourself successful person?	Yes **137**	No **23**							
4. Who is an example for you to succeed in?	hero of fairy tail or a story (write who) **16**	person you heard about from the TV (write who) **11**	mom, dad **117**	a teacher **13**	there is no example to succeed **3**	other variants			
5. Where do you get information about success and successful people from?	school textbooks **17**	children's magazines and newspapers **6**	fiction **6**	TV programs **51**	radio programs **1**	the Internet **48**	teachers **45**	parents **32**	theatre performance **6**
6. Choose your sex	Male **82**	Female **78**							

A pupil of a sufficient level, unlike a representative of a high one, makes insignificant mistakes in goal-setting, establishing the relationship between the success of the heroes and their values; in the interpretation of concepts in the field of success and successful activity, talks about the success of heroes in the media depending on the situation; the level of educational achievements is either unchanged or a slight increase is observed, creates media production on the topic of success with the help of adults and peers, situationally showing creativity, does exercises periodically and adheres to the success tips found in the media, sometimes violates media usage rules; makes errors, defining the level of success, defines the prospects of self-development using the ideas of media education with the help of a teacher.

As for the low-level children, they are not able to set goals, do not track the connection between the hero's values from the media and his success, have elementary knowledge of success and successful activity or lack of this knowledge, the level of academic achievement is either unchanged or decreasing, has no model for imitation, sometimes creates a media product about success with the help of adults without creativity, often violates media usage rules, cannot and does not want to adequately determine its level of success and the prospects of self-development.

Table 2. Criteria and indicators of the formation of a successful personality of pupils of primary school age

Indicators of the formation of primary school age pupils' progress	**Criteria for the formation of a successful personality**
• Setting the goals (determined, determined without complying with the rules of goal setting, non-determined); • the level of differentiation of moral and ethical values, judgments about the achievement of success (based on the definition of good and evil characters in the media, good and bad deeds): deep evaluative judgments, different degrees of the depth of evaluative judgments, evaluative judgments about the behavior of the characters of the media are largely absent.	Valuable and target
• Level of awareness of the types and functions of the media; • level of awareness of success, stages of successful activity; • level of communication on topics of success in the media (high, sufficient, low ability to polysubject interaction) • the dynamics of educational achievement levels.	Cognitive and communicative
• Activity level of actions (high, medium, low); • the level of creative activity and independence during the creation of media products on the theme of success (the ease of inventing constructive ideas and their independent realization, situationality in the production of creative ideas and implementation with the help of adults and peers, the rarity in the production of constructive ideas under the influence of adults and peers); • the level of realization in the life of innovations from the media about success: overcoming obstacles, performing exercises to increase the success rate (constantly, occasionally, never); • the level of formation of the ability to adhere to the rules of safe behavior when working with a computer; restrict yourself to accessing modern technical devices: tablet, gadgets, mobile phone (high, sufficient, low).	Activity and creative
• Analysis of own level of success (adequate with argumentation, with errors in the argument, overestimated or undervalued without arguments); • setting the prospects for increasing the level of formation of success (expressed skills, partially expressed, absent).	Evaluative and analytical

The feasibility of some of the indicators can be doubtful for some reasons. For example, why it is so important for a successful person to follow the rules of safe conduct while working with a computer; restrict yourself to accessing modern technical devices: a tablet, gadgets, a mobile phone. However, the very safe, rational use of the media makes it possible to preserve the physical, mental, spiritual health that is necessary to succeed.

To determine during the experimental study the levels of the formation of children's media literacy, a set of diagnostic methods was proposed: observation, questionnaires, surveys, analysis of the products of the child's activity (modeled ideal, project about success). Ultimately, the level of formation of media literacy was determined on the basis of the expert judgment method (the experts were a teacher, a representative from parents, the pupil, who carried out self-assessment). In this case, the child was able to gain ***maximum*** 2 points on the level of expression of the motivational and value criteria indicators; 4 points – cognitive and communicative with activity and creative; 2 points – evaluative and analytical (total 12 points). Representatives of the high-level gain from 9 to 12 points; medium – from 5 to 8 points; low – from 1 to 4 points. This corresponds to the traditional three-point scale (3 points – high, 2 – medium, 1 – low) of the formation of competencies.

After conducting the confirmatory experiment, it was found out that 17 (10.6%) children are at high level, 78 children (48.8% – on medium), 65 children (40.6%) – on a low level of formation of a successful personality. It was found that the level of success could be higher due to the development of media competencies and the positive dynamics of educational achievements.

The analysis of the results of the confirmatory experiment, scientific and educational and methodical sources made it possible to develop a model of the technology of formation of a successful personality of a primary school age pupil during media education implementation (Fig. 1).

Its purpose (formation of a successful personality of a primary school age pupil) corresponds to legislative acts, educational concepts, the State standard of primary education. Based on the main principles of these documents, methodological approaches (*systemic, personal, informational*) and principles are determined (*respect for national traditions, the priority of moral and ethical values, aesthetic inspiration*). The model of technology reflects the need for the implementation of the pedagogy of the heart and the pedagogy of success, the main ideas of which are grounded by the Polish scientist Maria Łopatkowa [12], the Ukrainian teacher Vasyl O. Sukhomlynskyi [18], etc. In our study, the implementation of the pedagogy of heart means that every child should feel the love and care of teachers, parents and classmates: a minimum of competition and maximum of trust, and confidence in the success of each child.

The content component of the technology embodied the theoretical and methodological foundations of success, media education tools. The elements of the procedural component are the algorithm of the actions of the participants of the pedagogical interaction (pupil, teachers, parents) acting on the principles of partnership pedagogy; forms of education for children (the creation of electronic books "Rules of Success Achievement", "Stories of Success" that ensure continuity in the formation of success), methods (conversations about media success, exercises, projects "How to determine life goals", "How to overcome obstacles", "How to increase self-esteem") and forms and methods of working with parents (conversations, pieces of training).

Diagnostic tools (criteria, level indicators) make it possible to verify the effectiveness of the technology under study.

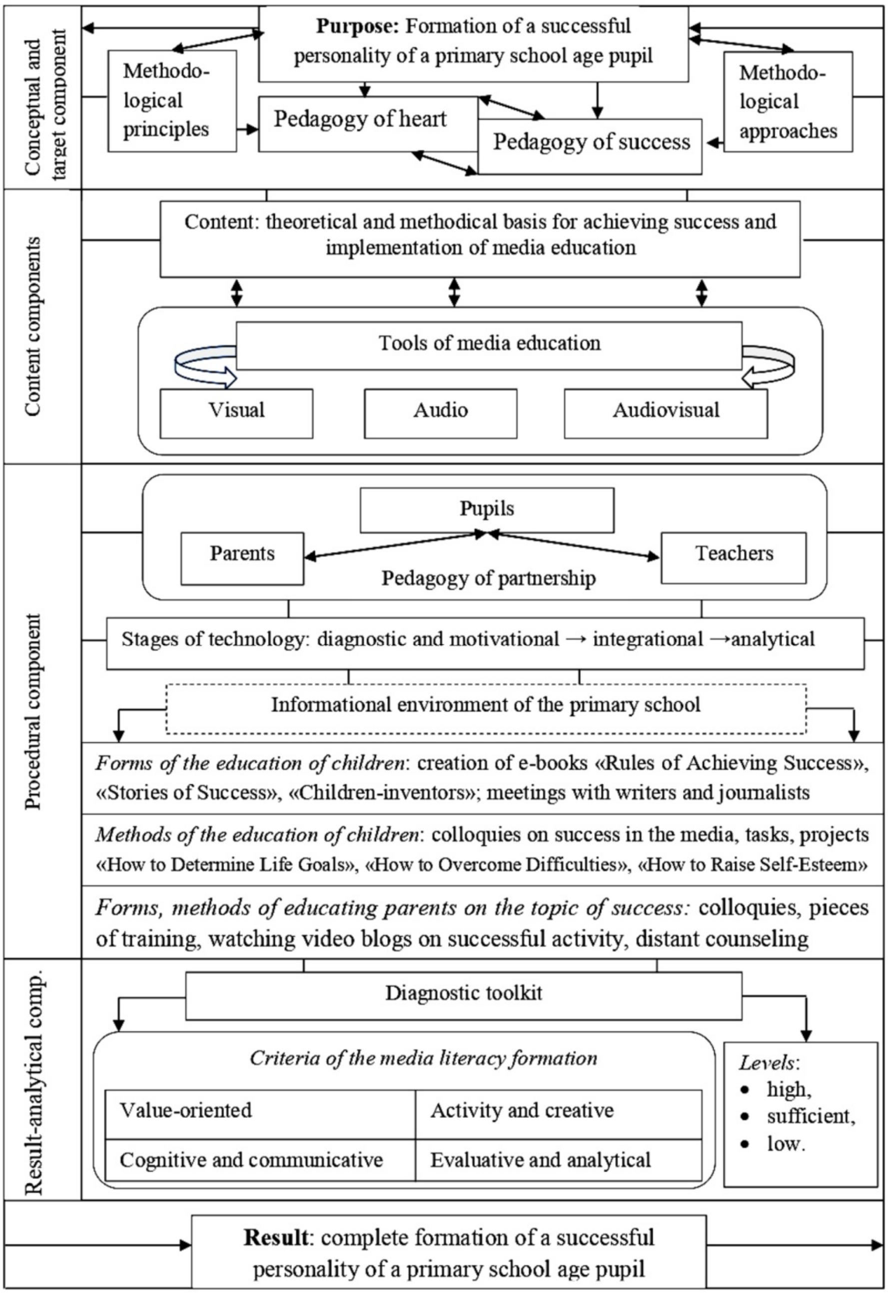

Fig. 1. Technology of formation of successful personality of a primary school age pupil during media education implementation

2.3 Organization and analysis of the results of experimental research

In order to test the effectiveness of the designed technology, a forming experiment was carried out during 2018. Since it is impossible to investigate all the types of activities involving children (someone is successful in one activity, and someone else in another), we have stopped on the leading types: studying, media education activities of the primary school children and their self-improvement activities. Control (81 persons) and experimental (83 persons) groups of the third-grade pupils (three classes in each group) were formed, and the level of formation of their success was diagnosed (the results of the diagnosis are presented in Table 3). Traditional forms and methods of forming success were used in control groups, in experimental, however, the developed technology was introduced.

Table 3. Dynamics of the formation of successful personality levels of primary school age pupils

Levels	Control group		Experimental group
	Before experiment	After experiment	Before experiment
High	9 (11 %)	11 (13,6%)	8 (9,6 %)
Sufficient	38 (47%)	40 (49,4%)	39 (47%)
Low	34 (42%)	30 (37%)	36 (43,4%)

The implementation of the technology was preceded by a preliminary work with the teachers of the experimental classes that received a specially designed educational methodological textbook for raising their level of competence in the field of educational technologies, in particular, media education, information and communication, and the organization of successful activities [20]. For teachers, colloquies and counseling were conducted. Students of Ternopil Volodymyr Hnatiuk National Pedagogical University and Khmelnitskyi Humanitarian and Pedagogical Academy were involved in the measurement of the results of the study.

As the technology provides for the formation of a successful personality of primary school pupils, along with the implementation of media education, the formation of key competences for life, in the experimental classes, pupils' knowledge of the media, their types and functions, information search, copyright, safe use of digital media, media communication ethics etc. has deepened.

Differences in the formation of a successful personality between control and experimental groups of children were revealed during the lessons of "Literature Reading", "Ukrainian Language", "I Explore the World". In the process of studying each subject in the experimental classes, attention was focused on the problems of success (for which the corresponding texts were selected). Particular attention was paid to the ability to overcome obstacles and the ways to overcome difficulties were discussed. During the experiment, acute topics were considered, in particular about envy and sincere joy for the success of friends, whether it worth to create an ideal and follow it, etc.

The most effective forms of working with primary school pupils were the creation of electronic books on successful children, watching films about the success of people with special needs, including the Christian preacher, author of the book "Life Without

Ends" an American Nick Vujicic, Italian singer who lost his eyesight, Andrea Bocelli, a Ukrainian artist Dasha Bezkosta, who having infantile cerebral palsy, draws pictures using her toes, etc. Effective methods include an analysis of the behavior of heroes of stories, fairy tales; the justification of which features of the character can help to achieve success, creation and discussion of various projects, primarily "How to determine life goals".

In both control and experimental groups, the formation of key competencies among pupils took place in accordance with the Concept of the New Ukrainian School [7], the State Standard of Primary Education [15]. Their formation is undoubtedly an important factor in achieving success. So, during the experiment, we predicted an increase in the formation of a successful personality in both control and experimental groups, which eventually happened.

According to the results of the forming experiment, 18.1% of the respondents of the experimental groups were at a high level; 54.2% – at a sufficient level; 27.7% – at a low level. In control groups, there was an increase in the number of children of the high level of formation of a successful personality by 2.6%, of sufficient – by 2.4%.

The increase in the formation of a successful personality of pupil in experimental groups was due to skillful goal-setting, awareness of the value of media education for life success, the formation of knowledge about success, successful activity, the creation of media production on successful activities – e-books "Rules of Success", "Stories of Success", "Children-inventors"; the analysis of works in which a life ideal is represented; projects, as well as due to children's compliance with the media usage rules. Positive impact on the results of the experiment also had the introduction of the pedagogy of heart, raising the level of media culture of parents, their awareness of the problems of upbringing a successful child.

Indicators of pupils who were less subject to changes are the dynamics of the levels of academic achievement of pupils; the level of their communicativeness and creativity, the definition of the prospects for self-development.

Another important outcome of our study is the need to increase the authority of a teacher in society in general and in the media in particular. Describing the status of a teacher in Ukrainian society, a well-known scholar, a daughter of a Ukrainian teacher Vasyl O. Sukhomlynskyi, Olha V. Sukhomlynska, stated: "The difficult political situation, the lack of morality of the so-called "political elites", adequate state youth policy, the use of youth in political games, apparent social injustice lead to the growth of nihilism, brutality, crime, anti-patriotic, anti-civilian speeches, to the fact that schoolchildren regard all teachers as losers, and sometimes openly bullying them" [17, p. 12].

Naturally, the attitude towards teacher is more positive in primary school pupils than in high school ones, but the fact that only 8.1% of children consider him/her a role model to succeed (the hero of a story or a fairy tale is an example for 10% of pupils) prompts thinking and making important conclusions about the elevation of the authority of a teacher. Perhaps the reason for the weakness of the state lies in the status of a teacher in the society that he/she cannot become an ideal in achieving success for his pupils.

3 Conclusions and prospects for further research

Formation of a successful personality of a primary school pupil during media education implementation helps to solve several actual tasks: to increase the level of media culture of a pupil, to form key competencies for life, to prepare a child for the life's self-realization, which in the end should contribute to the strengthening of the Ukrainian state in future. The research has proved the effectiveness of the implementation of the technology of formation of a successful personality of a primary school age pupil during media education implementation. In experimental groups, the percentage of children with a high level of successful personality development (from 9.6% to 18.1%) has increased, and the percentage of a low level has decreased (from 43.4% to 27.7%).

Praxeological principles of the formation of the content of primary education are the prospects of further research.

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The areas of educational studies of the cloud-based learning systems

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Abstract. The article analyzes the current stage of educational studies of the cloud-based learning systems. The relationship between the notions of the cloud-based learning system and the cloud-based learning environment are investigated. It was found that the researchers paid most attention to the design of a cloud-based learning environment. However, in the process of a cloud-based environment design, the researchers consider a cloud-based system as a component within the cloud-based learning environment of as a stage in the process of design. It is shown that in the research literature there is no single interpretation of the concept of a cloud-based system for educational purposes. Still the number of basic approaches to the interpretation of the concept under investigation are revealed. The first approach is based on the understanding of the system, as a set of cloud services or cloud-based technologies. The second approach is to consider a separate cloud service as a cloud-based learning system. In this case, the cloud service tools should include such components that cover the content, the tools, the forms and the methods of learning. The structure of the cloud-based learning system within the interpretation of the latest works of Ukrainian researchers is considered.

Keywords: cloud-based training system, cloud services, cloud-based learning environment, structure of cloud-based training support system.

1 Introduction

1.1 The problem statement

The use of the cloud technologies and services in the educational process is a rather promising direction of modern educational research. At the same time, the cloud services have taken their place both in the educational process of secondary and also higher educational institutions (HEI). This is evidenced by numerous dissertations defended during the latest years devoted to the given topic: Georgii A. Aleksanian "Formation of independent activities of students of secondary vocational education in teaching mathematics using cloud technologies" (2014) [1], Liudmila S. Galkina "The methodology for the development of ICT competence of future economists and managers using cloud technologies in teaching the disciplines of the information cycle"

(2017) [5], Serhii P. Kasian “Workflow Management institutions of postgraduate education based on cloud technology” (2016) [8], Maksym V. Khomutenko “A methodology of teaching senior students atomic and nuclear physics in a cloud oriented learning environment” (2018) [9], Olha V. Korotun “Use a cloud oriented environment to training future teachers of Information Science to master database” (2018) [14], Svitlana H. Lytvynova “Theoretical and methodological bases of designing cloud-oriented learning environment educational institution” (2016) [16], Oksana M. Markova “Cloud technologies as a learning tool of the foundations of mathematical informatics for students of technical universities” [18], Oleksandr V. Merzlykin “Cloud technologies as tools of high school students’ research competencies forming in profile physics learning” (2017) [19], Serhii V. Palii “Cloud mechanisms of formation of information-organizational environment of pre-university training of students” (2014) [20], Maiia V. Popel “The cloud service SageMathCloud as a tool of mathematics teacher professional competencies formation” (2017) [23], Susana N. Seytveliyeva “Methods of teaching cloud future software engineers” (2017) [29], Viktoriia G. Shevchenko “Cloud technologies as a tools of forming ICT competence of future informatics teachers” (2016) [30], Mariya P. Shyshkina “Theoretical and methodological principles of formation and development of the cloud-based educational and research environment of higher educational institution” (2016) [31], Nataliia V. Skrynnik “Techniques of teaching Ukrainian literature in the 5th-6th classes using cloud technologies” (2017) [33], Mariia V. Stupina “Formation of students’ competence in the field of using tools for developing information systems using cloud technologies (by example the training of future bachelors-developers of information systems)” (2018) [34], Tetiana J. Vdovychyn “The use of network technologies of open systems in the training of future bachelors of computer science” (2017) [39], Tetiana V. Voloshyna “The use of a hybrid cloud-based learning environment for forming the self-education competence of future IT specialists” (2018) [40] etc.

In addition, a number of planed research works were devoted to this topic: “Methodology of the cloud-based learning and research environment formation in the pedagogical educational institution” (SR No. 0115U002231, 2015-2017), “Adaptive cloud-based system of secondary schools teachers training and professional development” (SR No. 0118U003161, 2018-2020), “The development of information and communication competence of teachers in a cloud-based learning environment” (SR No. 0117U000198, 2017-2019) etc. The interest of researchers for the cloud-based environments, cloud-based systems does not decrease despite the fundamental works made in this direction. Although such concepts for pedagogical science as “cloud technologies”, “cloud services”, “cloud-based systems”, “cloud-based environments” are not new, but in research literature there is a certain mix of these concepts. In addition, the relationship between such concepts as “cloud-based systems” and “cloud-based environments” is not completely determined.

1.2 Literature review

Cloud computing provides rather new educational tools. They bring new digital resources, digital content, such as cloud-based teaching materials, multimedia learning content, virtual labs and administrative tools for educational institutions. They bring changes, progress and opportunities for HEI. By using cloud computing, the workload of IT staff is shrinking so that they can focus on strategies for more efficient use of IT infrastructure. Using cloud computing, students and teachers gain access to resources and collaborate with HEI, they can communicate and exchange resources and ideas with other students and teachers from various HEIs at any time and anywhere. Different educational institutions do not have the same software and hardware resources due to certain limitations such as financial and material and technical. The learners and staff can access these resources in the cloud by paying a nominal fee for cloud services. A HEI can access cloud resources according to the users needs, such as software, servers, computing machines, network devices, virtual labs, journals, textbooks, multimedia content, and other tools that are useful for their research and training. Thus, cloud computing is useful for HEI for conducting their research work and improving student learning as well as teaching and assessment practices of teachers [32].

Tetiana A. Vakaliuk in [38] gives the following interpretation of the "cloud-based learning support system" concept: "Under the cloud-based learning support system, we will understand a system in which the implementation of the didactic goals involves the use of cloud services and technologies, and ensures group collaboration of teachers and students, development, management, and distribution of educational materials with the provision of cloud-based technologies to the participants of the learning process" [38, p. 7]. The author defined in detail each component of the proposed model and their connections.

Maryna V. Rassovytska and Andrii M. Striuk do not give a clear definition of the concept of "system of cloud-based tools of learning". However, the meaning of the term is given, rather descriptive. In the study [24], it is noted that those types of cloud-based learning tools defined by the authors constitute this system.

Although Svitlana H. Lytvynova does not specifically refers to the concept of a cloud-baseed system, the concept of a cloud-based learning environment is revealed through a system of cloud services: the cloud-based learning environment is an artificially constructed system that provides cloud-based learning with educational services mobility, group collaboration of teachers and students for effective, safe achievement of didactic goals [16].

Oleksandr M. Kryvonos and Olha V. Korotun clarify the notion of the cloud-based system of distance learning: "a cloud-based distance learning system is a cloud-based service for the organization of an educational process that allows the creation, management and dissemination of educational materials in electronic form, monitor and evaluate learning outcomes, and formulate accounting records" [15, p. 134–135].

In this case, Olha V. Korotun, emphasizes that such cloud-based system of distance learning should be as much easy to use and administrate as possible [13]. Problems that may occur during its use, as a rule, do not concern the user, they are taken by the company's developer. At the same time, the cloud-based system as well as any cloud services does not require additional installation on the device of third-party software, configuration and, moreover, powerful hardware. According to a Korotun's study it can be argued that such cloud-based systems, which represent software as a service, acquire the most popularity in Ukrainian HEIs in the educational process [12].

In further research, Korotun gives somewhat modified author's definition: "the cloud-based distance learning system is a distance learning system deployed within the cloud for organizing an educational process that allows the creation, management and dissemination of educational materials in electronic form, organisation of communication and collaborative work between learners, monitor and evaluate learning outcomes, and formulate accounting training documentation" [14].

Giving the analysis of recent studies of Tetiana A. Vakaliuk, Svitlana H. Lytvynova, Mariya P. Shyshkina and others, the design of the cloud-based learning environments their structure and composition are quite thoroughly considered. However, the cloud-based educational system represent a separate component of this environment structure (Tetiana A. Vakaliuk), or certain cloud-based services (Oleksandr M. Kryvonos and Olha V. Korotun) serve as the basis for further construction of the cloud oriented environment (Maryna V. Rassovytska and Andrii M. Striuk). Therefore, in order to outline different approaches to the definition of the concept of "cloud-based system for educational purposes" and its structure, it should be considered how Ukrainian and foreign scientists understand the notion of "cloud-based learning environments" and how these concepts relate.

1.3 The aim of the research

To outline the content of the concept "cloud-based system for educational purposes" and to define the main directions of pedagogical studies of cloud-based systems for educational purposes.

2 Research results

2.1 The different approaches to the notion of the cloud-based system for educational purposes

According to the Paul Pocatilu, Felician Alecu, Marius Vetrici [21] at the advanced level the development of the cloud-based learning systems is consistent with the same scheme as any other software development project. For designing of the cloud-based e-learning system, you can use the same methods of development as for any software products. This is a source management software, build scenarios to create a deployment package, and automated regression testing.

AlAlaa N. Tashkandi and Ibrahim M. Al-Jabri argue that the gradual introduction of cloud services is also recommended, starting from the traditional cloud computing systems. E-mail, e-learning systems, learning management systems are the starting point for the implementation of the cloud. Cloud services providers targeting the higher education segment should invest in priority systems. Systems related to training, backup and file storage, as well as university or institute websites are systems that must first be realised by means of cloud computing [36].

According to Ibrahim Arpaci the cloud computing services such as Google Drive, Dropbox, SkyDrive and iCloud can be easily integrated into educational systems. These services can provide students with the ability to save files, share files, view and access files synchronized between different devices. Cloud services can also provide easier and quicker access to data, allow students to store and share documents, offer a more flexible environment, providing widespread access to materials and facilitating student-teacher interaction. Therefore, these services can support the practice of managing educational materials, including the creation or search of data, storage, transmission and use of data [2].

Daniel Pop [22] examining machine learning explodes cloud technologies and gives examples of their combination. The cloud computing paradigm and cloud providers have proven to be valuable alternative to accelerate the work of the machine learning platforms. Thus, some popular statistical tools such as R, Octave, Python are also integrated into a cloud. There are two main areas for integrating them with cloud providers: creating a cluster in the cloud and downloading it using static tools, or increasing the statistical environments with plug-ins that allow users to create Hadoop clusters in the cloud and run tasks on them. Environments such as R, Octave, Mapple, and similar to the low-level infrastructure for data analysis, can be applied to large datasets when used by cloud-based suppliers. Machine learning makes it easy to get training materials from huge data sets for customers who do not have a statistical background, automatically deducing from models of "knowledge models" [10; 27; 28]. Similar projects can either be PaaS / SaaS platforms, or products that can be deployed in private environments [17; 22].

Gustavo Gutiérrez-Carreón, Thanasis Daradoumis and Josep Jorba propose the semantic mechanism for integrating the API of the Cloud-service with the educational system. Researchers focus on issues related to the ease of use and the cognitive loads theory – CLT, which should be considered holistically. This subsection is followed in order to determine whether the proposed solution for integrating cloud education services can benefit both systems and learning. On the one hand, the basic assertion of CLT is that any curriculum design should take into account the limits of working memory in order to prevent the overload of the working memory and, consequently, the deterioration of the training process. On the other hand, the degree to which a user can complete a task with an effective tool is determined; Moreover, the level of ease of use of a tool or program can be determined only in the context of specific users and specific tasks that need to be performed. Gutiérrez-Carreón, Daradoumis and Jorba presents the study of learning management system using the semantic description of services and outlines the results of its implementation [6].

Manuel Sanchez, Jose Aguilar, Jorge Cordero and Priscila Valdiviezo-Diaz exploring cloud-based learning, note that this is an educational model that uses all the digital resources available on the Internet to improve the learning process. In this type of training, a set of tools and services in the cloud that promote the student's learning process, without the need for students and teachers to be physically present in one audience is provided. The combination of cloud learning with Ambient Intelligence can provide great benefits to the learning process, since it will not only rely on cloud learning services but the environment will be able to determine when it is appropriate to use these services, as well as with which devices or objects, available in the environment to be integrated. Thus, they propose a new concept called Ambient Intelligence for cloud learning (AmICL), which is defined as: "An AmICLis an Intelligent Learning Environment that combines educational services available in the cloud with objects (which can be intelligent or not) in the educational ambiance, in order to adapt the learning process to the student's learning style" [26, p. 40].

2.2 The relationship of the notions of the cloud-based learning system and cloud-based learning environment

In the process of analysis of domestic works of scientists and then at the stage of designing a cloud-based learning environment, Tetiana A. Vakaliuk revealed that one of its components is the cloud-based system of education support (CBSES). Therefore, Tetiana A. Vakaliuk considers it necessary first to create a model of a cloud-based system for supporting the education of bachelors of computer science, since this system is necessary for the design of a cloud-based learning environment. Moreover, in other Vakaliuk's works [38] considers the cloud-based system of education support as one of the main components of the cloud-based learning environment.

The types of cloud-based teaching aids, which reveal in their work Maryna V. Rassovytska and Andrii M. Striuk [24] within the process of its systematic use, can be considered as components of the cloud-based environment. Also, researchers are guiding the use of cloud-based learning tools and illustrating the practical implementation of individual components as components of the system of cloud-based learning tools.

Although Oleksandr M. Kryvonos and Olha V. Korotun otherwise understand the meaning of the concept of "cloud-based system for educational purpose", in the Korotun's study [13] it is indicated that using Canvas an open learning environment may be created, as well as open and also closed electronic courses. In this case, the researcher considers Canvas as a cloud-based system of distance learning, including a learning management system.

The ultimate goal of the research team of Jeremy Fischer, Steven Tuecke, Ian Foster and Craig A. Stewart was to create virtual machines as a desktop environment that any researcher can use to facilitate the research work. Jetstream also included cloud services OpenStack and Jetstream to support multiple formats of virtual machines that can convert them to other supported formats, giving the ability to transfer images to any number of platforms that can read certain formats [4].

Toru Kobayashi, Kenichi Arai, Hiroyuki Sato, Shigeaki Tanimoto and Atsushi Kanai focused their studies on a cloud-based education, and cloud-based tools that can be used to help students understand complex technical terms using social media. Thus, a group of scientists linked their research with e-learning services, using cloud computing and e-learning support systems. Many cloud-based services are offered. Most of these systems involve the exchange of educational materials. The use of e-learning systems enables the delivery and exchange of materials managed by means of a cloud in a common, consistent format. This system also provides students with individual learning content by analyzing their preferences, learning styles and patterns of content usage. In addition, there is a security system for managing data access and cloud encryption. NEC also provides “Smart Education” cloud systems for solving problems arising in the implementation of e-learning; training support, teacher support, school support and PC/tablet management. These systems are related to the system of general educational support for the exchange of educational material or the management of the learning process and the learning environment. On the other hand, the approach merely focuses on the adaptation of the original e-learning material to the e-learning environment. The study was focused on a program aimed at improving the e-learning system. As the e-learning standart SCORM was used, which advocated a reference model of the object Sharable Content Object [11].

Wei Huang, Li Jin and Imtiaz Sandia propose the use of intelligent agents for visualization to manage resources, hardware, platforms, education programs and cloud-based services to coordinate learning activities. The modern concept of the agent itself is associated with distributed artificial intelligence; it can be defined as an autonomous computer system that is capable of flexible interaction with other agents to perform autonomous actions. Agents are based on the concept of distributed artificial intelligence (DAI) in conjunction with distributed computing. They are able to use flexible and manageable strategies to solve many challenging tasks, fully utilizing the benefits of diverse perspectives, distributed problem solving methods, and the benefits of complex interaction schemes. These software tools demonstrate that utilizing intelligent agents can solve methodological problems in an open cloud-based environment. An agent paradigm is well suited to provide flexibility and reduce the complexity of the organization and management of the training system [7].

2.3 The structure of the cloud-based learning system

Tetiana A. Vakaliuk in the model of the cloud-based system of supporting the education of bachelors of informatics outlines the following subjects of interaction: administrator, teacher and student. In this case, the researcher combines the traditional system of education and the cloud-based one, therefore, the existing purpose, the content of training, means, methods and forms are presented. However, it should be noted that due to the use of cloud services and cloud technologies, the means, methods and forms of training are expanding, becoming cloud-based. That is, traditional means, methods and forms of training are used along with the cloud-based (those based on the cloud services and cloud technologies). A certain adaptation of the traditional education system to the use of cloud learning technologies is demonstrated due to the introduction of cloud-based learning systems. Among the forms of educational activity of students within the cloud-based learning environment are indicated: practical training, training sessions, control activities, independent work and research work [6]. Particular attention is paid to the scholar's form of organization of educational activities, as a lecture, since this form serves as the basis for conducting training sessions in a cloud-based learning support system. In this case, a detailed analysis of the types of lectures was performed and those that are considered as cloud-based are outlined.

Since cloud-based learning system is intended for the organization of independent work of students, therefore it contains the tools for collecting, checking and evaluating of laboratory, practical or individual works performed by students. A separate component is the tool for protecting laboratory works supported by cloud technologies in online mode [6]. The tasks for independent work are formed by the teacher in advance, not automatically, and the period for which students must complete the task is indicated. In this process, each student can contact the teacher for advice, which can take the form of correspondence (student-teacher) or collective discussion between the teacher and all students of the group.

One of the types of independent work is the group online projects that are intended for a certain period of implementation. The completed project is sent by the students to the teacher for verification. Tasks, their implementation, division into groups, verification and evaluation by the project teacher is carried out only with the use of tools of the cloud-based system.

The organization of the control of learning activities can be implemented using test tasks. In particular, an intermediate control on the learner activity may be online testing. In this case, the student is not limited spatially (because online testing may be passed out off the class) and the score is displayed automatically [37]. As for modular tests, tests and exams, using the cloud-based system toolkit, it is best to check the theoretical part of the study material. To do this, the teacher should prepare practical tasks, tests, surveys. Checking the tasks performed, in this situation can be done both in face-to-face form and with the use of cloud services, online. The consultations before the exam may be also conducted online or in a joint discussion with a group of students. A similar form of work is possible in consultation with a scientific adviser in the process of writing articles, course papers or diploma papers by students.

Maryna V. Rassovytska and Andrii M. Striuk consider the system of cloud-based tools of training consisting of the following tools [24]:

- management training;
- communications;
- joint activity;
- provision of training materials;
- knowledge control.

While selecting cloud-based tools, the specifics of their use and educational purpose were taken into account. In addition, researchers pointed out the most important types of cloud services and tools and noted that these types form a system of cloud-based learning tools. A separate issue is the study of cloud services such as Google and Microsoft, a detailed analysis of their advantages and disadvantages in the learning process.

Although, Tetiana V. Voloshyna does not provide a clear definition of the cloud-based learning support system, but it is noticed that it may include tools for modeling and monitoring student achievement and academic achievement. The progress of the development of educational achievements is preserved in similar cloud-based systems for the further planning of the educational process, its pace. By analyzing significant data sets in which student learning achievements are accumulated, the teacher will be able to individualize the educational process according to the level of preparation of each individual student of the group [40].

As Olha V. Korotun considers the cloud-based system of distance learning as a cloud service, the object of its research is the cloud-based training management system Canvas [13], which belongs to the category of cloud-based services: SaaS. This cloud-based system is designed for both tertiary and higher education. Using the Canvas tool, the teacher will be able to organize: distance and group work of students (including the project), assessment of their academic achievements and monitoring, training sessions (in the form of lectures, consultations and discussions). Interesting is the integration of Canvas with the following services: Facebook, Twitter, Skype, LinkedIn.

Olha V. Korotun believes that the new forms of organization of the educational process, in particular, mixed learning [14], become simpler thanks to the cloud-based educational system. She emphasizes that cloud-based systems of distance learning appeared within the trend of cloud computing development. At the same time, investigating the structure of such cloud-based systems, the researcher believes that their implementation will be appropriate first of all in small educational institutions. However, if the cloud-based system is not part of the cloud-based environment of a university, then its implementation should be gradual (within the department, faculty, individual student groups) [14].

The researcher carried out a significant analysis of the foreign experience of implementation of cloud-based systems of distance learning, the feasibility of their use, in particular in the educational process of the HEI of Ukraine. Interesting is the composition of a cloud-based system defined in the work [14]:

- a toolkit for authentication;
- a toolkit for access rights hierarchy for individual users and system users;
- a toolkit for managing and debugging an electronic course, including as separate actions of its configuration, setting parameters, etc .;
- a toolkit for managing user accounts;
- a toolkit for the organization of the educational process of a group of students (and individual students);
- a toolkit for organizing and maintaining communication between users of the system;
- a toolkit for analyzing the dynamics of academic achievements as a separate student and user group;
- a toolkit for planning and adjusting the dynamics of the educational process;
- a toolkit for combining with other cloud systems, services, perhaps with social networks;
- tools for organizing collective and individual work of students for the use of various forms of organization of educational activities.

Mattias Bitar argued that IaaS resources could be used to provide an appropriate amount of memory, bandwidth and other tools that were explored in separate versions of e-learning. The researcher also proposed an architecture and cloud-based e-learning model with components that are related with infrastructure, resources, software, service, and applications. Each component has certain benefits that can be changed for various educational purposes. Software features may vary to meet user requirements [3].

An e-learning based on the cloud is explored by Ghazal Riahi, who proposed a general architecture model for the cloud-based e-learning system. The proposed model has five components, infrastructure, software level, resource management level, service level and, finally, the application layer. Each component has specific characteristics that can be used for personalized e-learning. Hardware and infrastructure levels consist of resources such as physical memory, RAM, storage and central processing. The software component consists of an operating system and software that can have different performance and interface, and also provide developers with tools for further refinement of the software product. The existing level of resource management at the request of self-service and distribution of software through the free communication of hardware and software resources. Resource management can also be used to provide users with the required amount of resources. The existing service level that includes IaaS, PaaS and SaaS, where the service provides a different level of service provider responsibility. The provider can differentiate the software product, depending on what functions the user requires. The latest component is the application layer, which in fact serves as a custom application in e-learning. The key differences between e-learning components and clouds are at the application level. The features of this component are content production, content delivery, education goals, management components, and ratings [25].

By examining the possibilities for improving the delivery of MOOC resources and experience and the potential benefits of cloud computing, Geng Sun, Tingru Cui, Jianming Yong, Jun Shen and Shiping Chen attempted to develop a cloud-based system that creates virtual learning environments for so that both students and teachers work through mobile devices. This system consists of several programs like SaaS and three functional web services. All services and applications in the virtual learning environments will work together and will be deployed through the cloud infrastructure to provide powerful computing capabilities for storage space with a versatile and intuitive interface [35].

3 Conclusions and prospects for further research

The proposed research shows that there are different approaches to the interpretation of the concept of "cloud-based system for educational purpose". Depending on the author's understanding of this notion, the structure of the cloud-based system is defined. Some researchers understand the system of certain cloud services under this notion. Another approach is that a separate cloud service acts as a cloud-based system. Also the cloud-based system may be considered as a computer program for training purposes, which is deployed on the cloud. However, all scientists in their studies have come to the conclusion that the cloud-based system is part of the cloud-based learning environment. That is, the concept of cloud-based environment is much wider. However, the way of the cloud-based system design within this environment and combination of its components in each study is described in accordance to the structure of the cloud-based learning environment. Therefore, it was necessary to investigate not only the content of the concept of "cloud-based system for educational purpose", but also the structure of a similar system. It has been found that in certain studies, the cloud-based system is taken as a separate component. In the studies of other scholars, it is believed that the structure of the cloud-based system is closely intertwined with other components of the cloud-based environment.

The main areas of pedagogical research of cloud-based educational systems are:

- the design of cloud-based training systems, and the methods for developing existing software products that can be applied;
- introduction of cloud services is recommended to begin with the cloud-based learning system;
- cloud services can be easily integrated into the education systems of HEI and secondary education;
- cloud computing has proven to be a valuable alternative to accelerating the work of the machine learning platforms;
- the semantic mechanism of integration of cloud services with the educational system is investigated;
- existing studies of intellectual learning environments combine educational services available in the cloud with the objects of the educational environment;
- researchers propose using intelligent agent technologies to manage resources, hardware, platforms, education programs and cloud-based services.

Further research will focus on the evolution of the formation and development of cloud-based systems and the identification of trends in the development and use of cloud-based systems in the training of teachers in European countries.

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The state of the art and perspectives of using adaptive cloud-based learning systems in higher education pedagogical institutions (the scope of Ukraine)

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Abstract. The article deals with the problems of using adaptive cloud-based learning systems (ACLS) in the modern high-tech educational environment and expanding access to them as tools of educational and research activity at higher education pedagogical institutions in Ukraine. The conceptual apparatus of cloud-based adaptive learning systems application and design is considered; their main characteristics are revealed; the ways of their pedagogical application are described. The experience of Institute of Information Technologies and Learning Tools of NAES of Ukraine on designing and applying of the cloud-based learning and research environment is outlined. The results of the survey of 31 higher education pedagogical institutions on using ACLS are presented. It is established that in the near future ACLS will become the driving force behind the development of new pedagogy, new strategies for personalizing education, and expanding opportunities for active learning.

Keywords: cloud technology, learning-scientific environment, higher education pedagogical institution, adaptive cloud oriented learning system (ACLS).

1 Introduction

Modernization of teaching and learning in higher education institutions bringing it in line with the current achievements of scientific and technological progress is one of the priority problems of Ukrainian pedagogical research. One of the main conditions for the modernization of education, improving the quality of teaching and research staff training is the use of innovative technologies, in particular, the introduction of adaptive learning systems in educational institutions.

Adaptive learning systems attracted the interest of researchers in the field of ICT in education at almost all stages of development of this industry. It is always the goal of those who develop and implement computer-centric systems to create tools that would most fully meet educational needs. The cloud computing approach gives the new insights into the field of adaptive learning as artificial intelligence approaches and advanced networks tools merge to create the new trend [1]. The adaptive cloud-based learning systems become the new stage of adaptive systems development that have a great potential and significant prospects for use in educational institutions.

The purpose of the article is to determine the essence of adaptive cloud-based learning systems, the state of the art of their use in educational institutions of Ukraine, outline the prospects for their development and implementation.

2 Review

With the development of cloud computing the possibilities for individualization and adaptability in educational systems have increased significantly. Despite the fact that modern adaptive systems are still in the process of experimental study, they are gradually developing and implemented in educational practice in different countries [13] at different levels of education [11]. These systems are aimed at ensuring the differentiation and personalization of training at a higher level compared with previous generations. The principles of their work concern the dynamic adaptation to individual needs of the subject of the training course, which are conditioned by the abilities, knowledge and skills of the learner. By “tracking” the process of student’s knowledge acquiring a system with a high degree of accuracy builds the educational path, sequentially “moving” from one unit to the next until as the planned results are achieved [1].

Problems of designing and implementing adaptive learning systems in Ukraine including cloud-based are at the initial stage of development. So Pavlo I. Fedoruk highlights the methodology of organizing the process of individualized learning using the Web-based adaptive system of distance learning and knowledge control [3]. The peculiarities of the creation of a cloud-based learning and research environment of a higher education institution were considered by Valerii Yu. Bykov and Mariya P. Shyshkina [2]. Serhii M. Pryima analyzed peculiarities of intellectual adaptive learning systems of open adult education in accordance with the recommended didactic-educational strategy and methodology of analysis and empirical data Web Mining as the technology for the use of valuable knowledge [13].

First of all, scholars believe that adaptability is important in distance learning, as the distance learning system should be oriented towards a large number of users with different levels of knowledge.

So, Pavlo I. Fedoruk [4] considers the problem of personalization of distance learning, which, according to the author, can be achieved using adaptive and intelligent technologies. According to Pavlo I. Fedoruk, in the educational process, more attention should be paid to navigation systems; to make more efficient use of Internet resources, electronic libraries and repositories [5]. The researcher explored the problem of designing intelligent learning systems and noted that such systems should have an intuitive interface, so that the teacher could not only work with already prepared training material, but also independently modify, update and create their own developments. In the framework of the research, Fedoruk argued that through the use of adaptive and intellectual technologies, the educational system receives the opportunity to take into account the student's personal abilities, his prior knowledge, and ability [5]. The researcher discovered that none of the distance learning systems he considered, none of them was adaptive to interact with student groups, that is, they did not take into account the individual characteristics of each student and teacher training.

Elena V. Kasyanova, in 2006, researched adaptive hypermedia systems [9], which, in her opinion, greatly enhance the possibilities of educational systems in general. In addition, according to Kasyanova's research, all adaptive hypermedia systems can be united into one class, the components of which can include hypertext and hypermedia systems. Due to this, for each user, his workplace will be adapted with the individual tools and settings of various aspects of the system itself (without affecting the work of other users).

Theoretical and practical principles of the development and use of adaptive learning systems are actively studied by foreign experts. Peter Brusilovsky and Christoph Peylo conducted a comparative analysis of intellectual and adaptive learning systems, identified the prospects for the development of such systems on the basis of the Internet [1].

The thorough analysis of the concept of an adaptive learning system and its model design is presented in the works of Lou Pugliese [14; 15].

The experience of developing an adaptive open-source online course based on cloud-based Amazon Web Services architecture is presented in the paper [19].

Researchers [21] developed an adaptive learning system with two sources of personalization. Their research is based on two main sources of information about personalization such as behavior in learning and personal learning style.

If to turn to the theory of adaptive systems, then the task is reduced to the construction of a regulator, which will affect a certain object / subject and in time will ensure (under all conditions) the achievement of the goal. A system consisting of object / subject parameters and the specified controller will be called adaptive [7]. If you return to the research topic, then in this case the cloud-based system will act as the regulator.

In turn, according to the study by Vladimir G. Sragovich [20], the adaptability of the control algorithm means that the goal is provided on the whole class (objects / subjects and functional connections), besides, it remains unknown to the end, which the process itself is being managed. In the presence of a strategy it becomes possible to evaluate the characteristics of the process over which the control takes place. However, Sragovich emphasizes that it is not necessary to evaluate and control the object simultaneously. That is, the adaptive system changes its algorithm (or its structure) automatically, which means achieving the goal in any conditions.

Thus, modern adaptive learning technologies are specialized software or services that adapt to the needs of students. These tools are able to synchronize with the learning process and, based on the technology of machine learning [17; 18], can adapt to the progress of each student and independently adjust the training content in real time.

Any adaptive learning system shapes the model and profile of each user. The user profile stores personal user information such as scientific (training) benefits, training mode and user knowledge. The model is based on a profile research. Jelena Nakic, Andrina Granic and Vlado Glavinic [10] studied the characteristics needed to build a user model for adaptive learning systems. According to the research, as the sources of adaptation, selected individual characteristics of users. The result of the study can be considered a list of 17 characteristics that are considered sources of adaptation (age, gender, cognitive abilities, such as speed of processing, long-term memory, spatial ability and others, metacognitive ability, personality, anxiety, emotional and affective states, cognitive styles, learning styles, experience, background knowledge, motivation, expectations). According to the results, the adaptation of educational systems increases when they are adapted to one or more of the listed characteristics of the user.

The development of cloud computing, the growth of complex implementations in the cloud, has increased the requirements for the internal and interdomain network. However, it should be recognized that network performance is one of the key issues when implementing multi-cloud solutions. This leads to the fact that network management is considered as a major problem; it is an integral part needed to provide integrated security and application performance [6].

This leads to the fact that cloud-based network infrastructure must be extremely flexible and responsive to changes in queries dynamically as a complex workflow is implemented with the use of several cloud-based applications. To achieve this goal, the network must be fully automated, which leads not only to reduce the cost of supplying the new infrastructure, but, most importantly, allows you to independently provide yourself. Self-sufficiency, on the other hand, means that the network becomes service-oriented, provides automated control with adaptive levels of security and control. All this leads to improved user experience when the API interface becomes a flexible programming environment that works concordantly and meets the requirements of the cloud application level. Thus, in the process of debugging operations and managing the general cloud-oriented system discussed in the previous section, network deployment should be included. The main objectives of the network deployment process are to ensure the dynamic behavior of the network, which can be fully consistent with the client's requirements through self-adaptation and increased flexibility [6].

A group of scholars to better adapt to a wide range of uses provided by community of users. Davide Salomoni, Isabel Campos, Luciano Gaido et al. [16] decided to take a different approach from many of the more used PaaS: the solution is based on the concept of an orchestrated complex cluster of services and the ability to automate the actions needed to implement cases of use. This approach was really successful as it enabled the implementation of outdated programs and did not depend on the language on which the program was built.

Given that the practical experience of applying adaptive learning systems, both in Ukraine and in the world in general is rather insignificant consideration of the conceptual foundations of this technology is important in order to avoid ambiguity of interpretation and approaches to understanding its essence. The features and perspectives of the use of adaptive cloud-based systems in higher education pedagogical institutions, in the training of pre-service and in-service teachers, who are the main driving force of the introduction of innovations into general secondary education are not considered enough.

3 Results

3.1 Adaptive learning systems: the essence of the concept

Ability to adapt is one of the critical indicators that determine the human intellect and behaviour. People did not disappear just because they had a special ability to be adapted to everything that was happening in the surrounding environment. What should be the essence of a system to be adapted to such a complex entity as the person? To do this the model of a person namely a student, a teacher or a learner with a large number of parameters should be provided. The system should be configured in accordance to these parameters, flexibly respond to changes in parameters, with the setting going on automatically, without human intervention, then the system is adaptive to the full extent.

For this configuration the system should be provided with the algorithms for customization, which are usually created with the use of artificial intelligence methods. The flexibility of the system in terms of artificial intelligence can be greatly enhanced by the use of cloud computing approach. The cloud-based system is very flexible by its nature. The necessary computational resources such as memory, processing power, bandwidth network, etc. can be provided and discharged as needed, scaling takes place very quickly. In addition, this system has the ability to be adapted to tasks that can be added or modified as needed. So the adaptation may be provided also by functionality. Thus the cloud-based technologies have additional opportunities for a wider range of adaptation due to the much higher flexibility of their software and hardware and their characteristics.

Thus by *the adaptive cloud-based learning system* the cloud-based system that has the property to be adjusted automatically by its parameters to the different individual characteristics and educational needs of the learning process participants is meant.

In order to implement the computer-procedural functions of this system, a virtualized infrastructure (corporate or hybrid) should be purposefully created.

Among the advantages of the ALS are the following:

- automation of evaluation and forecasting, which greatly enhances the efficiency of these processes;
- the ability to be adapted to each student, regardless of the starting level of knowledge, abilities, peculiarities of psycho-physical development, etc., unlike the traditional system in which the student should be adapted to the general standards;
- adjustment of the degree of complexity of educational content, which contributes to a more efficient, consistent course of study;
- the possibility of constant evaluation, tracking the student's academic progress and adjusting it if necessary;
- the possibility of obtaining data not only about the educational progress of each student but also his individual needs;
- the possibility for the student to carry out self-analysis, track their own educational route, progress in the learning process through the receipt of feedback (feedbacks) from the system in real time;

- the encouragement of students to self-development and the implementation of an individual educational trajectory, regardless of the teacher, with the help of automated feedback loops;
- the possibility of reducing the routine load on teachers, releasing time for professional development, etc.,
- the possibility of continuous improvement of training courses on the basis of in-depth analysis of educational progress, peculiarities of the individual trajectory passing by each student which contributes to the improvement of the quality of educational activity of the institution as a whole.

ALS usually require architecture that integrates key functions of modules (training content), assessment and competencies, which together should provide support for a personified educational environment. As indicated in [14], ALS, at least, should contain the list of methods that provide:

1. The training modules (content) to be completed;
2. Several evaluation systems that track and assess students ' learning outcomes;
3. Methods for coordinating the demonstration of learning content to individual students in a dynamic and personalized way.
4. The analysis of the source base allowing the selection of a number of indicators that determine whether the learning system is adaptive.

So, consider the system of learning to be adaptive if it:

1. Can be adapted to different learning styles (for example, different pace).
2. Contains statistically accurate cognitive models that allow to determine and verify the reliability of the achieved competence level of students.
3. The adaptive sequence can be correctly implemented for the accurate and continuous collection of data in real time for the student's progress and the use of these data for the automatic correction of the educational route.
4. Contains a functions for adaptive evaluation.
5. It can accurately identify corrections and corrective actions through adaptive evaluation (both on the basis of norms and on the basis of criteria).
6. It is possible to synchronously measure critical components of the knowledge (how successful the student has mastered the content) and behavioral (how much time a student was actively involved in the learning process).
7. It can develop complex competencies characteristics that index the learning outcomes.

With regard to the cloud-based approach we also need to consider the cloud-based learning platform providing the ICT infrastructure for the adaptive learning system implementation. The learning platform is considered as the set of the cloud-based tools to support different learning and research activities. Within the unite platform a lot of different tools may be integrated providing more opportunities to realize adaptive learning.

3.2 State of the art of using adaptive learning systems in higher education pedagogical institutions of Ukraine

In order to find out which training support systems are used in educational institutions of Ukraine, and whether there are adaptive systems, we conducted a survey. Interviews were held with the representatives of 16 pedagogical universities and 15 institutes of postgraduate pedagogical education of Ukraine (31 institutions – 31 respondents) competent in the issues of which educational systems are used in the institutions where they work (technical departments, distance learning departments, specialists in issues of informatization of the institution, etc.), in the fall of 2018. It was established that currently none of the institutions surveyed uses ALS. The results of the survey are rendered in Fig. 1-3.

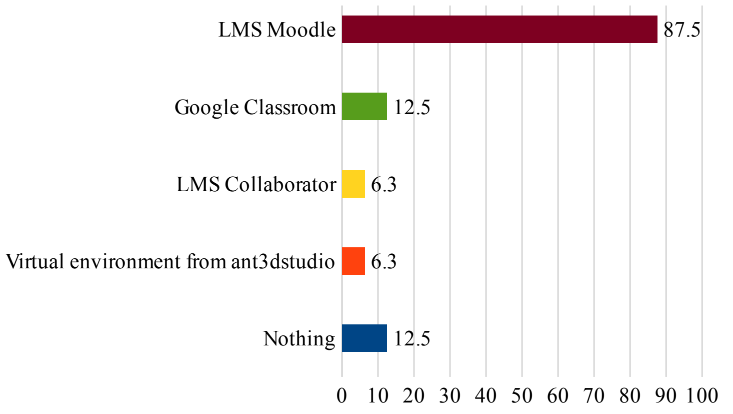

Fig. 1. The systems of training support used in pedagogical universities of Ukraine

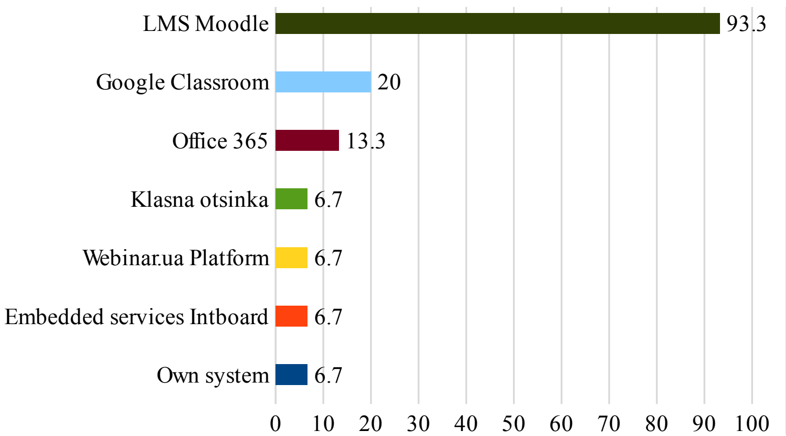

Fig. 2. The systems of training support used in institutions of postgraduate pedagogical education of Ukraine

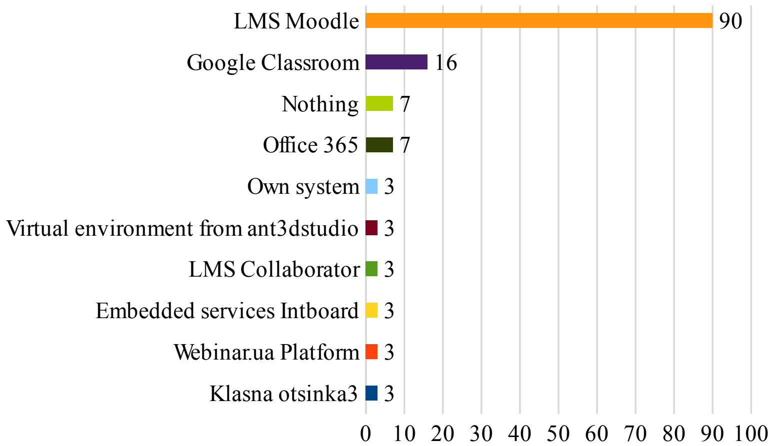

Fig. 3. The systems of training support used in institutions of pedagogical education of Ukraine – pedagogical universities and institutes of postgraduate pedagogical education (consolidated data)

As you can see, the most common is the Moodle Learning Management System (LMS Moodle). Despite the wide range of functionalities and the range of benefits provided by this system, it is, however, not adaptive, as well as the rest of the tools currently used in institutions of pedagogical education in Ukraine.

On the basis of a conducted survey it can be concluded that the cloud-based platforms being the necessary condition to provide ACLS are used only in 16 % of institutions.

So, we believe that scientifically and pedagogically grounded introduction of such systems will contribute to the learning environment development that the will become more open, personalized, will enable access to high-quality educational content for all subjects of learning with regard to their individual characteristics.

Note that today the ALS are only at the beginning of active development and progressive implementation. Even in the technologically developed countries of the world such systems have become widely distributed undergoing experimental testing. According to [8], in the next few years, the ALS will be the driving force behind the development of new pedagogy, new strategies for personalization of education, and the expansion of active learning opportunities.

4 Conclusions and discussion

The analysis and assessment of the state of the art of using adaptive cloud-based systems in the domestic educational space has shown that the adaptability is largely not realized; the use of cloud-based services is not complex, conditioned by learning needs and subordinated to pedagogical goals of teachers training.

In 2018 the Institute of Information Technologies and Learning Tools of NAES of Ukraine became one of the partners of V4+ Academic Research Consortium that would address regional issues related to EU ICT research priorities. The focus will be on the networking of the V4+ partners in order to integrate their research expertise, perform partner search and benchmark these issues using the virtual technological platform. The important part of the project is to explore the use of the cloud-based platform to integrate and deploy different types of learning and research services such as educational robots, language technologies and databases [12].

Despite numerous partial studies of specific issues in adaptive learning systems and cloud-based systems, the design and use of adaptive cloud-based systems remains relevant and current. ALS are still developing, gradually gaining momentum in developed countries of the world. The basis of the functioning of such systems is the competence approach, focusing on individual progress.

Because these systems require computation of a very high order, analyzing enormous amounts of data in real time, the scalability of the system can be considered from two points: how to effectively program these systems and how to prepare such an architecture to provide the processing, loading, distribution of these data. In view of this the relevant and perspective point is to study the principles and approaches of designing the ALS on the basis of cloud platforms, as well as developing methods for their use in the professional training of teachers as the main driving force of the introduction of innovation into general secondary education.

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Systematicity of students' independent work in cloud learning environment

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Abstract. The paper deals with the problem of out-of-class students' independent work in information and communication learning environment based on cloud technologies. Results of appropriate survey among students of pedagogical university are discussed. The students answered the questions about systematicity of their learning activity and propositions for its improving. It is determined that the leading problems are needs in more careful instruction according to features of the task completing, insufficient experience in self-management, the lack of internal motivation. Most of all, students recommend to provide the tasks with detail instruction (oral or written) and to pay attention to careful planning the time that is necessary for full completion of the task. It is pointed that such complicated requirements can be satisfied only by complex use of information and communication technologies as well as the automated system of pedagogical diagnostics. Some requirements for management of students' out-of-classroom independent work are formulated as a result of this discussion.

Keywords: students, independent work, cloud environment, systematicity.

1 Introduction

Cloud technologies is a basis of modern distance learning. It provides the students with possibility of study that is free in space and time. Students of full time learning also use the cloud pedagogical information and communication environment for out-of-classes independent work. But learning activities in cloud environment essential differs from traditional work in classroom or homework with short-term tasks. It also differs from learning work on large study projects. New kind of learning activity requires in new studies of pedagogical science in the field of didactical and psychological peculiarities of students' independent work.

Problems of educational activity in cloud environment were analyzed in studies of Liudmyla I. Bilousova [4], Valerii Yu. Bykov [10], Arnold E. Kiv [62], Hennadiy M. Kravtsov [31], Mykhailo S. Lvov [69], Yevhenii O. Modlo [43], Pavlo P. Nechypurenko [47], Maiia V. Popel [38], Serhiy O. Semerikov [72], Aleksander V.

Spivakovsky [14], Andrii M. Striuk [39], Illiia O. Teplytskyi [63] and others. The other side of investigations is devoted to the pedagogical theory of students' independent work management. Oleksandr V. Malykhin [36] is an author of one of the recent fundamental research, specifically oriented on the problems of management of students' independent work, he suggests a model of the system of management of the students' independent learning activity in pedagogical university as well as the corresponded pedagogical technology, which has been tested at foreign language learning.

The basis of effective management of students' independent learning activities in higher education institutions is the study of the didactical conditions of management of students' independent work both theoretically and by means of a questionnaire [29], [64], [66]. Thus, according to [64] it is determined that third-year students during independent work had such difficulties as unclear requirements, lack of special literature, the discrepancy tasks with the subject of the course. The results of survey of students on the use of information technologies during independent work [42] are interesting for understanding the technique of students' work. As a result of this survey, students mostly use lecture summaries and electronic resources rather than textbooks or other teaching materials [42] in process of their self-preparation for classes. Survey method was used to determine the problems of self-study of primary school teachers in Luhansk Taras Shevchenko National University [53]. By results of [53], students often identify such difficulties, when performing independent work: not enough books (not enough information on the Internet), objectives or requirements are unclear, lack of time, trouble finding information, too large amount of information that makes it difficult to study. Survey [6], which deals with the problems of management of the students' independent work in the information and communication pedagogical environment, show that students widely use Internet resources during independent work, but they do it spontaneously and do not obtain proper effect on the success of learning. So management of independent work should be provided special means in information and communication environment, aimed at improving the efficiency of the use of Internet resources during independent work of students [6].

The author of [28] took attention for the level of cognitive students' activity in process of independent work and suggested the appropriate system of tasks for independent work on educational discipline "Method of teaching informatics". This tasks are focused on productive and creative activities of students and anticipate their implementation in the Moodle system. The author underline that the most positive results were achieved by students, who characterized by a high and average level of cognitive activity and a certain experience of independent work in pedagogical information and communication environment [28].

Despite the considerable interest of researchers to pedagogical conditions of students' independent work, the problem of empirical research of relations between factors, which determine the effectiveness of independent learning activities is still not exhausted. In particular, one of the actual problem in management of students' independent work in pedagogical information and communication environment is providing the systematicity of such activity. The lack of direct personal contact between student and teacher as well as the lack of personal connections between students during the task execution and presentation of its results needs innovation approach for motivation and help that traditionally provides learning process.

Objectives of this paper is the analysis of pedagogical conditions of providing the systematic learning activity of students' in pedagogical information and communication environment.

2 Theoretical background

On the basis of the analysis of psychology and pedagogical scientific works, it has been established that independent work of students is a multi-faceted concept and involves various aspects of its research: as a teaching method (Vladislav B. Bondarevskii [7], Volodymyr K. Buriak [9], Ivan I. Kobyliatckii [27], Leonid I. Ruvinskii [59], etc.); as a type of activity (Evgenii K. Bortkevich [8], Mykhailo D. Kasianenko [25], Vitalii A. Kozakov [30], Olena O. Lavrentieva [34], Osvald A. Nilson [48], Ravil A. Nizamov [49], Liubomyr M. Okhrymovych [50], Gennadii P. Semanov [61], Mykola P. Skakun [67], etc.); as a form of organization of the educational process (Boris P. Esipov [16], Ilia I. Iliasov [21], Valentina Ia. Liaudis [35], Aleksandr G. Molibog [44], etc.); as a learning tool (Sergei I. Arkhangelskii [1], Malla G. Garunov [19], Galina N. Kulagina [32], Pavel I. Pidkasistyi [52], Valentin I. Tolkunov [74], etc.). In our study, independent work is considered as an activity of a student, which takes place without the direct involvement of the teacher, but is directed and guided by him.

Studying the problem of management of independent work of students involves, first of all, the identification of the essence of management, clarification of his role in the student's educational activities. It was defined on the basis of works of Vladimir P. Bespalko [2], Tatiana A. Dmitrenko [12], Larysa V. Filippova [17], Valerii A. Iakunin [23], Lev B. Itelson [24], Aelita K. Markova [37], Raushan K. Mashanova [40], Valerii Ia. Nechaev [46], Liudmila V. Rychkova [60], Kateryna V. Yaresko [13] and others that the essence of management consists in the implementation of the interaction of the student and the teacher, aimed at activating the student's activities in the learning process and at achieving the goal. As a result of this interaction, the socio-cognitive experience of the student changes. Depending on the nature of the teacher's influence on the student's independent work, the types of management are distinguished:

1. according the distribution of roles in the management between the subjects of the educational process – direct management, co-management and self-management;
2. by the presence of feedback – with feedback and without feedback; by the degree of individualization of influence – directed and dispersed; by level of using technical equipment – manual and automated.

From the standpoint of a cybernetic approach, the management is a process that is carried out in the following stages: collecting information and evaluating the situation; setting objectives; decision-making on choosing the appropriate method of solving the problem; realization of the decision; control and evaluation of results; adjustment. Each stage has a specific purpose and task assignments, provides for certain actions of the management entity.

A teacher can provide personal interaction with students to manage their independent work only, when students' independent work is in progress in classroom. The management of out-of-classroom learning activity in traditional study is based on preliminary instructing, didactical tools and student's experience in self-management of own learning activity. Such situation leads to the lack of creative and productive activity in students' out-of-class study, because teachers have problems with management of such activity by traditional means. Only using the innovation pedagogical technologies, based on information and communication learning environment and cloud technologies, gives us possibility to realize on-line management of students' independent work at distance.

The development of information and communication technologies, particular cloud technologies, creates the prerequisites for improving the efficiency of management of students' independent work. A number of scientific works is devoted to the didactic aspects of the use of ICT in independent work of students (Liudmyla I. Bilousova [6], Andrei P. Ershov [15], Boris S. Gershunsky [20], Liudmyla E. Gryzun [3], Yurii V. Horoshko [22], Aleksandr A. Kuznetcov [33], Yukhym I. Mashbyts [41], Vadim M. Monakhov [45], Nataliia M. Omelchenko [], Viktor N. Pustovoitov [54], Serhii A. Rakov [55], Yurii S. Ramskyi [26], Vasilii G. Razumovskii [56], Yuliia P. Reva [57], Irena V. Robert [58], Vitalii V. Rubtcov [11], Vladimir F. Sholokhovich [65], Tetiana V. Solodka [68], Iryna V. Synelnyk [71], Nina F. Talyzina [73], Aleksandr Iu. Uvarov [75], Myroslav I. Zhaldak [18], and others). In these studies, attention is paid to the disclosure of new forms of educational and cognitive activity of students with the use of information and communication technologies. The analysis makes it possible to put forward a hypothesis about expediency of computer-oriented management of independent work of students in the process of teaching disciplines of the natural-mathematical cycle.

3 Empirical research

To determine the leading problems, which impede students' independent work, we suggested them some questionnaire with a multiple choice (see Table 1). The target group are students of pedagogical university – future teachers. The size of the sample is 53.

The question 1 suggests to the students some hypothetical "opinions" that characterize probable problems, connected with quality and fullness of preliminary instructing, motivation and cognitive interest, students' experience in self-management of independent work. The answers show (see Fig. 1) that the leading problems are needs in more careful instruction according to features of the task completing, insufficient experience in self-management, the lack of internal motivation. Statistical analysis shows that influence of variants 2, 6, 7, 8, on the systematicity of independent learning activity is significantly less than the above factors (significance level 0.01 according to Pearson's criterion Chi-square). We should take into account the variant 4 also, because of importance of health problems for a student as a person.

Table 1. Questionnaire.

Question		Variant
Question 1. Sometimes it is difficult to complete a training task at the appointed time, the reason for this is often the following circumstances:	1	there is no enough understanding of how to complete a task
	2	there are other more important things
	3	there was a mistake in planning time, the task have been left for the last day and time was not enough
	4	bad health, illness
	5	the task is not of interest, it is difficult to force itself to borrow it, even if necessary
	6	fulfilling the task does not affect the achievement of my life goals (does not give the experience that will be needed in life)
	7	the task does not affect my grades at the university (the evaluation system does not take into account the results of this task)
	8	the task is so complicated (labor-intensive) that it is not possible to execute it
Question 2. To improve the systematicity of students' work , I would recommend teachers:	1	not to give for independent work of creative tasks, the order of execution of which is not known in advance
	2	not to give for the independent work of tasks of a reproductive nature, which is not interesting to perform
	3	to provide a detailed written instruction to complete the tasks
	4	to conduct oral consultations and demonstrations in relation to the execution of tasks
	5	to reduce the grading score for the violation of the term of the tasks
	6	to provide multiple reminders about the near deadline of the results presentation, using the means of communication
	7	to calculate the time on the task carefully

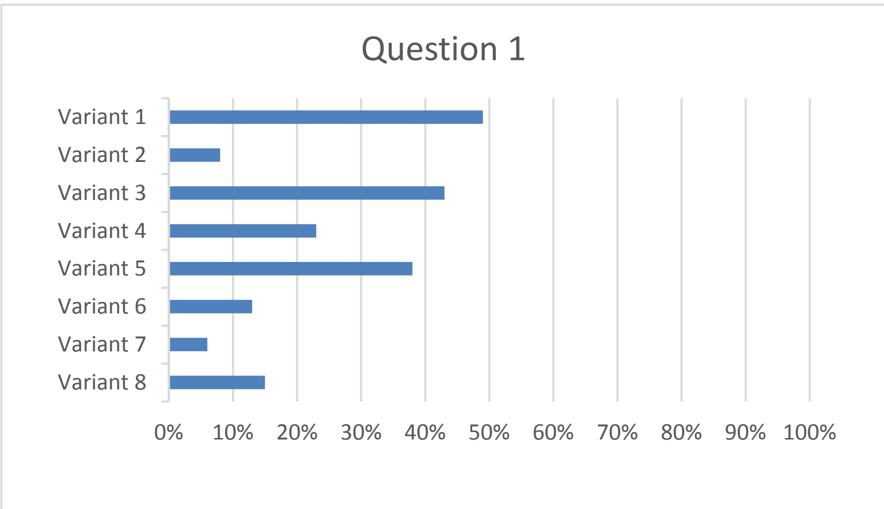

Fig. 1. Percentage of students’ choice according to Question 1 (see Table 1)

The same problems were analyzed by students during answering Question 2 from the other viewpoint (see Table 1 and Fig. 2). Most of all, students recommend to provide the tasks with detail instruction (oral or written) and to pay attention to careful planning the time that is necessary for full completion of the task. Other variants (1, 2, 5, 6) were chosen significantly less (significance level 0.01 according to Pearson's criterion Chi-square).

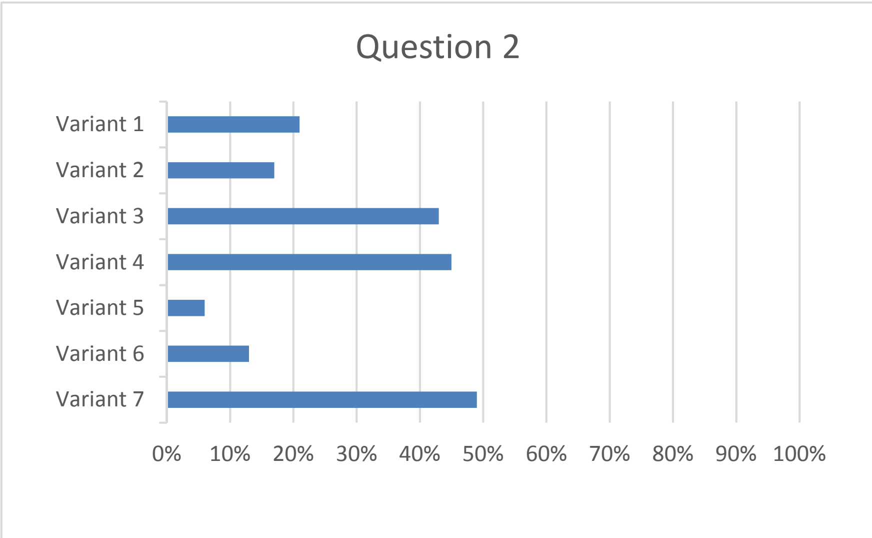

Fig. 2. Percentage of students' choice according to Question 1 (see Table 1)

Such answers of Question2 confirm the answers on Question 1 (Variants 1 and 4), but are in conflict with variant 5 of Question 1. To increase the cognitive interest of the task we should suggest creative tasks for the students, but such tasks are difficult. If the preliminary instructions are very detailed – we'll lost the creative component in the task. So detail instruction should be provided only in needs in time. This instruction should be individual for the student. One teacher cannot serve all students of academic group in such regime, so we need to organize the collective work of students in information and communication learning environment. We need to use the automated system of pedagogical diagnostics for control every student activity and providing him with context help [5]. There are experimental researches [70] and theoretical studies [10] that stress an attention on accordance between student's learning styles and the used method of teaching, "... the way the material presented in online electronics course" [70]. So the automated pedagogical diagnostic system should be comprehensive enough to determine appropriate student's characteristics.

As a result of this discussion let us to formulate some requirements for management of students' out-of-classroom independent work:

- availability of information and communication learning environment which is useful for students;

- students experience in self-management of own learning activity – this experience is provided by systematic independent work, which step by step transforms from direct management by teacher throw co-management with a teacher to self-management according to objectives, plan, system of learning tools and recommendations from teachers and the automated system of pedagogical diagnostics;
- creative elements in the system of learning tasks;
- students' cooperation and communication in process of independent work that increases motivation, helps to follow the time plan and to overcome problems;
- availability of the automated system of the pedagogical diagnostics that provides a student with help in pedagogical design of his learning activity;
- careful design of the system of learning tasks individually for each student with time planning.

4 Conclusions

1. As a result of survey among students of pedagogical university, the most common problems in systematicity of learning activity during the independent work of the student are the lack of instructions, the lack of cognitive interest, students' mistakes in self-management of own learning activity, teachers' mistakes in time planning for the systems of learning tasks for students' independent work.
2. Some requirements for management of students' independent work for fixing these problems are suggested:

   - information and communication learning environment should be available and useful for students;
   - students should continuously capture the experience in self-management of own learning activity;
   - the system of learning tasks should assume elements for creative students' learning activity;
   - students' cooperation and communication in process of independent work should increase motivation, help to follow the time plan and overcome problems;
   - the automated system of the pedagogical diagnostics should be worked out to provides a student with help in pedagogical design of his learning activity;
   - design of the system of learning tasks should be individual for each student and assume accurate time planning.

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Cloud services application ways for preparation of future PhD

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Abstract. Currently, it is important in Ukraine to harmonize cloud technologies application with European and world scientific initiatives. Need to modernize preparation of future PhDs is caused by challenges of new information, globalized society and digital transformation of all spheres of life, including education and science. The research was aimed to determine features of cloud services application in preparation of future PhDs. Concepts of "cloud computing", "cloud technologies", "cloud learning technologies", "cloud services", "cloud oriented environment" were analyzed. Experience of cloud technologies and their services application in educational and scientific space in researches of foreign and Ukrainian students was considered. Ukrainian experience in preparation of future PhD of various specialties with cloud services application was analyzed. It was emphasized that approaches improving to preparation of future PhDs based on cloud services application would increase their level of digital competence. It is recommended to include a separate course or module of specific discipline on work with cloud technologies and services during preparation of future PhDs. It is important to improve disciplines and tools content to support education process. It can be learning of disciplines using cloud technologies or services by future PhD's. Also, cloud services application to support scientific and scientific-organizational activities will increase level of organization and implementation of scientific research. It is important to create cloud-oriented environment for preparation of future PhDs in higher education and research institutions. Making cloud-oriented educational and scientific environment should be based on principles of open education. It is recommended to use cloud-based platforms and services (G Suite for Education; Microsoft Office 365; specialized SaaS (CoCalc or other)).

Keywords: cloud services, cloud-based learning environment, future Doctor of Philosophy.

1 Introduction

1.1 The problem statement

Problems of digital transformation of society in Ukraine are very topical. It is important that scientists and IT companies participate in EU long-term research projects. In future they will be source of innovation in such segments such as: Future emerging technologies; Future networks; Future internet research and experiments, etc. Main task of the research is to create experimental base for conduction of researches and testing of quantum technologies on distributed grid and cloud infrastructures in field of software engineering (application of things fir Internet, big data, artificial intelligence). In order to ensure efficient participation of Ukraine in European research and innovation space it is important to develop our own scientific digital infrastructure in accordance with priority areas where high-tech growth is expected. Connecting Ukrainian scientific digital infrastructures to European Open Science Cloud and European Data Infrastructure will give impulse to solve current Ukrainian scientific problems with minimal use of state resources [5].

Researches carried out in higher education and scientific institutions are directed on partial solution of issues listed by future PhDs. Nowadays development of scientific training system is an integral factor in scientific and technological progress of society. Mastering of modern achievements in the development of production and information technologies leads to new tasks for preparation of specialists of higher qualification, modernization of educational structure and qualification levels, updating of requirements for third degree – Doctor of Philosophy (PhD). Further search for efficient approaches to training of scientific personnel aimed at achievement of modern world levels by science and education and increasing of state intellectual capacity of the are important and relevant [42].

We emphasize that use of information and communication technologies is not fully implemented in the process of preparation of postgraduate and doctoral students. It happens because these technologies are mostly used to search information sources and text of dissertation, but other aspects of research are still performed in traditional way. Modern realities of society digitalization already dictate new tasks for preparation of graduate students and doctoral students, one of which is use of information and communication technologies not only for results design of dissertation research, but also for fulfillment of its individual components.

There is a problem of accessibility and ways of learning and supplying resources to achieve better pedagogical effect of their use. This problem can be partially solved by using of cloud computing power. The main benefit of cloud technology is improving access to quality resources (and sometimes it is only the way to access resources needed for everyone) [30]. The research [37] states that creation of high-tech cloud-based learning environment will integrate educational resources for educational purposes and support research. It will cover different levels of specialists training. In its turn it could help to address these issues, bridge gap between process of scientific search and level of implementation and use of its results.

We agree with the research [28], and believe that cloud technologies mostly meet needs of solving urgent social, educational and cultural problems of modern society. The problems include: increasing of availability and quality of education, interconnection of research processes and training of scientific-pedagogical personnel, improvement of designing, formation and maintenance of functioning of educational and scientific environment of pedagogical educational institutions. These promising technologies are instruments for human-centrism principles implementation, equal access to results of scientific research on learning materials [28]. Therefore, it is important to teach postgraduate and doctoral students to use cloud services to perform scientific research. It will have a positive influence on development of their information and communication competence.

1.2 Literature review

Ukrainian scientists emphasize importance of information and communication technologies using for digital transformation of society in their studies: for public administration [8; 34; 35], for ecology [31; 32], for education [4; 25], etc. Cloud technologies and services application for educational and scientific purpose was investigated by:

- domestic scientists: Valerii Yu. Bykov [3; 4], Olena H. Hlazunova [6], Olena H. Kuzminska [25], Nataliia V. Morze [25], Svitlana H. Lytvynova [13], Yuliya H. Nosenko [2; 28], Maiia V. Popel [15; 28; 30], Mariya P. Shyshkina [3; 28; 36; 37], Serhiy O. Semerikov [16; 22], Andrii M. Striuk [17; 43], Tetiana A. Vakaliuk [47] and others.
- foreign scientists: Anca Ioana Andreescu [19], Prashant Kumar Baheti [38], Li Hao [48], Anjali Jain [11], Jia Li [48], Marinela Mircea [19], Upendra Singh [38], Guolei Zhang [48] and others.

Preparation problems of postgraduate students and doctoral students were considered by: Tamara I. Koval [12], Iryna Yu. Reheilo [33], Svitlana O. Sysoieva [12], Yana V. Topolnyk [45] and others. Preparation experience of postgraduate and doctoral students in the scientific specialty “Information and communication technologies in education” is described in [40; 41; 42]. Various aspects of using cloud services in postgraduate training require further study due to constant improvement of information technologies.

1.3 The aim of the research

Publication aim – is research of cloud services using features in preparation of future PhDs.

2 Research results

2.1 Main definitions and terms

Following terms are important for the given research: “cloud computing”, “cloud technology”, “cloud learning technology”, “cloud services”, “cloud oriented environment”.

Today, global companies and public institutions in the world invest in advanced digital technologies: mobile communications, social networking, big data analytics, “smart” devices that control objects and sensors connected to them, and others. Cloud technologies are used by organizations around the world and play a special role. Cloud computing was recognized as a priority in technological development, as evidenced by number of international instruments (European cloud computing strategy, US Federal Government cloud initiative) and government initiatives in various countries. These countries launched large-scale educational projects in USA, Japan, Russia and European Union, numerous international conferences and scientific publications. Therefore, problems of cloud computing services and technologies designing for use in educational process of educational institutions are very important in the field of informatization [37].

The US National Standards Institute (NIST) defines concept of “cloud computing” as following – it is as a model of convenient network access to common computing resources (e.g., networks, servers, data files, software and services) that can be quickly given by minimal efforts and interaction with supplier. Also the NIST developed recommendations that outline five basic characteristics of cloud computing. These characteristics allows to distinguish these systems from other types of ICT. They include: free network access; self-service on demand; pooling resources (location-independent); measurability of service (payment upon delivery); fast elasticity (provision and releasing of resource in necessary amount and at any time” [18].

Definition of “cloud computing” is known as “NIST definition” (The NIST Definition of Cloud Computing). According to this definition cloud model supports high availability of services. It is described by five main characteristics (self-service on demand; pooling resources; measurability of service; fast elasticity, regulated by four deployment models (private cloud, community cloud, public cloud and hybrid cloud) [16].

In 2009 Gartner’s reporting materials described cloud technology as “another super-concept among ICTs that has hopes for (“Cloud Computing is the latest super-hyped concept in IT”). Cloud technologies are considered as simple idea according to the report. But there are many issues regarding types of cloud technologies or scale of their deployment that make them not so simple [16].

Ukrainian scientists, in particular Valerii Yu. Bykov defines concept of cloud technology, through the concept of “virtual network platform”. Networked virtual ICT objects are formed in adaptive information and communication networks due to a special user interface, supported by system software networking tools. Such objects – network virtual sites are situational component of logical network infrastructure of information and communication networks with temporary open flexible architecture, which in its structure and time of existence meets personal needs of user (individual and group), and their formation and use of technology [4; 36].

Author [16] defines concept of "cloud technology" (cloud information and communication technology) as a set of methods, tools and techniques used to collect, organize, store and process on remote servers, transmission over the network and submission through a client program of all kinds of messages and data. Cloud technologies are a subset of information and communication technologies. ICT learning is a subset of learning technologies. So, "cloud learning technologies" are such ICT training that involves use of cloud ICT. It can easily be defined as network ICTs, providing centralized network storage and data processing (execution of programs), for which user acts as a client (user of services), and "cloud" – is a server (service provider) [16].

Also, "cloud services" are services that provide user with network access to scalable and flexibly organized pool of distributed physical or virtual resources delivered in self-service and on-demand administration (e.g., software, storage, computing, and computing capabilities) – defined in [10].

According to [37] "cloud-oriented environment of a higher education institution" means the environment created by educational and scientific process participants in this institution where a virtualized computer-technological infrastructure is purposefully developed for implementation of computer-processing functions. Cloud services should be used to make available to user electronic educational resources that make up meaningful content of a cloud-oriented environment, as well as to provide processes for creating and supplying educational services [37].

2.2 Experience of cloud technologies application and their services in educational and scientific space

In the first time cloud technologies in a higher education institution were applied at the University of Maryland [7]. Amazon Web Service was deployed (corporate cloud deployment services to support IT infrastructure, for example, to train software design courses) [37].

More coordinated approach to development of research networks and infrastructures was pursued in European education area, in particular in creation of the European strategy forum on Research infrastructures. In 2013 the European Commission released concept paper "Digital Science" outlining basic principles of vision for development of digital science, including cloud, as well as integration into the Horizon 2020 program. Integration of ICT in research process should be aimed at development of Internet culture, based on principles of openness, social significance and broad cooperation. Science is becoming more global, more creative and closer to society. "It is a science that relies on e-Infrastructures, mainly to: develop and disseminate specific ICT tools to solve scientific problems; providing prompt online access to scientific resources, including publications and data; creation and development of platforms and tools that enable large-scale collaboration without need for physical presence" [37].

Experience of Massachusetts Institute of Technology in the context of using educational software in a cloud-based educational environment to deploy cloud access to mathematical application packages (Matlab, Mathematica, Maxima, Maple, R) is interesting. Hochschule Furtwangen University deployed corporate cloud-based infrastructure called Cloud Infrastructure and Application (CloudIA). Target users of this infrastructure were university staff and students who used it to launch educational applications and communicate with colleagues outside the university to organize collaboration. So, it's about deploying a corporate cloud. As a rule, to get services for supply of resources and services on a cloud model people appeals to major providers such as Google, Amazon or others [37].

Also, researches of foreign scientists [1; 11; 14; 18; 19; 38; 48] describes experience of cloud technologies and services using for higher education needs.

Ukraine moves towards information society and information technologies. They are actively implemented in all spheres of public life. However, this movement is slow compared to global. Lack of unified state policy and coordination caused chaos in electronic systems. Widespread use of Internet in everyday life requires thorough methodological analysis of Internet impact on interaction of public institutions with general public [34]. Publication [8] describes problems that slow down necessary social development and demonstrate difficult situation in Ukraine instead effective social dialogue between the state and society, government and citizens.

This issue is reflected in the Concept of digital economy and society of Ukraine for 2018–2020 [5] at the state level. The Concept foresees implementation of measures on appropriate incentives for digitization of economy, public and social spheres, awareness of existing challenges and tools for development of digital infrastructures, acquisition of digital competencies by citizens, and identifies critical areas and projects of digitization, promotion of internal market for production, use and consumption of digital technologies. One of the important tasks is to formulate national policy for digitizing education as a priority component of education reform. Digital education is integration of various components and modern technologies by use of digital platforms, introduction of new information and educational technologies, use of progressive forms of organization of educational process and active teaching methods, as well as modern educational and methodical materials [5].

The [5] also states that integration of Ukrainian science into European research space will enable the of advanced scientific ideas, participation in interdisciplinary projects focusing on promising ideas, technologies and innovations. One of the important elements of Digital single market in Europe and part of paradigm "Open innovations – Open science – Open world" within the European Research and Innovation Area is development of European open science cloud and European data infrastructure.

Basic postulates implementation of the Concept described above has been realised for some time in Ukraine. After analysis Ukrainian scientists' publications we recognize that researches can be grouped as follows:

- introduction of ICT in training of specialists in various specialties [6; 9; 20; 21; 23; 24; 41; 44], in particular cloud services [2; 30; 37; 47];
- use of cloud services for scientific research [28];
- deployment of cloud-oriented environments of educational institutions [3; 29; 36; 37].

Experience of using cloud services and cloud technologies in educational process of Ukrainian educational institutions is described in [3; 29; 36; 37; 39].

Dissertation [6] explores use of cloud services in supporting research and deployment of cloud-based environments based on open ICT platforms. Comparative analysis is conducted and experience of implementation of different deployment models of cloud infrastructure both on basis of the educational institution and lease of infrastructure from service provider is summarized, in particular, deployment cost aspects are covered.

The research [39] emphasized that use of cloud services by a lecturer will contribute to: preservation of educational material and its use anywhere and at any time; use in educational research, for example in mathematical disciplines; organization of teamwork and individual work with use of appropriate tools; applying various forms of control and evaluation of academic achievements of a group of students.

Cloud services are considered as learning tools in addition to mobile learning tools in recent publications [39; 43] investigated a number of cloud services that are proposed to use in education process in combination with traditional learning tools: G Suite for Education, Office 365, ThinkFree Online. In particular, cloud services are characterized, their characteristics and constituents are highlighted and advantages of their use as a means of learning mathematical disciplines are underlined [30].

The research of [30] describes an experimental study on use of CoCalc cloud service in learning of mathematical disciplines. It is suggested to use CoCalc for preparation of future Math teachers. CoCalc is a free service supported by the University of Washington, the National Science Foundation and Google. CoCalc was designed specifically to make it easier to use mathematical calculations on the Android platform. CoCalc implements all features of SAGE Web SCM, but there are some differences. Principle behind CoCalc is to build one-on-one or group projects, fill them with learning resources, and work with individual or group resources at the same time. The system also preserves user actions that are displayed in chronological order. It is possible to display work history with a particular learning resource (or project) of both specific user and group of users. Making certain changes to each project leads to structure backup of the project. All copies are stored in chronological order, indicating author of changes [30].

The research [37] indicates that development of cloud technologies creates a significant need to review approaches of development and delivery of ICT services in terms of their integration. It also concerns teaching methods of information science. Use of cloud-oriented resources, information and communication platforms in various disciplines teaching in higher education becomes an urgent need for modernization of pedagogical methods and technologies, since it indicates transition to new models of organization of educational and professional activities which are based on availability of electronic resources. It is important to use hybrid service models and infrastructure solutions that combine different public and enterprise services on a single platform. Use of hybrid models is particularly promising for education sector [36]. Numerous universal cloud-oriented applications and services find their place in educational process. They include cloud-based tools like Microsoft Office 365, Google Apps, and others. Most of types in this type contain a set of “office” functions that can be used to support different types of educational and research activities: it is a corporate email and calendar for planning and organizing events by a specific group or training community; tools for processing online office applications such as Word, Excel, Power Point, etc., which allows both collective and individual work with certain educational materials contained in the cloud storage (One Drive, Google Drive); creating groups to share documents and their collections; an electronic note (One Note) for recording both individually and collectively; Web conferencing (Skype or other) by means of which you can organize video conferencing, voice or chat with participants or with a group, etc. There is also a wide range of cloud services, such as online photo and video editors, web page editing tools, translation services, spell checking, borrowings in text, and others [36].

VMware cloud-based virtualized environment is used to support problem-solving, collaboration and teamwork. Virtualized learning environment makes ability to quickly create computer labs of all kinds, depending on requirements for different IT courses, making it flexible, scalable and accessible online. Is happens without increasing of load on equipment. Students can make mistakes during learning of new technologies which could harm servers, networks, or databases. It is much easier to recover virtualized cloud-based environment using backup versions. With virtual servers and virtual networks, students receive opportunity to make experiments [37].

Cloud services should be used to support IT training and deployment of cloud-based computer labs for various types of IT courses. Maintaining IT training labs is especially convenient with cloud technology support, given very fast-paced types of IT industry development. It is flexible and dynamic tool for customizing environment to suit your learning needs. It is advisable to use cloud services to create virtual machines that can be used for variety of courses during development of virtual labs. They can be used to support training courses such as web design or database development, system administration, and other [36].

The research [47] investigates theoretical and experimental issues of designing and use problem of cloud-oriented educational environment in preparation of bachelors on informatics.

Modernization of educational and scientific environment of university on the basis of cloud technologies and introduction of cloud-oriented platforms of ICT services supply is s subject of consideration and careful attention of scientists [37].

Modernization and development of educational and scientific environment of educational institutions are among the pressing problems of modern education reforming. Introduction of cloud services and technologies lead to formation of new areas of scientific and pedagogical researches. These researches are related to submission of electronic resources and services. Cloud technologies correspond to needs of solving urgent social and educational and cultural problems of modern society: increasing of accessibility level and quality of education, interconnection of processes of scientific research and training of scientific and pedagogical personnel, improving design, formation and maintenance of educational and scientific environment of pedagogical educational institutions. These promising technologies are an instrument for implementation of the principles of human-centrism, equal access to training [28].

One of the most important factors in deployment of cloud-based environment in different fields of activity, including education, is need to standardize requirements for cloud-based ICT. A number of documents in field of cloud-based ICT standardization were adopted or proposed for discussion [37].

Formation of cloud-oriented educational and scientific environment in higher education institutions and scientific institutions is an essential precondition for preparation of ICT-competent specialists, capable to further activities and scientifically grounded application of cloud technologies in their professional activity [28]. Efficient implementation of cloud services in an educational institution requires special training, introducing its relevant elements to content of training, retraining, advanced training of scientific and scientific-pedagogical staff, graduate students and doctoral students. Training content should be aimed at developing of competencies of researchers, graduate students and doctoral students in the use of various cloud-oriented systems and services in research and educational process [28].

We agree with research [37] that emergence of high-tech platforms, in particular on basis of cloud computing, adaptive information and communication networks, virtual and mobile training is a certain step towards solving problems of accessibility and quality of learning. It changes perception of infrastructure of organizing learning process and its content. Insufficient number of highly qualified personnel and lack of strategic approach to ICT infrastructure design of higher education institutions is one of reasons for lack of systematic decisions of higher education informatization. It impedes creation of single high-tech platform.

Nowadays, universities can play a key role in shaping regional strategies and setting priorities for local specialization, taking into account intellectual resources, skills and competences of research and production personnel existing both within university structures and in local business. Unification and integration processes are realized through creation of inter-university corporations and consortia, which are based on networked distributed structure of stuff training and skills development [36].

Ability to access remote educational resources on-line appears on the basis of modern network technologies. For example, it can be implemented using virtual labs and remote access labs, cabinet resources, and university labs for demonstration experiments. Also, ICT tools and technologies got further development based on cloud computing concept. This concept substantially changes existing perceptions of access organization and application integration. So, it is possible to manage large ICT infrastructures that allow creation and use of individual and collective “clouds” within a shared cloud-oriented educational space [37].

Well-known IT service providers offer some cloud services for training purposes: 1) IBM Blue Cloud offers tools to support migration of data from traditional IT infrastructure to a cloud called IBM Cloud Academy (IBM, 2009); 2) Google App Engine launched G Suite for Education program (Google, 2010) to support educational institutions; 3) Microsoft Windows Azure offers cloud solutions for educational institutions (Microsoft, 2011). All kinds of services can be used – IaaS, PaaS and SaaS [37].

A separate research way appeared on use of cloud technologies in supporting of common team work of programmers on code development. This was called “virtual computer labs" (VCL). The authors define this term as technology that can be used to deploy distributed small data centers and IT services for educational institutions (mostly used to build IT-based educational laboratories). One of the basic structural units of cloud-based educational environment is personalized remote-access training and science laboratory. This term is defined as set of interactions between participants in learning process, content elements and other elements of online learning environment with personalized access to all available resources and services from a remote location. Also, there are cloud versions of well-known manufacturers of service providers, including CoCalc, Maple, MATLAB, MapleNet, MATLAB web-server, WebMathematica, Calculation Laboratory and others [36].

Cloud computing applications allow you to deploy tools that can be scaled for any number of users. Often users use clouds (cloud services) without even knowing it [25].

The research [37] determined that basic characteristics of information and technological infrastructure formation of educational and scientific environment, approaches to design of corporate information systems were changed due to cloud computing tools and services. These changes affect organization of scientific and educational activities. Such activities can be improved with use of new models and approaches. Involvement of scientific and educational community in ICT and networking tools of open information and educational space can play a leading role in addressing these issues. These tools capacity significantly increased due to cloud computing services. Use of information-analytical network tools and services of cloud computing is very important in informatization sphere of education, development of open scientific and educational space.

2.3 Native experience analysis of postgraduates training using ICT (cloud services)

It is necessary to conduct appropriate training, introducing its relevant elements to content of training, retraining, advanced training of scientific and scientific-pedagogical staff in order to implement cloud services in an educational institution or scientific institution. Training content should be aimed at ICT competences building of lecturers, staff of ICT departments, graduate students and students in use of various cloud-oriented systems and services in research and learning process [28].

Innovations introduction into educational and scientific environment is significantly conditioned by availability of engineering, technical and pedagogical staff for informatization of educational systems of different levels. Special staff is needed to provide information processes – implementation and development of ICT training technologies. In connection with this, an education informatization stuff is a significant group of players in the cloud-oriented environment in connection with listed above [37]. The work [37] defines "scientific-pedagogical stuff of education informatization" as workers who work with organizational-normative, socio-economic, educational-methodical, scientific-technical, production and administrative support of processes aimed at meeting information and telecommunication needs (other needs related to ICT tools and methods implementation) by participants in learning process. Key categories of scientific and pedagogical staff are lecturers, management staff (heads of ICT units) and employees of educational management bodies concerned with widespread adoption and use of ICT in learning. ICT competences of education informatization staff are central in their preparation because their field of activity lies in innovative technologies [37]. Training and certification of such personnel should be systematic and planned. Therefore, we will present experience of the Institute of Information Technologies and Learning Tools of NAES of Ukraine (IITLT of NAES of Ukraine), which provides training, certification and professional development of education and science informatization staff.

It should be noted that in 2008 the IITLT of NAES of Ukraine staff developed a passport of new scientific specialty 13.00.10 – "Information and communication technologies in education (industry – pedagogical sciences)". In 2009 the passport of new specialty was approved and included in the list of specialties under which defense of dissertations is carried out to obtain scientific degrees of candidate and doctor of sciences (PhD) and assignment of academic titles. Later in 2010 the IITLT of NAES of Ukraine opened postgraduate studies in Ukraine for the first time, and since 2011 – doctoral studies. From 2011–2018, more than 47 PhD and 9 doctoral theses on the new specialty were defended at IITLT of NAES of Ukraine [41]. Figure 1 shows a graph on number of defended dissertations with highlighting of works explored use of cloud technologies and services for educational and scientific purposes. From this graph it is clear that only 11% of candidate dissertations and 33% of doctoral dissertations explored features of use of cloud technologies and services and deployment of cloud-oriented environment in educational institutions. Therefore, such studies are relevant and promising.

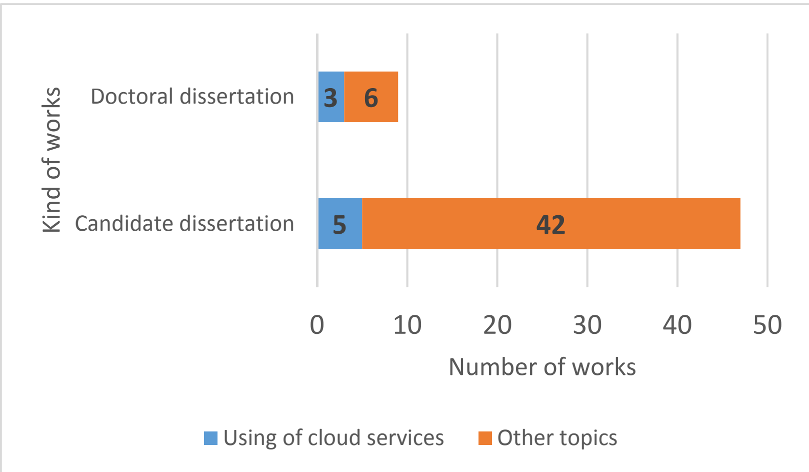

Fig. 1. Number of defended dissertations on use of cloud technologies and services for educational and scientific purposes in relation to the total number of defended scientific works

In 2016 leading scientists of the IITLT of NAES of Ukraine were involved in development of educational-scientific program "Information and communication technologies in education" for training of specialists of the third (educational-scientific) level of higher education on the specialty 011 "Sciences about Education". A number of legislative and regulatory acts provisions concerning preparation of PhD students were taken into account during development of methodological recommendations of educational program. Amount of time for preparation for educational component of education program is 32 ECTS credits (31 – for learning of disciplines, 1 – for the final certification), term of study – 4 years. The program is implemented in following forms of study: full-time (day and evening) and part-time (distance). Purpose of future PhD students training in program "Information and communication technologies in education" is to prepare specialists with in-depth theoretical knowledge, practical skills and competences. The specialists should be able to solve complex problems in the field of ICT in education and to carry out research in this field. Ability to solve complex problems in the field of professional and/or research and innovation activities should be formed at applicant during postgraduate study. It involves deep rethinking of existing and creation of new holistic knowledge and/or professional practice [41].

Educational-scientific program of PhD training on the specialty "011 Sciences about education" (program "Information and communication technologies in education") at IITLT of NAES of Ukraine consists of compulsory disciplines and disciplines at the graduate student choice. It includes:

1. Disciplines of the general training cycle ("Philosophy of education and methodology of educational research", "Foreign language and academic writing", "Organizational and project research and innovation activities in education", "Teaching in modern higher education".
2. Disciplines of vocational training cycle ("Cloud oriented technologies for supporting scientific and educational activities", "Scientific bases of ICT using in education", "ICT training, management and support of scientific and educational research").
3. Selective disciplines of vocational training cycle (Block A. "Information technologies in education and research", "Scientific electronic communications and open journal systems" and Block B. "Education and learning systems in a computer-oriented environment", "Scientific electronic libraries and scientometrics") [42].

After analysis of curriculum for preparation of future PhDs we determined that study of cloud technologies and their services is a separate discipline. Also other disciplines contain certain modules and topics that involve use of cloud services and further work with them. Number of cloud services are also applied to managing process of graduate student preparation.

Current state of development of educational and scientific environment is characterized by increasing requirements for quality of electronic resources for scientific and educational purposes; expansion of more flexible, personalized, open organizational systems. It becomes possible with use of cloud information and communication platform services. Involvement of open-source networking technologies with recently grown capacities in educational institutions can play a leading role in deepening of links between education, science and production; expansion of cooperation between educational and scientific institutions; creation of various corporate structures (branches of industrial establishments, training and engineering centers, etc.) aimed at developing of closer interaction with higher education sector, broader participation in solving urgent social and economic problems, improving the intensity of scientific research and training [28]. Therefore, the IITLT of NAES of Ukraine cooperates with a number of higher education institutions in Ukraine. They create joint research laboratories and cooperation agreements. In framework of these agreements future PhDs may conduct their own experimental research at higher education institutions and conduct teaching, organize and hold joint events (conferences, seminars, etc.). The IITLT of NAES of Ukraine cooperates with National Aviation University (NAU) because NAU is going to start preparation of masters on specialty “Information technologies in education”. Also, NAU plans to deploy a cloud-oriented environment for effective master’s and PhD preparation.

Let’s consider advantages of using cloud services in educational process of higher education institution and scientific institution, in particular for preparation of masters and future PhD.

Nowadays, it is important to improve educational and scientific cooperation through shared access to electronic resources – scientific and educational networks and open information systems (libraries, open journals and video conferencing systems, etc.). There is movement towards use of open systems of research. It is characterized by such innovative characteristics as better adaptability, mobility, full-scale interactivity, free network access, uniformity of infrastructure and others. At the same time, cloud-based electronic research infrastructures are implemented through use of cloud services of relevant ICT platforms. Cloud-oriented enterprise information systems can be understood as providing tools for supporting educational activities and research (computing power, storage space or network resources for interconnection, etc.) and are implemented on the basis of cloud services. New models of activity are formed due to introduction of cloud technology in education. It influences content, methods and organizational forms of open education [37].

We support opinion in [37] that “cooperation of universities with academic organizations and business structures, processes of training and professional development of personnel, implementation of international projects, realization of links between schools and higher education institutions can be realized within the network interaction framework”.

We analyzed the work [30; 36; 43] which describes general trends in formation of cloud-oriented educational environment: removal of restrictions on access from any device, anywhere, anytime; development of personalized learning environments; developing a service-oriented approach, increasing the number of SaaS; improvement of teamwork services (videoconferencing, access to shared content); introduction of unified ICT infrastructure of educational institution, increasing use of IaaS; development of hybrid service models, use of both corporate and public resources, integration of services; increasing requirements for interoperability, reliability, security and other dissemination of the “big data” approach in design of pedagogical ICT systems; reducing licensing and maintenance costs.

Using of cloud services contributes to achievement of new level of education quality; potential creation for individualization of the learning process; formation of individual trajectories for development of students; selection and use of appropriate technological tools. Compliance of ICT tools in higher education information and education environment with a number of requirements for support and management of resources, interface design, ergonomics and others is a necessary condition in the given case. In addition, innovative educational technologies must meet certain systemic pedagogical and information-technological requirements. They are dictated by level of scientific and technological progress. Requirement should meet principles of open education [37].

Modern technologies are aimed to support different types of lecturer activities in virtual environment. It is connected with formation of groups, communities that learn and interact virtually in real time. We use features that provide collective access to training content for a user group, lecturer ability to browse all computers in the group, concentrate students through messages, connect or disconnect participants in the learning process, share files or links among the target group, send messages to specific students to organize activities in such communities. Students can also ask questions, comments, and more. Cloud platforms and services (WizIQ, OpenClass, VideoWhisper etc.) can be used to train and organize virtual classroom activities. Also, there are new forms of work with services and applications that lecturers can use in educational process. They include virtual classes (Whiteboard, Breakout rooms), cloud-based application collaboration systems, web conferencing (web tours, webinars), online distance learning platform (Google Open Class, Canvas); G Suite educational apps (Gmail, Calendar, Blogger, Groups, Maps, Reader, YouTube, Talk) and more [36].

Proper material conditions are important to ensure training of highly qualified scientific personnel. The IITLT of NAES of Ukraine created appropriate conditions for implementation of educational and scientific process, work of graduate students and supervisors: area of free access to Wi-Fi, which extends to all premises; workplaces of academics are connected to Internet and equipped with webcams for on-line counseling; training spaces are provided with multimedia complexes [41]. Cloud-based environment for preparation of future PhDs is created. It includes deployed cloud with Office 365. CoCalc and Google services are actively used.

In the research [28] it is recommended to use Google cloud services. The main benefits of Google services for higher education and research institutions are following: free of charge; reliability (reliable data storage, crash protection, etc.); there is no need to deploy a cloud; intuitive interface, easy to use; availability of universal account that provides access to all services; availability of extensive functionality that is constantly updated and capable to provide support for virtually all activities of the institution; availability from any digital device connected to the Internet (on “anywhere”, ”anytime basis); ability to use different platforms (Windows, Android, iOS, etc.). Using Google services to perform research covers such matters as: planning and organization of work; professional communication; search and analysis of scientific sources; electronic workflow; data retention and sharing; conduction of on-line surveys and processing their results; dissemination research results and monitoring their implementation [28].

There are some of issues that can be solved by use of Google services:

1. Selection of source base of study (foreign and domestic literature).
2. Drafting and preparation of manuscript of dissertation or scientific article.
3. Conduction of on-line surveys.

4. Organization and management of process of preparation of graduate and doctoral students.

So, Google Cloud Services is a good fit for future PhD preparation (Gmail, Google Search, Google Docs, Slides, Sheets, Google Calendar, Google Drive, Google Scholar, Google Books, Hangouts, Google Forms, Google Keep, Google Sites, Google+, Blogger).

Development of network technologies leads to possibilities expanding of educational, professional and interpersonal communications. It enables efficient information and communication support to activity of future PhD. So, the IITLT of NAES of Ukraine uses cloud services, electronic social networks to support communications with graduate and doctoral students. Newsletters of conferences, invitations to seminars and other are sent to different group of people using Gmail mail service. Mailing list includes postgraduate students. Google Calendar is actively used to disseminate current events and events of the IITLT of NAES of Ukraine [42].

Important condition for preparation of future doctors of philosophy is approbation of dissertation research results during scientific mass events: forums, conferences, seminars, round tables, pedagogical readings, etc. The IITLT of NAES of Ukraine has conducted the All-Ukrainian Methodological Seminar for Young Scientists "Information and Communication Technologies in Education and Research" for postgraduate students and PhD students since 2013. This seminar is attended by representatives of various scientific and higher education institutions of Ukraine, and graduate students of the Institute. The All-Ukrainian Scientific-Methodological Seminar "Systems of Education and Education in Computer-Oriented Environment" has been held since 2011. It is aimed to cover results of completed dissertations before considering them by specialized scientific council. Also, the International Scientific and Methodological Internet Seminar "Cloud Technologies in Education" ('CTE') is held annually. Its results are published in English [41].

3 Conclusions and prospects for further research

Need to modernize preparation of future PhDs is caused by challenges of new information, globalized society and digital transformation of all spheres of life, including education and science.

So, following conclusion are done after analysis of scientific sources:

1. Cloud services are aimed on the following: increasing of users access to the best samples of electronic educational resources and services; personal development; potential obtaining of maximum possible results of use of ICT to achieve learning objectives. Making of cloud-oriented educational and scientific environment should be based on the following: principles of open education (mobility of students and teachers); equal access to educational system; provision quality education; formation of structure and realization of educational services; general pedagogical principles: adaptability; personalization of service delivery; unification of infrastructure; full-

scale interactivity; flexibility and scalability; standardization and compatibility; safety and reliability; innovation, etc.
2. Improving approaches to preparation of future PhDs based on use of cloud services will increase level of digital competence in them. It is recommended to introduce specific course or module in specific discipline for working directly with cloud technologies and services. It is possible to improve content of disciplines to support educative process – to teach courses using cloud technologies or services. Also, use of cloud services to support scientific organizational activities will increase level of organization and implementation of scientific research.
3. It is important to create cloud-oriented environment for future PhDs preparation in higher education and research institutions. Such educative environment should meet following characteristics: accessibility and mobility; openness; integrity and continuity of higher education; systematicity; consistency and structure; innovation; integration with cloud-oriented resources; clearness; functionality; collectivity; provision of project activities; scientific aspect; reliability; supporting of communication processes; flexibility and adaptability; individualization; completeness of information resources; convenience; expediency.
4. It is recommended to use cloud-oriented platforms and services (G Suite for Education; Microsoft Office 365; specialized SaaS (CoCalc or other); public cloud services based on ICT platforms (Amazon Web Services, Microsoft Azure or other), corporate services Clouds based on ICT platforms (Microsoft Azure, Xen, VMWare, etc.). Among Google's cloud services, we recommend following: search service (Google Search); communication services (Gmail service, Google Groups); surveys (Google Forms); office suite (Google Docs, Sheets, Slides); planning and organization support service (Google Calendar); data storage and document sharing (Google Drive); professional development and source search services (Google Books, Google Scholar); communication and feedback services (social networks). Thus, cloud services use will increase level of organization, implementation of research results. Also it will increase level of digital competence of reporting process subjects of (PhD students, department heads, research and teaching staff).

Further research requires practical aspects of using cloud services and open access electronic systems in preparation of future PhDs.

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Methodology of designing computer ontology of subject discipline by future teachers-engineers

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Abstract. The article deals with the problem of the methodology of designing computer ontology of the subject discipline by the future teachers-engineers in the field of computer technologies. The scheme of ontology of the subject discipline is presented in which the set of concepts of the future computer ontology and the set of relations between them are represented. The main criteria of the choice of systems of computer ontologies for designing computer ontology of the subject discipline: software architecture and tools development; interoperability; intuitive interface are established. The selection of techniques for designing ontologies using computer ontology systems is carried out. The algorithm of designing computer ontology of the subject discipline by the future teachers-engineers in the field of computer technologies is proposed.

Keywords: computer ontology, knowledge representation, subject field, educational discipline, model, teacher-engineer, designing.

1 Introduction

1.1 Setting of a problem

One of the important trends in the development of modern computer systems is ontologically managed information systems. The construction of the latter is closely connected with the development of theoretical foundations and design methodologies including a formalized approach, fundamental principles and mechanisms, generalized architecture and structure of the system, a formal model and methodology for designing ontology of the subject field (including ontologies of educational disciplines), formal model of presentation of knowledge, generalized algorithms of procedures for knowledge processing, etc. Accordingly, each of the listed components of the overall design methodology is a complex information and algorithmic structure and is part of the field of future teachers-engineers in the field of computer technologies (CT). Comprehensive solution of these tasks of design will provide an opportunity to enhance the role of ontological (conceptual) knowledge in solving concrete problems in applied branches in general and in the educational process in particular [4, p. 9].

Investigations on the study and use of computer ontologies by the future teachers-engineers in the field of CT cover both cognitive knowledge of knowledge bases and their means of engineering, and the structure of information (a list of its types and relationships), necessary for obtaining solutions, means of obtaining and preparing this information, the procedures for setting tasks for the design of computer ontologies, solving these problems and obtaining results.

However, the process of designing computer ontologies is complex and lengthy and requires knowledge of many declarative languages, and in order to facilitate it, there is a need for the use of certain systems created to design computer ontologies that provide such interfaces that allow them to conceptualize, implement, verify inconsistency and documentation. In recent years the number of tools for working with computer ontologies has increased dramatically (more than 50 editing tools). However, most of these tools are intended to use existing ontologies by the help of formal languages, such as: Common logic; Cyc; Gellish; IDEF5; KIF; Rule Interchange Format (RIF) and F-Logic; OWL; XBRL [20]. Therefore, in the process of training future teachers-engineers, it became necessary to use these systems for designing computer ontologies that could provide interfaces that would allow operations to be carried out in connection with the formal representation of sets of concepts and relationships between them. Computer system ontology (CSO) is a definite answer to this need specifically in the context of designing computer ontology of the discipline subject field by future engineers-teachers in the field of CT.

1.2 Analysis of recent research and publications

The process of developing and using ontology in general form is considered in the works of Sergei Nirenburg [17], Natalya Fridman Noy [18], Victor V. Raskin [23]. Problems of ontologies and their use in computer systems were considered by Vladimir A. Lapshin [9]. The discovery of the meaning of the concept of “ontology”, given to it in the computer sciences, the works of James F. Allen [19], Richard Fikes [15], Thomas R. Gruber [6], and others are devoted to it. Some aspects of the use of computer ontologies, in the context of intellectual technologies, are discussed in the works of Vasyl V. Lytvyn [13], Oksana M. Markova [14], Volodymyr V. Pasichnyk [11], Serhiy O. Semerikov [24], Oleh M. Spirin [26], Illia O. Teplytskyi [25], Ivan M. Tsidylo [31], Yurii V. Yatsyshyn [12] and others. An overview of the instruments of ontology engineering was done by Olha M. Ovdii and Galyna Yu. Proskudina [20]. Methods for creating an interface based on ontology in the environment of the WEB portal were studied by Kostiantyn V. Liashuk [27], Maryna A. Popova [22], Oleksandr Ye.

Stryzhak [28]. The modeling of the ontology of the educational subject field as a means of integrating knowledge was studied by Vira V. Liubchenko [10], Oleksandr Ye. Stryzhak [28], Ivan M. Tsidylo [30], Olena H. Yevseieva [32] and others. Modeling the categorical level of the language-ontological picture of the world was studied by Oleksandr V. Palagin and Mykola H. Petrenko [21]. Ontological representation of decision-making processes was done by Yurii P. Chaplinskyi [3]. Using the ontology of the subject area to eliminate ambiguities in the computer translation of technical texts was applied by Alla V. Morentsova [16] and others. The works of the above-mentioned authors contributed to the accumulation and systematization of knowledge for improving the practical training of students on the creation and use of computer ontology. However, they do not sufficiently revealed the peculiarities of the creation of the ontology of a certain subject field in the professional training of future teachers-engineers of the computer field, taking into account the professional-engineering and professional-pedagogical activities of future specialists.

1.3 Purpose

The purpose of the article is to justify the methodology of designing the ontology of the subject field of the discipline as a means and result of systematization of knowledge in the process of preparation and practical work of the future teachers-engineers in the field of computer technologies.

2 Results of the study

In the process of training teachers-engineers in the field of CT in the higher educational institutions, a significant place is the study of intelligent systems, in which ontologies are used for the formal specification of concepts and relationships that are inherent in a certain field of knowledge. Since the computer cannot understand how a person does, the state of things in the world, it must be submitted with all the information in a formal way. Consequently, ontologies serve as a kind of model of the surrounding world, and their structure is such that it is easily subjected to machining and analysis. Ontologies provide the system with information about well-described semantics of given words and indicate the hierarchical structure of the medium and the relationship of the elements. All of this allows computer programs to draw conclusions from available information and manipulate those using ontologies.

The term “ontology” first appeared in the work of Thomas R. Gruber [3], who considered various aspects of the interaction of intellectual systems directly between themselves and with man. Intelligent systems are called programs that simulate some aspects of human intellectual activity. Certainly, any program to some extent deals with this simulation, because this is the value of a computer for a person: the computer system allows you to free it from performing some rather complex and sophisticated, but always the same type of activity: the computer system created, for example, for editing graphics, cannot be used to manage complex production machines.

The task of constructing a description of knowledge is very specific. Therefore, Gruber has identified a specific term for this task – the explicit specification of conceptualization. A conceptualization is an abstract, simplified view of the world that we wish to represent for some purpose. Every knowledge base, knowledge-based system, or knowledge-level agent is committed to some conceptualization, explicitly or implicitly. The peculiarity of the task of conceptualization lies in the fact that for the exchange of knowledge between software systems (in the context of the concept of artificial intelligence), it is necessary to openly specify their conceptualization, that is to build a description of this knowledge, moreover, sufficiently formal, that it was "understood" by other systems.

In the process of developing intelligent systems, the most time-consuming are the stages of conceptualization and formalization, which are considered in work [2] in the process of designing a structural model of a neuro-fuzzy expert decision-making system for determining the professional selection of students for the training of IT specialties.

Consequently, the concept of "engineering ontology" can be defined as a specification (a formal description) of a certain conceptualization (representation of the subject field of the investigated task as necessary for a particular task). If the specification of the interpretation is rather unambiguous, then conceptualization is not all so simple. Thomas R. Gruber believed that conceptualization was carried out in terms of classes and attributes [7, p. 911]. The medium of the study problem is presented in the form of concepts that are described by classes, along with their properties (attributes) and specific objects – instances of classes.

More specifically, the concept of ontology is defined by David Faure, Claire Nédellec and Céline Rouveirol [5], who assumes that ontology is an explicit specification of a particular topic.

This approach involves the formal and declarative representation of some of them covering the dictionary (or list of constants) for reference to the terms of the subject industry, limiting integrity to terms, logical statements that limit the interpretation of terms and how they relate with each other.

Thus, ontology defines a general terminology for scholars who need to share information in a particular subject area. It covers computer-aided interpretations of the basic concepts of the subject industry and the interrelationship between them.

Thus, ontology defines a general terminology for scholars who need to share information in a particular subject area. It covers suitable for interpretation by means of a computer definition of the main concepts of the subject field and the interconnection between them. With the increasing popularity of usage of computer ontologies, their study should be included in the curricula of the higher educational institutions, since they can generate test tasks, create didactic materials from different disciplines and branches of knowledge, etc.

However, as noted above, the process of designing computer ontologies is complex and lengthy and requires knowledge of many declarative languages. Therefore, in the activities of future CT teachers-engineers it is more appropriate to use CSO that are a computer program or software package that intended for the construction of computer ontology from a certain subject field and perform operations related to the formal representation of sets of concepts and relationships between them, in addition, computer ontologies can be exported to a variety of formats, including invoking RDF (RDF Schema), OWL and XML Schema, etc.

Regarding the choice of a specific CSO, it should be implemented according to some of the following criteria [8]:

- software architecture and development of tools containing information about the necessary platforms for using the tool;
- functional compatibility, which includes information on tools and interaction with other languages and tools for the development of ontologies, translation from some languages ontologies;
- the intuition of the interface, covering the work with graphic editors, the co-operation of several users and the need to provide multiple use of ontology libraries.

However, for the construction of computer ontology of the subject field of the discipline, future teachers-engineers need to reflect the content of the subject field of the discipline, which is described in the form of a list of modules, implemented in various forms of occupations in a particular discipline. While in addition to the content, form and control of their volume, the corresponding competence for each module are indicated. Based on the analysis of the subjects and objects of the learning process, the processes of creating and managing the educational material, one can identify the following problems that arise during the development of the training course:

- high complexity of the process of finding new teaching materials;
- the need to assess the conformity of educational resources with the requirements of the content of the training course;
- providing educational resources with the full coverage of the modules of the discipline in general and the course in particular;
- excessive coverage of the modules of the discipline and implementation of the choice of the most optimal educational resource for a particular situation;
- the need to assess the quality of educational resources.

Thus, in the process of developing the content modules of the discipline, it is important that on the basis of the system analysis of the specifics of the subject field, the following requirements for the model of presentation of knowledge and data, which was offered by Anton V. Anikin [1, p. 62].

1. The model should describe the subject discipline, the structure of the subject field, the hyponymic relationship between the concepts of the subject industry (hierarchical relations), the relation of the meronymic (part-whole), the connection of related terms (which may, in particular, reflect antagonistic relationships, active-passive relationships, cause-effect relationships, position or paradigmatic relationships).
2. The model should describe the synonymy of the terms of the subject field of the discipline, as well as their presentation in various languages.
3. The model should describe: competences of different levels, obtained because of mastering the discipline; the knowledge, skills and abilities they carry out; hierarchical relations between these elements.

4. The model should describe the electronic educational resources, regardless of their presentation, place of storage, didactic role and allow the creation of a repository of such resources based on their descriptions. In this case, the description of the educational material should include the specified parameters, as well as the language of presentation of information, the educational goal in the form of the received competencies, determined through knowledge, skills, and complexity of educational resources.
5. The model should describe the student's profile: the choice of language, the current field of knowledge of the studied discipline taking into account the level of his knowledge of the various structural elements of discipline, the level of mastering of individual competencies within the framework of the discipline as well as the learning objectives described on the basis of the target competences of the discipline.
6. The model should describe the personalized educational collection as a plurality of learning resources, which is a subset of the discipline and is included in the repository, selected based on the student profile, as well as the set of relations between them, which specify the recommended order of their study.
7. The model should ensure the harmonization and integration of the description of the teaching resources, the subject discipline, the student profile and personalized e-learning material through the use of general concepts of the subject industry for the identification and reuse of: competencies (current and target), data through knowledge (presented in the form of terms – concepts of the subject field), skills and assumptions; language (representation and perception of information); the complexity of teaching material and the level of knowledge of these competencies.
8. The model should provide the possibility to search educational material according to its parameters, the possibility of building a personalized electronic educational collection based on the profile of the student and the repository of the subject field.
9. The model should support accumulation, distribution (joint use) and reuse of knowledge about the subject field of educational disciplines in electronic educational resources.
10. The model should provide modularity and extensibility.

To implement a model of presentation of knowledge and data that meet the requirements considered, it is expedient to use an ontological model of presentation of knowledge, which combines the properties and advantages of other models of presentation of knowledge and data (graph model, tree-based model, relational model, semantic network, framing, logical model, etc.).

Solving the tasks of the search and integration of educational material in the personalized educational collection can be realized in the ontological model because of the development and inclusion of the corresponding semantic rules in computer ontology.

The formal model of ontology can be represented as:

$$O = \langle C, R, F \rangle,$$

where C – the final set of concepts of the subject field, which determines the ontology of O; R – the final set of relations between them; F is the final set of functions of interpretation given on the concepts and / or ontology relations of O.

The restrictions imposed on the set C are not infinity and are not empty ($C \neq \emptyset$). The sets R and F can be empty, which corresponds to certain types of ontology, when it degenerates into a simple dictionary ($R = \emptyset$, $F = \emptyset$), taxonomy of concepts ($F = \emptyset$), etc.

One of the possible ontological bases for describing computer ontologies in the context of the use of CSO by future engineer teachers, presented in the work of Iurii A. Zagorulko and Olesia I. Borovikova [33, p. 197], are:

- classes united in taxonomy;
- relationship (type of links between concepts of the subject industry);
- functions (a special kind of relationship in which the *n*-th element of the relationship is determined by the values of n–1 of the preceding elements);
- axioms (simulate offers that are always true);
- specimens (entities) that make up specific objects of the real or abstract world.

Iurii A. Zagorulko and Olesia I. Borovikova [33, p. 199] chose OWL-DL, the language for the description of ontology, recommended by the consortium W3C, which is widely used in Semantic Web, is able to be converted by the overwhelming majority of CSO and allows to use:

- the logic of the first order for assigning axioms to ontology concepts through the design of constructs of descriptive logic;
- existing ontology output machines on OWL-DL, allowing for arguments based on the rules of descriptive logic;
- existing free tools for designing ontologies in the OWL-DL language.

OWL-DL combines OWL expressiveness and completeness of computations (all logical conclusions performed on an ontology basis will be thoroughly calculated) and extensibility (all calculations are completed at a certain time). The OWL-DL contains all OWL language constructs that are subject to certain restrictions (for example, a class may be a subclass of many classes, but cannot be a representative of another class).

Accordingly, the ontological model of the subject discipline of the discipline ODD (Fig. 1) will be defined as:

$$O_{DD} = <C_{DD}, Inst_{DD}, R_{DD}, I_{DD}>,$$

where C_{DD} is the final set of concepts for the ontology of the core curriculum knowledge ($C_{DD} = \{c_{DD1}, c_{DD2}, c_{DD3}, c_{DD4}, c_{DD5}, c_{DD6}, c_{DD7}, c_{DD8}, c_{DD9}, c_{DD10}, c_{DD11}, c_{DD12}\}$, c_{DD1} is the DataDomain class for the definition of the subject discipline; c_{DD2} is the Competence class for identifying competences in a learning discipline; c_{DD3} is a Concept class for defining the concepts (terms) of a discipline subject field that is a subclass of c_{DD2}; c_{DD4} is a UCompetence class for identifying universal competencies; c_{DD5} is a class of PCompetence for defining professional competencies; c_{DD6} is a ZNKCompetence class for general knowledge competencies; c_{DD7} is a ICompetence class tool for determining competence; c_{DD8} is a SOKCompetence class for the definition of social / personal / general cultural competencies; c_{DD9} is the Skill class for determining the skills obtained in the subject discipline, which is a subclass of c_{DD2}; c_{DD10} is the Ability class for determining the skills obtained in the subject field of the discipline, which is a subclass of c_{DD2}; c_{DD11} is a Language class that defines the language of presentation of information in the discipline subject field; c_{DD12} is a Complexity class to determine the level of development of competencies of the discipline);

$Inst_{DD}$ is the set of competencies, concepts of the subject discipline, as well as the skills represented in the natural language of instances of classes C_{DD}; $Inst_{DD} = \{i_{DD1}, i_{DD2}, ... i_{DDm}, ... i_{DDn}\}$;

R_{DD} is the final set of relations of the ontology of the knowledge base of the discipline; ($R_{DD} = \{r_{DD1}, r_{DD2}, r_{DD3}, r_{DD4}, r_{DD5}, r_{DD6}, r_{DD7}, r_{DD8}, r_{DD9}\}$; r_{DD1} is a hasLanguage ratio, r_{DD2} is a hasComplexity ratio, r_{DD3} is a ratio includes, r_{DD4} is a hasHierarchicalRelation ratio, r_{DD5} is a dependOn ratio, r_{DD6} is a ratio isSynonym, r_{DD7} is a ratio "is", r_{DD8} is a hasTitle, r_{DD9} is a hasCompetence);

I_{DD} is the set of interpretation rules, $I_{DD} = \emptyset$.

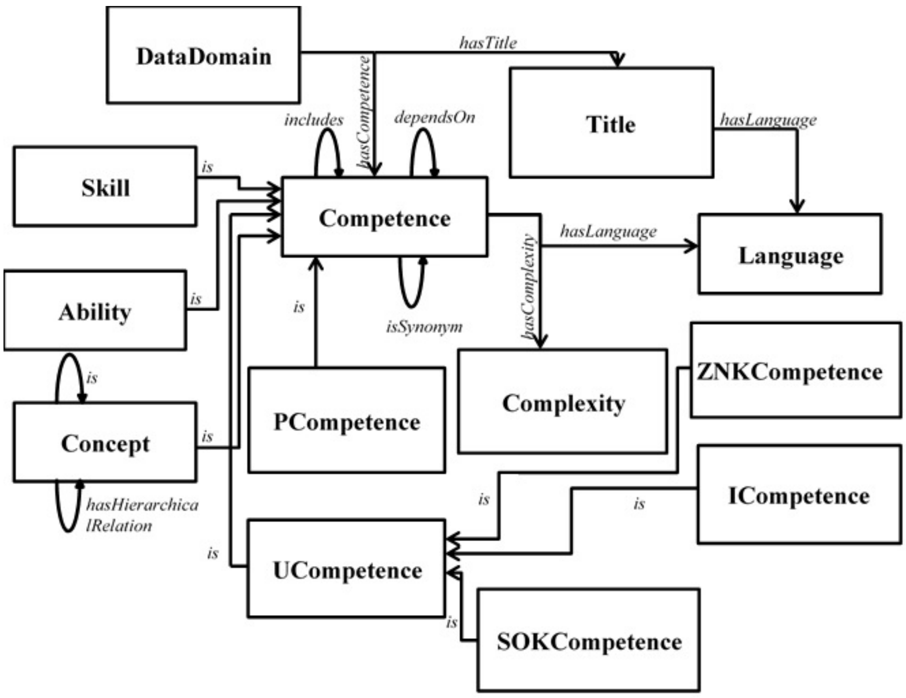

Fig. 1. Scheme of ontology of the subject field of discipline

The set of concepts for the C_{DD} ontology of the knowledge base of the discipline is presented in Table 1, and the set of R_{DD} relationships is in Table 2. The defining areas and the domains of relationship values can be both defined concepts and their daughter concepts within the framework of the ontology. Based on the plurality of these concepts and the relationship between them using the CSO, future teachers-engineers will be able to conduct ontological design of the subject field of the discipline they need.

Table 1. The set of concepts of ontology of the subject discipline

Ontology concept	Parental concept	Concept description
DataDomain	Thing	Subject field of discipline
Competence	Thing	Competences
Concept	Competence	Concepts (terms) of the subject discipline
UCompetence	Competence	Universal competences of the subject discipline
PCompetence	Competence	Professional competence of the subject field of the discipline
ZNKCompetence	UCompetence	General scientific competence of the subject field of the discipline
ICompetence	UCompetence	Instrumental competences of the subject discipline
SOKCompetence	UCompetence	Socio-personal / general cultural competences of the subject discipline
Skill	Competence	Skills in the subject field of the discipline
Ability	Competence	Ability of the subject field of the discipline
Language	Thing	Language of presentation of information
Complexity	Thing	Level of mastery of the competence of the subject discipline

Table 2. The set of relations of the ontology of the subject discipline

Correlation	Definition area	Value range	Description
hasLanguage	Competence	Language	The ratio that sets the language of the presentation of the ontology
hasComplexity	Competence	Complexity	The ratio that sets the level of competence development
includes	Competence	Competence	The relation of inclusion of competences in the competence of a higher level, concepts, skills and abilities – in competence (through the mechanism of imitation)
dependsOn	Competence	Competence	Relationship between the two competencies, concepts, skills or abilities
isSynonym	Competence	Competence	The relation of synonymy to the concepts of the subject field and competencies
is	Concept	Concept	The relationship "is" between the concepts of the subject field
hasHierarchicalRelation	Concept	Concept	The ratio of the hierarchy between the concepts
hasTitle	Competence DataDomain	String	The ratio that sets out the description of competence, concept, skills, ability in form of text
hasCompetence	DataDomain	Competence	The ratio that sets the relationship of competence with the subject field

However, the question about the methodology of designing computer ontology remains unsolved. Now there are several methods of constructing ontologies and they all are based on the principles proposed by Thomas R. Gruber [7]:

- *Clarity*. Ontology must effectively convey the meaning of the terms. Definitions should be objective, although the motives for introducing terms may be determined by the situation or the requirements of computing efficiency. To objectivize definitions, a clearly defined formalism must be used, in which logical definitions should be defined as logical axioms.
- *Coherence*. The ontology must be compatible, that is, the conclusions that can be drawn from the definitions of concepts and relationships between them must be compatible with the initial terms. Compatibility should also be maintained for the concepts informally described. If the conclusions drawn from the formal meanings are incompatible with the informal descriptions, then the ontology is considered incompatible.
- *Extendibility*. The ontology must be constructed so that it can be used without additional effort in separate ontology libraries. One of the most important conditions for such a design is the ability to identify new concepts based on the elements existing in the ontology so that this does not require the change of the latter.
- *Minimal encoding bias*. The projected conceptual scheme should not depend on the specific language used to record the formal description. Dependence on coding occurs when the choice of an ontological representation is based on compatibility with the peculiarity of the language in which the ontology is written. This dependence must be minimized so that various ontology databases using other languages can easily understand the projected ontology.
- *Minimal ontological commitment*. The ontology must contain at least the facts about the ontology of the world, which is modeled, while giving the freedom to use this ontology in others. If the conceptual scheme of the problem is that the description of the ontology of the world is essential, then this description should, if possible, be minimal. One should restrict itself to merely recounting the terms of the concepts without determining the relation between them that is to build a "weak" theory. Then different bases of ontologies, which determine the ontologies of the world in their own way, can give meaning to this concept.

However, in the context of designing computer ontology of the subject field of discipline by means of Protege, it is most appropriate to use the technique of constructing an ontology proposed by Vasyl V. Lytvyn, Volodymyr V. Pasichnyk and Yurii V. Yatsyshyn, which includes seven steps [12, p. 319].

Step 1. Define the industry and the scale of the ontology. Work on the development of ontology should begin with determining its scope. To this end, competence issues are being developed to verify the relevance of the ontology of a given subject field, which will continue to serve as a litmus test, giving an idea of the completeness of the information provided and the level of its detail.

Step 2. The ability to use existing ontologies. It is worth bearing in mind that somebody worked on the task of creating an ontology, for example, in the field of material science. Then you need to check the possibility of adapting the existing ontological systems for our specific subject area. Otherwise, work must start from scratch. Today, many developed ontologies in various subject areas are available and can be successfully imported into the design environment chosen by the developer.

Step 3. List of important terms in ontology. It is useful to compile a list of all the terms and their properties, which provide the basic information about the given subject area. At the beginning, it's important to get a complete list of terms without worrying about whether the concept is a class or property.

Step 4. Define classes and their hierarchy. There are several approaches to constructing a hierarchy of classes: top-down, bottom-up, and combined process.

Step 5. Define the properties of the classes. After determining a certain number of classes, it is necessary to describe the internal structure of concepts. In step 3, the classes in the list of terms created were selected. Most of the remaining terms are likely to be the properties of these classes. All subclasses of the class inherit the property of this class.

Step 6. Determination of facets properties. Properties may have different facets that describe the type and factor (power) of the property value, range, and other characteristics that it may have.

Step 7. Creating instances. The last step is to create separate instances of classes in the hierarchy. To determine an individual instance you need:

- choose a class;
- create a separate instance of this class;
- enter slot values.

Therefore, for the design of computer ontology of the subject field of educational discipline for future engineers-teachers in the field of computer technologies, it is expedient to carry out the following algorithm:

- Select on the basis of the scheme proposed in Fig. 1, competencies of the first level – universal (general, instrumental, social-personal competencies of subject discipline) and professional – on the basis of analysis of the work program of discipline and matrix of competencies. Describe them as instances of the corresponding classes of computer ontology of the study discipline (UCompetence, PCompetence, ZNKCompetence, ICompetence, SOKCompetence).
- Sequentially allocate competences of the second level by analyzing the list of acquired knowledge, skills and abilities. Describe them as instances of the corresponding classes of computer ontology of the discipline (Concept, Skill, Ability).
- Based on the analysis of the work program of the discipline and the matrix of competencies, allocate the third level competencies that are implemented within each module of the curriculum and describe them as instances of the corresponding classrooms of the computer ontology (Concept, Skill, Ability).
- Based on the knowledge of the future teacher-engineer in the field of CT on the subject discipline and the availability of educational-methodical literature, identify the competences of lower levels and describe them as instances of the corresponding classes of computer ontology of the discipline (Concept, Skill, Ability). The

recommended number of levels of competence in describing the set of knowledge discipline is 3 or 4. Additional levels can be used in the description of knowledge in the form of concepts of the subject area in the case of availability in the individual modules of discipline a large number of terms of the subject field, which are related hierarchically. For the description of skills and abilities, in most cases it is up to 3-4 levels of competencies.

– On the basis of the curriculum work program, as well as knowledge of the subject area and the analysis of educational methodical literature, identify the relationship between the competencies described and set them with the following relationships of the ontology of the discipline: includes (the ratio of the inclusion of competencies in a higher level of competence), dependsOn (dependency ratio between two competencies, concepts, skills or abilities). If there is synonymy, set the appropriate relation to isSynonym. In describing the discipline subject field, use the hasTitle and hasLanguage relationship to describe the description of the respective competences in the natural language and language of the description.

3 Conclusions and perspectives of further research

1. The scheme of the ontology of the subject discipline is presented based on which the future teachers-engineers in the field of CT are. In it, the set of concepts of the future computer ontology of the subject discipline is represented; and the set of relations between them, and corresponding definition areas and range of values can be as these concepts, as well as their daughter concepts in the framework of ontology. Based on the set of these concepts and the relationships between them using the CSO, future teachers-engineers will be able to conduct ontological design of the subject field of the discipline they need.
2. The main criteria for choosing a CSO are: 1) software architecture and tools development contain information on the required platforms for using the tool; 2) functional compatibility contains information on tools and interaction with other languages and tools for the development of ontologies, translation from some languages ontologies; 3) intuitive interface – covers work with graphic editors, collaborative work of several users and the need to provide multiple uses of ontology libraries.
3. In the process of selecting a method for designing computer ontologies by means of CSO, the optimal option in the educational process of the future teacher-engineer is the method proposed by Vasyl V. Lytvyn, Volodymyr V. Pasichnyk and Yurii V. Yatsyshyn [12], which provides a number of stages of designing a computer ontologies.
4. The methodology of designing computer ontology of the subject discipline for the future teachers-engineers in the field of CT is offere, which includes the scheme of ontology of the subject discipline, the choice of CSO with the help of which the project is being implemented. The methodology of designing computer ontology and the algorithm for computer ontology designing of the subject discipline for future teachers-engineers in the field of CT is proposed.

5. The continuation of scientific research on the given problem is useful in the study of the dependence of constructed hierarchy concepts in the computer ontology of the subject discipline and the development of ontologically managed information systems on their basis.

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TODOS as digital science-support environment to provide STEM-education

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Abstract. The amount of scientific information has been growing exponentially. It became more complicated to process and systemize this amount of unstructured data. The approach to systematization of scientific information based on the ontological IT platform Transdisciplinary Ontological Dialogs of Object-Oriented Systems (TODOS) has many benefits. It has been proposed to select semantic characteristics of each work for their further introduction into the IT platform TODOS. An ontological graph with a ranking function for previous scientific research and for a system of selection of journals has been worked out. These systems provide high performance of information management of scientific information.

Keywords: TODOS, science environment, educational environment, ontology, taxonomy, STEM-education.

1 Introduction

1.1 The problem of digital science

Nowadays, cooperation and all-world international integration are conducted. Therefore, it leads us to the generation of a huge amount of not-structured information. One of the humanity actions fields which is one of the leaders of information production is science. The situation is being complicated due to the fact that providing science is foresees knowing of the huge amount of already made scientific researches.

Therefore, in science nowadays is a lot of information generated and there is a problem to process it. Considering this, educational approaches are adopting and one the modern approaches which include principles of multidisciplinary and studying to work with a huge amount of knowledge is STEM-education. The specifics of it is the lack of digital instruments to provide it [2; 3; 20].

1.2 Scientometric databases in post-soviet countries challenge

For post-soviet countries, this situation is even more important due to the fast speed of integration of their science with worldwide which wasn't provided previously.

Nowadays, in the example of Ukraine, the huge challenge is to provide publication in both well-known scientometric databases (such as Scopus or Web of Sciences) and journals recommended by Ministry of Education and Science of Ukraine (scientific professional editions of Ukraine; further – SPE). This makes informational chaos in the field of journal selection to publish the results of scientific work.

1.3 Information processing problem

As was noted before, a huge amount of scientific information is generated nowadays. However, there is no effective was to process them. Sure, systems which can simplify exists, such as Mendeley, but they still do not provide analysis and processing of the information. For example, well-known designs can only provide commenting of the scientific papers which isn't provide any analysis and actually do not provide any systemizing of the information to provide structuration. The interface of commenting in Mendeley is shown in Figure 1.

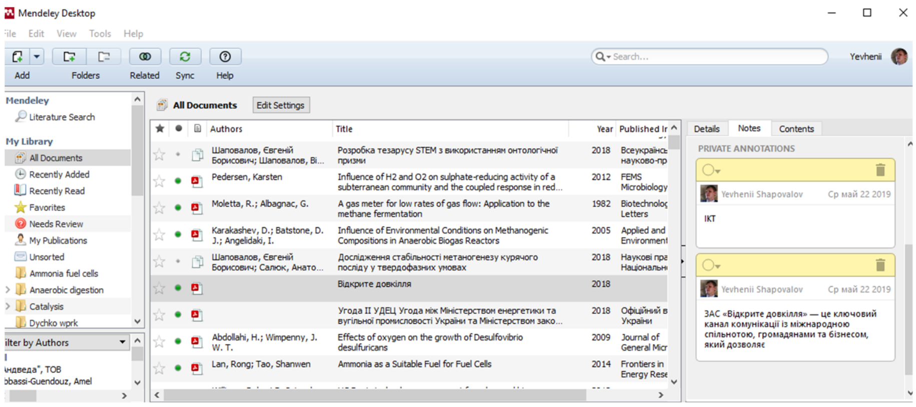


Fig. 1. The interface of commenting in Mendeley

We propose using of Transdisciplinary Ontological Dialogues Object-Oriented Systems (TODOS) [6; 9; 13; 25; 26] to provide systemizing and processing of Big Data with taxonomy creation, filtering, and ranking of information. A key benefit of this system is the context-based method of data processing and structuring based on semantic relations. Previously, there was provided attempts to use ontology-based approaches in education [1; 7; 8]. However, they were characterized by not attractive for students and teachers' interface and by low interactivity such as the absence of multiagency approaches or wasn't interactive at all. In the case of Ukraine, it is very important to provide education in the national language and IT platform TODOS can implement it.

Therefore, this work aims justification of necessarily of digital science supporting processing and creation of the base of it.

2 Literature review and problem statement

2.1 TODOS as ontology systemizing of information

Using the ontological approach to provide informational systemizing is an important part of the learning process [4; 5]. Such an educational environment based on the ontological approach involves filling adaptive educational services with information resources that reflect the conceptual system of a particular discipline. The methodical provision of the educational-cognitive process consists of the assimilation of the conceptual system, axiomatics, rules, syntactic and morphological foundations of this theory. The set of terms determines the conceptual basis of scientific theories by determining a certain ordering of the concepts of the discipline. Thus, the ontological multiagent in content reflects the conceptual system of a certain disciplinary theory. It takes into account the individual characteristics of each subject of the educational process.

Structures in TODOS are represented by three categories (O, A, R), where O and A are a set of elements called objects and attributes, and R, respectively, is the binary relation between O and A. In particular, if oRa for o O, A, then we assume that "the object possesses the attribute A" or "the object has the attribute O" [7].

The feature of the ontological graph is the high level of structuring and data visualization, the possibility of transition between related edges and search for semantic links between vertices and its elements. The graph provides a transition to scientific data carried out quickly and understandably. In addition, operationality of information can be significantly improved by transforming it to taxonomy under using of ontological approach [6; 22].

TODOS is an innovative complex of programmatic information and methodological knowledge management tools using ontological management approaches to corporate information resources, where people are considered as the source of the birth of new knowledge for transferring them in the form of their own knowledge through the tool TODOS, which is the only integrated point of access – "the single window" – to the information and applications of the system to provide interactive interaction with users. A key benefit of this system is the context-based method of data processing and structuring based on semantic relations.

The architecture of the formation of transdisciplinary information environments IT-platform based on the multiple procedures of transdisciplinary interaction with network information resources is realized on the basis of semantic control and ontological interface of TODOS [23; 26]. The technical basis of the TODOS is consisted of [25]:

- SYSTEM CONSPECT provides the construction of terminological trees based on the analysis of natural language text. It is a linguistic processor that provides the initial formation of a linguistic case and allows to solve the following practical tasks: improving the quality of processing of linguistic texts by increasing the vocabulary of the system; automatic definition of thematic directions of the document; sorting of documents according to thematic directions.

- SYSTEM CONFOR provides the creation of ontology subject areas, classification, and generation of taxonomies in the form of ontological graphs. The system ensures the creation of subject area ontology, classification, and generation of taxonomies in the form of ontological graphs, which allows solving the following practical tasks: construction of a semantic network of terms of the document; combining semantic network of terms for several documents.
- SYSTEM EDITOR ensures the formation of ontological models through the creation, editing, review and analysis of networks of concepts based on the construction of semantic links between objects of the subject area and the formation of patterns, presented in the form of a set of values of attributes, which describes the initial concepts of subject areas. The isolation of regularities is carried out by the method of inductive formation of concepts based on the pyramidal network.
- ALTERNATIVE SYSTEM ensures the organization of objects-concepts of ontology, on the basis of integrated processing of properties that characterize them. For this, we use weight, ball, and linguistic scales. Each such scale defines the values of the criteria characterizing the properties of the objects of the thematic ontology of the subject area. In general, the properties-criteria are characterized by different degrees of importance, which when solving the problem of choice are given by some real numbers – weight coefficients. Before solving the problem for each criterion, it is necessary to form its value for each alternative. Thus, the formation of ontologies of the tasks of choice is ensured.
- LINGUISTIC CORPUS and built into its environment SEARCH MACHINE provides marking and indexing of semantic units that define and describe the contexts of objects of thematic ontologies of the subject areas. Contexts of semantic units make up an electronic library with means of associative search of semantically related information arrays, including determining the level of semantic equivalence of texts.

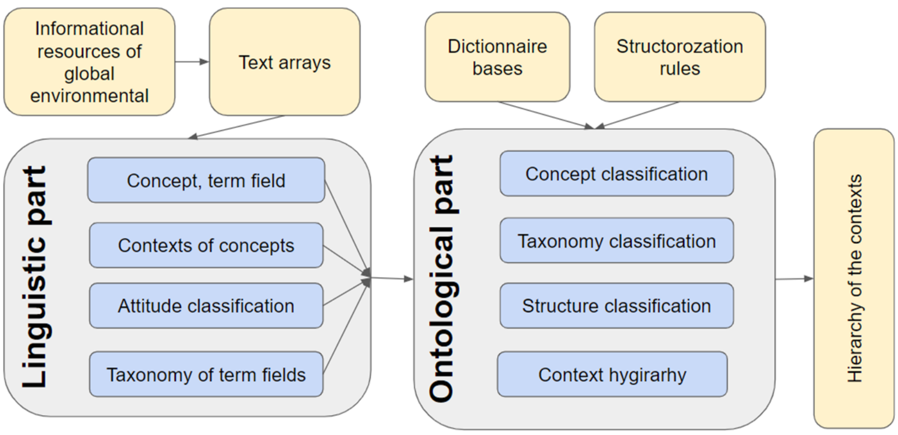


Fig. 2. Information management system TODOS

These modules are working together to transform unstructured incoming data to the hierarchy of contexts. Information management system TODOS is shown in Figure 2.

2.2 Main features of the TODOS: taxonomy, filtering, ranging

Ontologies are based on taxonomy creation. The main feature of the TODOS platform is a simplification of its creation. To create the ontology user do not need to know any programming languages just MS Excel. The example of taxonomy created on TODOS platform is presented in Figure 3.

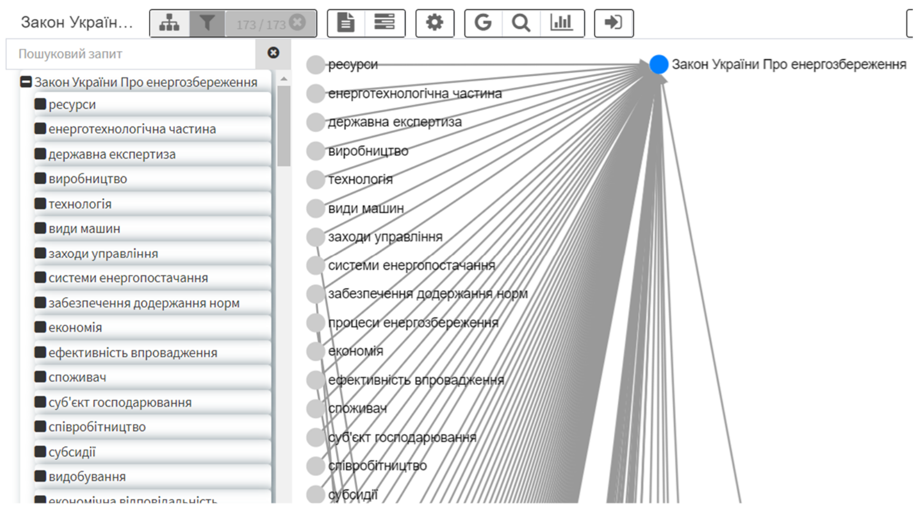


Fig. 3. The example of a taxonomy provided by TODOS platform

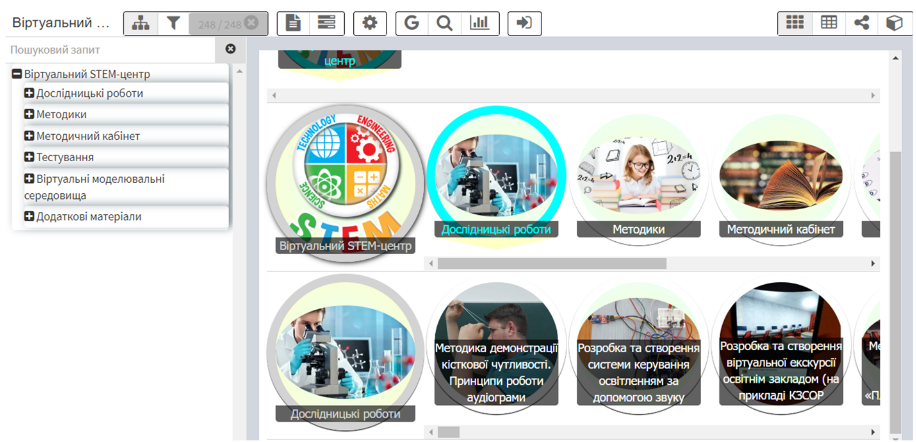


Fig. 4. The example of an objective view of the ontology created in TODOS platform

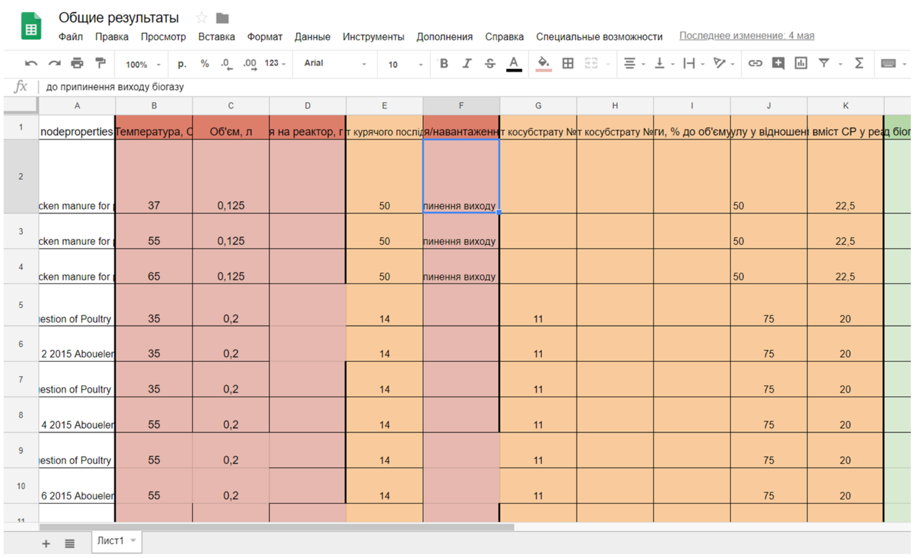
To provide visualizing of the taxonomy, it’s possible using the objective view. This view presents each edge of the ontology as a personal object. The hierarchy is saved by creating links between those objects. The example of a taxonomy provided by TODOS platform is presented in Figure 4.

Analysis of information is provided through the identification and separation of semantic information of each edge. As edge, we can use any object kind scientific paper, single microorganism, the technology of water clearing, etc. It depends on the expert-creator idea, but anyway, it provides separation of the semantic data of edges. This can provide further data processing and systemize in way of filtering of ranking. The proposed informational system is characterized by multiagent features and has all the benefits of such a system.

3 Materials and methods

For creating digital educational programs and other educational content, the sheets were loaded to the part of TODOS IT-platform editor4. After that, the generation of the graph edges with its characteristics was carried out.

To store information and provide its sharing, Google sheets were used, with their further conversion into the .xls and .csv MS Excel sheets (see in Figure 5).



	A	B	C	D	E	F	G	H	I	J	K
1	nodeproperties	Температура, С	Об'єм, л	я на реактор, г	т курячого послід	я/навантаження	т косубстрату №1	т косубстрату №2	ги, % до об'єму	улу у відношенні	вміст СР у реа
2	cken manure for	37	0,125		50	пинення виходу				50	22,5
3	cken manure for	55	0,125		50	пинення виходу				50	22,5
4	cken manure for	65	0,125		50	пинення виходу				50	22,5
5	estion of Poultry	35	0,2		14		11			75	20
6	2 2015 Abouelen	35	0,2		14		11			75	20
7	estion of Poultry	35	0,2		14		11			75	20
8	4 2015 Abouelen	55	0,2		14		11			75	20
9	estion of Poultry	55	0,2		14		11			75	20
10	6 2015 Abouelen	55	0,2		14		11			75	20

Fig. 5. Google sheet with data

The obtained documents were used to create the ontology structure .xml and to fill the ontology graphs with semantic and numeric information for ranking and filtering. Some of the instruments of the web-oriented educational environment are using intellectual features of TODOS, and to provide it, semantic characteristics were added.

The received documents were used to create an ontology structure (xls) and to fill the ontology graphs of ranking and filtering. To provide it, they were downloaded in editor4, the part of TODOS IT-platform. After that, the graph generation and the inputting of semantic characteristics to each vertex were carried out. Ontological edges were formed using predicate equations [25]:

$$Pr(x_1,\ldots,x_n) = \begin{cases} 1, \neg Pr(YGrx_i) \wedge Pr(x_1,\ldots,x_n) \\ 0, Pr(YGrx_i) \end{cases} \tag{1}$$

where $x_i \in X; 1 \le i \le n$.

The relation between taxonomic categories has the properties of the hyperrelation *Gr* type – *YGrx*, where *Y* is the set of all possible sets of concepts of *X* taxonomic category *T*, *x* is one of the concepts of this set and *Pr* – predicate.

The obtained ontological graphs were opened in the appropriate form, ranking or filtering. To provide filtering, the function of choice has been applied. The function of choice in terms of taxonomic categories is as follows:

$$\forall \boldsymbol{T}\left[\emptyset \notin \boldsymbol{T} \Rightarrow \exists \boldsymbol{F}: \boldsymbol{T} \rightarrow \cup\, \boldsymbol{T}, \forall \boldsymbol{T} \in \breve{\boldsymbol{T}}(\boldsymbol{F}(\boldsymbol{T}) \in \breve{\boldsymbol{T}}\right] \tag{2}$$

where *F* – is a function of the interpretation of a certain ontology; *T* – taxonomy.

4 TODOS as the digital science-support environment

All advantages of TODOS can be used to both systemize the science information and to create useful databases (Big Data based) instruments for the scientist.

4.1 Using TODOS to create Big Data databases

SPE and SCOPUS ontology-based selection systems.

We created the online web-oriented ontological graph for both, SPE and SCOPUS journals to provide selection. As graph edge, each journal was chosen. For both, semantic characteristics were separated. For SPE journals they were “Founder”, “Branch of science”, “Date of inclusion/renewal”, “Journal indexing”, “Journal specialization ». User can use those characteristics to select a journal du to it needs. SPE journal selection instrument is presented in Figure 6.

To create a database on SCOPUS journals “SJR”, “SNIP”, “CiteScore”, “Activity status” (active or not), “All Science Classification Codes (ASJC)”, “Language in the source (three-letter ISO language codes)” and “Publisher’s Country” were separated from each journal and added to edges as semantic data. Scopus journal selection instrument is presented in Figure 7.

Ontology-based catalog of the microorganisms.

Systematization of knowledge in the field of biotechnology may also be complicated by the fact that semantic characteristics cannot always be quantified, and therefore the ranking system cannot always solve the issue of information management. For such systems, it was suggested to separate the semantic information and apply a filtering function. The semantic characteristics of each microorganism were also proposed and input into the Google Sheets. All semantic characteristics were added in the collective access mode [19].

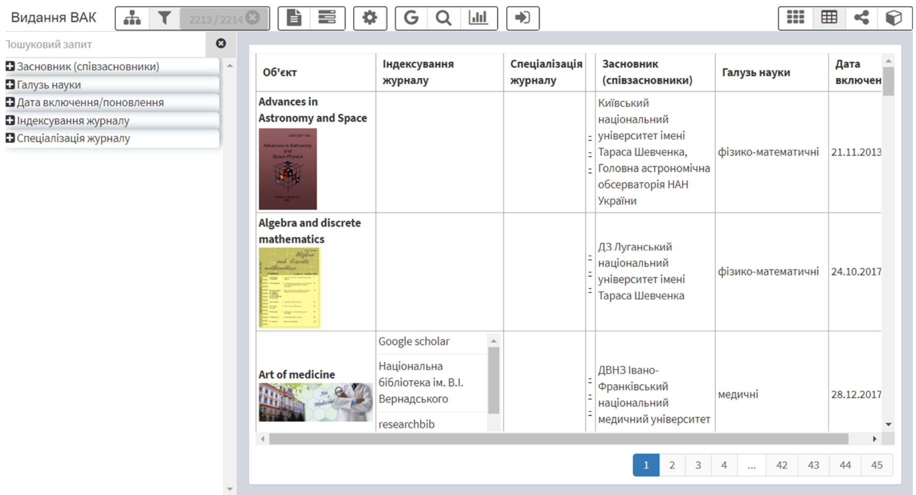


Fig. 6. SPE journal selection instrument

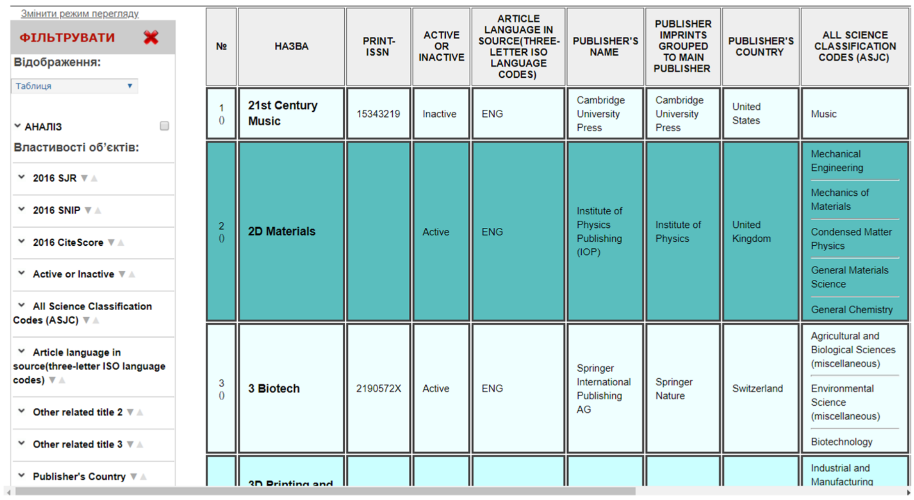


Fig. 7. Scopus journal selection instrument

The resulting ontological graph provides the possibility to use the filtering, and it is possible to find the discovered microorganism or group of microorganisms. General view of the ontological taxonomy of microorganisms is presented in Figure 8 and a general view of the microorganisms selecting system is presented in Figure 9.

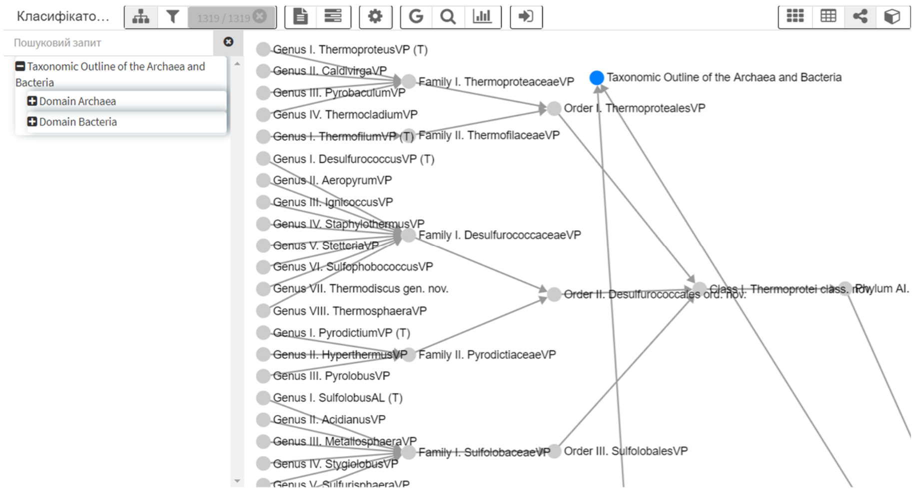


Fig. 8. General view of the ontological taxonomy of microorganisms

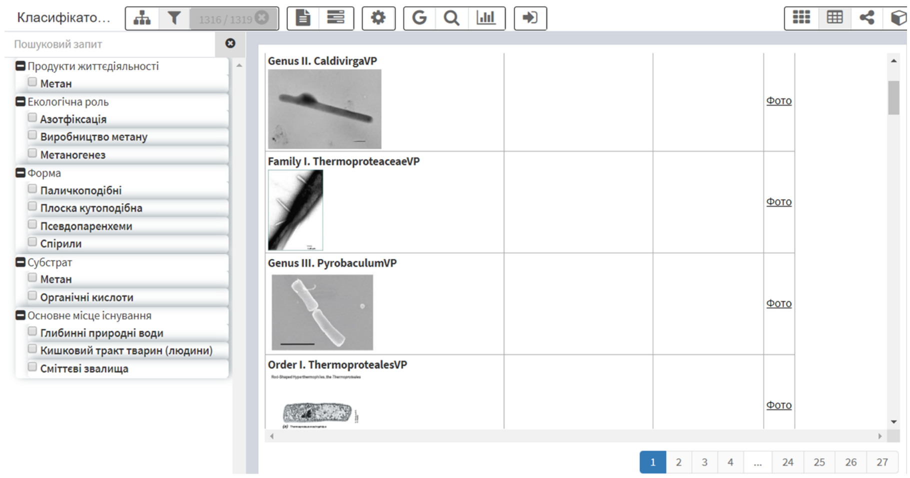


Fig. 9. General view of the microorganisms selecting system

4.2 TODOS to systemize scientific information

To construct a system of ranking of previous studies, we have identified semantic characteristics of the scientific research devoted to biogas production from chicken manure. These semantic characteristics include “Temperature (° C)”, “Volume of reactor (l)”, “Chicken manure content (%)”, “Moisture content (%)”, “Active sludge content (%)”, “Final solids content (%)”, “Biogas production (ml/g VS)”, “Methane production (ml/g VS)”, “methane content (%)”, “Year of the research”, “Ammonium nitrogen content (mg/l)”, “Final pH”, “Initial pH”, “Minimal pH” and “Maximum pH”

[14; 17; 18; 27]. The characteristics were selected from the studies on dry fermentation of chicken manure and were input to the google sheets.

The data were processed by the methods described in detail in our previous works [3; 16]. As a result, it was possible to use ranging from previous research results. The general view of the taxonomy is presented in Figure 10. The interface for selecting the importance of indicators is presented in Figure 11, and the interface for ranking the results is presented in Figure 12. The interface for selecting the priorities of numerical information for ranking allows taking into account the priority of modern articles, with the correct marking of important criteria. The considered system allows a quick search of the information by the necessary criterion [19].

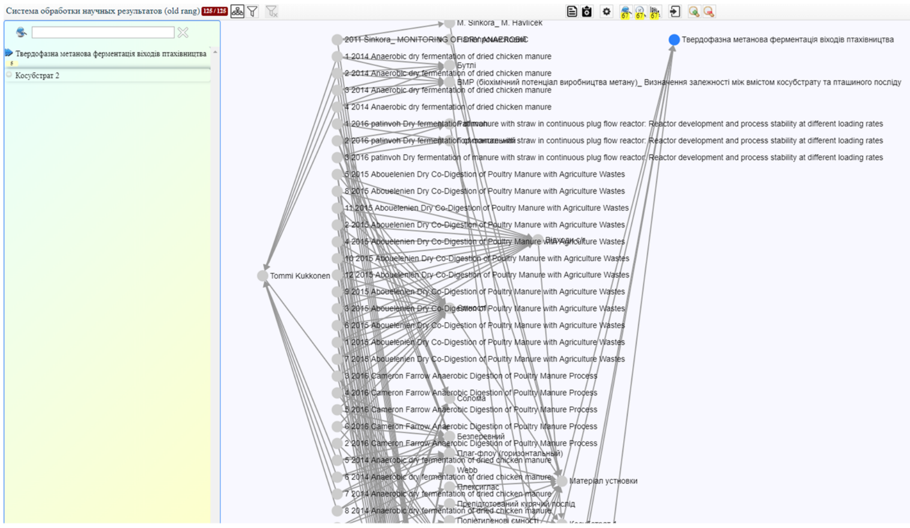


Fig. 10. The general view of the taxonomy

4.3 Transdisciplinary using scientific results in education and science. Single science digital environment to provide STEM-education

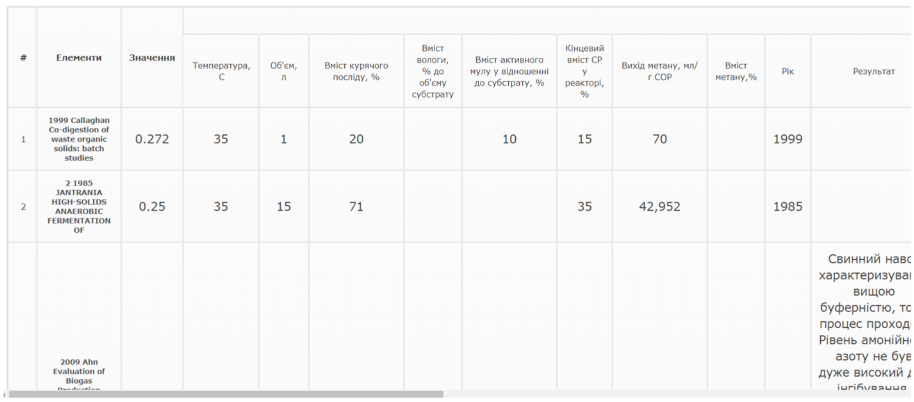
As it was proposed previously, the ontology-based system can be used to provide integration and transdisciplinary using internal sources [20; 15]. Databases created by a group of scientists who provides research will be able to share it to the open-source general database. That knowledge can be used by a huge amount of people not just scientist. As it was proposed previously, the ontology-based system can be used to provide integration and transdisciplinarity using internal sources. It means, that multidisciplinary ontology-based educational environment can't be used as the main instrument which provides scientific method of education and can integrate other instruments of STEM-education such as augmented reality or mobile phones involving [10; 11; 12; 15; 20; 24]. The proposed system will be very useful for students and young scientists who just start their research work.

Система обработки научных результатов (old rang)
(Оптимізація)

Опрацювати

Вибір	Ім'я	Ваг. Коеф.	Опт (max/min)	Способи задання вагових коефіцієнтів		
				Бальна шкала (10)	Лінгвістична шкала	Ранжування
✔	Температура, С	0.038	max	5	Середня важливість	1
✔	Об'єм, л	0.038	max	5	Середня важливість	1
✔	Вміст курячого посліду, %	0.038	max	5	Середня важливість	1
✔	Вміст вологи, % до об'єму субстрату	0.038	max	5	Середня важливість	1
✔	Вміст активного мулу у відношенні до субстрату, %	0.038	max	5	Середня важливість	1
✔	Кінцевий вміст СР у реакторі, %	0.038	max	5	Середня важливість	1
✔	Вихід метану, мл/ г СОР	0.038	max	5	Середня важливість	1
✔	Вміст метану,%	0.038	max	5	Середня важливість	1
✔	Рік	0.038	max	5	Середня важливість	1
✔	Результат	0.038	max	5	Середня важливість	1

Fig. 11. The interface for selecting the importance of indicators



#	Елементи	Значення	Температура, С	Об'єм, л	Вміст курячого посліду, %	Вміст вологи, % до об'єму субстрату	Вміст активного мулу у відношенні до субстрату, %	Кінцевий вміст СР у реакторі, %	Вихід метану, мл/ г СОР	Вміст метану,%	Рік	Результат
1	1999 Callaghan Co-digestion of waste organic solids: batch studies	0.272	35	1	20		10	15	70		1999	
2	2 1985 JANTRANIA HIGH-SOLIDS ANAEROBIC FERMENTATION OF	0.25	35	15	71			35	42,952		1985	
	2009 Ahn Evaluation of Biogas											Свинний навс характеризува вищою буферністю, то процес проход Рівень амонійн азоту не був дуже високий д

Fig. 12. The interface for ranking the results

5 Conclusions

1. A huge amount of scientific information can be systemized by using TODOS IT-platform.
2. TODOS IT-platform can provide a high level of informational structuring and information processing through the creation of the hierarchy and using TODOS instruments such as ranking and filtering.
3. TODOS can be used to both systemize the science information and to create useful databases (Big Data based) instruments for the scientist.

4. We developed the method of systemizing scientific information which is characterized by a higher level of informational processing.
5. TODOS integrate the scientific processed data in a single scientific informational field which involves scientists and students to provide transdisciplinary researches.
6. The proposed system can be used not just for a huge amount of people not just scientist and provides integration of internal and external sources to provide research approach in STEM-education.

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Centralized information web-oriented educational environment of Ukraine

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Abstract. The modern development of science and technology has provided high quantity of information. This information must be systemized and classified. For taxonomization of educational materials, it was proposed to use existing graph-generators and graph-visualizers of the TODOS IT platform. A separate aspect of the TODOS IT platform is the possibility of using a centralized web-oriented learning environment. Creation of the system and transdisciplinary knowledge is a problem of modern education, which can be solved by creating a centralized web-oriented educational environment. Using this approach is an important part of the learning process. Such a centralized web-oriented environment based on the ontological approach involves filling, adaptive educational services with information resources that reflect the conceptual system of a particular discipline.

One of the systems providing not only collection of information but include its systemizing is centralized web-oriented educational environment based on Ontology4 system. Ontology 4 use elements of the TODOS.

The paper presents specific developments of one centralized web-oriented educational environment can be used to teach different subjects such as biology, chemistry, Ukrainian language and literature, using the STEM approach.

Keywords: unified network-centric educational information environment, Ontology4, multiagent system, systematics of microorganisms.

1 Introduction

Modernization of the educational process is an important recent problem. One of the huge problems of education is the absence of the methods which can provide a complex of transdisciplinary knowledge transfer, which can be solved by creating a unified web-oriented educational environment. This problem is limiting the implementation of modern approaches in education such as the research approach.

2 Literature review and problem statement

Research approach in education is one of the ways to achieve a high quality of education. Simulation of the research process is based on using of main scientific research steps such as choosing of the topic, analysis of previous research results, hypothesis formulating, experimental research, data analysis and publication of results (not used under studying) [13]. Quality of the research may depend on the quality of the analysis of previous researches because it is the key to formulate the actual hypothesis [2; 4]. Hart et al. and Gerard et al. prove the necessity of this step [7; 8]. However, there is no decision which can provide safety for students and structured search for analysis of previous researches. Creation of centralized information web-oriented educational environment which based on educational programs can solve this problem and it is important to provide a research approach in the educational process.

Using the ontological approach to provide informational systemizing is an important part of the learning process. Such an educational environment based on the ontological approach involves filling adaptive educational services with information resources that reflect the conceptual system of a particular discipline. The methodical provision of the educational-cognitive process consists of the assimilation of the conceptual system, axiomatics, rules, syntactic and morphological foundations of this theory. The set of terms determines the conceptual basis of scientific theories by determining a certain ordering of the concepts of the discipline. Thus, the ontological multiagent in content reflects the conceptual system of a certain disciplinary theory. It takes into account the individual characteristics of each subject of the educational process.

We propose using of Transdisciplinary Ontological Dialogues Object-Oriented Systems (TODOS) to provide ontologization of information. A key benefit of this system is the context-based method of data processing and structuring based on semantic relations. Previously there was provided attempts to use ontology-based approaches in education [8; 19].Then, the received information system is a multiagent and has all the benefits of such a system.

However, they were characterized by not attractive for students and teachers interface and by low interactivity such as the absence of multiagency approaches. In the case of Ukraine, it is very important to provide education in the national language and IT platform TODOS can implement it.

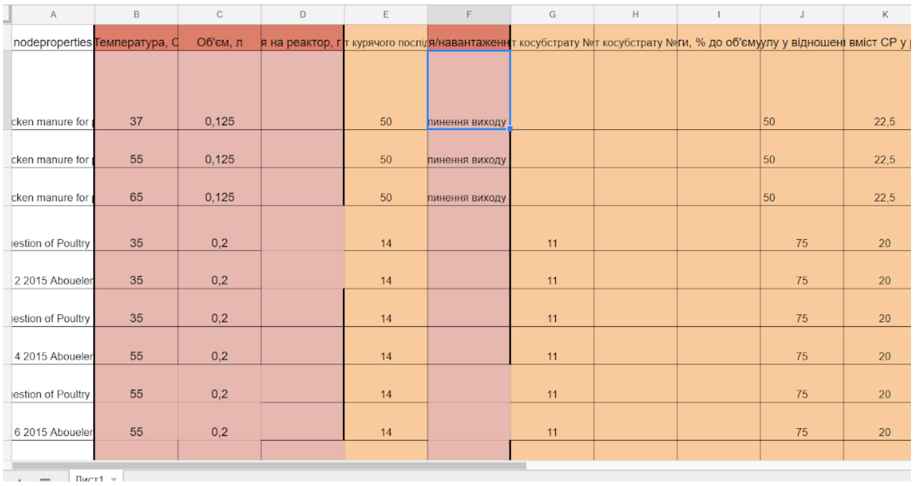
Structures in TODOS are represented by three categories (O, A, R), where O and A are a set of elements called objects and attributes, and R, respectively, is the binary relation between O and A. In particular, if oRa for o O, a A, then we assume that “the object possesses the attribute A” or “the object has the attribute O” [9].

The feature of the ontological graph is the high level of structuring and data visualization, the possibility of transition between related vertices and search for semantic links between vertices and its elements. Graph provides a transition to scientific data carried out quickly and understandably. In addition, operationality of information can be significantly improved by transforming it to taxonomy under using of ontological approach [6; 18].

3 Materials and methods

For creating digital educational programs and other educational content, the sheets were loaded to the part of TODOS IT-platform editor4. After that, the generation of the graph edges with its characteristics was carried out.

To store information and provide its sharing, Google sheets were used, with their further conversion into the .xls and .csv Excel sheets (see in Figure 1). The obtained documents were used to create the ontology structure .xml and to fill the ontology graphs with semantic and numeric information for ranking and filtering. Some of the instruments of the web-oriented educational environment are using intellectual features of TODOS and to provide these semantic characteristics were added.



A	B	C	D	E	F	G	H	I	J	K
nodeproperties	Температура, С	Об'єм, л	я на реактор, г	т курячого послі	я/навантаженн	т косубстрату №	т косубстрату №	ги, % до об'єму	улу у відношен	вміст СР у
cken manure for	37	0,125		50	пинення виходу				50	22,5
cken manure for	55	0,125		50	пинення виходу				50	22,5
cken manure for	65	0,125		50	пинення виходу				50	22,5
ıestion of Poultry	35	0,2		14		11			75	20
2 2015 Aboueler	35	0,2		14		11			75	20
ıestion of Poultry	35	0,2		14		11			75	20
4 2015 Aboueler	55	0,2		14		11			75	20
ıestion of Poultry	55	0,2		14		11			75	20
6 2015 Aboueler	55	0,2		14		11			75	20

Лист1

Fig. 1. Google sheet with data

Web-oriented educational environment using external network resources as agents to extend own knowledge base. Recommended by the Ministry of Education of Ukraine external resources were used as agents of centralized information web-oriented the educational environment of Ukraine. They were indexed by a TODOS search machine tool.

To improve the interactivity, it is possible to use modern approaches, including approaches of Augmented reality [10; 11; 17; 21] to increase interest to education [12].

4 Mechanism of the multiagent using in centralized information web-oriented educational environment of Ukraine

One of the examples of multiagent integration with educational environmental is using of network source stemua.science [14]. Stemua.science is an educational resource based on CMS Wordpress. It was created as repozytorium for transdisciplinary educational projects. Unlike other internet resources, stemua.science makes possible to add multi-categories and meta fields to post objects by using custom plugins. This portal provides free to use the base of educational materials and gives the possibility to share methods and projects ideas.

Teaching materials presented on it have a clear structure which based on scientific or engineering method. This is achieved by adding custom metadata to post an object. This post object can be used as building part of a centralized information web-oriented educational environment. Stemua.science has open JSON endpoints provided via Representational State Transfer (REST) technology. JSON formatted documents can be converted to XML format on the fly. All amount of education data used for reactive creating ontological graphs and use all information processing benefits of TODOS IT platform in real time.

5 Providing the researches in education due to the integration of multidisciplinary resources

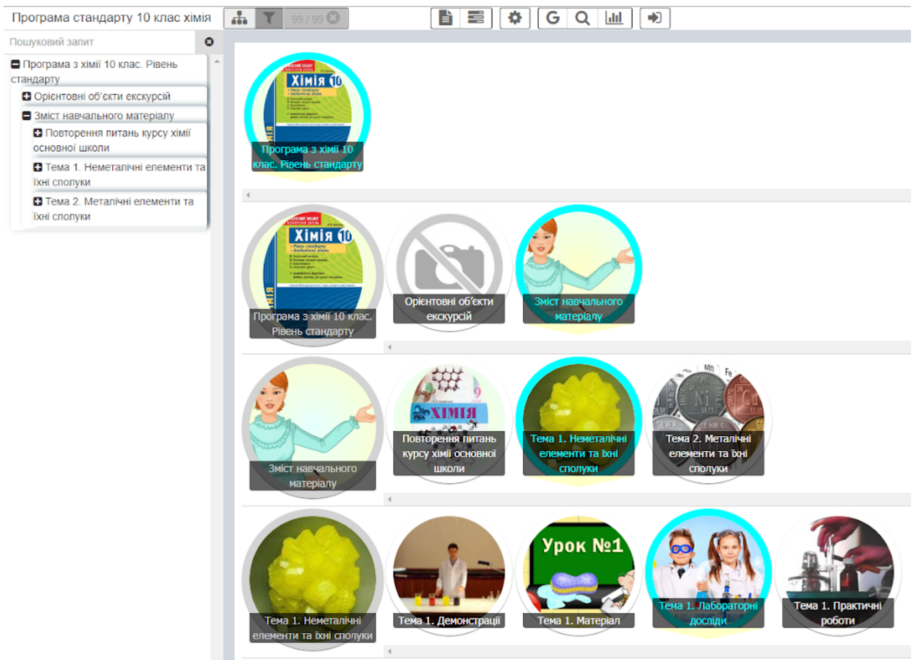


Fig. 2. The educational program of Chemistry for 10th-grade students

The base of the centralized information web-oriented educational environment consists of the different types of educational programs (such as primary, secondary, extracurricular). This program differs from classical approaches of educational programs interpretation by a higher level of material structuring and interactivity. Both students and teachers can view all the structure of the curriculum online. To provide this approach we used a graph edge to describe the topics of the curriculum. Therefore, these graph edges are connected with their mother-edges to create the hierarchy. This is the way of creation of structured interactive educational programs. General view of the educational program of Chemistry for 10th-grade students (http://ontology4.inhost.com.ua/?fname=programa-standartu-10-klas-himiya) is presented in Figure 2.

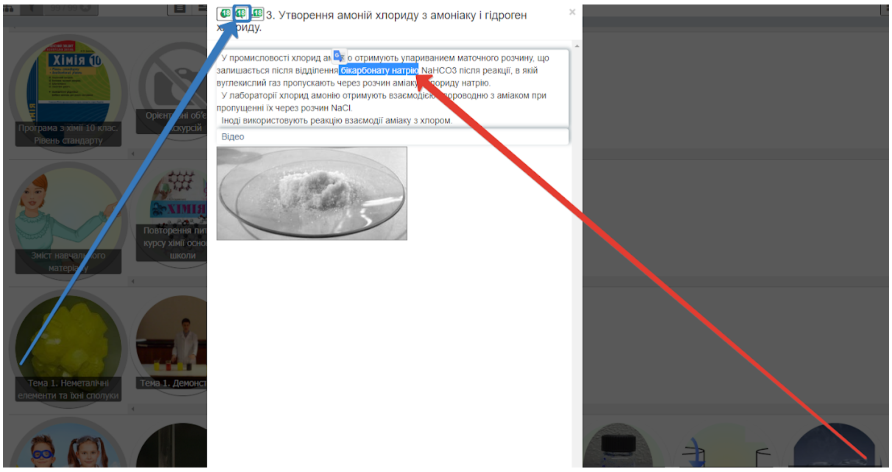


Fig. 3. The mechanism of the internal search function

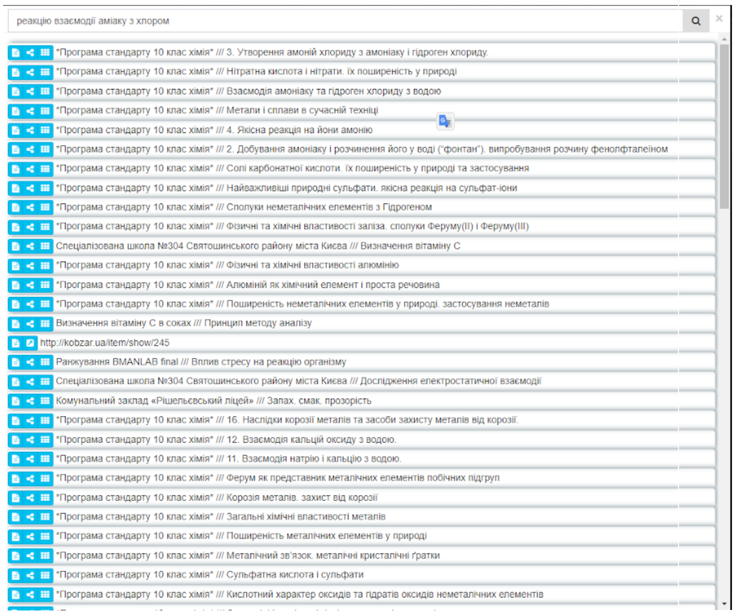


Fig. 4. The results of the internal search function

Integration of the different resources is the way to provide multidisciplinarity and research approach of the educational process. A student who studies the subject and uses an interactive web-oriented educational program based on IT-platform TODOS can use external search to provide informational research of question he has. The mechanism of the internal search function is illustrated in Figure 3 and the results of it in Figure 4.

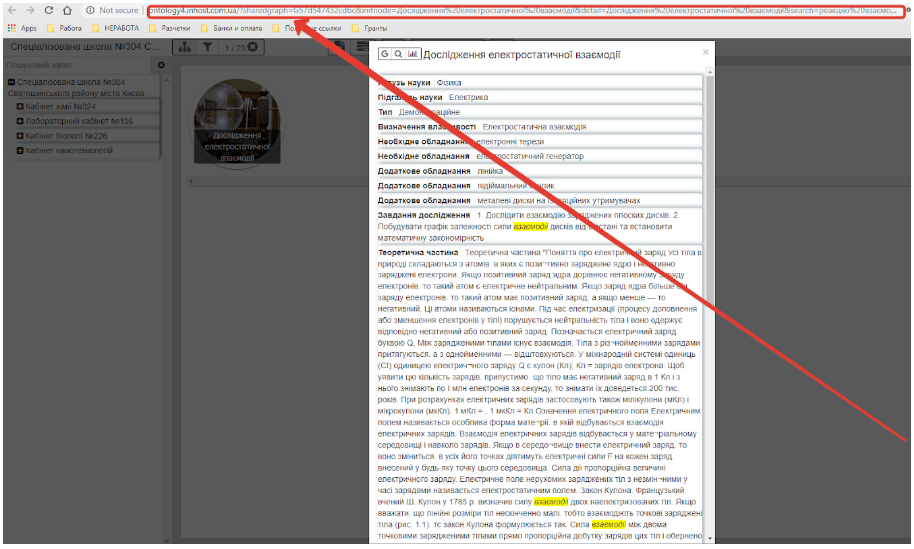


Fig. 5. Internal material visualizing

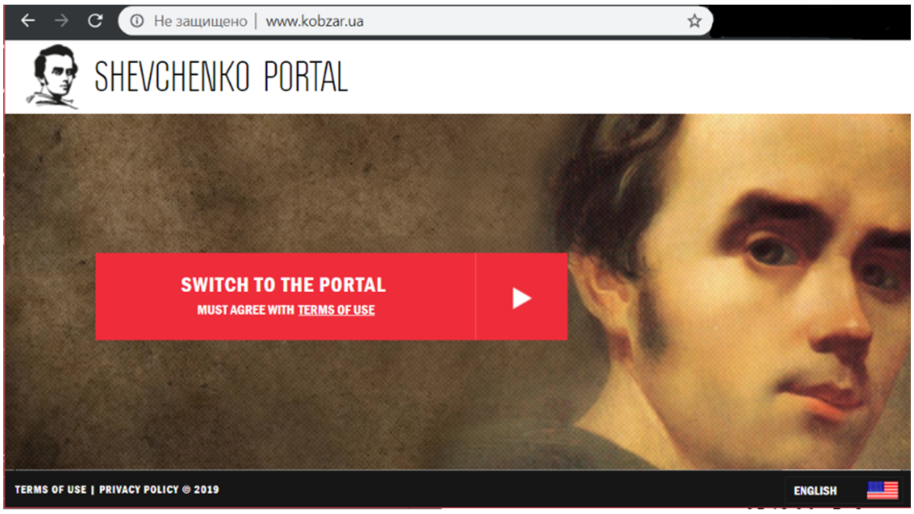


Fig. 6. The external material opening

The internal resources are shown in results as names of graphs, but multiagents of the centralized information web-oriented educational environment are shown as web-links (as we can see in Figure 4 – http://kobzar.ua/item/show/245). In the case of transition to internal graphs, it will open in TODOS-visualizer (ontology4.inhost.com.ua) (Figure 5).

Clearly, that multiagent opening mechanism of TODOS web-oriented educational environment differs and an opening of them is lead to opening websites (Figure 6).

6 Instruments to informational support of research and educational process

Ontology-based instruments are the same characterized by a higher level of informational structuring. To show an example of such instruments we chose microorganism classification due to the problem of the absence of their interactive systemized structures which can be used in the educational process. It is clear, that hierarchy is created by their own taxonomy: types, genera, families, classes, orders, divisions, domains. Semantic characteristics are used to provide filtering. General view of the ontology-based structure is presented in Figure 7 and filtering of microorganisms in Figure 8.

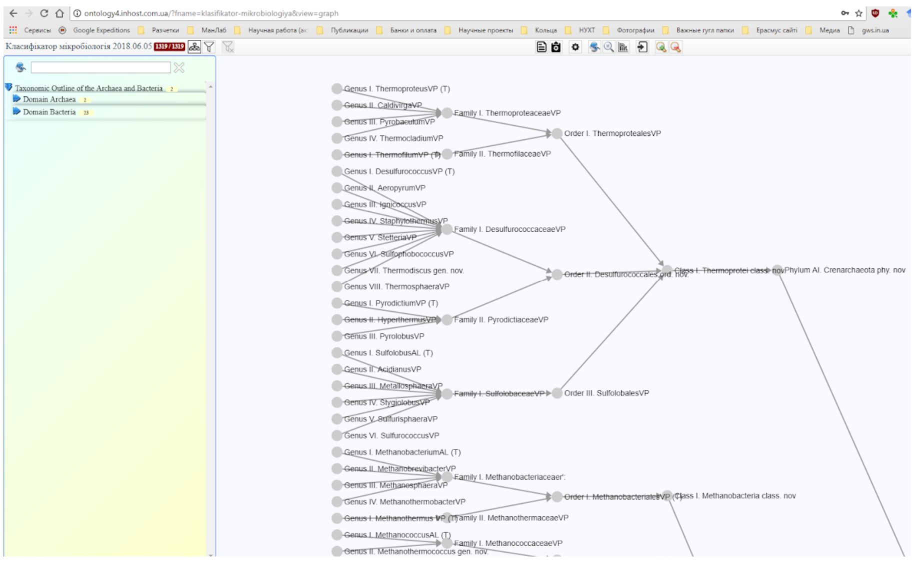


Fig. 7. Ontology-based structure of microorganisms

We already propose a few methodical approaches to use TODOS web-oriented educational environment in classes. First of all, we propose to use it to provide STEM-education. It may be used to provide research on topics such as “yogurt preparation” [3; 16]. However, the proposed educational environment can be used to provide classical lessons such as the role of copper in the environment and industry [20] and to solve the problem of the research works ranging for students [5; 15].

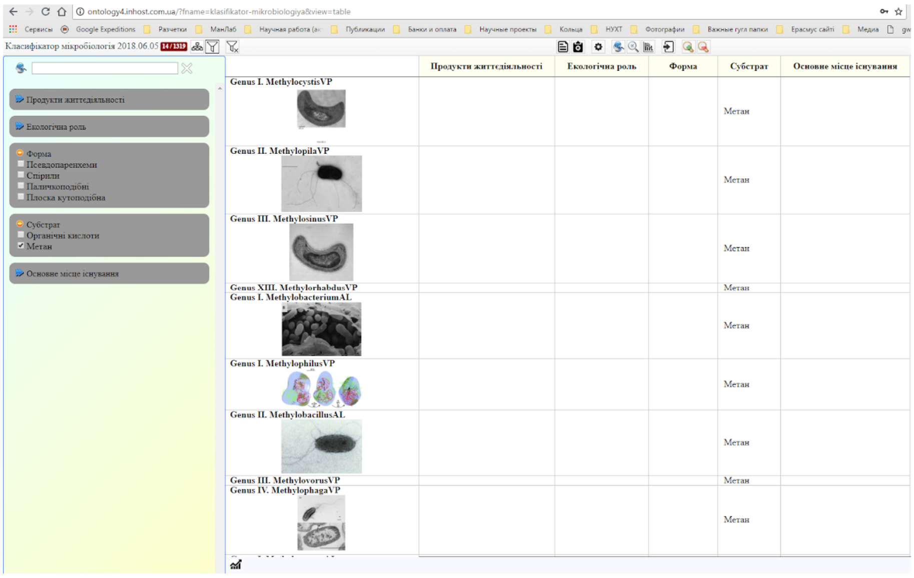


Fig. 8. Filtering of microorganisms to select

7 Existing methodical support for teachers for providing STEM/STEAM education

Educational portal stemua.science particularly devoted to providing ontology-based research approach, using of the ontology-based instruments in the educational process, methodical support and instruction to use centralized information web-oriented the educational environment of Ukraine and its elements.

8 Conclusions

1. Firstly, we propose the method of informational support of the educational process based on the ontologized interactive program.
2. The proposed method is characterized by a higher level of informational structuring and simple interface to use.
3. Firstly, we have implemented to use a multiagent approach for creation of centralized information web-oriented the educational environment to increase the quantity and quality of information support of the research approach in education.
4. It is created the methodical support to the simplify implementation of centralized information web-oriented the educational environment.

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Use of Web 2.0 technology tool – educational blog – in the system of foreign language teaching

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Abstract. This paper discusses the use of a Web 2.0 technology tool – educational blog – in the system of teaching foreign languages for enhancement of teaching effectiveness and optimization of students' performance. The authors describe the content, characteristics and didactic properties of an educational blog as an alternative or auxiliary educational environment, define its methodological objectives and list a number of advantages of this approach versus conventional teaching model. The effectiveness of the above-mentioned Web 2.0 technology tool was confirmed by the experiment which showed that an educational blog integrated in a foreign language teaching system contributed to optimization of the process of teaching and learning, development of foreign language communicative competence of students and thereby allowed them to acquire not only communicative but also technological skills.

Keywords: tools, Web 2.0 technology, optimization, training, foreign language, educational blog, communicative competence, communicative and technological skills, educational blogosphere.

1 Introduction

Nowadays, optimization of foreign language teaching and learning approaches is a relevant objective not only in the field of education, but also in other areas of modern human activities. Today, every person willing to master a foreign language always faces the task to accomplish the language learning within a short period of time and with minimal effort. Searching for the optimal way to solve this problem, the authors came to an idea that expedient and effective learning of a foreign language can be achieved in the environment that contributes to accelerated assimilation of language and speech units and overcoming of language barriers.

Development of effective tools for teaching foreign languages has been an objective of the education system over the past decades. However, each year this problem obtains new features due to the wide involvement of new ICT into our lives [7; 21]. In our opinion, to solve this problem such learning tools can be used, which, on one hand, require minimal effort in terms of their implementation but, on the other hand, require the most complex and time-consuming preparation for optimization of foreign language teaching and learning. Currently, the leading methodologies of foreign language teaching and learning implicate use of Internet with its rich resources including websites, e-mail and electronic encyclopaedias, telecommunication projects, Web 2.0 technologies, e.g. video conferences, podcasts (for example, Elementary Podcast from the British Council and 6 Minute English from the BBC), chat sessions, forums, blogs, and more [6; 17].

Our study showed that Web 2.0 technologies, in particular educational blogs provide the most complete solution to optimization of educational activities in the field of teaching foreign languages. We are convinced that integration of Web 2.0 technology tools in the educational process provides an effective teaching approach due to didactic properties of such tools, including ease of use and accessibility, efficiency of the information space organization, interactivity and multimedia interface, reliability and security, and will contribute to optimization of the system of teaching and learning a foreign language.

2 Description of an educational blog as a Web 2.0 technology tool

Scientific substantiation of the theory of learning through an educational blog is implied by the studies published by Lisa Kim Bach [2], Joel Bloch [3], Rebecca Blood [4], Aaron Patric Campbell [5], Charles Lowe [14], Will Richardson [19], Terra Williams [14], and others. In turn, Maksim N. Evstigneev [22], Anna V. Filatova [8], Dmitrii A. Ivanchenko [9], Liliia K. Raitckaia [18], Pavel V. Sysoev [22], Svetlana V. Titova [23], and others established the modern theoretical basis for integration of blog technologies in the process of teaching foreign languages.

In this paper, we will focus on using an educational blog as a tool for optimization of the foreign language teaching process. The blog is one of the Web 2.0 technology services which creates conditions for improving all types of student's foreign language speech activities.

Web 2.0 technologies present an attractive educational tool due to, first of all, their availability, simplicity and possibility of independent and unsupervised work of students providing thereby more free time in the classroom. At present, an educational blog is used in teaching foreign languages with the aim to solve a whole range of methodological objectives, including: building and improving the listening comprehension skills (speech recognition), pronunciation, expanding and enriching a vocabulary, developing speaking and writing skills (Lisa Kim Bach [2], John Barger [20], Joel Bloch [3], Maksim N. Evstigneev [22], Liliia K. Raitckaia [18], Pavel V. Sysoev [22], Geoff Isaacs [15]).

Creating a blog as a part of the educational process, can solve such **tasks** as *forming informational, communicative, and sociocultural competencies of students, expanding information space of the educational process, organizing extracurricular work on the subject, publishing creative works, forming the bases for correct cultural and safe behaviour in the network, improving communicative and technological skills* [11].

The modern classification of educational blogs is widely described in methodological literature. A blog can be created for free on one of the blogging platforms, such as Blogger, LiveJournal or Tumblr, using ready-to-use layouts and templates. Blogs are usually dedicated to a certain topic and include entries on various subjects.

First of all, we should define the term “blog”. A blog (or web log) is an online journal or diary on a website, the main content of which is regularly updated with adding posts, images or multimedia. Blog pages can contain links to Internet resources and integrated external applications such as flash videos, news feeds, simulators, tests, gadgets, mini-applications, etc. Gadgets (widgets) are mini-applications created by software developers as support tools. There is a quite broad range of gadgets in the Internet, from which you can choose those that could be useful both for teachers (moderators) and students. Among those related to learning a foreign language are, for example, “Translator”, “Holiday Calendar”, “Aphorism of the Day”, “Useful Links”, Pinterest, Fluent U, Cramberry, BX language acquisition, Barabook, Urban Dictionary, Fluent U, Conversation Exchange, MosaLingua, etc. Characteristic features of blogs include short posts with time-sensitive content, sorted in reverse chronological order (the last entry on the top).

The main and the most significant difference between a blog and a website is its interactivity. In a blog, students can communicate with each other and with the teacher in the extracurricular time via external applications integrated on a gadget page through a chat or video conference. Communication can be further performed through publication of comments, which, in fact, resembles forums. Blog readers (students and teacher’s colleagues) can write comments to each message posted by the blog moderator on blog pages. In addition, the moderator can provide online tutorial or give advices, organize a joint online work on a project or study. We should further note that a blog differs from a classic website primarily by the ease of its creation, since the user does not require any knowledge of HTML-layout, design, or network marketing skills needed for a website promotion. It is very easy to make changes to a blog, even though a smartphone, as well as to add new modules due to an “open source” philosophy. According to Steve Lee and Melis Berry, the occurrence of web 2.0 technologies allowed to shift the focus from the technology and media to communication and cooperation, which by itself is the goal of education [13].

3 Integration of an educational blog as a Web 2.0 technology tool in a foreign language teaching system

Since today an educational blog, as was noted above, presents an innovative teaching/learning resource, at the stage of learning a foreign language (local language of the country of study) we conducted a teaching experiment in groups of foreign students at technical higher education institutions (http://rusdiliukraina.blogspot.com). The experiment demonstrated effectiveness of this approach as an optimal way of teaching electronic communication to foreign students, as a new form of their self-actualization. In view of the fact that a blog also provides tools of synchronous and asynchronous communication [16], such technological environment of learning also contributes to overcoming the communicative barrier that a foreign student faces in interpersonal communication. Exemplary screenshots of educational blogs are provided in Figure 1.

Integration of this educational environment into the process of foreign language teaching includes a number of advantages, as was shown by the results of our teaching experiments. Introduction of educational blogs in the educational process also contributes to optimization of this process, enhancement of foreign student's motivation and development of cognitive activities, formation of skills of independent/unsupervised work and creative thinking [1]. Optimization of foreign language teaching and learning is achieved through the use of special functions of an educational blog which allow not only to realize the general didactic principles, including *visual aids, accessibility, systematicity and consistency, developmental and educational character of education*, but also the special functions of teaching: *social, communicative, informative and administrative.*

The teacher who also performs the blog moderator functions, works with students remotely, posting on the page a number of tasks for independent and group work, tests for self-examination.

In the course of the teaching experiment, it was observed that one of the main advantages of using an educational blog in foreign language teaching is the possibility to place a set of educational documents for the student in a separate section of the blog. Such documents include the curriculum on the subject, individual and grade-based educational programs, system of grades, teacher's consultation schedule, homework assignments, supplementary materials for specific classes, recommended sources for independent student's learning (reading and listening, for example, podcasts and feature stories), links to information, reference and educational online resources, links to online tests on the topics studies within the scope of an independent student's work (for example, after finishing some topics on Grammar, students have the opportunity to check their knowledge by passing an online test).

An important role in a blog-based learning belongs to the use of google-forms based on which questionnaires or tests can be created, to reinforce the material studied. Students can answer the proposed questions both offline and online. Comments of group members in this format help the teacher to quickly respond by making changes, corrections and adjustments to the educational material. Publication of questionnaires and on-line tests allows to track the learning success of each individual student and the entire group within a scope of the topic studied.

A significant part of a blog is allocated to additional, supplementary materials designed to enhance lesson materials. Thus, for example, within the scope of the teaching experiment, use of educational films and cartoons, audio files, and video clips caused a lively and active discussion in the group of students.

Fig. 1. Exemplary screenshots of educational blogs

It was observed that the educational blog contributed to the formation of student's skills of independent work, enhanced student activity, increased motivation, activated self-control during the learning process, student's motivation to independently find the necessary information. Accordingly, the level of student's interest correlates with the amount of time spent on homework, projects, etc. Thus, improvement in the quality of tasks performed was observed, since the student was not limited by the timeframe of the lesson.

In our opinion, an educational blog helps to expand the educational space, as during the lesson there was not enough time to pay attention to each student and answer all students' questions, while the "blog lesson" allows students to work in a free mode, without any strict time limits, and to learn material at own pace.

In addition, an educational blog provides an opportunity to reorganize extracurricular activities of the educational process participants. Various slide-shows, summaries and discussions of conference talks, thematic evenings and concerts, presentations, reports about events happened in a student group or during classes, writing essays, exchange of useful links – all this improves the skills of working with information and communication technologies, promotes the development of communicative and technological skills and broadens student's mind.

The teacher works with students offline, giving them freedom in performing their tasks, but at the same time directing, controlling and correcting the process of their foreign language learning which undoubtedly contributes to intensification of the educational process.

In addition, blogging leads to optimization of organization of students' independent work [10; 12], because blog sections contain necessary for students information in the form of links, texts, finished educational materials, databases, based on which students can accomplish both independent and individual work.

Our study showed that blog-based learning provided students with the opportunity to manage their learning activities, publish their own thoughts and demonstrate understanding of educational material. It also broadened the tasks to be performed beyond the educational process and the "teacher-student" relationships, allowing everyone to rate and comment on their activities. Blogs also provide students with an opportunity for individualization, increase their interest in the learning process, as novel technologies belong to motivating factors in the learning process. In our study, such motivation was not only the result of technological opportunities, but was also related to the fact that students could write about what was important for them personally.

Thus, after organizing and preparing the teaching experiment supported by dedicated pedagogical technologies, we conducted a survey of the level of foreign language communicative competence of foreign students at a number of technical higher education institutions. The data obtained during this experiment were analysed statistically using Pearson's chi-squared test and Fisher's exact test. Table 1 and Figure 2 show improvements in the learning success in the experimental group vs. control.

The results obtained show significant changes achieved in the experimental group compared with the background level. The experimental group achieved a high level of foreign-language communication and technological skills and developed professionally significant personal qualities. In the control group, which learned foreign language according to the standard scheme, the level of foreign language communicative competence increased by only 4.28%, compared to 14% in the experimental group.

Table 1. Changes in the level foreign language communicative competence of foreign students in the experimental and control groups (% of the total)

Level	Control group (106 participants)				Experimental group (105 participants)			
	Stage of the experiment							
	Ascertaining		Control		Ascertaining		Control	
	n	%	*n*	%	*n*	%	*n*	%
High	14	13.2	18	17.0	12	11.4	25	23.8
Satisfactory	38	35.8	44	41.5	38	36.2	52	49.5
Low	54	51.0	44	41.5	55	52.4	28	26.7

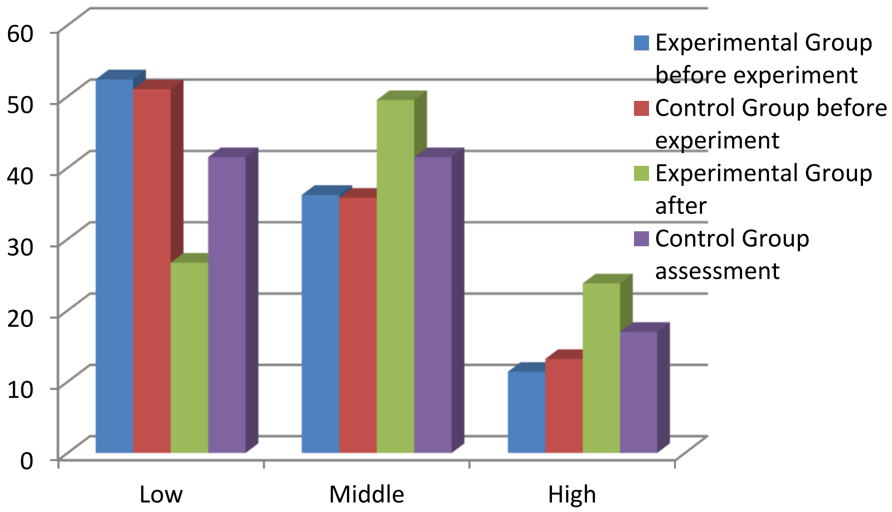

Fig. 2. Comparative histogram of changes in the level of foreign language communicative competence of foreign students at technical higher education institutions in the experimental and control groups

These results suggest that an educational blog creates an alternative, auxiliary learning environment providing beneficial effects for student success.

4 Conclusions

In conclusion, we must emphasize that the above mentioned Web 2.0 technology tool – an educational blog – proved to be effective in optimizing foreign language teaching, in view of its multiple features and advantages, such as:

- hierarchical structure of the blog providing comfort and availability of work in the blog environment;
- function of translation of information in foreign language posted in sections of the blog, which allows students to view information in their native language;
- widgets and gadgets placed on the blog pages (various external applications – blog chat, calendar of events, etc.), links to information and reference Internet resources (online dictionaries, Google translator), links to training Internet resources (Webquests, optional distance education courses, podcasts, etc.) helping foreign students to navigate while working on a blog;
- creation of a micro-social environment contributing to the establishment of a trustful, accommodating relationships between the teacher – moderator of the blog – and students from different national groups and of different temperaments;
- opportunity to conduct consultations in different communication modes (both online and/or offline);
- co-authoring of the blog enhancing the level of motivation of students with this form of education;
- opportunity to use forms, methods and techniques of cooperative learning during the learning process, as well as integrate tests into the relevant sections of the blog by the moderator;
- technical possibility to place the most optimal for the modern educational process form of presentation of the educational content ("three in one": text, audio/video, graphics), etc.

Therefore, didactic properties of Web 2.0 technology tools, in particular the educational blog, contribute to organization of innovative management of educational activities of students, allowing to create a new, alternative, auxiliary educational environment taking into account individual capabilities and characteristics of each participant in the educational process. In our opinion, integration of open educational blogs in the process of education, should lead to the creation of a unique learning blogosphere, in which all participants of the educational process will be able to obtain necessary information, communicate, jointly create a database, exchange ideas, improve communication and technological skills.

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Information and technology case as an indicator of information competence level of the translator

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Abstract. The article deals with the innovative approach to the organization of the information training of translators. The proposed approach will ensure not only the formation of information competence of future translators, but also the formation of an individual information and technology case of the translator. The components of an individual information and technology case are determined. They may include electronic terminology databases, translation memory databases for use in automated translation systems, databases of electronic links to terminological resources network, databases of electronic links to corpora of parallel texts. The using information and technology case of the translator as one of the diagnostic tools for evaluating the information competence level of the translator is proposed. It was found that the creating information and technology case is effective in developing information literacy and improving information technology skills.

Keywords: innovative approach, information technology, information and technology case, information competence of future translators.

1 Introduction

The realities of the information society lead to radical changes in the conditions and nature of professional activities of specialists in all spheres of life. Special transformations relate to professions that have traditionally been not closely linked with the use of information technology, in particular, professional translation activities. Appropriate reorientation is also needed in higher education institutions that train translators. Given the rapid development of information technologies that affect, in particular, scientific and technical translation, and based on a competent approach to the training future professionals, it is important to focus on the development of information competence of translators. The development of this competence will enhance the competitiveness of current students in the market of translation services. In view of this, the search and implementation of innovative approaches to information training of translators in the process of their study is relevant.

2 Related work

The specification of an optimal translator's competencies complex that meets modern requirements and takes into account the technology of translation activities was investigated by domestic and foreign scientists, in particular, Oleksandr S. Bondarenko [4], Christiane Nord [8], Alla S. Olkhovska [9], Dennis Scheller-Boltz [11], and others. All researchers agree that, along with language knowledge, the knowledge of modern translation tools based on specialized information technologies is equally important.

In particular, Dennis Scheller-Boltz notes that in the CIS countries today there is no understanding of the integral complex of competencies of the professional translators, or it is only partial and has not sufficiently developed yet. So far, many translators believe that language competence is a dominant in the translation process. Without denying that knowledge of a foreign language is one of the main components of the translator's competencies complex, the scientist states that nonetheless, many other competencies, in particular informational, should be formed for the successful translation [11].

The Research group PACTE (Process in Acquisition of Translation Competence and Evaluation – Amparo Hurtado Albir (director), Allison Beeby, Mònica Rodríguez Fernández, Olivia Fox, Inna Kozlova, Anna Kuznik, Wilhelm Neunzig, Patricia Rodríguez-Inés, Lupe Romero Ramos), on the basis of the Autonomous University of Barcelona (Universitat Autònoma de Barcelona), has developed a model of competence of the translator, emphasizing the need to take into account the knowledge of various components due to the translation process. According to scientists, the competence of the translator consists of five subcompetencies, namely:

- language competence, that involves fluent knowledge of two languages,
- extra-language competence, that covers different types of background knowledge,
- translation competence, that means the ability to translate in working languages,
- strategic competence, related to knowledge and decision making on the choice of translation strategy,
- instrumental competence, related to modern information tools of translator based on information technologies [10].

In order to develop information and technological skills, Christiane Nord offers the structure of a training program for technical translators, according to which the course "Practice and theory of specialized translation" should be studied during the last two semesters and involve studying both traditional and electronic translation tools [8].

However, despite the available work of scientists, an effective system of formation of the information competence of the translators has not been developed yet.

The purpose of the article is to consider innovative approaches to the information training of the future translators at different stages of mastering information technologies and to determine their content and tasks in relation to the formation of an individual information and technological case of the translator.

3 Research methodology

The methodology of the study covered a number of methods that provided for the study of individual aspects of the problem, namely:

- method of analysis and synthesis in the study of scientific literature and methodological documentation to determine the degree of problem investigation;
- comparative analysis of international standards for the training translators, standards for their professional activities to distinguish the main components of the informational competence of future translators;
- empirical methods – questionnaires, interviews, interviews to determine the attitude of future translators to the issue of information competence.

4 Research results

The problem of forming the informational competence of future translators during their studies at the university is considered in the context of concepts developed by scientists. They are based on numerous theoretical and empirical studies on the implementation into the educational process of various forms of educational work, methods and means of training that in aggregate contribute to the achievement of students by such level of knowledge of information technology, which is necessary for successful professional activities.

It is worth noting that the researchers expressed the idea of a close relationship of information competence and ways of interaction of a person with information, which is determined by a set of three main components: information technology, conditions of use of information and features, due to special circumstances. This understanding has been reflected in a distinct complex of concepts that summarize the main characteristics of the information competence:

- information technology conception – using information technology for information retrieval and communication;
- information sources conception – finding information;
- information process conception – executing a process;
- information control conception – controlling information;
- knowledge construction conception – building up a personal knowledge base in a new area of interest;
- knowledge extension conception – working with knowledge and personal perspectives adopted in such a way that novel insights are gained;
- wisdom conception – using information wisely for the benefit of others [5].

Variable components, which depend on the particular circumstances of use of the information, are as follows:

- information technology for access to relevant information;

- information sources (including organizational structures and information specialists);
- information process for problem solving and decision making;
- information management to get more information;
- critical analysis of ideas and knowledge expansion;
- intuition to develop new ideas;
- personal values and moral perceptions regarding the use of information.

Taking into account the aforementioned, the successful mastering of the modern translator's tools by the future specialist depends on his awareness of the growing prospect of no alternative to the use of information technology in translation. In order to determine the degree of awareness of the role of information technology in translation activities at the present stage and the importance of their study during the training period, a questionnaire was conducted among future translators. 68 students of the specialty "Translation" of the National University of Life and Environmental Sciences of Ukraine attended it. As a result, it was found, that 87% of students noted the need to study information technology in translation. In addition, 26% of respondents even expressed the need for an in-depth study of modern translator tools based on information technology. This testifies to the urgency of finding new approaches to the organization of the educational process in order to improve the information training of translators.

Among the innovations that can contribute to improving the effectiveness of informational competence formation in future translators, the following should be noted:

- orientation of professional training of translators to the requirements of European and international standards for the formation of information competence as a factor in ensuring their competitiveness in labor markets;
- direction of the content of courses of professional and practical training for forming the components of information competence;
- implementation into the curriculum of a special course, which will ensure the formation of the components of information competence in applying modern information technology in professional activities;
- internships in translation agencies using modern tools based on information technology involving students to the main stages of translation projects [2].

The enhancement of the synergetic effect in applying these innovations in mastering modern information technologies by future translators can be achieved by introducing such a system of their training that would involve the formation of their information competence. It includes the acquisition of abilities through the implementation of a complex of translation tasks with simultaneous filling throughout the period of training of an individual information and technology case of the translator. Under the information and technology case of a translator, we understand the complex of student outcomes, which reflects his ability to use information technology in translation and for which he must focus his efforts during studying.

The conceptual idea of such an approach is that the student develops, at the initial stage of training, under the guidance of a tutor, his own working plan for the period of study, which includes a phased implementation of a series of tasks aimed at:

- in-depth mastery of the terminology of several specialized branches;
- search for available terminology resources databases, including those selected for in-depth study;
- development of own terminology databases in formats that can be used when working with automated translation systems;
- formation of bases of aligned parallel texts and translation memories databases in specialized formats based on the results of their own translation activities and using materials that are freely available;
- translation of branch materials using desktop and cloud automated translation systems;
- expansion of its own information space by participating in network professional communities (forums, blogs, webinars, conferences);
- research on the efficiency of the use of information technology in translation.

Successful implementation of this process can be achieved by clearly defining the results that a student must achieve; stages of achieving these results; the components of the information competence of the translator, the formation of which ensures the execution of the specified set of tasks. It is worth noting that it is necessary to adhere to the definition of the structure of the stages of such activity, their correlation with the classical division of the educational process for periods, and most importantly with the levels of knowledge by future translators of information technology [2].

Considering in this context the process of forming a coherent structure of the informational competence of the future translators, it is worth noting that its content should be consistent with the standards of leading foreign countries that regulate the quality and order of providing translation services. The most common of these standards are International ISO 17100:2015 “Translation Services – Requirements for translation services” [7] and American ASTM F2575-14 “Standard Guide for Quality Assurance in Translation” [3]. These standards define a common list of competencies of the translator, which generally coincide in name and content, and in particular, the structure of information competence.

An important aspect in shaping the structure of the information competence of the translator is taking into account the elements of information competence identified in the European Master’s program (European Master’s in Translation) [6].

Summarizing the requirements of these documents and the experience of training translators, we consider it appropriate to form the information competence of the translator in the list of components that cover the most significant aspects of their information training, namely the complex of such components:

- information retrieval component;
- information and technology component;
- informational and technical component;
- informational and analytical component;

- information and editorial component;
- informational and thematic component;
- information and legal component [12].

By concentrating on filling the information and technology case of a translator by each student, it is necessary to determine its components in a quantitative and qualitative dimension, because of which it will be possible to assess the level of formation.

Given that such levels can be used as indicators of the formation of an information competence of a translator, each level should have a separate set of constituents with defined quantitative indicators, or these components can be repeated at different levels but with other numerical limits. In addition, each higher level must contain at least one component that was not available at the previous level and is characterized by a higher complexity of its implementation. The number of levels for the expediency of determining the completeness of the information and technology case of the translator should be defined as four, which corresponds to the levels of formation of the information competence of the translator: low (reproductive), medium (technologized); sufficient (constructive), high (productive) [12].

Considering the above, the information and technology case of a translator may include several indicator. The list and the quantity may vary, and depending on the level of their implementation, it will be possible to determine the level of formation of the student's information competence. In particular, such components may include:

- database of software products for performing various translation tasks, taking into account information about the type and value of the license;
- databases of electronic links to network terminology resources;
- electronic terminology databases of branch terminology;
- databases of aligned parallel texts;
- translation memory databases for use in automated translation systems;
- database of texts translated using CAT systems;
- databases of electronic links to corpora of parallel texts;
- database of network professional communities, registration and participation;
- scientific articles covering various aspects of the use of information technologies in translation;
- certificates of internship in agencies and organizations, including international ones, using information technology in translation;
- certificates of the level of knowledge of specialized software in translation (companies, their dealers, certification centers, etc.).

The practical realization of the components of this complex must certainly be provided for the instrumental support, which in this case is realized by means of specialized software. Since it is about using this software by students during training, it is worth noting that the use of professional proprietary software has certain limitations associated with its cost. In this regard, students should be oriented, preferably, to studying and using for these purposes software with a free license, or cloud services with available periods of free access or access for a minimum fee. This option of using specialized software by students is realistic, as a significant number of companies offer services on the use of cloud-based automated translation systems, which implement the functions of creating terminology bases, aligning parallel texts, creating databases for translation, etc. The presence of such functions will allow realizing the overwhelming part of the set of components of the information and technology case of the translator. Such systems are MemSource, Wordfast Anywhere, XTM Cloud, MateCat, MemoQ, smartCAT. There is also a significant number of desktop software products with open source licensed, that have similar features.

As noted, one of the components of the information and technology case is the electronic terminology database of the branch terminology. The ability to implement such a component lies at the heart of many technological processes associated both with translation and with terminology management. In particular, it should be noted that, depending on the needs, such databases could be made in different structures, in different formats and by different software tools [1].

The simplest and most widespread form of structuring terminological entries and forming terminology databases on this basis is the tabular form that is usually implemented by means of the MS Excel table processor and the saving results in the format of XLSX. Applying this option allow to structure the terminology entries in the columns by language, and within the line, there is a concentration of entries, which relate to one term. The advantages of such structuring terminological data and using the appropriate format are:

- wide access to relevant software products in the structure of many desktop and network office packages (Office 2019; Office 365; Google Sheets, etc.), with the help of which it is possible to structure data in tabular form and save results in XLSX format;
- previous experience with the use of tabular editors and processors for structuring data in tabular form;
- universality of the XLSX format for saving terminology databases, since almost all network automated translation systems and part of desktop systems can work with them directly in this format or with certain transformations to their own format.

The slight differences in the preparation of terminology databases in the XLSX format for various automated translation systems lie predominantly in the area of application of the corresponding language coding systems in accordance with the standards ISO 639-1 and ISO 3166-1 alpha-2 (Figures 1, 2). Although in some cases, it is necessary to take into account possible changes in the structure of the base.

Taking into account the peculiarities of the preparation of this component of the information and technology case of the translator, its formation with different quantitative indicators should be part of the case formed at the initial and subsequent levels.

The higher level of the formation of the case, and, accordingly, the information competence, must meet the developed terminology database in specialized formats, which can be connected to the common automated translation systems. In particular, SDLTB terminology databases for SDL Trados (Figure 3) can be included. Despite the fact that SDL MultiTerm specialized terminological management system is required to create and fill it, it is possible to achieve qualitatively new indicators of their informativeness and technology, in particular by filling descriptive fields, using filtering functions, etc. In this context, it is necessary to focus separately on the possibility of filling the information-technological case by forming and saving terminology bases directly in the environment of the CAT systems. Since almost all cloud-based CAT systems contain tools for filling them in various ways, in particular, importing terms from files, adding terms using the appropriate forms and functions (Figure 4), adding terms directly in the translation process, etc. Such options can be implemented during the period of work with the information technology case using the available tools.

	A	B	C
1	**en_US**	**en_US**	**uk_UA**
2	multishare plow	multifurrow plow	багатокорпусний плуг
3	corn cutter	corn mower	жатка кукурудзяна
4	sweer-fork feed	shaker feeder	живильник вібраційний
5	grass drill	grass seeder	трав'яна сівалка
6	hi-arch tractor	high-clearance tractor	висококліренсний трактор
7	caterpillar tractor	crawler tractor	гусеничний трактор
8	wheel tractor	wheel-type tractor	колісний трактор
9	power take-off shaft	pto shaft	вал відбору потужності

Fig. 1. Structure of the branch terminology database in XLSX format with the possibility of using it in cloud-based CAT systems XTM Cloud, MemSource, Wordfast Anywhere

	A	B	C
1	**English**	**English**	**Ukrainian**
2	corn harvester	maize harvester	кукурудзобиральна машина
3	corn sorting machine	maize sorting machine	кукурудзоочищувальна машина
4	hulling machine	hulling separator	лущильна машина
5	packaging machine	packager	пакувальна машина
6	compress machine	press machine	пресувальна машина
7	drum-type washer	rotary washer	барабанна мийка
8	apron washer	belt washer	конвеєрна мийка
9	agitator	mixer	мішалка

Fig. 2. Structure of the branch terminology database in the format of XLSX with the possibility of its further conversion and use in the SDL Trados

A special place in the structure of the components of the information and technology case of the translator take the translation memory, since it is based on the work of the main modern tools in translation, namely, automated translation systems. A future translator can reach a certain level of filling his own translation memory databases during studying by performing appropriate operations and using specialized tools. In particular, the most accessible in this aspect may be actions aimed at the use of predefined databases of aligned parallel texts in appropriate formats for filling such databases, or saving the results of translations by using automated translation systems.

That is, the implementation of this component of the information technology case is closely related to two other components, namely, the formation of a database of aligned parallel texts and the development of a translation memory database using CAT systems.

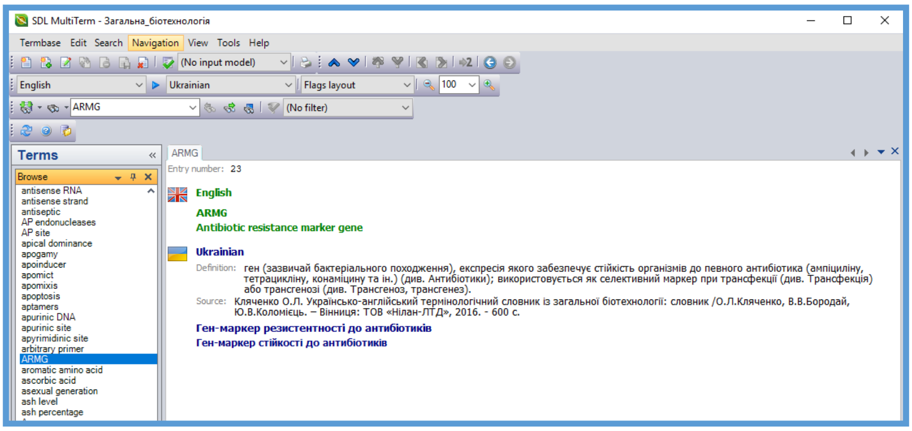

Fig. 3. Structure of the window and tools of the SDL MultiTerm system for working with the terminology database in .sdltb format.

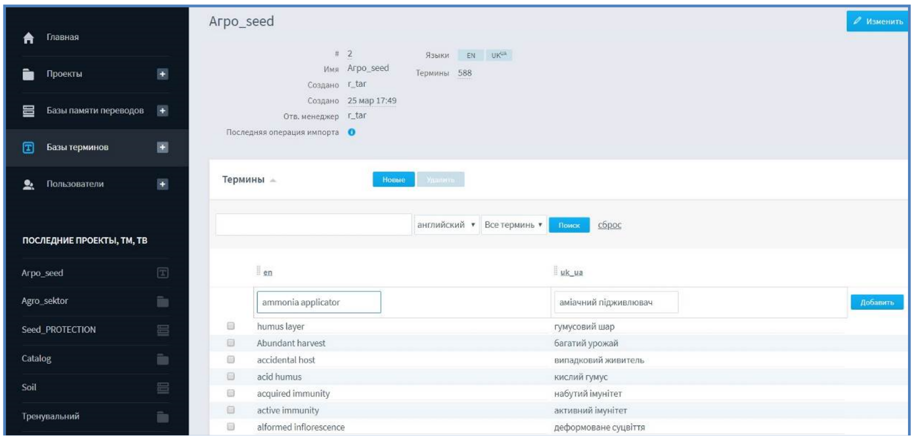

Fig. 4. Structure of the window and tools of the cloud-based CAT system MemSource for working with the terminology database

Alignment of parallel texts can be done both with the use of desktop systems and with the toolkit that is in the structure of cloud-based CAT systems. In particular, a powerful tool for aligning parallel texts is the WinAlign program, which is part of the structure of the SDL Trados system, but it relates to proprietary software. To this end, the software Okapi Olifant Translation Memory Editor, which has a free license for use, can be successfully used and, accordingly, is available for use in the studying process and in self-study work. These software products can save the alignment results of parallel texts in a specialized TMX format that can be directly used as a translation memory database in some CAT systems, and it serves for such systems as SDL Trados as the main resource for importing into a database stored in SDLTM format.

As noted, alternatives to desktop systems may be appropriate tools for cloud-based systems. The process of aligning parallel texts in cloud-based CAT systems occurs mainly in automatic mode, with subsequent loading of files in the format XLSX to a personal computer (Figure 5).

	A	B	C	D
1	en	uk_ua	filename	
2	{b>Crop protection products (CPPs)<b}	{b>Засоби захисту рослин (ЗЗР)<b}	Засоби захисту рослин.docx	
3	Syngenta aims to ensure stability in agricultural manufacture through up-to-date innovation research and technologies, manufactures wide range of various plant- protecting agents and is currently a leader in a world agrochemical market.	«Сингента», мета якої — забезпечувати стабільне сільськогосподарське виробництво за допомогою сучасних інноваційних досліджень і технологій, виробляє широкий спектр різноманітних засобів захисту рослин і сьогодні лідирує на світовому агрохімічному ринку.	Засоби захисту рослин.docx	
4	{b>Seeds<b}	{b>Насіння<b}	Засоби захисту рослин.docx	
5	Syngenta is also a world leader in seeds business, offering a wide range of seeds of field and vegetable crops to manufacturers of agricultural products in all countries of the world.	«Сингента» є також світовим лідером насіннєвого бізнесу, пропонуючи широкий спектр насіння польових і овочевих культур виробникам сільськогосподарської продукції в усіх країнах світу.	Засоби захисту рослин.docx	
6	Syngenta creates hybrids of vegetable and field crops, which yield high-quality and stable harvest.	«Сингента» створює гібриди сільськогосподарських культур, які дають високоякісний і стабільний урожай.	Засоби захисту рослин.docx	
7	{b>Lawns and garden<b}	{b>Газони та сади<b}	Засоби захисту рослин.docx	
8	Syngenta plays an important role in world flower business back from XIX century.	Компанія «Сингента» посідає чільне місце у світовому квітковому бізнесі, починаючи з XIX століття.	Засоби захисту рослин.docx	
9	Our company combines power and experience of such trademarks as Sluis&Groot (Holland), Fischer (Germany), Goldsmith and Yoder (USA).	Наша компанія поєднала в собі силу й досвід таких торгових марок, як Sluis&Groot (Голландія), Fischer (Німеччина), Goldsmith та Yoder (США).	Засоби захисту рослин.docx	
10	For more than 140 years, we apply innovation technologies and leading selection methods to help professional florists achieve highest results in growing flowers.	Уже понад 140 років ми застосовуємо інноваційні технології і провідні методи селекції для досягнення професійними квітникарями найкращих результатів у вирощуванні квіткової продукції.	Засоби захисту рослин.docx	

Fig. 5. Fragment of aligned parallel texts base by cloud-based CAT system MemSource in the format of XLSX

Formation of other identified components of the information and technology case of a translator is no less important than those discussed in more detail above and is an important indicator of students' knowledge of the information technologies used in translation process.

The results of systematization of the aforementioned aspects of the formation of the components of the information and technology case of the translator in quantitative and qualitative dimensions, which are correlated with the levels of formation of information competence, are given in Table 1.

The structuring of data summarized in the data table concerning the qualitative and quantitative indicators of the information and technology case of the translator can be used as one of the diagnostic tools for determining the levels of formation of the information competence of the translator, which was carried out during the experimental study.

Table 1. The correlation of the results of the formation of an information and technology case of a translator with the level of information competence

The formation level of information and technology case	**Components of information and technology case**	**Quantitative indicators of the components of the information technology case**	**The level of the information competence**
I	Database with a list of software products for performing various translation tasks	Up to 5 products	low (reproductive)
	Database of electronic links to network terminology resources	Up to 5 links	
	Electronic terminology databases in XLSX format	Up to 500 terms	
II	Database with a list of software products for performing various translation tasks	At least 10 products	medium (technologized)
	Electronic terminology databases in XLSX format	At least 2000 terms	
	Databases of aligned parallel texts	Up to 1000 segments	
	Database of electronic links to corpora of parallel texts	Up to 5 links	
	Database of network professional communities, registration and participation	Up to 5 links	
III	Electronic terminology databases in formats XLSX, SDLTB	At least 5000 terms	sufficient (constructive)
	Databases of aligned parallel texts	More than 5000 segments	
	Translation memory bases for use in automated translation systems	More than 7000 segments	
	Base of texts translated using CAT systems	More than 50,000 characters	
	Database of network professional communities, registration and participation	Up to 5 links and participation in 1 of them	
	Scientific publications	Up to 2 publications	
	Certificates of internship in agencies and organizations	Not less than 1	
IV	Electronic terminology databases in formats XLSX, SDLTB	At least 7000 terms	high (productive)
	Translation memory bases for use in automated translation systems	More than 15,000 segments	
	Base of texts translated using CAT systems	More than 50,000 characters	
	Database of network professional communities, registration and participation	Up to 7 links and participation in 2 of them	
	Certificates of the level of skills of the use of specialized software in translation	Not less than 1	
	Certificates of internship in agencies and organizations	Not less than 2	
	Scientific publications	More than 2 publications	

The overall sample consisted of 96 students. They were assigned to experimental group and control group so that each group comprised 48 students. The analysis carried out at the end of the experiment based on control diagnosis showed significant changes in the experimental group (Table 2).

Table 2. Dynamics of formation levels of information competence

Levels	Control group		Experimental group	
	at the beginning of the experiment, %	**at the end of the experiment, %**	**at the beginning of the experiment, %**	**at the end of the experiment, %**
low (reproductive)	68.1	59.6	69.6	15.2
medium (technologized)	31.9	38.3	30.4	43.5
sufficient (constructive)	0.0	2.1	0.0	34.8
high (productive)	0.0	0.0	0.0	6.5

In particular, the number of students in the experimental group, which had a low level of information competence formation at the beginning of the experiment, decreased from 69.6% to 15.2%. At the same time, positive dynamics is observed also at the average level, where the growth was 13.0%. The effectiveness of the study of information technology, typical of translation process, to increase the level of information competence of future translators is that 34.8% of students have reached a sufficient level and 6.5% the high level, although at the beginning of the experiment there were no students at all such levels of information competence.

5 Conclusions and future work

Based on the study, an approach has been proposed that can contribute to the achievement of high efficiency in the formation of an integral structure of information competence of translators. This approach is based on the orientation of the student on the creation of an information and technology case of the translator. It is determined that the indicator of the level of formation of information competence is the completeness of a certain set of components of such a case. The translator's information technology case includes a set of components that reflect a list of the most important information, terminological and technological resources that can contribute to the successful implementation of translation projects in educational and professional activities.

Thus, it is possible to create the prerequisites for successful start of professional activity of future translators, determining and evaluating the completeness and level of formation of the translator's information and technology case during the implementation of an individual plan by each student. It is due to the availability of important developments in information resources and knowledge of information technologies with a confirmed level of formation of information competence.

Findings of the present study have revealed the need to undertake further research works in many related areas. Further scientific studies may be related to the development of methodological aspects of the formation of the components of the information and technology case of the translator.

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The enhancement of a foreign language competence: free online resources, mobile apps, and other opportunities

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Abstract. In this article, we present an overview of free online resources, mobile apps, and other opportunities available for an independent study of a foreign language (based on the examples of English and Korean languages) in group and individual settings, geared towards increasing a foreign language competence. Initially, the authors formulated the criteria for selecting free online resources: the resource should be convenient for independent work; the resource should be available at any convenient time; it should be easy in navigation; it should provide opportunities for improving as many components of a foreign language competence as possible; preferably, the resource should have online as well as offline mobile apps. It is suggested to classify free online resources based on their functional characteristics. Various opportunities of the available resources are highlighted and the expediency of their utilization for specific objectives (i.e., advancement of foreign language competence in listening, reading, writing, speaking; the expansion of the vocabulary, etc.) is substantiated. The authors also emphasize free online opportunities of preparation for international examinations not only in the English language, such as TOEFL or IELTS, but also in the Korean language, such as TOPIK, by using online resources in English.

Keywords: Foreign Language Competence, Free Online Resources, Mobile Apps, Web Services, Websites, United Nations Bibliographic Information System THESAURUS, Learning English & Korean Languages, TOEFL, IELTS, TOPIK.

1 Introduction

The issues of formation and improvement of competences have been of constant concern to those who teach and those who study. Along with the existing classical textbooks for teaching foreign languages, there is a growing range of educational open resources. The questions raised in this article deal with the structure, organization, navigation and availability of the resources, such as: 1) how should they look like, 2) how should they work, 3) which resource should be chosen in each particular case, etc. These and other issues are being discussed by the scientific and educational community [4; 5; 8]. On the one hand, some scholars investigate eLearning Qualitäts-Evaluationstool [2], success factors for eLearning [6], categories of mediapedagogics [7], applying information and communication technologies to language teaching and research [9], usage of eLearning tools in self-education [11], Internet-Technology Instruments for Global Education [10], practical use of commonly used YouTube video materials in the process of teaching German as the first or second foreign language in higher education [3], other scholars substantiate classification of online resources in the field of language teaching [4; 5; 8]. On the other hand, the interest in the topic is dictated by the current socio-economic context.

1.1 Socio-economic context

Globalization and integration have stirred up labor markets, giving impetus to the revitalization of labour force. The so-called "erasing of borders" raised a new wave of interest in learning foreign languages, above all, the global one – English – and the languages of those countries characterized as emerging markets (Korean, Japanese, Chinese). Therefore, the topic of the article – the enhancement of a foreign language competence through free online resources, mobile apps, and other opportunities – can be of scientific as well as practical interest.

2 The opportunities of free online resources

As foreign language practitioners, both instructors and students face a difficult choice of selecting the most appropriate educational material. The wide array of free online resources complicates this choice to a greater extent.

The authors indicate that the free online resources discussed below were selected based on the following criteria: a) the resource should be convenient for an individual and independent usage; b) the resource should be available at any time; c) the resource should be user-friendly and easy to navigate; d) the resource should be able to enhance the greater number of the components of a foreign language; e) preferably, the resource should have a mobile app; f) preferably, the resource should be available online as well as offline.

2.1 The opportunities that free online resources provide for learning English language

Free online resources: websites.

The websites are considered to be some of the most well-known free online resources for learning English language. The benefits and limitations of such resources are discussed below.

The **Lingualeo** website (https://lingualeo.com) provides the opportunity to train memorization of the vocabulary (by offering a wide array of exercises geared towards word recollection), grammar, reading, listening to audio, viewing video, and the ability to add new words to a learner's profile in order to automatically increase their appearance in memorization exercises. For each successful completion of an exercise and memorization of new vocabulary, the points can be accumulated and later redeemed for paid exercises. Hence, the more the user practices, the more new exercises become available. Lingualeo also offers a mobile app.

The **Duolingo** website (https://www.duolingo.com) is also an excellent website for learning and memorizing vocabulary. A user is required to register and select the desired level of language proficiency or take a test to assess the current level of knowledge and choose the amount of exercise based on that level. There is also an option to pick a certain time and study for 5 to 20 minutes per day. The mobile app for Duolingo is also available.

The **Cambridge Assessment English** (https://www.cambridgeenglish.org/test-your-english/) website offers a great deal of useful information, however, in order to enhance a foreign language competence, there is a totally free testing portal. The tests available at CAE website give users the most accurate assessment of their current skills. In essence, these tests resemble TOEFL or IELTS, thus, the progress of the learner can be effectively evaluated.

The **Learn at Home** website (https://www.learnathome.ru) is another good service for an individual study of English language. All aspects of language can be trained, including vocabulary, grammar, writing, speaking and reading. Upon completion of a language test, an individual plan can be outlined. Needless to mention, the Learn at Home website also offers a podcast Learn@Home (https://apps.apple.com/ua/app/learn-home/id731118782), which makes it an even more sought-after resource for training all kinds of communication.

The **HiNative** website (https://hinative.com) is another free website, also available in Russian interface. The main benefit of this platform is that a learner is being guided by a native speaker. Native speakers assist with the pronunciation, answer questions, help understand context for using certain words or phrases. There is also a mobile app.

The **United Nations Bibliographic Information System THESAURUS. Dag Hammarskjöld Library** (https://lib-thesaurus.un.org), **The UN Database with documents in different languages** (https://conf-dts1.unog.ch), **The database of terminology, related to UN activities** (https://unterm.un.org) are the professional online resources, allowing learners to advance interpreter and/or professional foreign language competence. In fact, these resources are used as guides and templates for translating UN documents to other languages. A user is able to search by the name or tags of documents that fits the situation best.

For example, in UN Database of documents in different languages (Fig. 1), a specific search index can be selected. All results will be showed in default language, and indexing by language will filter the given results.

There is also an option to search by individual keywords, set of keywords, or exact matching keywords (Fig. 2).

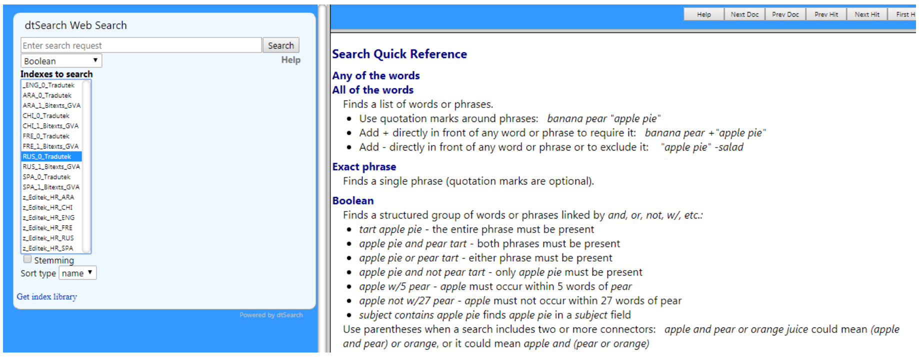

Fig. 1. A screenshot of a page from the UN Database and selecting search index

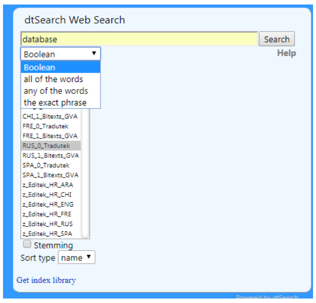

Fig. 2. A screenshot of a page from the UN Database: search by keywords

Found documents come up on the left side of the results page, and they can be downloaded or opened on the right side of the screen (Fig. 3). The documents with different language versions are leveled and highlighted to compare each paragraph.

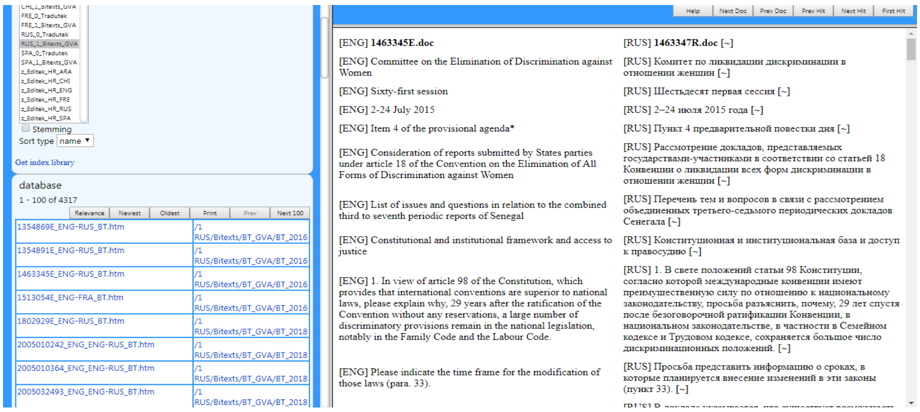

Fig. 3. A screenshot of a page from the UN Database: the comparison of two versions of the document in different languages

Using a search bar in the browser, it is possible to find all the mentions of a searched keyword. It would be highlighted in yellow (Fig. 4).

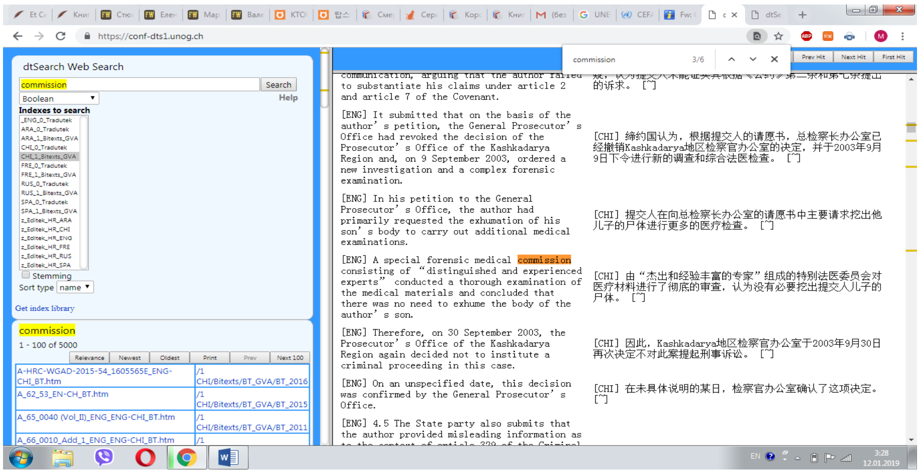

Fig. 4. A screenshot of a page from the UN Database: search by in-text keyword mentions

The abovementioned databases of UN terminology and documents allow learners to use high-quality examples and enhance the translational and/or professional foreign language competence for users.

Free online resources: podcasts.

It is worth highlighting that there is another large group of free online resources, namely, podcasts. To put it in simply, a podcast is a permanent broadcast of the programme. In this case, it's about the YouTube channel broadcast. Everyone can subscribe to resources for free.

The **Learn@Home** podcast by the **Learn at Home** site (https://apps.apple.com/ua/app/learn-home/id731118782) has already been mentioned above.

The **Skyeng** (https://www.youtube.com/channel/UCcBbiCpR-eBwL5l6H63lgfg) podcast is an English language school (a Russian-speaking resource) that works with the listeners online. There is a YouTube channel, where Skyeng educators explain the details and situations with the proper usage of the English language. Additionally, it is a great resource for working with video content (analysis).

The **TED Talks** podcast (https://www.youtube.com/user/TEDtalksDirector) is a resource that collects public speeches is perfect for training listening skills, according to the authors. The invited speakers discuss different topics, including politics, economics, social issues, arts, etc. It is considered that this experience would be one of the most beneficial since the listeners can not only absorb new vocabulary and phraseology, but also develop a deeper comprehension of different external factors, as well as diction, tone, tempo, etc. Necessary to note, subtitles can be turned on to create additional ways for perception, understanding, and control of the speech.

The **Learn English with EnglishClass101.com** (https://www.youtube.com/user/ENGLISHCLASS101) podcast is an English language speaking resource that provides a classic approach to teaching and explaining the material. The undoubtful benefit of this resource is that the listeners can always listen to the native speakers' speech.

Free online resources: mobile apps.

Mobile applications help to always be ready to master the new or revise already learned material, since the usage of smartphones has surpassed that of personal computers. It's mobile, convenient, and there are many different free apps, so there is an opportunity to choose the best fit in terms of the interface, the system of training the vocabulary offered, and, in general, the variety of functions of these applications. In this article, the authors distinguish top 5 applications on the iOS platform, which they used / use. Most of these apps are also on the Android platform, so they can be found in Google Play too.

Offline **Ukrainian-English dictionary** (https://apps.apple.com/us/app/english-ukrainian-dictionary/id1088834323) has a convenient interface, works offline, so even without an Internet connection, there is always access to the dictionary in any situation giving the translation of an unknown word, if necessary.

The mobile version of a well-known **Google Translate** (https://apps.apple.com/us/app/google-translate/id414706506). This mobile app requires Internet connection, however, it can store and process a greater deal of information, and there is an option to translate words and phrases between all world languages. In addition, this mobile app is user-friendly and absolutely free.

Hello English app (https://apps.apple.com/us/app/hello-english/id1148009516) is an application developed by the entire educational platform, but if the platform itself supposes purchasing the subscription or requires to register for the paid online courses. The mobile app, on a contrary, is totally free with an option for in-app purchases. A free version includes over 400 interactive exercises for training memorization or grammar. Moreover, this app also contains a translator. For an additional fee, there is an option to talk and consult with tutors, who are also the native speakers.

Beelinguapp: Language Learning (https://apps.apple.com/app/beelinguapp-learn-languages-with-audio-books/id1225056371) is a mobile app, allowing users to learn English language by listening to audiobooks. Aside from training listening skills, audio books require continuous engagement. Narrated by the native speakers, audiobooks help users expand their vocabulary and the knowledge of common phrases as well as improve their reading skills. The mobile app contains optional in-app purchases, and one of the languages available as the interface default is Russian.

English Word Card (https://apps.apple.com/ru/app/english-word-card/id759821899) is focused on expanding one's vocabulary by studying with flashcards. The flash cards are sorted by topic-based groups and various levels of difficulty. This form of learning fits everyone from the beginner to the advanced levels, and all available words are shown in context, combined with a detail description and the audio of pronunciation.

2.2 The opportunities that free online resources provide for learning Korean language

As for studying the Korean language in the classroom or on their own, European students experience more significant difficulties than studying the European languages. The most important problem in the study of the Korean language lies in the fact that this language is phonetic. This means that listening to what is being studied is essential.

The experience of teaching and feedback from students studying Korean during the last four years at the University of Customs and Finance, Ukraine has enabled the following resources to be offered for both classroom and independent work. The authors understand that this list cannot be limited to the proposed resources as there are other useful educational resources. However, we have chosen them according to the criteria we set forth above.

2.3 Free online resources: websites, mobile apps, and podcasts

Free online resources provided for learning Korean language are grouped together by the authors, since most of them exist in the form of mobile applications and in the form of high-quality web resources.

LingoDeer - Learn Languages (https://apps.apple.com/us/app/lingodeer-learn-languages/id1261193709) is a mobile application. In the free mode, the access is open for beginners. The resource helps to learn the necessary volume of vocabulary, there are also sections of “listening” and “speaking”. The service is adapted in English.

How to study Korean (https://www.howtostudykorean.com) is a free service offering a detailed description of all grammar rules and other details as it pertains to the structure of Korean language. The only drawback of this resource is that the only default interface language available is English. On a plus side, it is considered to be one of the most powerful services for learning and advancing Korean language. This resource helps train speaking, listening, reading and writing skills on all proficiency levels from A1 to C2. Additionally, this service offers hieroglyphs and the vocabulary. The resource contains six complete units.

KoreanClass101: Learn Korean Online with Podcasts (https://www.koreanclass101.com) is a podcasting service that upon registration opens access to a great variety of useful material and exercises for training all the necessary skills. Additional paid material is also available, although, in the authors’ opinion, the free version offers a sufficient amount. This service also has mobile apps, which makes it easier to keep all the materials in sync and easily share them on the Internet.

The **HiNative** service has already been mentioned and discussed above in the section regarding learning English. There is also Korean language available. This resource has both the website (https://hinative.com), and the mobile app (https://apps.apple.com/app/apple-store/id923920480). This free service helps improve listening and speaking skills, improves pronunciation, as well as gives an opportunity to listen, ask questions, communicate and get assistance from Korean native speakers. Considering the different characteristics of formal and informal styles of communication, this service is recommended for intermediate students of Korean language.

Topik Guide (https://www.topikguide.com/complete-topik-practice-test-online) is a resource that helps prepare for international test in Korean language. Specifically, registration on the website opens access to the database of all past versions of the test. Thus, it becomes realistic to obtain real information, real test copies, audio files, assignments and have an opportunity to study this information independently, as well as better understand the algorithm and format of testing and better prepare. Besides, the service offers a newsletter with relevant information regarding the exam, the dates of registration and results, discounts or unique promotions as it pertains to free courses of Korean language as well as lectures and other learning materials.

NAVER Korean Dictionary – in the authors' opinion, is the most important and essential service in the phone of every Korean language practitioner (https://dict.naver.com – dictionary; https://papago.naver.com – translator; https://apps.apple.com/us/app/naver-korean-dictionary/id673085116 – mobile app). At this point in time, this is the only comprehensive online vocabulary of Korean language, available online for free. This service gives the option of English and Russian dictionaries and has the translator option. The latter might not be absolutely accurate in every case or misunderstand the usage or the differences between formal and informal styles, however, the dictionary itself acts as an essential tool for communication and enhancement of foreign language competence. Still, there is some substantial criticism associated with the service. Since this service is capable of translating long forms of text, students might be using it to ease an overwhelming task. However, this service cannot guarantee the most accurate interpretation, since it has been created to assist foreign tourists who travel to Korea and do not speak the local language. This resource is recommended for individuals who are committed to studying Korean language as well as the advanced students who fully understand the difference between formal and informal communication. Needless to mention, a vast number of students are not familiar with this service and still use Google Translate. However, the latter is less capable in providing a professional translation.

The popularity of Korean culture and K-pop has a significant impact on the use of YouTube resources for learning Korean language. This can be explained by the fact that most students are showing interest in the Korean language precisely because of the K-pop and the Korean musicals. Therefore, the distribution of video clips about Korean culture and K-pop, music videos, sets of videos of popular actors / their biographies, and so on is most appropriate for the intermediate level students. Because their intermediate level already allows them to understand and comprehend the information, then the skills of translation and listening comprehension are being trained. However, from the beginners' perspective, the use of music clips, etc., is not quite efficient. Video tales in Korean with subtitles are more effective in the beginning stage of learning the language, especially for listening. They are easy to listen to; relatively short, and vocabulary is easily absorbed (https://youtu.be/cmJlisfnTKQ; https://youtu.be/j6zWwAoEi_w).

Talk To Me In Korean (https://www.youtube.com/channel/UC5r3WHrX4Z7peSYpDlgktGw) – is a channel that not only helps learn the language, but also educates the learners about Korean culture and life in Korea. The playlists cover a tremendous amount of learning material for all levels from A1 to C2. This resource also has a website, although it is recommended for advanced students only, and individuals with deep understanding of Korean culture and mentality, which was the reason why the website itself was excluded from the list of free resources.

TOPIK 3 (https://www.youtube.com/channel/UC8tBZ26eo-a8txIPdXLWEEQ) – a channel that is considered as a resource exclusively for preparation and completion of Korean language tests starting from the third level (B1) and up. An enormous number of audio files are available for developing speaking and listening skills. The material from the previous TOPIK tests is used in the audios.

MasterTOPIK (https://www.youtube.com/channel/UCcU6RCjsoPqJ7HtiIpLmyyw) – another resource for Korean language test preparation. The provided material is tailored for students of all levels of proficiency. Various components of foreign language competence, including grammar, reading, and listening, can be improved. In addition, more detailed explanations regarding the writing part of the test are outlined.

Learn Korean with KoreanClass101.com (https://www.youtube.com/channel/UCsgBUobNGksxIKTagZayKEw) – a resource similar to the one for studying English. In addition to the website this resource also has a YouTube channel, somewhat similar to Talk To Me In Korean.

2.4 The improvement of listening and reading skills in Korean language

By presenting free online resources for learning Korean, the authors would like to leave their comments regarding the improvement of listening and reading skills in Korean.

First of all, the use of Korean music for the language learning, in our opinion, is more suitable for students who have begun to study the language on the intermediate level. In songs, in general, there are no clear grammatical structures, but there is plenty of vocabulary that is required for the exam TOPIK. So, students being fans of K-pop, can listen to their favourite songs and learn the useful vocabulary at the same time (music videos belong here too). Nevertheless, our experience confirms that this technique can also be successfully applied to elementary level students, but for the purpose of training reading. While reading their favourite songs, students adapt more quickly to the language, and each time they read more confidently and quickly and, most importantly, phonetically correct. It is advisable for students to do translations of the songs by themselves (it is more interesting on advanced levels), but for beginners all the texts are available in the free online access, for example at the Color Coded Lyrics website (https://colorcodedlyrics.com)

Viewing Korean series / movies / TV shows /web blogs with subtitles – these activities are extremely beneficial if the priorities are set to learning Korean language, as opposed to solely enjoying the entertainment. Unfortunately, the subtitles in Ukrainian are rarely available; however, there is a vast number of video content with Russian and English subtitles (although, there are certain limitations due to blocking of the Russian websites). It is also important to discuss the fact that there's an overwhelming amount of pirated content, such as http://doramatv.live/list/country/south_korea, which is not recommended due to ethical considerations. To view desired content without infringing upon copyright laws, it is recommended to use YouTube or the official websites of Korean video content creators. There are countless YouTube channels of various Korean vloggers who work in different genres, which makes it possible to suit every taste. Some of the suggested vloggers are https://youtu.be/bkg5_JsZ6gM (on this channel, the details of Korean language usage are highlighted) and https://www.youtube.com/channel/UCj-durTg1W7uWsB8oq0u7kA (interesting content regarding Korean slang).

Manhwa (Web Comics). The culture of webcomics is highly popularized in Korea. There have been studies that have shown that the majority of Koreans of ages 10 to 30 have positive sentiments towards webcomics. They are relatively short types of content, quick to read, and well-rounded in terms of covering various topics. There are several things to consider as it pertains to relying to webcomics for learning Korean language: 1) the comics are appropriate for students at intermediate level an up due to a common usage of slang and swear language; 2) while there are free webcomics, the majority of them are paid. This service is available in English, as well. In the following discussion, the most popular companies that create platforms for such comics as Lezhin Comics – https://www.lezhin.com/ko (in Korean); https://www.lezhin.com/en (in English) and WEBTOON – https://www.webtoons.com/ko (in Korean); https://www.webtoons.com/en (in English) are examined.

3 Classification of free online resources by functional approach

On the one hand, the majority of communication textbooks and online educational resources for foreign language learners focus on functional approach to learning. One of the most substantial determining factors is the way of providing learning material and forming the knowledge and skills associated with the delivery of vocabulary-grammar material: the learning material should be provided in compliance with communicative functions (favour, question, offer, agreement, disagreement, etc.). These functions translate the communicative purpose of a speaker. With this goal, the linguistic structures are offered, and provide the opportunity to realize certain functions in the process of communication [1].

On the contrary, “according to the “new” paradigm of language teaching/learning activities” ... can be classified as … skills (active skills: speaking, writing; passive skills: reading, listening and watching) and Language use (grammar, vocabulary) [8, p. 12].

With the claims outlined earlier, the authors were able to classify free online resources from the perspective of functional approach, which allowed presenting the opportunities of these free online resources in order to enhance the skills as components of foreign language competence. All of the discussed free online resources provided for learning English and Korean languages were grouped into four tables (Table 1 – Table 4), as presented below.

3.1 The opportunities that free online resources (websites, podcasts) provide for learning English language

Table 1 presents the opportunities that free online resources (websites, podcasts) provide for learning English language in the types of communicative activities, including listening, reading, writing, speaking, the expansion of the vocabulary considering format of tutoring (group and/or individual) and level of language proficiency (A1-C2).

Table 1. The opportunities that free online resources (websites, podcasts) provide for learning English language

Resources (websites, podcasts)	**Focus on listening comprehension**		**The improvement of reading skills**		**The improvement of writing skills**		**Focus on speaking ability**		**The expansion of the vocabulary**	
	Level of language proficiency (A1-C2)									
	Format of tutoring (group and/or individual)									
	group	**ind.**	**group**	**ind.**	**group**	**ind.**	**group**	**ind.**	**group**	**ind.**
Lingualeo (website)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Duolingo (website)		+ A1-B2		+ A1-B2		+ A1-B2		+ A1-B2		+ A1-B2
Cambridge Assessment English (website)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Learn at Home (website)		+ A1-B1		+ A1-B1		+ A1-B1		+ A1-B1		+ A1-B1
HiNative (website)		+ A1-C2		+ A1-C2		+ A1-C2		+ A1-C2		+ A1-C2
Skyeng (podcast)	+ A1-C2	+ A1-C2					+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
TED Talks (podcast)	+ B1-C2	+ B1-C2			+ B1-C2	+ B1-C2	+ B1-C2	+ B1-C2	+ B1-C2	+ B1-C2
Learn English with EnglishClass101.com (podcast)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
United Nations Bibliographic Information System **THESAURUS**. Dag Hammarskjöld Library (website)			+ B2-C2	+ B2-C2	+ B2-C2	+ B2-C2			+ B2-C2	+ B2-C2
The UN database with documents in different languages (website)			+ B2-C2	+ B2-C2	+ B2-C2	+ B2-C2			+ B2-C2	+ B2-C2
The database of terminology, related to UN activities (website)			+ B2-C2	+ B2-C2	+ B2-C2	+ B2-C2			+ B2-C2	+ B2-C2
Lezhin Comics (website)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2					+ A1-C2	+ A1-C2
WEBTOON (website)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2					+ A1-C2	+ A1-C2

Table 2 presents the opportunities that free online resources (mobile apps) provide for learning English language for the types of communicative skills such as listening, reading, writing, speaking, the expansion of the vocabulary considering the format of tutoring (group and/or individual) and the level of language proficiency (A1-C2).

Table 2. The opportunities that free online resources (mobile apps) provide for learning English language

Resources	**Focus on listening comprehension**		**The improvement of reading skills**		**The improvement of writing skills**		**Focus on speaking ability**		**The expansion of the vocabulary**	
	Level of language proficiency (A1-C2)									
	Format of tutoring (group and/or individual)									
	group	**ind.**	**group**	**ind.**	**group**	**ind.**	**group**	**ind.**	**group**	**ind.**
Lingualeo	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Duolingo		+ A1-B2		+ A1-B2		+ A1-B2		+ A1-B2		+ A1-B2
Learn@Home		+ A1-B1		+ A1-B1		+ A1-B1		+ A1-B1		+ A1-B1
HiNative		+ A1-C2		+ A1-C2		+ A1-C2		+ A1-C2		+ A1-C2
Skyeng	+ A1-C2	+ A1-C2					+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
TED Talks	+ B1-C2	+ B1-C2			+ B1-C2	+ B1-C2	+ B1-C2	+ B1-C2	+ B1-C2	+ B1-C2
Learn English with English-Class101.com	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Ukrainian-English dictionary			+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2			+ A1-C2	+ A1-C2
Google Translate	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2			+ A1-C2	+ A1-C2
Hello English app	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Beelinguapp: Language Learning	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
English Word Card	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2

3.2 The opportunities of free online resources for learning Korean language

Table 3 presents the opportunities that free online resources (websites, podcasts) provide for learning Korean language for the types of communicative skills such as listening, reading, writing, speaking, the expansion of the vocabulary considering the format of tutoring (group and/or individual) and the level of language proficiency (A1-C2).

Table 4 presents the opportunities that free online resources (websites, podcasts) provide for learning Korean language for the types of communicative skills such as listening, reading, writing, speaking, the expansion of the vocabulary considering the format of tutoring (group and/or individual) and the level of language proficiency (A1-C2).

Table 3. The opportunities that free online resources (websites, podcasts) provide for learning Korean language

Resources (websites, podcasts)	**Focus on listening comprehension**		**The improvement of reading skills**		**The improvement of writing skills**		**Focus on speaking ability**		**The expansion of the vocabulary**	
	Level of language proficiency (A1-C2)									
	Format of tutoring (group and/or individual)									
	group	**ind.**	**group**	**ind.**	**group**	**ind.**	**group**	**ind.**	**group**	**ind.**
HiNative (website)		+ A1-C2		+ A1-C2		+ A1-C2		+ A1-C2		+ A1-C2
Topik Guide (website)	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1			+ A1-C1	+ A1-C1
How to study Korean (website + podcast)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
KoreanClass101: Learn Korean Online with Podcasts (podcast)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Talk To Me In Korean (podcast)	+ A1-C1	+ A1-C1					+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1
PAPAGO – translator (website)	+ A1-C1	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Naver Korean Dictionary (website)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Lezhin Comics (website)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2					+ A1-C2	+ A1-C2
WEBTOON (website)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2					+ A1-C2	+ A1-C2

Table 4. The opportunities that free online resources (mobile apps) provide for learning Korean language

Resources	**Focus on liste-ning compre-hension**		**The improve-ment of rea-ding skills**		**The improve-ment of writing skills**		**Focus on spea-king ability**		**The expansion of the vocabu-lary**	
	Level of language proficiency (A1-C2)									
	Format of tutoring (group and/or individual)									
	group	**ind.**	**group**	**ind.**	**group**	**ind.**	**group**	**ind.**	**group**	**ind.**
How to study Korean	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Naver Korean Dictionary (has access to PAPAGO)	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2					+ A1-C2	+ A1-C2
LingoDeer – Le-arn Languages		+ A1-A2						+ A1-A2		+ A1-A2
HiNative		+ A1-C2		+ A1-C2		+ A1-C2		+ A1-C2		+ A1-C2

Resources	Focus on listening comprehension		The improvement of reading skills		The improvement of writing skills		Focus on speaking ability		The expansion of the vocabulary	
	Level of language proficiency (A1-C2)									
	Format of tutoring (group and/or individual)									
	group	ind.	group	ind.	group	ind.	group	ind.	group	ind.
(Learn Korean with) **Korean Class 101**	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2	+ A1-C2
Talk to Me in Korean	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1
Channel (YouTube vlogger) https://youtu.be/bkg5_JsZ6gM – *the details of Korean language usage*	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1			+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1
Channel (YouTube vlogger) https://www.youtube.com/channel/UCj-durTg1W7uWsB8oq0u7kA – *interesting content regarding Korean slang*	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1			+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1
TOPIK 3	+ B1-C1	+ B1-C1	+ B1-C1	+ B1-C1			+ B1-C1	+ B1-C1	+ B1-C1	+ B1-C1
MasterTOPIK	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1	+ A1-C1

4 Conclusions

Summing up, it can be stated that the free online resources, mobile applications and other opportunities presented in the article are relevant and indispensable present-day tools for group (classroom) and independent study of a foreign language in order to improve a foreign language competence. While examining the resources on the example of the English and Korean languages, certain differences were identified determining and substantiating the recommendations for the practical use of the investigated online services. The authors' classification of free online resources by functional approach allowed visualizing the possibilities of the described free online resources in order to improve specific skills and abilities as components of a foreign language competence (focus on listening comprehension, the improvement of reading skills, the improvement of writing skills, focus on speaking ability, the expansion of the vocabulary). In addition, the authors corroborated the feasibility of using free online resources for certain purposes.

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Use of YouTube on lessons of practical course of German language as the first and second language at the pedagogical university

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Abstract. Integration of ICT significantly increases the possibilities of the educational process and extends the boundaries of the educational sphere as a whole. Publicly available resources, such as e-mail, blogs, forums, online applications, video hosting sites, can serve as the basis for building open learning and education. Informational educational technologies of learning foreign languages are in the focus of this study.

The article represents the results of theoretical analysis of content on the subject of its personal- and didactic-definite orientation, as well as some aspects of the practical use of commonly used YouTube video materials in the process of teaching German as the first or second foreign language in higher education, namely at the pedagogical university. Taking into account the practical experience of using the materials of several relevant thematic YouTube channels with a fairly wide constant audience, a concise didactic analysis of their product is presented and recommendations on converting video content into methodological material in the framework of practical course of German language by future teachers are offered.

Due to the suggested recommendations, the following tasks can be solved: enrichment of the vocabulary; semantization of phraseological units, constant figures of speech, cliché; development of pronunciation skills; expansion of linguistic competence; improving listening and speaking skills; increasing motivation to learn, etc.

Keywords: YouTube, video hosting, German language, foreign language competence.

1 Introduction

Information and communication technologies, which are gradually integrating into education, expand its boundaries and create additional opportunities for the educational process. The gradual development of open learning and education is based on the latest information technologies and open resources, among which web services are particularly appealing in recent times, which allow you to download and view videos in your browser.

YouTube [32], as a video hosting, provides video hosting services, from amateur videos to professional video clips and videoblogs. Nowadays it is one of the most visited sites in the world of the Internet due to the simplicity and ease of use, the ability to communicate without time and territorial restrictions, sharing views in the comments on the videos.

Kedoo [31] created its own analytics panel that provides public information to track the work of leading channels on the YouTube.com platform. According to the March 2018 statistical data, dozens of most popular video categories include entertainment, music, people and blogs, movies and animation, computer games, education, humor, hobby and style, politics and news, sports. It should be noted that education occupied a rather high sixth place with 38.6 billion views and 2.9 billion regular users. This allows to enroll confidently video hosting to modern learning tools, in particular, of German language.

2 Types of video materials on YouTube

As of April 2, 2018, 72,466,260 videos were found in general request “learning German language”, that was formulated by four languages, namely: 2 860 – in Ukrainian, 13 400 – in Russian, 1,750,000 – in German and 70,700 000 – in English. You can find videos of different specializations on YouTube. Table 1 summarizes the information of the orientation of the authors of the numerous channels of video materials, which are offered to everybody, who is interested in learning German as a foreign language.

However, the issue about the effectiveness of the use of widely used video materials in the process of learning a foreign language, in particular German, in a universities, remains open-ended.

Table 1. Orientation of educational videos

Personal-definite orientation	
by age	– for children – for teenagers – for adults
by level of language proficiency	– for beginners – according to the levels of the European Language Education Recommendations
by line of work of users	– for pupils – for students – for professional purposes
Didactic-definite orientation	
by aim	– development of certain linguistic competence (lexical, grammatical) – preparation for the examination to confirm the level of language proficiency – everyday communication – communication in a professional environment

by the type of speech activity	– lexical trainer – grammar trainer – trainer for improving pronunciation – listening and / or reading
by means and forms of study	– based upon real / educational videos – in the dialogues – by means of exercises – based upon stories – by films – “on the street” – with music

3 Theoretical comprehension of YouTube-possibilities in education

Analysis of last researches and publications worldwide indicates an increase of the number of authors who devote their works to the problems of using YouTube in teaching foreign languages. The highest level of interest is shown in learning English as a foreign language. This is due to the status of this language in the modern world as lingua franca.

The subject covers a wide range of issues. In particular, Henriette Arndt, Robert Woore aim to compare the processes of forming the vocabulary of the second language as a result of interaction with two network media: written blog posts and video blogs. In this analysis the level of assimilation of various aspects of lexical knowledge (spelling, semantic and grammatical) was a subject [2]. In turn, Saudi Arabia scholars have experimentally demonstrated higher productivity of targeting vocabulary in a multimedia environment using video on YouTube compared to the traditional way of learning with images [18].

Antoro Sunu Dwi explores the use of ICTs, including YouTube, as key tools for creating training materials in order to support distance learning and language learning [1].

The experimental study of Iranian scholars Souzanzan Rozi and Bagheri Mohammad Sadegh is concerned with the problem of perceiving English as a foreign language in the context of expediency of ICTs use, in particular YouTube, during individual learning [27].

A group of Brazilian researchers [5], having analyzed the impact of some digital resources on the quality of teaching English at elementary school concluded that the latest ITs could make learning of foreign languages more contextualized, creative and motivated.

On the strength of the assertion, that life-satisfying learning is the best policy for learning English (especially by children), Lee Chien-I, Huang Ying-Chih and Lin Yi-Chun believe that the video is a good bearer of information that is the most suitable for language learning. First of all, it is a great opportunity to capture real life situations, and secondly, it is easy to access the necessary information through YouTube [25].

According to Cakir Cemal, due to the emergence of numerous open sources of information (YouTube, Facebook, Twitter, Internet newspapers and magazines) during the globalization period, we are able to observe the phenomenon called “Teaching English to the Speakers of Other Languages” (TESOL) as well as “Teaching English as a Language of Open Sources” (TELOS). TELOS can provide expected multimodal and multidimensional support for TESOL (especially in the context of learning English as a foreign language), enabling the acquisition of pragmatic skills (in particular semantic-syntactic skills), which can only be partially formed in traditional lessons, according to Cemal [4].

According to research [3], YouTube acts as a cognitive tool, which is able to promote raise of the level of critical thinking and cognitive ability of students in the process of learning English as a foreign language.

The analysis of experimental data [30] showed that the use of existing videos and creation of their own videos for the distribution through video hosting increases the motivation of students to learn foreign languages.

Multifunctionality and effectiveness of YouTube as a tool for learning foreign languages is thus evident.

The *purpose* of the submitted report is:

- the illustration of certain aspects of the practical use of commonly used sources of video material in the process of teaching German as the first or second foreign language at universities, namely at the pedagogical university;
- the representation of recommendations on the conversion of video hosting content to didactic material while learning Practical Course of German Language by future teachers.

4 Research results

The interest of the main German apologists, in particular of the Goethe-Institut [14] and DeutscheWelle (DW) [22], to the platform undeniably proves its availability and effectiveness in influencing the process of mastering foreign languages. In the legitimateness of the said, once again the activity of the German international public broadcaster DeutscheWelle convinces of worldwide popularization of German language and the creation and dissemination of the necessary free study programs for its successful completion. Several video playlists that can be used both during class work while learning language and in the process of individual studying, are presented on “Deutsch lernen mit der DW” channel. The differentiation of the levels of language proficiency from the “absolute beginner” to C1 / C2 allows the user independently organize his/her work according to the principle “from simple to more difficult”, and the teacher - quickly orientates in the selection of educational material for a particular audience. The length of the video increases gradually, in order not to overload the viewer and maximize the focus on the didactic material of each lesson or series. It is the series, because most of the educational videos are inherently films whose heroes live a particular part of their lives in the German-speaking environment. Heroes, as a rule, are foreigners, and therefore “they look at Germany and German language” through the eyes of YouTube channel viewers.

In addition to the main theme, the mention should be made of the traditional separation in the structure of the speech activity of the four components: speaking and listening (these two types belong to oral speech), writing and reading (written speech). The exams for determining the level of language proficiency, including the “Goethe-Zertifikat”, consist of “Lesen” (reading), “Hören” (listening), “Schreiben” (writing) and “Sprechen” (speaking) (oral or individual exam) “Sprechen” (oral or individual exam). Such a division is quite logical, since mastering the native language takes place precisely in this natural scenario: from listening to speaking, reading, and, finally, writing. The practice of working with students, which learn German, shows, that audio competence is the most difficult to formulate. Although at first glance there may be an impression that listening is the easiest for children, without much visible effort, as opposed to writing. However, before starting to pronounce the first words and construct a coherent phrases and sentences, the child for several years is in an absolute linguistic environment where he/she can hear sounds and words of his/her native language, in fact, 24 hours a day. Learning the same foreign language often begins with reading and writing, and then speaking and listening. The perception of speech in real life rarely occurs without visual support, and therefore a significant percentage of information is transmitted by non-verbal means. Involving video materials for listening to music is much more effective than using audio tracks. When a video hero pick up a certain item, naming it at the same time, the need to accompany the introduction of a new lexical unit by the translation disappears. Contemplating certain actions with the subject and listening to the commentary of the heroes, the viewer learns the linguistic roots and grammatical structures.

Of course, it is impossible to make a training video to explain every linguistic phenomenon, so the effectiveness of this learning tool can be greatly enhanced by fixing the new material with additional exercises. Understanding this, the authors of the training series DW offer users to go to interactive tasks at the specified link to the official personal site of the television and radio company. Given the current tendency to reduce the audience load at universities of Ukraine and increase the amount of material for independent learning by the student, the use of educational films with exercise complexes can help to optimize their independent work.

YouTube, with its openness to everyone, can be used by teachers as a space for communication. The format of communication in the form of comments is ordinary for modern youth. Free expression of opinions in a foreign language (i.e. speaking) in classes is often hindered by the fear of a public demonstration of an error. Being in a position of assessment by a teacher places the latter in the eyes of the first as a controller, and not as an equal partner in communication.

Offering students the opportunity to discuss certain video materials in comments without mandatory identification of the person, the teacher uses the opportunity to remove excessive nervous tension of the audience and thus intensify the speech activity. Leading a live dialogue requires a quick reaction of the interlocutors, which is difficult to achieve, especially at the initial stage of language learning. In addition, the limited auditorium time does not allow thinking for too long. Pause reduces the dynamics of conversation, thoughts do not find the personification in the right words, the conversation fails, and thus the ability to feel the language as a means of communication loses. A written discussion of a given topic gives an opportunity to think about a replica, to engage in a conversation in a convenient time, to comment on the previously stated statements more reasonably. The tasks performed during the comments may be verified by the teacher (sometimes by the owner of the channel or by other users). If you watch online video tutorials, you can also achieve momentary synchronous interactivity that brings the conversation as close as possible to the "live" one, but this format is more likely to be used for individual work at home, since for class usage this can be technically difficult and organizationally incompatible, with the same schedule.

On the other hand, the teacher's own comments (if necessary also incognito) can promote the unobtrusive orientation of the conversation to a certain didactically determined path, and the usage of correct or contextually relevant linguistic constructions, in response to mistaken or misused, will allow correction of errors without causing a psychological discomfort. Observation of the general course of the conversation may become a valuable source of information for revealing personal qualities, preferences, interests and the level of formation of the foreign language competence of its participants. Such a format of communication may become a kind of modernized Socratic dialogue. It will replace the control by monitoring of the quality of education with the subsequent full realization of all the advantages of the latter for the constant improvement of the educational process.

In addition, participants who are not members of a particular training group may be involved in the conversation, so to speak "strangers". To distinguish them from others in the absence of the desire to register under their own names (at least for the reasons above), you can by agreeing to add a certain code word to the name of the subscriber. The presence of "strangers" opens up good opportunities for the search for "pen-friend", because among them there are rarely happen to random people. Users from around the world are usually interested in learning German. Focusing on comments, you can choose a potentially interesting and useful for further private communication with the interlocutor. Not only students but also teachers can find for themselves like-minded colleagues in the hosting. Viewers often conduct didactic discussions and share reflections on problems and difficulties related to the learning of German language, especially difficult topics, stylistic nuances, etc.

The occasional cases of participation in commentary discussions on language video teaching media positively motivate those who are only German learners, to search for a tandem partner not only on educational channels. Having a certain passion or hobby and watching videos of relevant subjects in German, where the language ceases to be the subject of study and is used exclusively as a means of communication, one can turn to those, who are interested in the common theme of the language and to establish contacts on the appropriate language basis.

Encouraging students or pupils to review not only educational videos but also native speakers' and various video knowledge departments, you can somewhat make a transition to substantive-linguistic integrated learning in German – CLILIG. Participation in the conference organized by the Goethe-Institute in Kyiv in September, 2017 [6] has become the basis for understanding that learning with the help of the CLIL method allows achieving higher levels of linguistic and substantive competence. The emergence of this methodology has become a response to the needs of the era of technical and digital technologies in specialists of different specialties, which, in addition to specialized knowledge, also speak foreign languages. The combination of professional knowledge, substantive-linguistic and general competences, which is the main goal of CLIL, has become a guarantee of a successful specialist's career. Numerous reports of conference participants from Germany, Italy, Lithuania and Hungary have revealed the specifics of the usage of the CLIL methodology in the process of learning and the experience of foreign colleagues in integrating foreign language learning with other subjects during school education. Substantially interesting learning motivates learning of German language and creates a linguistic basis, with the help of which it will be possible to build further education, in particular, in a higher school.

The wide theme range of YouTube videos allows you to organize CLIL-based learning not only at school but also in higher school. Implementations of the principle of inter-subject communications are subordinated to the program from all disciplines, regardless of the cycles they belong to. So it only remains to make established communications in foreign languages. We will speculate on the example of students learning German language within the specialty 014.02 Secondary education. Language and literature (German / English) with an additional specialty, accordingly (English / German) language. The main professional disciplines for them are Pedagogics, German and English languages. The vast majority of educational videos, where the German language is the subject of a study as a foreign language, is aimed to the English-speaking audience. They are often accompanied by English subtitles or by the translation of individual lexical units (for example [23]). The experience of using similar videos in the learning of Practical Course of German as a second foreign language shows a significant increase in students' interest in learning material, since they are able to orientate on "native" English. The latter in this case ceases to play the role of the direct object of study and becomes a means of learning, although indirectly it continues to study. The topics of practical classes in German and English are often coincided and studied in parallel, so the use of English-German video as a didactic material contributes to improving the quality of knowledge in both disciplines. It also serves as the development of translation skills. At the very least, practice shows that the quality of the implementation of the author's didactic game "Translator" is significantly increased (according to the rules of the game, one or more participants, performing the role of English speakers, and the other / others German speakers, must be understood on a specific topic, using the participant's help, who is playing the translator).

A narrowly-focused video may be useful while studying a wide range of topics within practical courses and linguistic studies.

As for Pedagogics and German language, it should be noted that it is not difficult to find videos on the YouTube of a particular topic (for example, the Christian Kißler [21] channel). However, the question arises – within which discipline is it more appropriate to use them? In our opinion, it is most appropriate to do this at classes on the methodology of teaching a foreign language, since this discipline is taught, as a rule, by a specialist in Pedagogics and the corresponding foreign language simultaneously.

Teacher of pedagogical disciplines who does not speak German can find the necessary material in collaboration with his colleagues, and offer students the opportunity to study individually in order to consolidate the knowledge gained during their class work in their native language.

The video format, which is offered by the "LearnGerman" channel, for example [13], allows you to achieve better results in one more direction of language work. This is a kind of educational activity, such as home or academic reading. Generally, the main goal of individual reading is to develop perceiving skills of written foreign language text, expanding vocabulary and deepening linguistic competence. The accompaniment of audio reproduction of the available for visual perception of the printed source contributes not only to the accompanying development of the above-mentioned listening skills, but also to the improvement of pronunciation. Comparison of the results of text work in two groups of students, one of which used only paper, and the other – audiovisual, showed that the pronunciation, and most importantly intonation, during the retelling of certain passages of the read (and listened) story in the second group significantly improved.

Returning to the institutions that promote German in the world, the Goethe-Institute should be reminded once more and noted that a significant number of its projects on YouTube and not only there is intended to prepare applicants for exams to confirm a certain level of language proficiency. In collaboration with the institute, there are also numerous printed guides from several German publishing houses, mostly accompanied by interactive exercises and audio materials. This logically updates the question of what is and is there in general the prevalence of video channels over "classical", albeit modernized, learning tools. In our opinion, the advantage becomes more obvious, the higher level of language proficiency of the person who prepares for the exam is.

According to [15], having passed the "Goethe-Zertifikat" C1 / C2 exam, you confirm the ability to "understand a wide range of long, rather difficult texts, also capturing the hidden meaning, ... flexible use of language in public and professional life, ... easy understanding of almost everything, read or heard in German". So, in order to confirm the C1 / C2 level it is not enough just to speak correctly and quickly on all well-known topics, but you must be aware of all topics, understand the current trends in the development of science and culture in the world and Germany in particular, and therefore be able to get the latest information about the country. Despite the fact that exam preparation tools are quite often updated, so that available information at the time of the exam may become somewhat obsolete. It's possible to be informed if you read periodicals regularly, listen to radio or watch videos on television or YouTube channels. However, only special videos are accompanied by subtitles or full text, translations, explanations, and exercises that convert them from the usual source of information to the learning tool. The "LearnGerman" channel [24] offers, among other things, German daily news editions, and adapted by subtitles for foreigners videos, which are published several times a day.

The number of educational author channels of various content (from lexical / grammatical explanations and audio exercises to reading / listening to literary texts and preparation for language tests) is constantly increasing. Informal educational videos feature a relaxed atmosphere, relevance, and meta-language reflection opportunity, gaining increasing popularity due to such characteristics. Interested in learning language may choose a teacher not only by the form of teaching didactic material (home videos in the format of communication tete-a-tete or recorded videos), but also by the personal authors' qualities. The latter, in fact, significantly contribute to the promotion of the language and its coverage by a broad audience. It is rarely when a university teacher may boast thousands of students from around the world who are eagerly awaiting each of his lectures, often defining its topic.

A brief didactical analysis of the general opportunities and practical experience of using the materials of several relevant in the thematic plan channels with a quite wide permanent audience is presented below.

The author of the "Slow German" channel, Anik Rubens, offers users of YouTube audio clips on a wide variety of topics (biographies of prominent German figures, national traditions and customs, domestic issues, social relationships, etc.), dictated at a slow tempo in order to ensure their better understanding. Each lesson is complemented by full written support of the sounded text. Using the Urlaub (Vacation) [26] material while studying the topic "Travelling" by the Practical Course of German Language (PCGL) program, in combination with self-developed exercises to control understanding showed that the tempo of teaching is optimal for students who speak German at the A2 level / B1, since the vast majority of them understood the general meaning of the heard information after the first listening, and some nuances – after the second or the third.

The "Deutschlernen durch Hören" channel also produces audio tutorials (educational dialogues on various themes, songs) and video materials. In particular, audio texts with control tasks are similar to those used during the "Telc" language exam passing, for example [7]. Doing a trial test on the YouTube platform allows you to feel the atmosphere of a real exam, to assess the difficulty of the task, and to determine the level of your own audio competence by using the correct answer key added to each video. The mentioned above materials may be used as control tasks while the Practical Course of German Language. At the initial stage of learning language, it was quite positive to use a study song which is composed of numerous language cliches typical to the situations "Acquaintance" and "At the cafe / restaurant" [10].

The real master of the visual-dramatic song, which does not leave anyone indifferent and awakens interest to learn language, is Uwe Kind, the author of the "Uwe Kind & LingoTech" channel, and Singling techniques. Thanks to the amusement, the extraordinariness and, at the same time, the noticeable efficiency of the latter is used by the students and teachers of the whole world in studying spoken foreign languages. In collaboration with composer Mark Schaffel, "LingoTech" was created – "it is a music that combines melody, rhythm, drama, movement and linguistic feedback, becoming a common experience that inspires young people to learn languages." LingoTech is based on the assumption that music simplifies the process of memorization, which allows students to improve foreign pronunciation and intonation [19]. It is a song, dance, drama and an interesting way of learning. Due to the understanding interest appears, music (melody) provides the duration of preservation in memory, the dance determines the interaction, and all together contributes to the success of learning. The fact that after the use of the song "Romanze im Perfekt" [20], students easily memorized three main forms of the irregular Verbs mentioned therein and chanted it on breaks, is an irrefutable proof of the effectiveness of this methodology, the basis of which consists a mnemonic technology based on music and motor activity.

The author of the "Deutsch in Bildern" channel creates his own educational videos using the positive aspects of another mnemonic technique, namely, illustrative. In order to demonstrate the syntactic structure of the sentence and the relationship between its members, there was a train, in which the locomotive is as a Subject, numerous wagons replace the Object, and the Adverbial Modifier is associated with railways [28]. According to the laws of mnemonic, an interesting picture, which will appear before the inner sight in the future, at the right moment will help to find quickly the necessary grammatical material in the long-term memory. The channel is created for native speakers to help them learn German and Literature (as native), Physics, Mathematics and other subjects. For this reason, the tempo of the author's speech is fast enough, which complicates the use of materials (in any case at the initial stage and for self-study). However, the expressiveness of graphic illustrations and the non-standard creative approach to the giving complex teaching material make the channel as a valuable source of positive experience for teachers.

Despite the enormous amount of educational YouTube channels, it is difficult sometimes to find "your own channel" – the one that offers comprehensive, competent answers to relevant issues regarding a wide variety of linguistic aspects and promotes the development of speech and meta-language competencies. Before advising a specific video or channel to students, you should critically treat content, format, and the author's professionalism. Three next channels were created by YouTube bloggers who not only studied German as a specialty for a long time, but also have many years of experience in teaching it.

The "Deutsch mit Marija" channel may be useful, first of all, for those who are preparing to pass a language exam, in particular TELC. The author herself is one of the company's examiners (telc GmbH) [29] and has a great practical experience in pre-test candidate training. A series of videos was created in the form of tips on how to avoid typical mistakes while passing the exam and to what features of each type of task should attention be paid to. At the following links [11], [12], for example, we find videos that provide specific recommendations for the successful doing the "Image Description" task. The description skills are necessary for productive communication in real life and are checked not only during the preparation of the above exam. The method of image description is successfully used in Practical classes of a foreign language. In particular, it is the basis for card games that are equally effective at the initial (for the acquisition of the new vocabulary), as well as at subsequent stages of language learning (deploying the speech situation, creating a story / dialogue with the help of the image). Among other things, the author explains what is the difference between doing the "Description" task at the level A1 / A2 and at higher levels, beginning with B / 1; what is the principle of the transfer, according to which the image should be described, in order to demonstrate a good level of language proficiency; how to make the best use of visual information to ensure a productive and informative process of communication; how to make a logical transition from the real image to the situations associated with it, etc.

That is why such videos should be used not only while preparing for language tests, but also at Practical Course of German Language as a means of improving communicative competences of students.

In the channel playlists, you can find videos that are dedicated to the enrichment of the vocabulary (Wortschatz). Some of them explain the meaning of constant figures of speech or cliché and contain recommendations on the practicability of using them in speech. Some of them highlight semantic and stylistic features of cognate verbs or nouns. Other video groups are aimed to help you learn grammar and expand your country studying competence. The description of different life situations, seemingly, is devoid of didactic loading, becomes a valuable source of information for those who learn the language in the absence of the possibility of constant communication with its native speakers, who are in modern realities of Germany or another German-speaking country.

Considering information given above, let us note that the author of the next channel has developed a unique method of flooding in a foreign environment. Peter Heinrich, a teacher of German language from Austria, has engaged all his family to create nominal YouTube channel [16]. Based on the fact that "most of those who learn German have little access to authentic everyday language and culture", over 120 videos were made within the framework of the online family project (ONLINE-Gastfamilie), which show the actual everyday life of an ordinary German family: family holidays, traditions, travelling, problematic home situations, typical working days, etc. Video materials are accompanied by vocabulary, which shows the key communicative structures and reveals important cultural aspects. With a wide range of suggested topics, the training videos can be easily adapted to the tasks of the curriculum of Practical Course of German Language. However, the situation may be somewhat complicated by the fact that not all videos and teaching materials are available on YouTube, but there are more than enough to "catapult your German language from theoretical grammar to active understanding and speaking and make a leap into German culture" [17].

Among the positive achievements of the GermanSkills.com channel, it has to be noted the provided methodological recommendations for the development of pronunciation skills. The proposed exercises, for example [8], brought tangible results in the formation of the correct articulation of one of the most difficult sounds in German language for Ukrainian students, – pronounced in the French manner [r].

The practical application for materials, which appears within the framework of 30 Days Challenge, has also been found at Practical Course of German Language lessons. 30 TageChallenge is dedicated to the problems of learning German language: how to speak correctly and quickly, how to use multimedia to learn language, how to master different types of speech activity, how to avoid mistakes while learning new vocabulary, why there is a fear of speaking in foreign languages, etc. [9]. Students were asked to register as the project participant and to join a peculiar thirty-day marathon. Depending on the level of language proficiency, the participants received an e-mail daily task – the theme of the day from which they had to speak by recording an audio message. The predicted audio format of the answer helped many to overcome the fear of speaking aloud, and the ability to listen to the messages of other participants and discuss them contributed to the activation of speech skills. Several reports by the author of the channel on the issues of challenge were offered for individual extra-audition listening to students who did not join the experiment, which caused an active reflection of the latter.

5 Conclusions and perspectives for further studies

We should note that the author's training channels on YouTube from professional vendors and amateurs can be used as additional teaching material in class and extracurricular for those students, who learn German language. There is obvious positive impact on: creating a dynamic learning environment; increasing the motivation of students' educational and cognitive activity by flooding into the linguistic environment through authentic video materials; optimization of individual work aimed at deepening or strengthening knowledge on specific educational topics, on condition of availability of professional monitoring and control. The use of information technologies creates additional opportunities for teachers, but requires a responsible approach to their use in order to achieve the goals and objectives provided by the curriculum. Integration of open sources of information into the educational process in universities requires careful selection of available material and its creative didactical revision (in particular, supplementation with the training activities agreed upon the purpose of concrete practical training). However, the question remains open of the probability of achieving a certain level of language proficiency solely on their basis. The latter requires a particular scientific research.

Content characteristics and some tips for using YouTube channels are summarized in Table 2.

Table 2. Content characteristics and some recommendations toward using YouTube channels

Channel / Level	Kind of educational material	Subject / additional information	Resource	Scope of use
Deutsche Welle / A1 – C1	video clips	casual situations, intercultural differences	interactive tasks, forum	classwork, homework
Learn German / A1 – C1	video clips	various subjects, news of culture and science	subtitles in English, full text, exercises, explanations	home reading
Slow German / A1 – B1	audio	everyday situations, social problems, country studies	full text, slow speech	classwork, homework, listening
Deutsch lernen durch hören / A1 – C1	training dialogs, video clips, songs	everyday topics, country studies	exam format, task, keys	classwork, homework
Deutsch mit Marija / A1 – C1	video clips	everyday topics, country studies	tasks, grammar- and vocabulary-training	classwork, homework

Expanding the boundaries of educational videos usage, which are represented as additional tools for teaching foreign languages provided in video hosting, on condition that they would be pre-adapted to the requirements of educational programs, has no doubt. Hence it seems expedient to master the methodical techniques of introducing them into the process of universities training of students of pedagogical specialties and encouraging the latter to create their own educational videos that are suitable for work in the audience and outside it.

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Modern techniques of organizing computer support for future teachers' independent work in German language

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Abstract. The purpose of the study is to elucidate the theoretical and methodological aspects of computer support organization for independent work in a foreign (German) language for future teachers of different subjects.

The subject of the study is a methodological technique of organizing effective computer support for future teachers to work independently in a foreign (German) language.

Objectives of the study: to state the goals of studying foreign languages in its broad and narrow sense, the requirements for the results of future teachers' training in different subjects; to explore ways of organizing computer support for future teachers' independent work; to determine the list and purpose of the basic and auxiliary structural elements of a typical e-learning Moodle course in a foreign language; to provide methodological recommendations for the organization of future teachers' independent work in the content of a separate training module of the Moodle course "Foreign (German) Language".

The article summarizes the experience of organizing computer support for future teachers' independent work and the substantive and methodological features of its implementation into the process of experimental introduction of the Moodle course "Foreign (German) Language" into the educational process carried out on the basis of Kryvyi Rih State Pedagogical University.

Keywords: computerization of independent work, future teachers, methodology of teaching a foreign language, Moodle.

1 Introduction

The purpose of studying a foreign language in its broad sense (by future experts in any field) is mastering the language means for the implementation of the basic functions of the language, namely:

1. instrumental (language used to obtain things);
2. regulatory (to regulate the behavior of others);

3. interactive (to interact with other people);
4. personal (to express personal feelings and meanings);
5. heuristic (for learning and discovery);
6. imaginative (to create a world of imagination);
7. representative (for transmitting information) [14].

According to the educational programs for the preparation of future teachers of various subjects at Kryvyi Rih State Pedagogical University (KSPU), the purpose of studying the discipline “Foreign language” (as a normative one from the cycle of general preparation) is to acquire such competencies as:

- fluent reading and understanding of authentic (“true”, official) texts of both general and professional orientation;
- recognition of basic grammatical constructions and their use in oral and written speech;
- defining of the topic covered in the text, the selection of the main opinion, the choice of basic facts; drawing up a plan;
- answers to questions about the main content, the ability to find and analyze the required content;
- communication on general and professional topics [29].

The main task of studying a foreign language for future teachers is the development of vocational competence in the field of professional communication, which includes the accumulation of geographical, historical, economic, cultural and political knowledge; expanding the universal cultural outlook, bringing them into the values and socio-cultural features inherent in different levels of civilization; forming one's own views, ability to hold discussions, ground one’s own opinion, etc.

Considering the results of Valerii Yu. Bykov [5], Andrii M. Hurzhii [13], Tamara I. Koval [20], Mikhail P. Lapchik [23], Alla F. Manako [24], Nataliia V. Morze [28], Maiia V. Popel [25], Serhiy O. Semerikov [36], Mariya P. Shyshkina [34], Kateryna I. Slovak [33], Oleh M. Spirin [37], Aleksander V. Spivakovsky [8], Andrii M. Striuk [18], Illia O. Teplytskyi [35], Nataliia P. Volkova [31], Yuliia V. Yechkalo [38], Myroslav I. Zhaldak [46] and other national as well as foreign scientists, there can be argued that the effectiveness of the fundamental training of future teachers in general (and in a foreign language in particular) can be implemented through the organization of a modern educational process using information and communication technologies (ICT). The pedagogically balanced and appropriate involvement of ICT software and Internet services will enable the students (future teachers) to become independent in their work. After all, the potential of independent work (in the classical as well as in the modern sense) allows you to realize the educational, developmental and educational functions of the educational process, promotes the development of students’ intellectual and creative abilities, their cognitive activity and creative thinking, language and speech skills as well as to define their humanitarian position [43].

The organization of future teachers’ independent work in a foreign language involving innovative ICT software and Internet services is especially relevant for:

- full-time students who receive education according to an individual plan (the proportion of independent work is more than 40% of the total number of academic hours in the discipline);
- students of part-time (distance) form of study (the proportion of independent work – at least 80%);
- students with special educational needs, etc.

2 Ways of organizing computer support for future teachers' independent work

Computer support for the educational process, including the independent work of students (future teachers), in any academic discipline, including a foreign (German) language, can be implemented in various ways with the involvement of current technologies of open education (education for everyone and education everywhere).

The first method is based on the presentation of an electronic educational and methodical complex in the discipline (or its individual components) in the repository of the educational establishment or on the webpages of educational and methodical materials of the department [7; 15; 16; 17].

Under these conditions, students' independent work usually involves working with electronic versions of officially published printed educational materials (textbooks, tutorials, etc.), which today require re-issue to supplement them with an interactive computer-oriented component.

The second method is based on the presentation of the components of the e-learning complex in the discipline, including materials for students' self-study, on the corporate Google teacher's or department disk. (Note: On July 1, 2019, the volume of corporate account disks for non-profit educational institutions is not limited.)

One of the advantages of this method over the above mentioned is that cloud repositories can store resources in different formats (including multimedia), and not just text documents.

Another advantage is that, even when presenting practical tasks in the format of text documents – *.doc/*.docx or *.odt – (prototypes of electronic workbooks), students have the opportunity to download copies of such documents in order to store and open them for editing in a personal learning environment [21; 22] created with Google Drive and Docs services.

In addition, the owner of the e-learning complex in the discipline (teacher) independently determines the degree of openness of its components, because it has the ability to set up shared access to a folder with the complete complex or individual components of the complex for:

- a specific group of users whose e-mail is indicated in the corresponding window;
- users of corporate (educational) domain who will have a link to the resource;
- users of corporate (educational) domain in the absence of the link to the resource, and based on the results of its successful search;
- users of the Internet community by the link provided;

— Internet community users by search results.

The third way of organizing computer support for students' independent work is based on the presentation of relevant educational and methodological materials in the form of electronic training courses created and implemented in the educational process using systems or services of learning management, the most common of which (in the system of national education) is *Google Classroom* [2; 15] and *Moodle* [39].

Google Classroom is a portal solution that enables you to create an integrated e-environment based on a variety of cloud services and tools; a service that connects Google Docs, Google Drive, and Gmail, helps you create and streamline tasks, rate, comment, and organize effects – outside of real-time communication with students [10; 26].

Moodle (an acronym for Modular Object-Oriented Dynamic Learning Environment) is a learning platform designed by Martin Dougiamas, aimed at bringing educators, administrators and pupils (students) together into one reliable, secure and integrated system for creating a personalized learning environment; a free, open, extensible learning management system that implements the philosophy of "pedagogy of social constructivism" (Ernst von Glasersfeld [9], Seymour Papert [30], Jean Piaget [32], Illia O. Teplytskyi [40], Lev S. Vygotskii [44]) and is focused primarily on organizing interaction between the teacher and students, although suitable for the organization of traditional distance courses as well as the support of full-time study; written in PHP using a SQL database (MySQL, PostgreSQL or Microsoft SQL Server) complies with SCORM; has been translated into dozens of languages, including Ukrainian, and is used in over 190 countries [27].

Opportunities for lecturers (teachers) in the Moodle environment: providing tools for developing author distance courses; placement of teaching materials (lecture texts, practical / laboratory and self-study assignments; supplementary materials (books, manuals, manuals, methodological developments) in .doc, .odt, .html, .pdf formats, and video, audio and presentation materials in different formats and through additional plugins; possibility of adding various elements of the course; rapid modification of educational materials; possibility of using different types of tests for creating test tasks; automatic formation of tests; automation of the process of knowledge testing; student completion of coursework and student test reports, adding a variety of plugins to the course (using a variety of third-party distance learning software).

Opportunities for university (secondary school) students in the Moodle environment: availability of learning materials (lecture texts, assignments for practical / laboratory and self-study papers; additional materials (books, guides, manuals, methodology recommendations) and tools for communication and testing 24/7; availability for group work (wiki, forum, chat, seminar, webinar); viewing your own results of the distance course, including the results of all attempts to pass the test; communication with the teacher through personal messages, forum , chat; downloading files from completed tasks, using event reminders up to date, etc. [1]

The Moodle system is not a specialized language learning tool, but its additional modules, including Read Aloud [12; 20], provide the ability to form and develop lexical, grammatical and phonetic competences in the process of different types of speech activity (reading, listening, writing and dialog speech), to evaluate pupils (students) on the fluency of reading and the correct pronunciation of foreign words in the texts reading process (Words Correct Per Minute) and more.

Taking into account the results of studies carried by Klaus Brandl [3], Michael D. Bush [4], Gary A. Cziko [6], Robert Godwin-Jones [11], Justin Hunt [12], Claudia Warth-Sontheimer [45], the achievements of enthusiastic teachers who have been conducting experimental implementation of e-courses since 2006 the KSPU educational process, and recent trends in the KSPU educational policy [19], for the organization of independent work of students (future teachers) in learning German, the technique of design and implementation of the e-learning Moodle-course "Foreign (German) Language" was chosen. The typical course structure, the specific content and elements of the methods of its implementation are described below.

3 Basic and auxiliary structural elements of a typical e-learning Moodle course in a foreign language

In the structure of a typical e-learning Moodle course in a foreign language, certain basic and auxiliary elements can be distinguished.

The basic structural elements of a typical e-learning Moodle-course in a foreign language are:

- "Folder", "File", and "URL (web link)" resources (to submit / refer to the regulatory documentation of the discipline (work program and / or extracts from it, electronic versions of printed didactic resources, descriptive recommendations, etc.); for submitting / accessing thematic texts and authentic texts for additional reading or performing individual research tasks; for accessing Google documents with a systematic list of sources (printed and electronic) recommended for further mastering), audio and / or video, for the treatment helped to inter-installed software and Internet services to support the study of foreign languages to refer to the forms of input (intermediate and / or final) survey, etc.);
- "Glossary" activity (for submission of thematic dictionaries);
- "Tasks" activity (for performing oral or written exercises with recording of their performance in the Moodle journal);
- "Test" activity (to organize and support ongoing and / or final testing with automatic processing of its results and entering estimates for their performance in the Moodle journal).

Additional structural elements of a typical e-learning Moodle course in a foreign language are:

- "Page-type" resource (for submitting a systematic list of sources (print and electronic; open educational resources), audio and/or video materials recommended for additional mastering; in support of foreign language learning);
- "SCORM package" activity (for example, to access interactive exercises created with LearningApps and to record their performance in the Moodle journal);

- “Forum” activity (for written asynchronous communication with the teacher and / or other students of the course, with the possibility of entering the resulting grades in the Moodle journal);
- “Chat” activity (for written synchronous communication with the teacher and/or other course participants with the possibility of entering the resulting grades in the Moodle journal).

Demonstration of examples of the following elements application on the example of the content module “Ukraine. Education and Culture” is presented in the next section.

4 Typical content of the module “Ukraine. Education and Culture” in the e-learning Moodle-course “Foreign (German) Language” and guidelines for organizing students’ independent work

At this stage of the study, the e-learning Moodle course “Foreign (German) Language” is at the design stage (involving content regulation techniques [22]) simultaneously with the experimental introduction into the KSPU educational process.

Thus, the basis of the module “Ukraine. Education and Culture” of the educational Moodle course “Foreign (German) Language” (Fig. 1) contains the materials of the traditional (academic) textbook in German “Ukraine” [42].

Theoretical materials of the module (thematic educational texts) are presented in the form of elements-resources of the file type (pdf-format, currently without audio-supplement).

Each thematic text has a corresponding glossary page with new vocabulary, which, if necessary, can be supplemented by course’ participants with both text and audio components (Fig. 2).

To effectively master the new vocabulary, LearningApps interactive exercises with audio content were designed and loaded into the course in the form of “SCORM package” activity elements (Fig. 1, 3).

To effectively learn the spelling of the new vocabulary, the design of test tasks (Fig. 4) was performed, which could be used by the trainees in the training mode (without evaluation and unlimited number of attempts).

Other tasks for the written practical performance are presented in the form of a Google text document (Fig. 5).

Students copy the document to their personal learning environment, set up document sharing for the teacher, and after self-completion, wait for the teacher's assessment in the Moodle Register.

During the written practical tasks, students may, if necessary, refer to the pages with additional course resources (content module / topic, Fig. 6), a text chat room or a Question / Answer forum (Fig. 1).

A key type of extra-curricular independent work in Foreign Language is performing Individual Science-and-Research Assignments (ISRA).

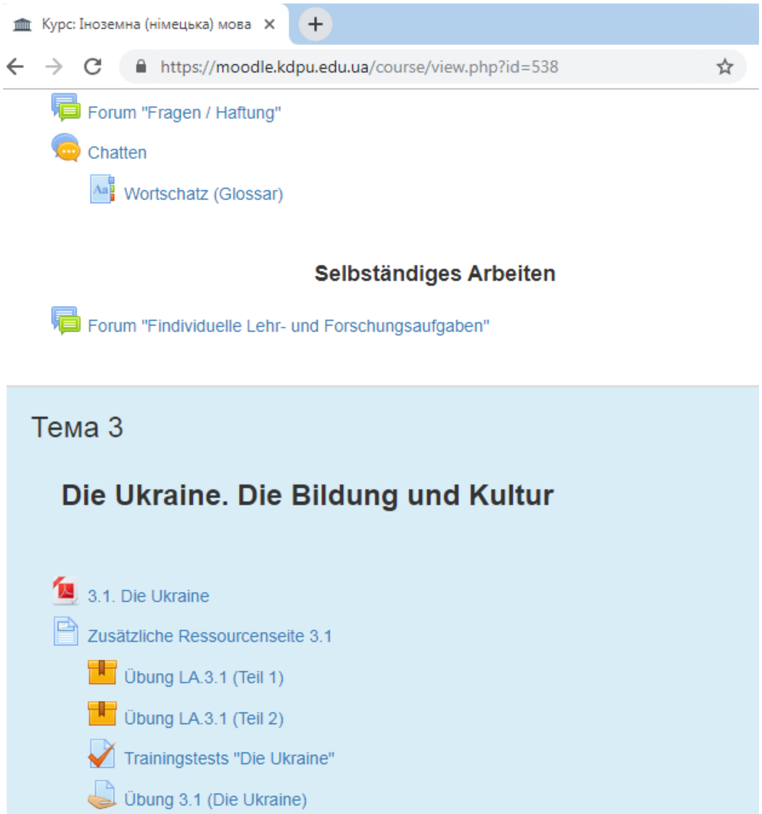

Fig. 1. Moodle course page “Foreign (German) Language”

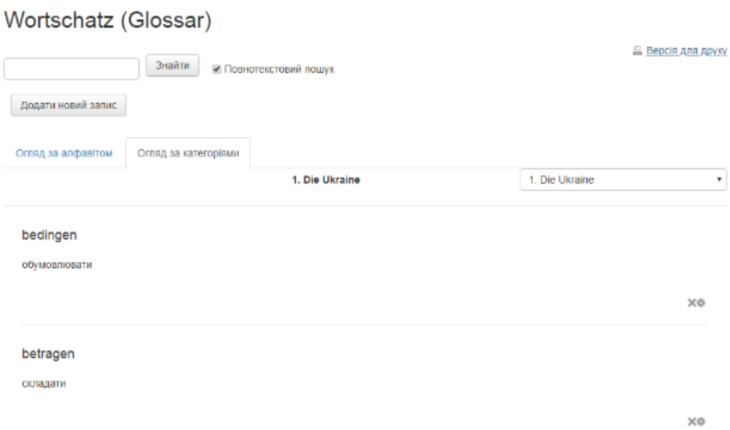

Fig. 2. Glossary page with vocabulary for the topic "Die Ukraine"

Fig. 3. Interactive LearningApps page

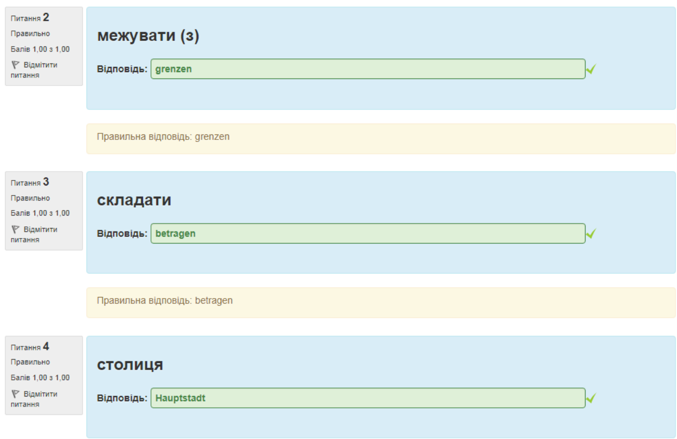

Fig. 4. Training test page

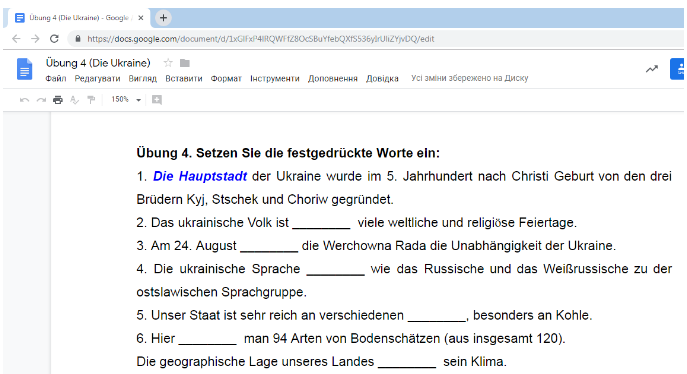

Fig. 5. The page with the task for written practical implementation

Fig. 6. Page with links to additional resources

The purpose of ISRA in Foreign Language (in this case German) is to study part of the program material individually, namely: individual work with profession-oriented authentic texts, systematization, deepening, generalization, consolidation and practical application of the acquired subject knowledge and development of components of the key competence – readiness for lifelong learning.

Individual work with professionally directed authentic texts involves the following activities:

- reading of the original text (introductory, in-depth reading, scanning/skimming);
- translation (oral and written, special and artistic, synchronous and sequential, abstract, etc.);
- performing pre-text and post-text lexical-grammatical exercises, exercises for developing the mechanism of probable forecasting and creative imagination;
- referring to special reference literature in foreign language;
- processing of materials of professional load, which is based on the terminology of a certain specialty, etc.

When evaluating individual work with authentic literature, the following should be considered:

- the degree of consistency of statements with a given theme, text;
- completeness of perception and reflection of the theme, situation;
- ability to use and find the necessary information in dictionaries and additional literature in the specialty;
- the level and characteristics of improvisation in the formulation;
- correctness and variety of use of linguistic means;
- ability to analyze individual places in the text, organize and comment on the received information;
- the level of awareness of linguistic features in the artistic translation of authentic text;
- creative and extraordinary approach to working with texts on a specialty, etc.

The LMS Moodle E-Learning Course offers students a link to a folder of authenticated texts (Fig. 1) and a Moodle page containing a list of open educational resources in foreign languages. For current control over their performance, personal (student) topics of the “ISRA” forum were created (Fig. 1).

To perform the final control, a test was designed with test tasks of different kinds (Fig. 7) – closed and open, with and without multimedia content, as well as one task of "Essay" type.

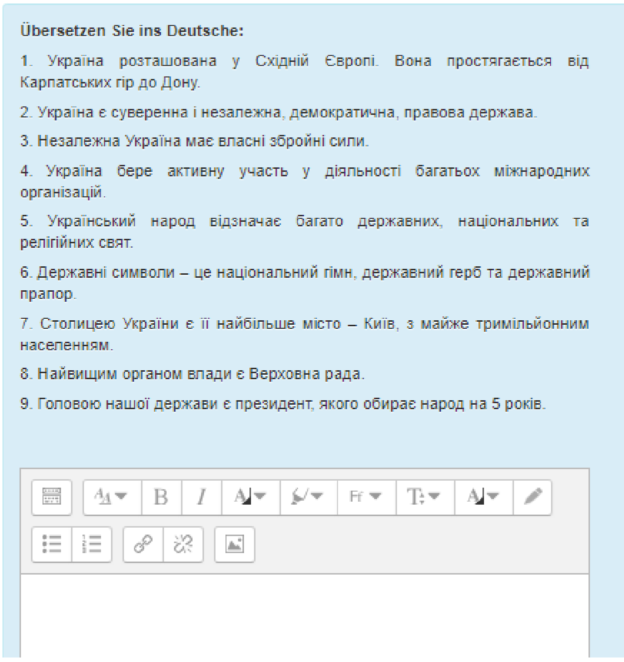

Fig. 7. Page with final test tasks

Students have one attempt to complete the final test tasks, the results of which are automatically recorded in the course's Moodle-journal.

5 Conclusions

1. The pedagogically balanced and appropriate involvement of ICT software and Internet services, including training management systems and services, gives the opportunity to innovatively activate the independent work of future teachers – both full-time and part-time (distance) students.
2. Standard (universal, general) and specialized LMS Moodle tools provide powerful potential for the formation and development of future teachers' high-level lexical, grammatical and phonetic competences in various forms of educational process organization, including independent work.
3. The defined structure, content and methodology of working with the elements of the Moodle course "Foreign (German) Language" require further introduction into the educational process and implementation of monitoring expertise to obtain scientifically sound and grounded conclusions on their effectiveness.

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Features of the use of cloud-based translation systems in the process of forming information competence of translators

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Abstract. The current trends in the translator training are shown, which reflect the orientation towards the use of cloud-based automated translation systems. The possibilities of studying cloud-based translation systems in the educational process of training the translator are considered. The role of mastering modern translation tools for forming information competence of translators, particularly technological component, was described. The definition of the list and type of basic translation tools that should be mastered in the studying process was discussed. These tools should include automated translation systems and terminological management systems. It is advisable to provide for the study of both desktop and cloud-based systems. The inclusion in the content of the training translators the study of cloud-based systems of automated translation after desktop systems is proposed. A number of advantages of cloud-based translation systems for the use in the process of training the translators is defined and substantiated. A comparative analysis of the functional of cloud-based automated translation systems (Wordfast Anywhere, XTM Cloud, and MemSource) with the aim of including them in the content of the training program for translators has been carried out.

Keywords: information competence, computer-assisted translation (CAT), cloud-based translation system, translation memory database, terminology database, studying, translator.

1 Introduction

The system of professional training the modern translator should be aimed at the formation of a number of professionally significant competencies. The list of these competencies in terms of name and content may vary significantly depending on various factors, in particular, the characteristics of the educational system of a particular country, the content of educational programs for the training translators for different institutions of higher education, etc. This program involves the formation of five core competencies [6]. The essence of one of these competencies, technological (tools and applications), is, among other things, the acquisition of knowledge of the effective use of automated translation systems (CAT systems) in solving professional problems [2]. A similar aspect of the requirements for the results of professional training of a translator on the ability to apply innovative technologies in translation based on the use of information technologies is also reflected in the International standard for providing translation services ISO 17100:2015 "Translation Services. Requirements for translation services". In this standard, this is indicated by the technical competence of the translator, which means having the knowledge, skills and abilities necessary to perform technical tasks in the translation process by applying tools and IT systems that support the entire translation process [11].

2 The purpose of the article

The purpose of the article is to consider the possibilities of studying cloud-based translation systems in the educational process of training the translator and to determine their advantages and limitations (on the example of Wordfast Anywhere, XTM Cloud, and MemSource).

3 Literature review

Today, cloud technologies are developing very rapidly [13; 18]. Translators can choose from a wide variety of professional cloud-based translation memory products. The cloud-based translation memory systems are more convenient and easier to use than traditional desktop systems. The characteristics of cloud-based translation memory systems are game-changers for freelance translators, as well as for small and medium-sized language service provider businesses [15]. Translators will still be needed, but their working conditions into the next decade will be completely different [6].

Ignacio Garcia explores the influence of cloud computing on translation, including professional translation. He believes that the cloud computing reshapes the management of labor in ways that unsettle the traditional relations between managers and workers. It gives managers live control over how a project progresses, and a minute description of how each worker performs [8; 7]. According to some researchers [5], cloud technologies allowed to unite translation memory with machine translating, get access to external databases and introduce more flexible translation management systems. In turn, this allows you to improve the quality of translation.

Alexandra Kleijn considers, in particular, Wordfast Anywhere and XTM Cloud to be the most common examples of the new type of CAT systems. She clarifies that some of cloud-based CAT systems are primarily aimed at translation agencies and provide a translation environment as well as a number of project management functions. Others, such as Wordfast Anywhere, XTM Cloud and WordBee, are also great for single translators. For example, Wordfast Anywhere is provided by the manufacturer Wordfast as a free SaaS application on the Internet. Here only a registration is required [12].

Rei Morikawa marks among the best CAT systems, in particular, Memsource and XTM cloud-based CAT systems. The advantages of Memsource include the leading cloud-based translation management system, accepting 50+ file types and powerful workflow automation. The author considers XTM features to provide new projects from common file types [14]. However, as Klaus Hauptfleisch notes, the skills of working with SDL Trados remain important for the translator. It is the leading CAT system for German Computer-Aided Translation with integrated Translation Memory System (TMS), terminology database and much more. In his opinion, in fact, SDL Trados Studio also convinces with its ease of use and rich features that other CAT tools have limited [10].

Recently, both scientists and practitioners have compared various CAT systems, trying to determine the most effective of them. So, Emma Goldsmith compares SDL Trados Studio and memoQ and concludes that "both systems share almost all the features that can be considered essential in a CAT tool" [9]. Laura Moreno Sorolla carried out a comparative study of advantages and disadvantages of OmegaT and Memsource. At the same time, a predominance of Memsource providing more functions was noted: "OmegaT works solely as a CAT tool. On the other hand, Memsource includes features that permit the management of a translation project" [19]. Nikita A. Panasenkov, Larisa I. Korneeva compare the performance capabilities of working in the computer-assisted translation systems SDL Trados and SmartCat. In their opinion, SmartCAT can be recommended, most notably, to novice translators who wish to quickly master and start using the CAT-tool, as well as to learn how to offer their services in the translation market. SDL Trados is oftentimes chosen by experienced translators who are engaged in the translation industry on a permanent basis, work with a variety of document formats and wish to improve their competitiveness in the translation market [17].

The changing conditions of translators work depending on the rapid development of information technologies requires the appropriate orientation of the educational process content. Ukrainian universities that train translators are beginning to pay more attention to the need to study automated translation systems, including cloud-based translation systems [4; 16].

4 Results and discussion

It is worth noting that one of the core competencies of the translator, which is close in essence to the above, reflects the current trends in translator training, and therefore not only accumulates mentioned properties, but also complements them with other components in the aspect of mastering modern translation tools, is defined by us as information competence [3]. In our opinion, the information competence of a translator should contain the following components: information retrieval competence, information and technological competence, information and technical competence, information and analytical competence, information and editorial competence, information and thematic competence, information and legal competence. These components differentiate the approach to mastering, first of all, specialized software in various aspects of the preparation and implementation of translation projects.

Confirmation of the multidimensional nature and importance of the process of mastering modern translator tools is the awareness of the increasing number of higher educational institutions in Ukraine, which train future translators, the need to study information technologies, in particular, automated translation systems and terminological management. Thus, some of them, in addition to traditional courses in computer science, began teaching special or optional courses aimed at studying the peculiarities of using CAT systems in translation. In other universities, elements of information technologies are included in the content of professional courses. However, educational programs for the training translators in various educational institutions where such steps have been taken have significant differences in terms of:

- availability of special courses, modules or sections of academic disciplines;
- list of modern tools of translator based on information technologies and selected to study;
- the time allotted for the study of modern tools and technologies;
- a place in the schedule of the educational process, determined for the study of special courses, specialized modules or sections;
- ensuring the continuity of the study of modern tools and technologies during the training period;
- availability of specialized technology translation practices on the skills and abilities of using specialized translation tools.

In view of the wide range of differences in the content and organizational structure of educational programs for the training translators in terms of technological competence formation, in our opinion, the key aspect is the definition of unified approaches to the list and the type of basic tools to be mastered in the studying process. First of all, we mean automated translation systems. This issue is ambiguous from the standpoint of the availability of one or another software, the typicality of performing basic operations, its prevalence in the translation services market, the possibility of its use in further professional activities, etc.

An important aspect is the consideration of current trends in the development of the global translation industry and the strategies of leading companies that are leaders in the development and provision of modern translation tools. Over the past 10 years, the essence of the work of a translator, especially in the field of technical translation, has changed dramatically. This is primarily due to the widespread implementation of information technologies, in particular, automated translation systems and terminology management system.

Today, leaders have been identified in the development of such specialized software, whose products are used by the vast majority of both translation agencies and freelancers. These include software products such as SDL Trados, MemoQ, STAR Transit, Wordfast, Across, Atril Déjà Vu and others. Studying one or several such programs in the process of training translators is a guarantee of the formation of information competence components that will ensure their competitiveness in the market of translation services.

However, the structure of translation services continues to change and improve. Despite the dominant position of powerful desktop CAT systems, over the past 5 years cloud technologies have been actively developing to provide key tools to the translator. The concept of companies that offer such technologies is not to earn profits through the sale of software licenses, but through the involvement of as many translators as possible in their services. At the same time, they receive a free, or at a minimum price, access to services and tools, and profit is generated by deducting the percentage of orders executed and the use of additional services. Such a policy is attractive to novice translators and freelancers who make up a significant percentage of the professionals involved in the translation industry, due to the possibility of constructing a full cycle of the production process for the performance of translation projects. Somewhat slower, such technologies penetrate into the work of powerful translation structures, although the developers of these technologies also make efforts to meet their needs. Such changes significantly affect the paradigm of the translation industry, its development trends, and the content of the translator's skills, which requires improvement of the process of their training and largely involves the formation of readiness for the use of such services. These technologies are currently implemented in such cloud-based CAT systems as: XTM Cloud, Wordfast Anywhere, MemSource, MateCat, MemoQ, smartCAT, etc.

Considering the possibility of studying the cloud-based systems of automated translation in the process of training the translators, it is worth noting that they have a number of limitations that need to be taken into account when making such a decision. One of the major limitations is the size of files that can be processed in one or another program. In particular, the file size that can be downloaded, for example, in XTM Cloud, should be no larger than 550 MB. This restriction applies to the following categories of files:

- project source files;
- imported translation memory files;
- imported files of terminology databases;
- imported files with client information;
- imported files with user information.

There are a number of similar restrictions in the Wordfast Anywhere system. In particular, Wordfast servers can store up to ten documents for translation at a time. At the same time, the maximum volume of one download must not exceed 20 MB. The range of file sizes to translate can extended a bit by downloading their archived version. With regard to the file with the translation memory database, it has a restriction in two categories: either its volume should be up to 200 MB or contain no more than 500 000 segments. In general, Wordfast allows to store up to 100 files with translation memory databases. For files with terminology databases, the limit is set to the number of entries in them, which cannot exceed 100,000. And such files, in general, can be downloaded to 100.

Such restrictions can be a barrier to professional translating in companies with a large volume of orders. However, as it comes to the choice of cloud-based automated translation systems for use in the studying process, these constraints make it possible to apply these systems as a means of studying and to work out the main stages of the performance of translation tasks.

Considering the possibility and expediency of including the study of cloud-based systems of automated translation, it is necessary to determine the level of unification of knowledge and skills that can be formed when simultaneously or sequentially studying desktop and cloud-based systems. In this case, it is advisable to emphasize the logic of the priority study of the desktop variants of such systems and then demonstrate to students the transition to cloud solutions, since the combination of both systems in the production process is logical and confirmed by existing trends in the translation field. It is advisable to make such a comparison according to the main stages of performing translation projects using both types of systems. In particular, for comparison, we distinguish the following main stages:

- creating a project and setting its parameters;
- creation and connection of terminology databases;
- creation and connection of translation memory databases;
- translation and verification of its quality.

The results of the study indicate that for performing a significant number of operations within certain stages, both in desktop and in cloud-based systems, the same type of skills can be formed. However, for the most part, the same type of operations are more complex and technologically advanced when executed in desktop automated translation systems compared with cloud-based translation systems, which tend to be fully automated. On the one hand, it simplifies the use of cloud-based systems, but, on the other hand, their study does not provide the depth of knowledge that is required to perform certain stages of translation projects by means of desktop systems. This confirms the previously expressed opinion on the expediency of the priority study of desktop automated translation systems. At the same time, the differences between different cloud-based systems are considerably smaller, which gives grounds for asserting that it is possible to form skills for performing these stages of translation projects, for example one of them. This can be confirmed by using most of the MS Excel office files to create terminology databases, similar tools for automatically aligning parallel texts, and using them as a translation memory database in .tmx format, similar tools for checking the quality of translations, etc.

In this aspect, it should be noted that the direct translation work in the overwhelming majority of both desktop and cloud-based systems is positioned as work on the project and begins with its creation. Despite some differences, the essence of the main operations to create a project is common, in particular: the choice of the direction of translation, the choice of translation files included in the project, the connection of translation memory databases, the connection of terminology databases, etc.

A positive feature of this process in XTM Cloud is the automatic analysis of the output file for its structure, the amount of materials to be translated, the repetition of individual elements of the text, exact and inaccurate coincidence with the translation memory database, etc. A fairly detailed report on such an analysis is generated in the form of a .xls spreadsheet and sent to the user on the mailbox. Such information is important at the initial stage of interaction with the customer in agreeing on the main parameters of the project: terms of execution, definition of cost, conditions for the creation and transfer of the translation memory database, etc.

A qualitatively new level of translation efficiency with the use of automated translation systems has been achieved thanks to their use in combination with translation memory databases, which allowed the use of previously performed and verified translations. This fact makes one of the priority tasks in the study of CAT systems to focus on the formation of knowledge and skills for the creation and use of the translation memory databases basically. One of the common approaches to such operations is to align parallel texts. About the importance of these operations can be judged from the fact that in most desktop versions of common automated translation systems there are separate modules that ensure their performance not only manual but also automated. An example of such modules can be SDL Trados WinAlign, LogiTerm Text Aligner, MultiTrans PRISM TextBase Builder, TextAlign, YouAlign, etc. When choosing cloud-based systems, special attention should also be paid to the availability and terms of use of such tools.

Aligning parallel texts in order to create translation memory databases using the Wordfast Anywhere toolkit is done automatically, requiring only downloading files with target and source text. As a result of alignment an archive is created that contains at once three files with aligned parallel text in the formats .tmx, .txt, .xls. Student can download such archive directly to their computer, or send it to their own mailbox.

The highest value among the available files of the specified archive is the aligned parallel text in the .tmx format, since it is actually a file with a translation memory database. It can be directly connected to many automated translation systems or, through simple transformations, transformed into its own format of the translation memory database of one of the CAT systems. A significant advantage in generating such a file is that it automatically runs filters that allow to not add repeat segments to the base, numerical segments, untranslated segments, and so on. In these circumstances, the need for specialized editors to rearrange aligned segments disappears. However, a certain disadvantage of creating parallel aligned text in automatic mode is the inability to influence the established relationships between the segments of the source and target texts.

A feature of the .xls file in the current archive is the placement in a tabular form of segmented text, where the compared segments in the source and target languages are placed within the same line. In addition to each segment in the following columns, the numerical values of the quality comparison of segments are given. Additionally, separate segments may be provided with additional information about the identity of the source and target segments, their repeatability, etc. This form of presentation of parallel text alignment results is convenient for analyzing the alignment performed, editing segments in the event of errors, removing segments that contain only the source or target text, and so on. However, the aligned results processed in this way and saved in .xls format do not allow them to be used as a complete translation memory database in combination with automated translation systems. In case of making a decision on the use of materials stored in this format as a translation memory database, it is necessary to carry out a number of software transformations in order to save them in the appropriate format.

The MemSource tool for aligning parallel texts and creating, based on them, the translation memory databases by the nature of the work is similar to that performed in Wordfast Anywhere. In particular, the user's algorithm thus reduces to the installation of source and target languages and downloads of files with target and source text. Subsequent operations for segmentation of text, matching segments, and loading of results in the form of .xlsx file on a user's computer are done automatically. Similarity of execution of such operations in different cloud-based systems of automated translation is a positive aspect from the point of view of ease of their mastering in the availability of the developed skills of such actions in one of the systems. The result of this operation is automatically segmented and aligned parallel text that can be downloaded to own computer as two spreadsheet options in various .xls files. The difference between them is that one of them contains a complete list of segments and variants of their comparisons, and the other – only those segments, the level of probability of coincidence exceeding 90%. However, in the version of the program, which can be given a free term of 30 days and has reliable advantages in this regard for use in the educational process, the function of parallel texts, as well as the creation of translation memory databases, is absent at all. All segments that are translated into work are automatically saved to the connected translation memory database. If necessary, you can download the database at your computer in .tmx, .txt, .xls, .txlf formats (Wordfast Anywhere).

An integral part of the process of studying automated translation systems, both desktop and cloud-based, is the ability to collect, process, structure and store terminological material in such a way that it can be used as terminology databases compatible with these systems. The conceptual principles of quality management of translations are based on this in terms of ensuring the unity of terminology within a translation project or a separate document.

Depending on the level of information technology acquisition in the process of professional training of a translator, it is expedient to use a differentiated approach to mastering the technology of working with the terminology material. In particular, at an early stage, future translators need to develop the skills of placing terminological records in the MS Excel table structure. Studying by students of this method of organizing the terminology will ensure the possibility of constant accumulation of the developed terminology due to the simplicity and comprehensiveness of the process of data entry [1]. From the point of view of the organization of the educational process, this creates additional advantages due to the availability of the specified program as part of the office package.

It is important to note that a large part of popular automated translation systems require terminology databases in specialized formats, the technology of their creation is quite complicated. So in particular, for the SDL Trados system terminology base should be presented in .sdltb format.

Considering in this context cloud-based automated translation systems, it should be noted that most of them are capable of working with terminology bases that can be stored in several formats, one of which is usually .xls format. So in particular, when working with the MemSource system in order to improve the efficiency of translation, terminology databases can be imported in the formats .xlsx and .tbx. Wordfast

Anywhere supports work with terminology databases stored in .xls, .tbx and .txt formats. The XTM Cloud system is able to accept a fairly wide range of terminology database files – .xlsx, .xls, .tbx, .mtf. However, it should be noted that despite the possibility of these systems operating with terminology databases in .xls format, the structure of the placement of terminological data in them is different. There are also differences in the use of character identifier of languages, which denote column headers, within which the terms and their correspondences in different languages are placed. This feature requires the inclusion of a separate topic in the structure of the training material, which allows to master different approaches to the use of character or numeric identifiers of languages that vary according to the chosen standard or other features.

The structure of the terminology data placement in Wordfast and XTM Cloud systems is the simplest and most logical since it involves the organization of terminological material in such a way that all information relating to one term is placed sequentially within adjacent columns at the same level. In addition, such a structure almost coincides with the structure of preliminary preparation of terminological material for the formation of the terminology database for the SDL Trados system. The difference lies in the fact that Wordfast does not use any identifiers and codes for column headings with terms. In XTM Cloud it is necessary to use the combined language codes and country codes (locale) in accordance with the standards ISO 639-1 and ISO 3166-1 alpha-2 (en_US for English, uk_UA for the Ukrainian language), and for SDL Trados must be used the Ukrainian and English identifiers respectively. Instead, the organizational structure of the MS Excel spreadsheet for ordering terms in the MemSource system involves the presence of not only columns with terms in different languages, for which the names are used by codes according to ISO 639-1 (uk – Ukrainian language code, en – code of English language), but separate fields for the placement of special IDs for each term. However, such a structure is the most complete, and at the initial stage of structuring terminological data in an MS Excel table, to load them into the terminological base, it is enough to place them in two adjacent table columns.

Despite these differences, the possibility of structuring terminology in the spreadsheet format MS Excel creates favorable conditions for the rapid mastery of one or another cloud-based system implemented in the content of specialized courses or modules.

After studying the main stages of translation projects using the desktop system SDL Trados CAT system in the course “Information technologies in translation projects”, three laboratory works were added to the course content. These labs were aimed at performing translation projects using cloud-based CAT systems, in particular MemSource, Wordfast and XTM Cloud. The developers of these systems provide the opportunity to use them for free for a certain period, sufficient to complete the task. These systems were chosen for study in view of the fact that they are leaders among the cloud-based CAT systems [12; 14; 15]. After the completion of these tasks, students were surveyed to identify their attitude to the use of a particular cloud-based system, as well as a generalized assessment of desktop and cloud-based CAT systems, the need and consistency of their study, functional features, and so on. 52 students took part in the survey.

The content of the first questionnaire included questions, in answers to which students had the opportunity to express their desire to study and their vision of the logic of studying CAT systems in general and in particular their types. There were five such questions.

The results of the questionnaire are given in Table 1.

Table 1. The results of student survey about the vision of the logic of studying CAT systems

Questions	Answer "Yes"		Answer "No"	
	Number	%	Number	%
1. Is it reasonable to study desktop CAT systems before studying cloud-based CAT systems?	34	65.4	18	34.6
2. Is studying cloud-based CAT systems promising for a future translator?	46	88.5	6	11.5
3. It is advisable to study the desktop and cloud-based CAT systems in the process of training translators at the same time?	29	55.8	23	44.2
4. It is advisable to study several cloud-based CAT systems in the process of training translators?	12	23.1	40	76.9
5. Do you think that the key criterion for choosing and studying the CAT system is its popularity among professional translators, and not the cost?	22	42.3	30	57.7

According to the results of the survey, after studying both types of CAT systems, the majority of students (65.4%) realize the need to master the work with both desktop and cloud-based CAT systems. In addition, the overwhelming majority of students (88.5%) understand the need to master cloud-based CAT systems at the current stage for successful further professional activity. However, 76.9% of them believe that in the learning process it is advisable to concentrate their efforts on studying only one of them.

The content of the second questionnaire included eight questions that reflect the main aspects of the experience of students using cloud-based CAT systems.

The results of the survey are shown in Table 2 and Figure 1.

Analyzing the students' answers on the second questionnaire, we can conclude that, in general, all three cloud-based CAT systems were positively evaluated by them as an important tool for preparing and carrying-out translation projects. At the same time, it is worth noting that students expressed the greatest number of positive reviews about the MemSource cloud-based CAT system, in particular, about the understandability of the interface (51.9%), the convenience of creating a translation project (53.8%), supporting the translation process (42.3%).

However, students also praised other CAT systems for individual indicators. So, the students liked Wordfast most of all by such indicators as the registration process for using the free version (78.8%) and the preparation of terminology bases (46.2%). When studying the XTM Cloud system, they made the most of the previously acquired experience in creating and carrying-out a translation project in the SDL Trados system, which was noted by 46.2% of students.

Table 2. The results of a student survey on the experience of using cloud-based CAT systems

Questions	MemSource		Wordfast		XTM Cloud	
	Number	%	Number	%	Number	%
1. In which of the cloud-based CAT systems is the easiest to register for using the free version?	8	15.4	41	78.8	3	5.8
2. Which of the cloud-based CAT systems is the easiest to learn?	21	40.4	14	26.9	17	32.7
3. In which of the cloud-based CAT systems interface is the most understandable?	27	51.9	10	19.2	15	28.8
4. In which of the cloud-based CAT systems to create a translation project was the most convenient?	28	53.8	15	28.8	9	17.3
5. In which of the cloud-based CAT systems the skills of placing terminological records in the structure of the MS Excel table most effectively ensured the creation of terminological databases?	15	28.8	24	46.2	13	25.0
6. Which cloud-based CAT system toolkit provided the most efficient creation of a translation memory base?	20	38.5	15	28.8	17	32.7
7. In which of the cloud-based CAT systems the support of document translation process is better provided?	22	42.3	12	23.1	18	34.6
8. In which of the cloud-based CAT systems are the main stages of creating and carrying-out a translation project as close as possible to the desktop system SDL Trados?	17	32.7	11	21.2	24	46.2

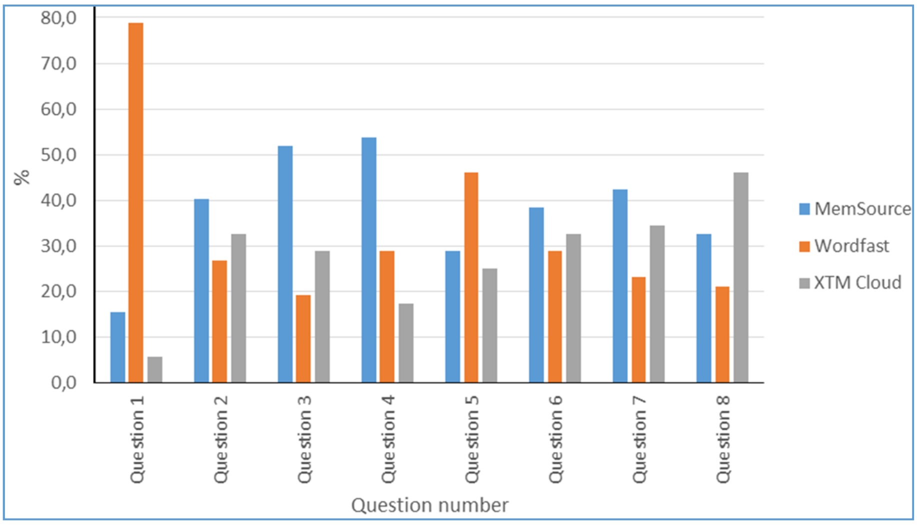

Fig. 1. Comparison of cloud-based CAT systems based on the results of a student survey

5 Conclusions

An important aspect of the process of formation of the information competence of a translator is to determine the list and type of basic tools of translation activities that should be mastered in the learning process. First of all, such tools should include automated translation systems and terminological management systems. The implementation of the study of cloud-based CAT systems into the content of future translators training is one of the pressing problems at the present stage of development of the translation industry, which is promoted by a number of factors.

1. Full functionality of the latest versions of the top cloud-based CAT systems and their widespread use in the translation industry:

- availability of basic tools for the carrying-out of all stages of the translation project (creating a project and setting its parameters; creating and connecting of terminology databases; creating and connecting of translation memory bases; translating and quality control);
- a high level of unification of technologies for creating terminological resources in various systems greatly simplifies their study.

2. Simplified version of their use in the educational process:

- availability of free versions on a permanent or temporary basis;
- no need to install systems on your own computer;
- ability to work with systems anywhere with an Internet connection.

3. Possible reliance on previous knowledge of students:

- preparation of terminological databases based on previously obtained knowledge and skills to use MS Excel office suite for structuring data in tabular form;
- having skills to use desktop systems, in particular: structuring terminological data using international standards for the use of symbolic or numeric identifiers of languages, specialized formats for terminological data, adding records during the process of translating, importing and exporting terminological databases to the system.

4. High motivation of students to study them:

- understanding the prospects of studying cloud-based CAT systems for future professional activities;
- awareness of the need to use specialized tools in professional activities with consideration of cloud systems as an alternative with insufficient financial opportunities.

Therefore, in order to shape the readiness of future translators to use modern technologies and tools in translation, it is necessary to improve the process of their training, focusing on the formation of information competence in terms of its components, in particular technological, including the study of cloud-based CAT systems.

Prospects for further research may be related to the study of the use of cloud-based CAT systems not only in independent, but also in the classroom work of students.

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Cloud-based complex of computer transdisciplinary models in the context of holistic educational approach

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Abstract. The paper represents the authors' cloud-based complex of computer dynamic models and their transdisciplinary facilities. Proper theoretical background for the complex design is elaborated and the process of the computer models development is covered. The models in the complex are grouped in the sections according to the curriculum subjects (Physics, Algebra, Geometry, Biology, Geography, and Informatics). Each of the sections includes proper models along with their description and transdisciplinary didactic support. The paper also presents recommendations as for using of the complex to provide holistic learning of Mathematics, Science and Informatics at secondary school. The prospects of further research are outlined.

Keywords: holistic education, cloud-based learning environment, computer dynamic model, transdisciplinary tasks, didactic support of holistic learning.

1 Introduction

Contemporary education at all of its levels is currently experiencing the period of necessary transformations. It is connected with complicated social processes, tendencies to globalization, integration of science branches, and incredible growth of new knowledge amount. As a result, it causes challenges to education and training at schools and universities. Mainstream educational paradigm (considered today to be static and split up [9]) tends to be transformed with holistic educational approach which tries to build dynamic, harmonized, and interconnected pedagogy.

This approach aims to form students' concentrated conceptual knowledge and the complex of transdisciplinary skills. It will allow to establish in the trainees' memory greater amount of strong links between concepts and notions, and as a result, to encourage students to investigate and apply what they know and can do to other subject areas. In order to provide such an approach we need to elaborate special teaching strategies and arm teachers with effective aids appropriate for different students and learning situations.

Thus, it is really urgent today to develop and implement special learning tools in order to facilitate implementation of holistic educational approach.

Analysing recent research papers on the theory of holistic education, we could distinguish main characteristics and peculiarities of the approach. According to some authors, holistic education should be considered as a paradigm (not as a technique, strategy or method) that provides educators with a system of principles which can be used in various ways [9; 14; 15].

The core idea of holistic education is the cohesive development of the whole person both at the intellectual and emotional levels [22]. At the same time this cohesive development should base on strong links between personal experience and real life problems.

Among basic principles of holistic education the studies (in particular, [9; 13]) point out several pillars which seem to be really important and significant in the context of contemporary requirements to the education. The first pillar expects students' freedom and autonomy. So, within the holistic paradigm any trainee is considered to be really active participant of the learning process who is ready to interact with reality via his own cognitive activity, via his own ups and downs.

Next important facet of the holistic approach is necessity to establish connections and relationships between the object of learning and existing knowledge. The more links trainees have, the stronger memories are formed in their minds and better understanding of the whole they obtain.

Similar to the establishing links is the principle of transdiciplinarity which focuses teaching and learning on ruining boundaries between subject fields themselves as well as between subject areas and reality.

Researchers also point out that holism helps both the connection facet and transdiciplinarity, because it seems to be fruitful to learn separate things which in fact are not separate. However, at the same time it is necessary to understand how they work together.

The analysis of the holistic education basis reveals a need to apply efficient learning tools enabled to provide holistic approach to nowadays teaching and learning.

One of such tool seems to be computer dynamic models (CDM). The learning of recent studies on their didactic facilities testifies that CDM have quite powerful potential as for revealing transdisciplinary connections and facilitating their understanding by schoolchildren. In particular, researchers point out that CDM are typically based on the mathematical model of a concept (process, phenomenon, etc.), and enable to visualize its essence at real time operation, learn dynamic changes, and investigate the concept or process via active cognition. In such a way CDM help to form and develop students' techniques of mental activity including transdisciplinary ones [1; 18].

Characterizing advantages and facilities of CDM using in the context of holistic education, it is important to emphasize that they encourage students to learn objects independently and actively. In addition, they reveal and demonstrate in action the wholeness of the learnt concepts (phenomenon).

The special attention must be paid to the cloud-based complex of CDM as a potential mean of holistic approach realization. According to recent studies, cloud-based learning environment for teaching STEM disciplines opens wide horizons for holistic education due to its important features. Among them researchers call support for various processes of learning and research activities; great level of learning resources flexibility; integration of variety of educational components based on innovative technologies [10; 12; 19; 20; 21].

On balance, cloud-based complex of CDM (as an integral part of the learning environment) with transdisciplinary didactic support is able to enhance the advantages of CDM usage and to facilitate implementation of main pillars of holistic education.

The purpose of the article is to describe the authors' cloud-based complex of computer dynamic models and their transdisciplinary facilities. The paper also presents recommendations as for using of the complex to provide holistic learning of Mathematics, Science and Informatics at secondary school.

2 Theoretical framework

During the research, the set of theoretical, empirical, and modelling methods were applied. Theoretical background for the cloud-based CDM complex elaboration made deep and comprehensive analysis of the proper subject areas, held by the authors beforehand. In order to meet the main pillars of holistic approach (covered earlier) it is necessary to reveal key objects of learning in the subject areas, establish connections between them, and build chains of proper transdisciplinary links.

Researchers distinguish different types of transdisciplinary connections. However, scientists (in particular, [2; 5; 11]) recommend to base the connections classification upon the set of three main grounds: information content of the subject, structure of learning activity, and organization of educational process. As a result, considering the transdisciplinary connections from the standpoints of holistic education, we have to reveal key concepts of subjects, detect their place in the current curriculum, consider peculiarities of their mastering and proper cognitive activity.

These procedures were done through the learning main content threads of the said curriculum subjects [16; 17], author's didactic analysis of each subject (covered in [6; 7]) and detailed analysis of the subject areas.

Main content threads of Mathematics, Science subjects (Physics, Chemistry, Biology) and Informatics enabled us to reveal some transdisciplinary chains. We would like to point out a paramount role of penetrating content threads in revealing transdisciplinary concepts and links between them. According to the Concept of the New Ukrainian School, there are four penetrating content threads - "Ecology security and sustainable development", "Civil responsibility", "Health and security", "Financial literacy" – which are seen as a mean of key competences integration of all curriculum subjects. The penetrating threads are considered to be socially important super themes that focus teaching and learning on the trainees' holistic understanding of the world. They are recommended to be regarded during the learning environment creation [8].

Analysis of subjects' content threads in the terms of four penetrating threads enabled us to build the following set of connection chains between curriculum subjects:

- Algebra – Geometry – Informatics;

- Algebra – Physics – Geometry;
- Physics – Algebra – Geometry – Biology;
- Chemistry – Biology – Informatics;
- Physics – Biology – Geography.

Subsequent detailed analysis of the subjects standards [16; 17], textbooks, and subject areas resulted in establishing of transdisciplinary links between learning elements (LE), representing concepts and phenomena which are co-explored by several subjects. In particular, the effective semantic analysis was held with the help of specialized software, such as: TextAnalyst 2.0, Text Miner 12.1 (its Text Parsing Node), Trope 8.4. Such a "smart" analysis of the subject areas enabled to distinguish the weightiest LEs of the specific subject along with their conceptual links.

Basing on the depicted analysis, for the revealed weightiest LEs of a subject it was built a graph, representing their transdisciplinary links with exact learning elements (LE1...LE*n*) of other subjects, according to the chains of connections mentioned earlier. The general scheme of the graph and the example of the graph for selected physics LEs, representing the transdisciplinary links for the chain: Physics – Algebra – Geometry – Biology, are given on the Figures 1, 2. Graphs also contain information about the school grades (from the 5th to 9th) in which the LEs are studied according to current curriculum standards.

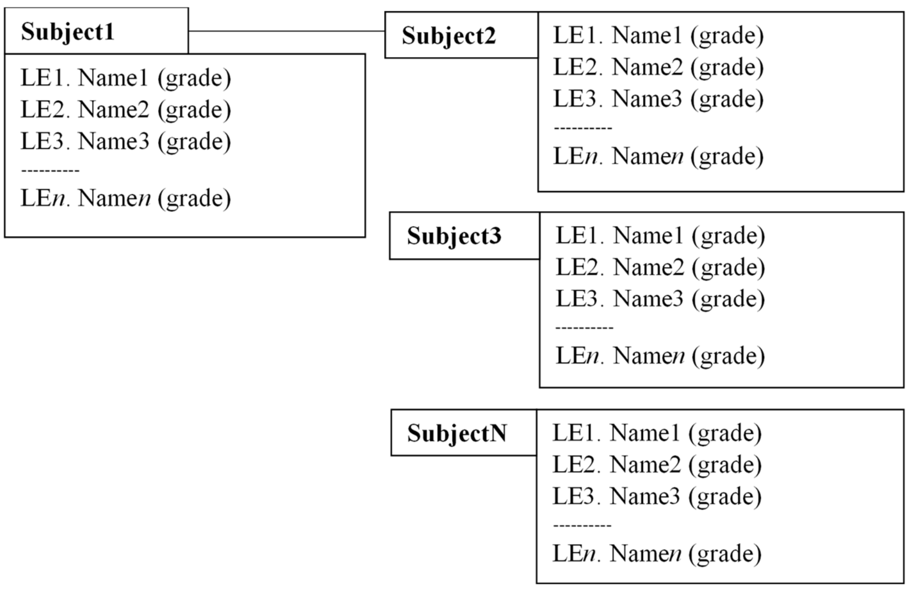

Fig. 1. The common scheme of the graph, representing their transdisciplinary links with exact learning elements (LE1...LE*n*) of other subjects and grades numbers

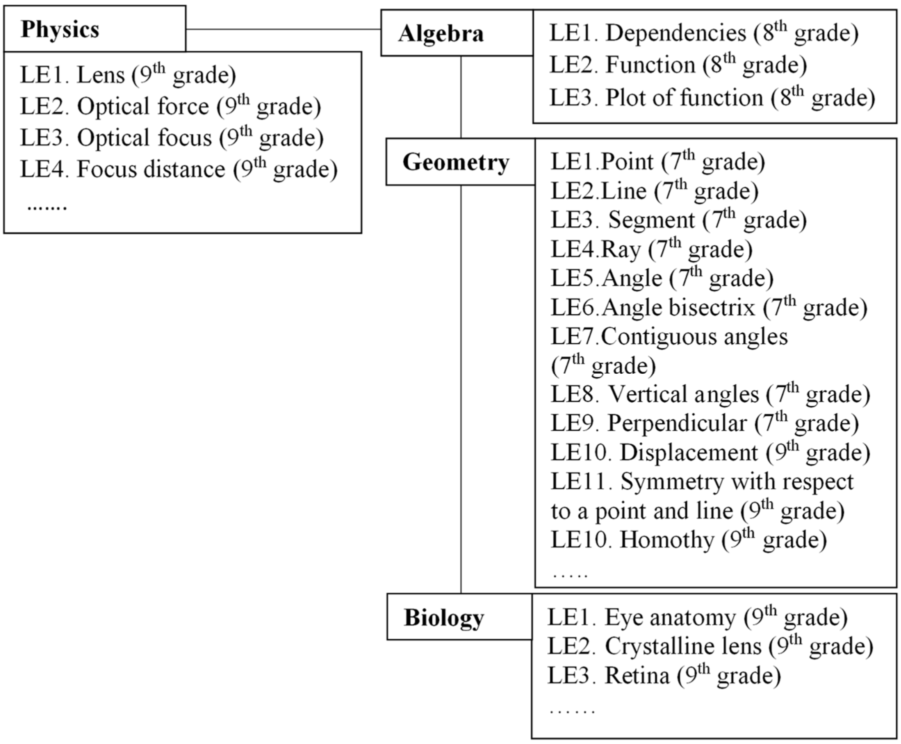

Fig. 2. The example of the graph for selected physics LEs, representing the transdisciplinary links for the chain: Physics-Algebra-Geometry-Biology (Section "Physics". Model "Lens")

3 Results and discussion

The results of theoretical framework were used at the design of cloud-based complex of computer transdisciplinary models.

The process of the models elaboration embraces some phases. At the first phase mathematical model of the future computer model is built. At this point it is done: (1) revealing and learning of the transdisciplinary essence of the proper concept (See theoretical framework); (2) defining of the mathematical dependencies which can illustrate and investigate the concept; (3) determination of the fixed model parameters and changeable ones along with the range and step of their changes; (4) picking up proper graphic elements which are able to illustrate dynamic changes; (5) revealing of transdisciplinary tasks and real-life problems which might be solved by the model.

At the second phase the mathematical model is built by the means of GeoGebra. In particular, the set of standard GeoGebra tools are used (*Points, Lines, Special Lines, Polygon, Circle and Arc, Measurement, Transformations*) as well as the CAS components (*Calculations and Analysis Tools*). For realization of dynamic transformations, the *Action Object Tools and Movement Tools* are used [18].

In order to make the use of the complex more flexible and available to a wide community of students and teachers, we organized it in the form of GeoGebra Book. GeoGebra Book is a cloud service which enables to gather GeoGebra resources, to enhance them didactically, and to share them easily. Due to this fact, our complex of models is oriented to be a component of a cloud-based learning environment.

The third phase is devoted to the testing, debugging and improving of the model.

The models in the complex are grouped in the sections according to the curriculum subjects (Physics, Algebra, Geometry, Biology, Geography, and Informatics). Each of the sections presents proper models along with their description and transdisciplinary didactic support. Main page of the complex and some of its sections are shown on the Figures 3-5.

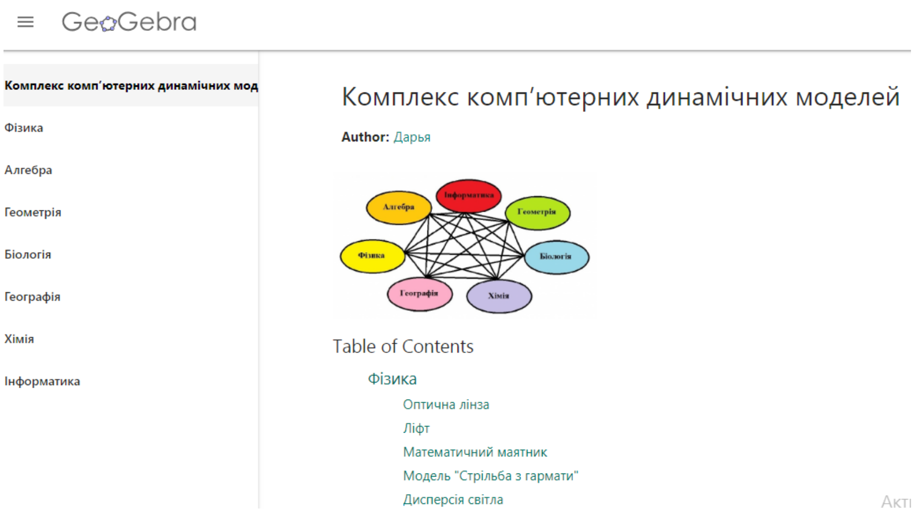

Fig. 3. Main page of the complex of computer transdisciplinary models

Fig. 4. Computer models of the Physics section

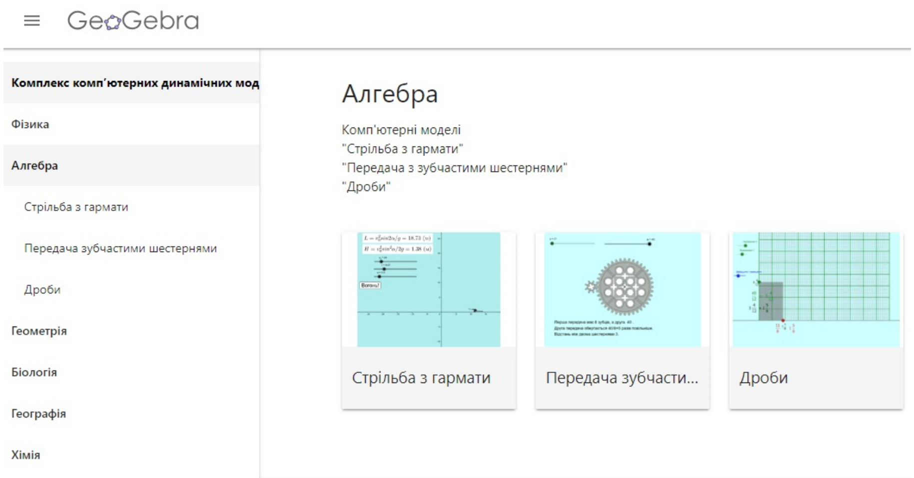

Fig. 5. Episode of work with Algebra section of the complex

Each of the models is presented in the complex according to the general scheme.
It includes (see examples below):

- model title;
- chain of the transdisciplinary links which are illustrated by the model;
- model description which explains concept (phenomenon) that is a prototype of the model;
- dynamic model itself with a proper functionality;
- procedure of cognitive activity on the realizing the essence of the concept (phenomenon);
- didactic support as a set of transdisciplinary tasks and real-life problems for forming holistic image of the said concept (phenomenon);
- graph of the revealed transdisciplinary links for the visualization and remembering this holistic representation.

As it was mentioned above, holistic education expects students' personal cognitive activity. In order to facilitate it we elaborated procedure of cognitive activity which includes some tips on changing the parameters of the dynamic model, monitoring the results, investigating, making conclusions etc. Such a procedure is aimed to streamline understanding the essence of the concept (phenomenon).

Our didactic support for each model is developed to involve students into the solving special problems and real-life tasks which encourage them to obtain holistic understanding of the basic concepts via special cognitive activity based on work with dynamic models. All of the tasks focus students on the revealing and realizing transdisciplinary links.

Some of the models with their description and functionality are included into more than one subject section. However, didactic support as a set of transdisciplinary tasks for each model is specific in each section and focuses on the subject essence of every concept and different transdisciplinary connections.

Below we demonstrate fragmentary some of the models from various sections of the complex (according to general scheme of model presentation depicted above) and offer recommendations as for their using to provide holistic learning of Mathematics, Science and Informatics at school.

Example 1. Section "Physics". Model "Lens"

Chain of the transdisciplinary links: Physics – Algebra – Geometry – Biology.

Model description: The model illustrates principle of operation of a lens as a simplest optical device that focuses or disperses a light beam. A lens consists of a single piece of transparent material (e.g. glass or plastic). A lens can focus light to form an image which differs it from prism (See Section "Physics". Model "Optical dispersion"). A lens has its optical axis, two focuses, main optical center and plane (you can find their definitions in your textbook). Lenses are classified by the curvature of the two optical surfaces. The model demonstrates the operation of exactly biconvex lens.

Procedure of cognitive activity with the model (selected tasks):

1. Operate the model. Change curvature with the slider. Monitor the focuses positions and image positions. Find and formulate dependences.
2. Fix the lens curvature and change the object position relative to the focus. What is happening with the image of the object?
3. Fix the object at the distances: $d = 2F$, $d > 2F$, $d < 2F$. Analyze changes and make conclusions.
4. Analyze changes of the image's size and position when the object is between $2F$ and F, between F and lens center.

Fragment of didactic support as a set of transdisciplinary tasks and real-life problems for forming holistic understanding of the optical device (might be offered trainees during both Physics, Algebra (Geometry), and Biology lessons):

1. Operate the model. What is mathematical dependence between object distance to the lens and focus distance? How is it called? Write the formula of the dependence.
2. What geometrical figures describe the object, its image, light beams and the phenomena of light penetration through the lens?
3. What geometrical facts and properties are revealed by the device operation?
4. Which angles are equal at any values of the model parameters? Why? Which rays are parallel? Why?
5. Working with the model, detect the parameters of the model which provide the highest optical power of the lens.
6. Operating the model and using the scheme of the optical system of a human eye (Figure 6), answer the questions: (1) what are the components of the eye optical system? (2) what is the difference between real and virtual image? (3) what are the basics of a human eye functioning from the standpoint of physics? (4) can you explain eye-sight disorders (short sight, long sight, etc.) via physical concepts and phenomena? (5) compare the principles of human eye operation and work of a digital camera.

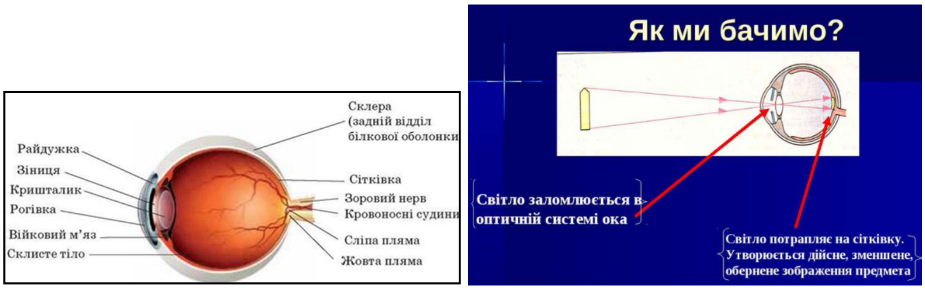

Fig. 6. Scheme of the optical system of a human eye

Episodes of transdisciplinary tasks doing and the model operating are shown on the Figure 7.

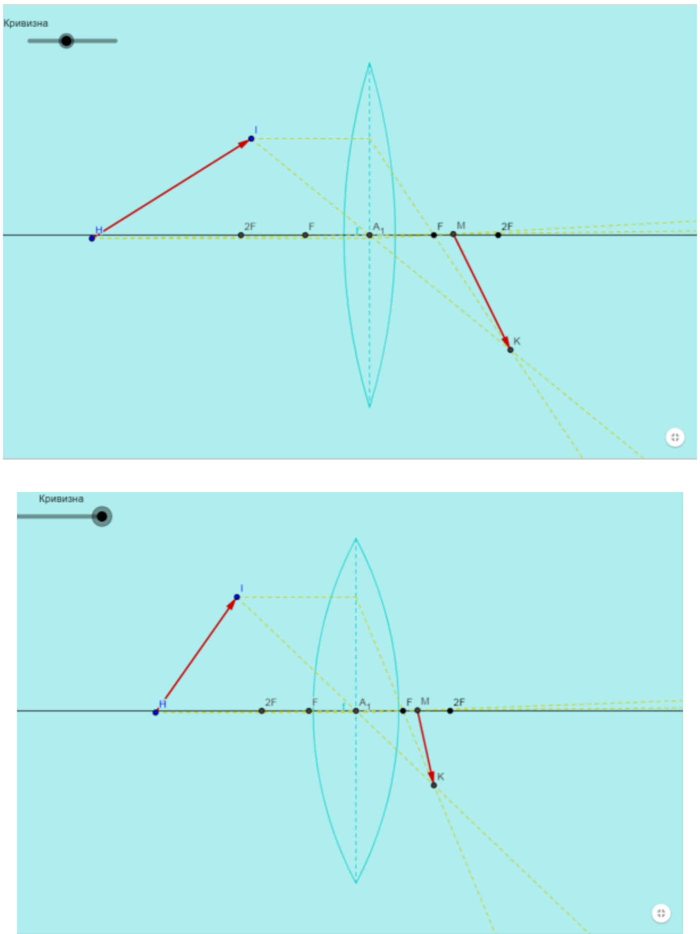

Fig. 7. Episodes of transdisciplinary tasks doing and the model "Lens" operating

Graph of the revealed transdisciplinary links for the visualization and remembering this holistic representation (presented on Figure 2 above).

Example 2. Section "Geometry". Model "Clock"

Chain of the transdisciplinary links: Geometry – Algebra – Physics.

Fragment of didactic support as a set of transdisciplinary tasks and real-life problems.

1. Operate the model, turn the clock hands, set the time (See Figure 8) and detect degree measure of the angles made by the hands.

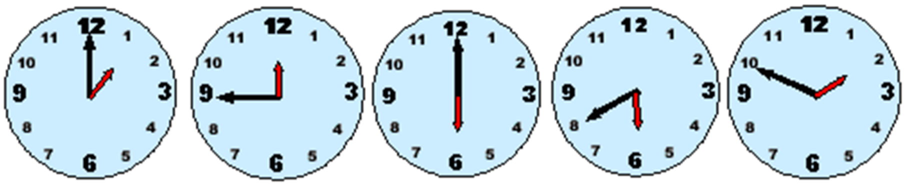

Fig. 8. Various moments of time to measure the angles between clock hands with the help of the model

2. Use the model with different parameters and calculate degree measure of: (1) the angel which makes tree fifth of the right angle, (2) the angle five sixth of which make a right angle, (3) the angle which makes 30% of a flat angle etc.
3. Operate the model to express the given values of speed in the measure of m/c: 7,2 km/h; 3600 cm/min; 6 m/min; 36 dm/h etc.
4. You know that clock is a device which measures time that is really precious thing for real life. Try to solve the real-life task like this one: Vira and Lara decided to send messages to his friend Igor to greet him with his birthday. Vira can text 24 words per 4 min, whereas Lara - 35 words per 7 min. Who is quicker, and whose greeting will Igor receive earlier if Vira sent a message of 30 warm words, and Lara texted 20 ones?

Episodes of transdisciplinary tasks doing and the model operating are shown on the Figure 9.

Presented transdisciplinary tasks done with the model, focus on forming holistic understanding of (1) a clock as a physical and geometrical device, (2) time as a physical concept and social phenomenon, (3) geometrical, algebraic and "clock" sense of degree measure of an angle.

Graph of the revealed transdisciplinary links (Figure 10).

Examples of transdisciplinary tasks doing with the different models operating are shown on the Figures 11, 12.

Our monitoring trainees' cognitive activity testified that they often do offered transdisciplinary tasks, applying two or three dynamic models together. It helps students to visualize cognitive connections and makes the investigation process more attractive and motivating for them [3]. The results of trainees' exploring with the models “Binary tree” (Section “Informatics”) and the model “Similarity” (Section “Geomentry”) are given on the Fig. 13.

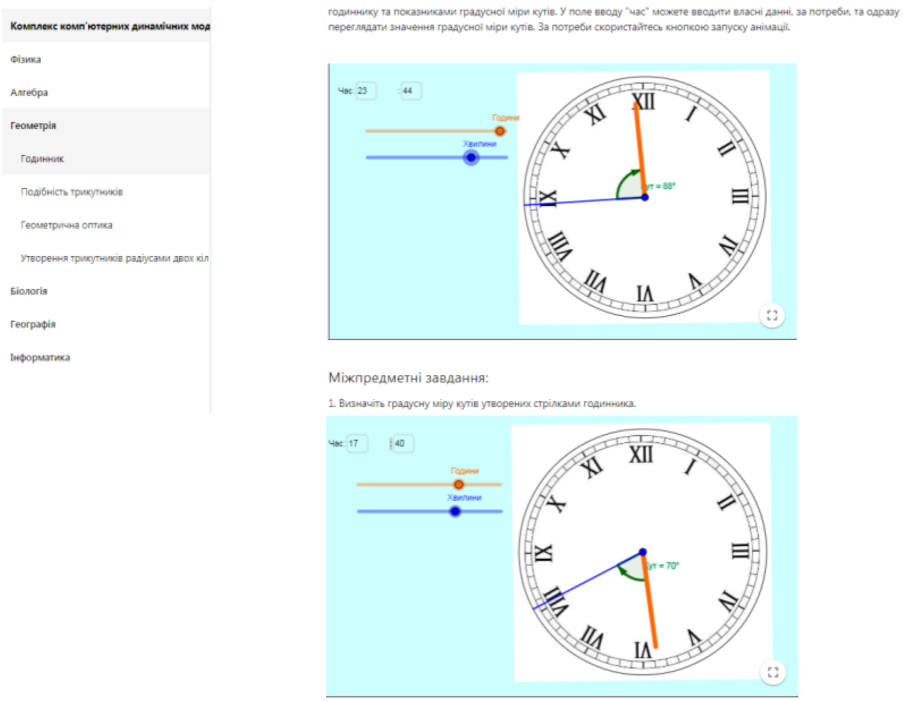

Fig. 9. Episodes of transdisciplinary tasks doing and the model “Clock” operating

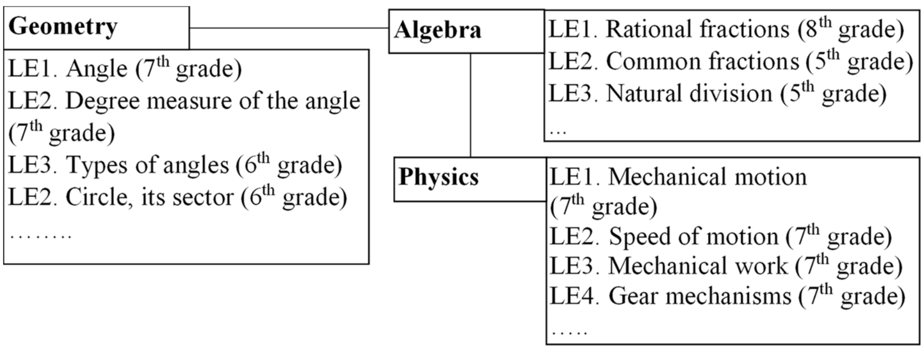

Fig. 10. Graph for selected Geomety LEs, representing the transdisciplinary links for the chain: Geometry-Algebra-Physics (Section “Geometry”. Model “Clock”)

Characterizing our didactic support to the models it is important to emphasize that it offers the transdisciplinary tasks of various types. In particular, there are tasks on establishing connections between concepts from different subjects. The aim of these tasks is to specify and generalize mentioned connections; to form the system of the notions of different level of generalization and subordination; to illustrate casual relations of phenomena. This type tasks and problems are directed on the forming of the set of transdisciplinary skills: to understand the links between the notions of different subjects and to formulate them verbally; to explain processes and phenomena of one science branch with the help of concepts of other branch; to make outlook conclusions based on common concepts, and others.

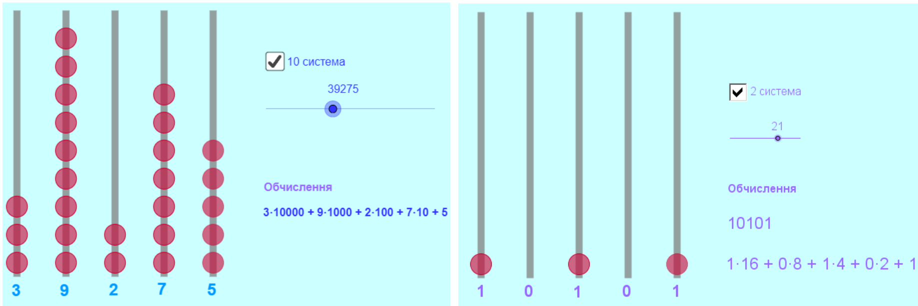

Fig. 11. Episodes of transdisciplinary tasks doing and the model "Number systems" operating. Connections chain: Informatics-Algebra

Besides, our didactic support proposes students transdisciplinary tasks on the determination of community of the facts from different subject areas. They help to specify learning material, to form new concepts and explain them from the standpoints of other branches of science, to use some facts to illustrate other ones. Such tasks are aimed at the forming students' skill of facts' analysis, generalization and explanation from the standpoint of general scientific ideas; skill to integrate generalized facts into the existing knowledge system; skill to apply generalized knowledge into practice.

In addition, into the didactic support there are included the tasks on the establishing connections between theoretical knowledge and methods, and their practical use. Mostly they are real-life problems which focus on the ruining boundaries between subject fields and reality. They might help to form the students' skill to see scientific subtext in pure practical tasks, to attract generalized knowledge from surrounding areas, and to apply them to resolving the problem.

Designing learning activity with the complex of models, we would recommend offering described transdisciplinary tasks of the didactic support after students' learning the model description and procedure of their cognitive activity with the model. It will also promote wholeness of the learning elements understanding.

Thus, the cloud-based complex of computer transdisciplinary models as for their functionality provides main principles of the holistic education, such as connections establishing, personal cognitive activity, focus on the ruining boundaries between subject fields and reality. It seems to be relevant to predict positive influence of the complex application on the forming of trainees' holistic system of knowledge and skills. Elaboration of proper methodology of its diagnosing [4] and estimation is a prospect of our further research.

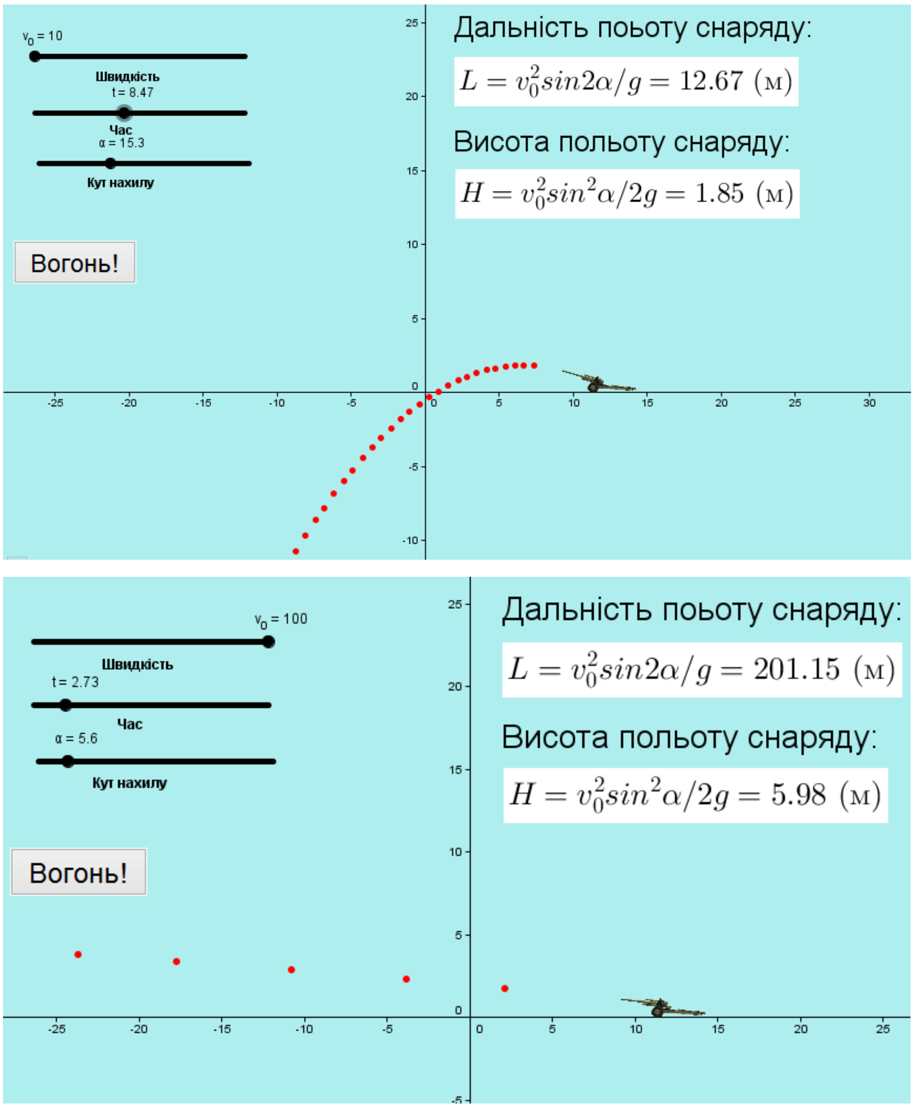

Fig. 12. Episodes of transdisciplinary tasks doing and the model “Cannon” operating. Connections chain: Algebra-Physics-Geometry-History

4 Conclusions

In accordance with its goal, the paper represents the authors’ cloud-based complex of computer dynamic models and their transdisciplinary facilities. Proper theoretical background for the complex design is elaborated and the process of the computer models development is covered. The models in the complex are grouped in the sections according to the curriculum subjects (Physics, Algebra, Geometry, Biology, Geography, and Informatics). Each of the sections includes proper models along with their description and transdisciplinary didactic support. The paper also presents recommendations as for using of the complex to provide holistic learning of Mathematics, Science and Informatics at secondary school. The prospects of further research are outlined.

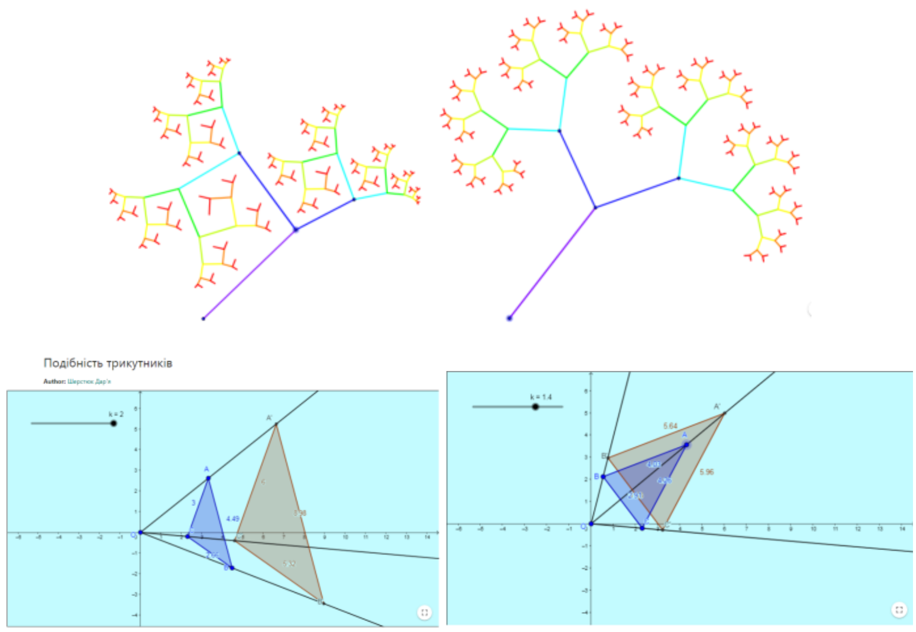

Fig. 13. Results of trainees' exploring with the models "Binary tree" (Section "Informatics") and the model """Similarity" (Section "Geomentry")

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The overview of software for computer simulations in profile physics learning

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Abstract. The paper deals with the possibilities of using specialized (virtual labs and simulators, software for natural process simulation) and general (programming languages and libraries, spreadsheets, CAS) software in school researches.

Such software as virtual labs, software for natural process simulation, programming languages and libraries in school researches can be used to simulate phenomena that cannot be learned in a school lab (for example, for modeling a radioactive decay or for demonstrating the states of relativistic mechanics). Also, virtual labs in school practice are usually used in those cases where students cannot perform an experiment in real labs. For example, it is convenient for distance learning.

The using of programming languages and libraries in physics learning research requires both students' physics research competencies and programming competencies. That is why using this software in physics classes can hardly be recommended. However, programming languages and libraries can become a powerful tool for the formation and development of research competencies of physics students in extracurricular learning activities.

The implementation of the spreadheets and the CAS in school physics researches is the easiest and has its benefits.

Keywords: profile physics learning, physics research, CAS, spreadsheets, virtual labs, virtual simulators, programming languages and libraries, software for natural process simulation.

1 Introduction

Valerii I. Seldiaev [11] classifies the possibilities of using a computer in physics labs. He emphasizes that there are many experiments that cannot be performed without computer (studying the kinematic characteristics of motion caused by the gravity, the conditions of spark discharge occurrence etc.). Furthermore, Seldiaev defines the main methods of ICT using in educational studies:

a. using the computational experiment in conjunction with the lab experiment;
b. using the computational experiment only;
c. using ICT tools in the set of measuring equipment.

Donald R. Hamann states that the most traditional methods of ICT using in physics researches are automation of computing and physics processes modeling ("numerical analysis" or "imitation" [5, p. 240]).

Richard Phillips Feynman proposed to generalize "step by step" calculations in the form of a table to determine the orbits of the planets [4, p. 170-171]. He proposed to use the tables of squares, cubes, and inverse quantities to simplify mathematical calculations. Feynman emphasized that even in this case, the implementation of such calculations manually requires a lot of time. That is why it can be useful to solve such tasks with the use of a computer as a tool of computing automation [4, p. 173].

2 Discussion and results

Charles W. Misner examined the possibilities of using spreadsheets in physics researches. Using spreadsheets provides the ability to automate the data processing [12], mathematical and logical actions; provides the opportunity of numerical solving of equations, of submitting data in the form of charts. The most common modern spreadsheets are Microsoft Excel Online, LibreOffice Calc Online, KSpread, Kingsoft Spreadsheets, Google Sheets [13], Gnumeric.

According to Misner, the main advantage of spreadsheets is their possibility to combine text and numeric data. It makes the execution of similar "routine" actions (such as reports writing) easier [8, p. 396]. Moreover, the researcher notes that the range of physics problems that can be solved via spreadsheets is much wider (these tasks are also more complex) than the range of problems for which the spreadsheets were created. First of all, spreadsheets in physics are used for calculations and building additional charts and diagrams. Misner described main features of spreadsheets using for calculations in physics: "a high ratio of design time to run time and the need for small amount of data" [8, p. 395].

The spreadsheets in profile physics learning can be used in studies that require the processing of homogeneous data arrays and their generalization in charts. The examples of such studies are the research of the process of discharging the capacitor and determining its capacity, determining the temperature coefficient of metal resistance, studying the efficiency of the electric source, studying the correlation between the resistance of semiconductors and temperature, studying the volt-ampere characteristics of the semiconductor diode (Figure 1). It is also advisable to use spreadsheets to process the results of series of identical experiments [16], which is relevant for the most of school workshops.

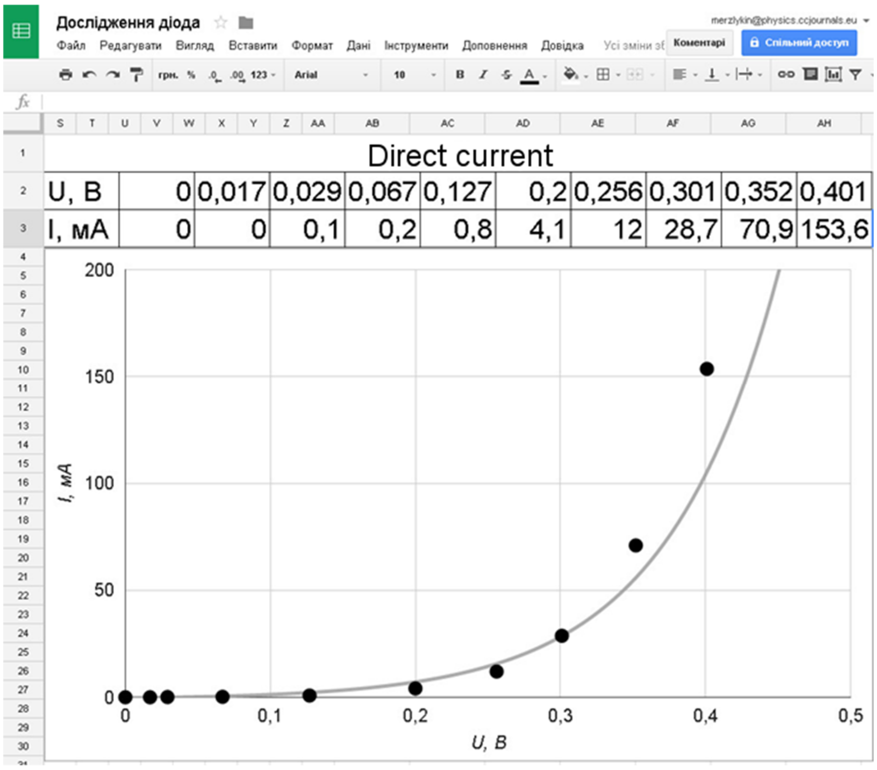


Fig. 1. Example of Using Google Spreadsheets for the Studying of Semiconductor Diode

Donald R. Hamann emphasizes the significant potential of problem-oriented programming languages, such as MACSYMA and ALTRAN. Nowadays the common name of such software is the computer algebra systems (CAS). The main purpose of this software is the performance of mathematical operations and transformations of algebraic expressions given in a symbolic form. Moreover, most of modern CAS provide the ability to numerical problem solving, to work with matrices, to process the data arrays. The most of modern CAS also support the ability to display data in a graphical form. The most common modern CAS are CoCalc [7], MATLAB Online, MapleCloud, Mathcad, Scilab on Cloud [9], Maxima Online, Wolfram Mathematica Online, Yacas Online.

At school CAS can be used to solve the same problems as spreadsheets. However, their use for researches, which require the work with a large amount of mathematical abstractions (such as vectors) is the most effective. The examples of such researches are the study of body balance under the action of several forces in, finding the center of mass of the flat body. Moreover, CAS can be used for statistical data processing (Figure 2).

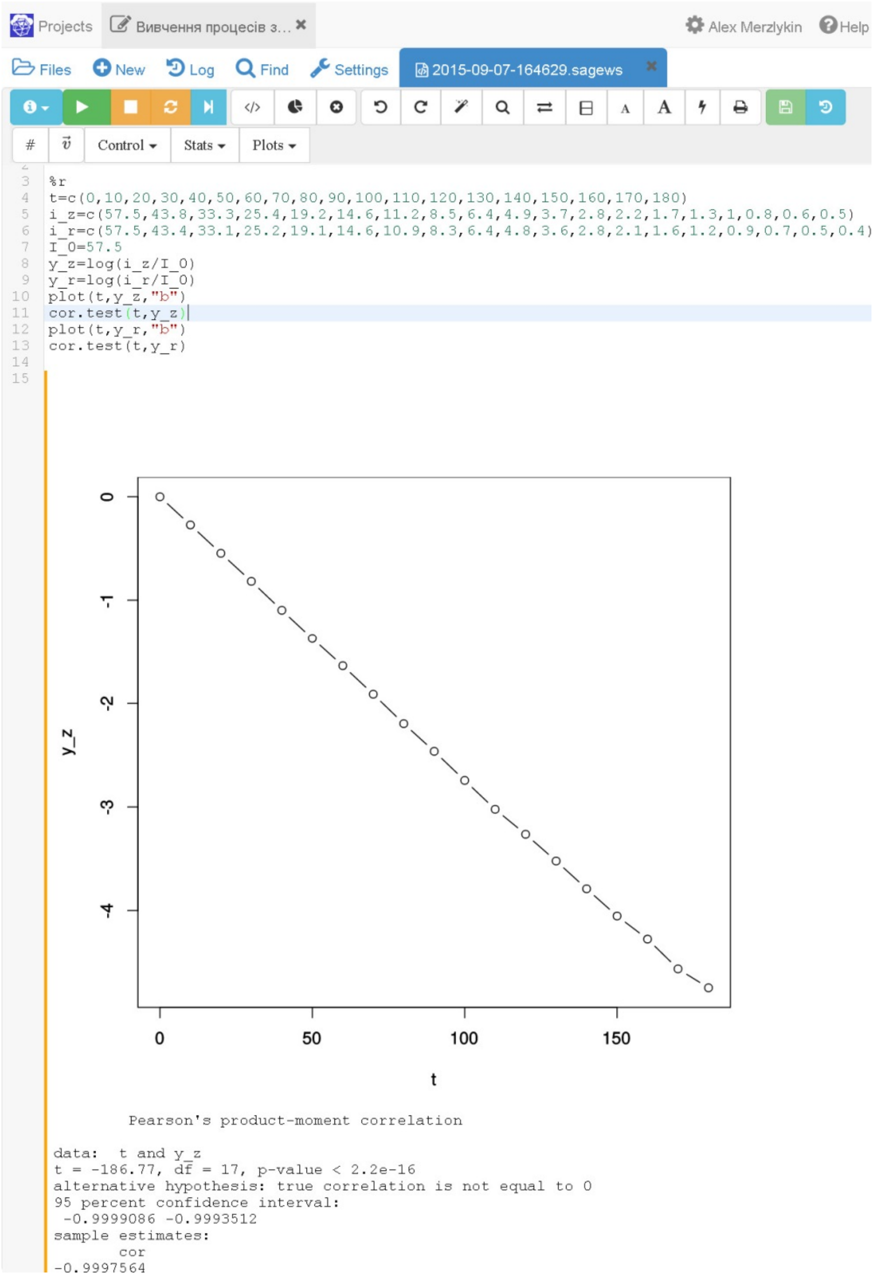


Fig. 2. Using CoCalc in studying the processes of charge and discharge the capacitor

Donald R. Hamann considers contemporary (Fortran, C, ALGOL, Pascal) and prospective programming languages and libraries separately [5, p. 248-251]. We will use the term “programming languages” for definition of the complex of programming languages as is (character system for writing algorithms) and its translator (compiler or interpreter). A programming language translator, along with a text editor, debugger, profiler, file and object management, set of specialized libraries for a given programming language, etc. can be combined into an integrated programming environment.

In this definition, the programming languages and libraries together are the tool of implementing any algorithm as a computer program. The ways of data presenting can be diverse (text, charts, video, audio, multimedia, database, etc.). That is why programming languages can be considered as the universal tool at all stages of physical research [14].

It should be noted that the using of programming languages and libraries in physics learning research requires both students’ physics research competencies and programming competencies. That is why using this software in physics classes can hardly be recommended. However, programming languages and libraries can become a powerful tool for the formation and development of research competencies of physics students in extracurricular learning activities.

Figure 3 shows the user interface of the computer program for demonstrating Faraday’s law in a cloud-based GlowScript environment created with use of Python programming language and Visual Library [15].

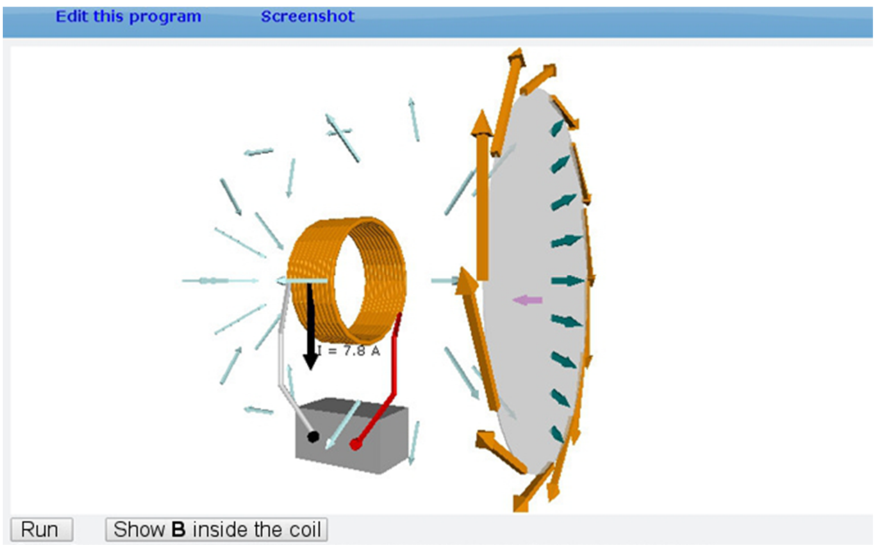


Fig. 3. User interface of computer program for demonstrating the Faraday’s law

Virtual labs are a narrow class of software that is designed to simulate the process of natural research [10]. Using virtual labs involves working with virtualized objects of a real physical laboratory. Virtual labs may involve the creation of the user's experiments or researches, pre-designed by the authors of the virtual lab or by the teacher. The purpose of students' work at the virtual lab is to process an experiment using the appropriate set of virtualized devices and performing measurements.

The virtual lab designed by Gregory Bothun, Sean Russell and Amy Hulse is the part of Oregon's Physical Education Resources package and is a collection of Java applets available on the University's website. Research in the virtual lab, according to the authors, is intended to give students an access to the data that simulates a real physical experiment. According to Gregory Bothun, it was previously planned to use a virtual lab for students of non-science specialties (their Physics course does not involve lab works). Later it turned out that the Java applets were downloaded thousands times per month and became popular at physics classes in high schools. Every research in the virtual lab consists of two parts: in one of them students work with computer models of devices, and the other one reflects the lesson plan. The virtual lab includes both studies which can be and cannot be provided in the conditions of the physics lab (Figure 4).

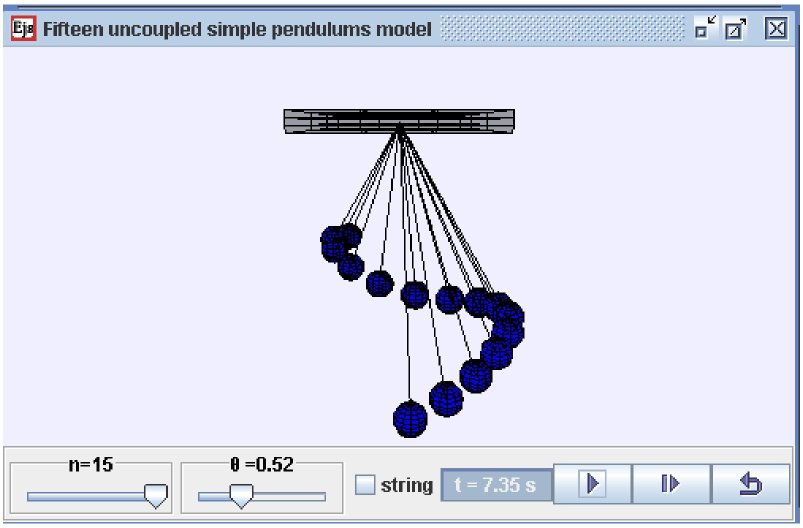


Fig. 4. Wave pendulum simulated by Easy Java / Javascript Simulations (EjsS) of the Open Source Physics Project

You can use improperly most of the equipment in this virtual lab. In this case, the equipment will "virtually" fail, and the sound message will notify user [1]. It provides the ability to use the part of the described virtual lab as a virtual simulator for the use of physical equipment.

Virtual simulators are the software that is similar to virtual laboratories. The main difference between these two classes of software is their purpose. Using virtual simulators mainly involves working with virtualized devices as is, but not with the "scheme" of the whole experiment. Virtual simulators can be used for students' familiarization with the devices used in research. Often the virtual lab and the virtual simulator are the same software. Thus, virtual simulators simulate physics equipment, while virtual labs simulate physics research.

Virtual simulators in a school physics research should be used at the preparatory research stage to provide to students the opportunity to familiarize themselves with the equipment which is used in the research (Figure 5). This is especially useful for students who have to work with devices they have never used before.

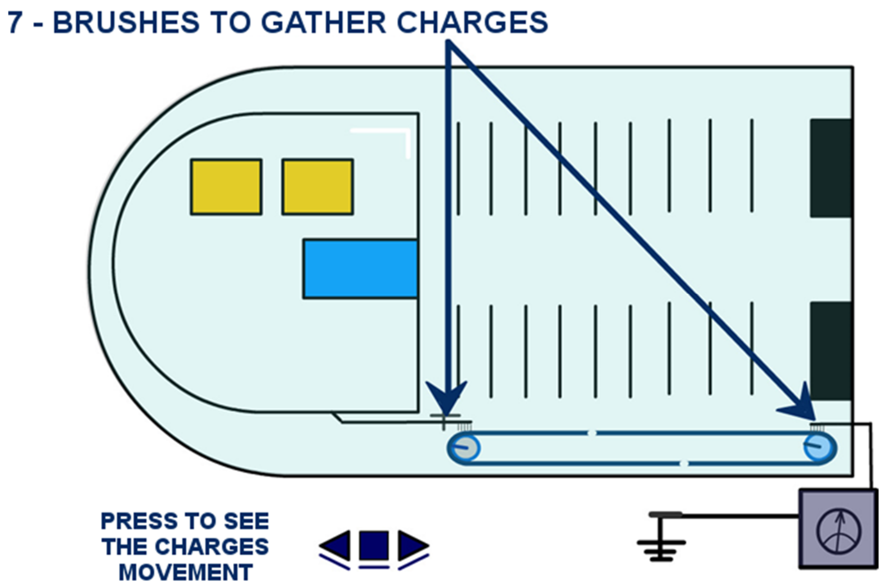


Fig. 5. Introduction to electrostatic ion accelerator on the site of the Institute of High Technologies of Kyiv Taras Shevchenko National University

The using computer simulations can extend the content of school curriculum because any natural phenomenon can be modeled using a computer. Donald R. Hamann states that there are three factors of the successful application of numerical modeling: "analytical simplification based on well-known physical theory, good algorithm and successful graphical representation of results" [5, p. 247]. The article [6] presents a number of models, which using in the educational process, according to the authors, is more effective than the real demonstration of physical phenomena.

Software for natural process simulation is similar to virtual labs. In virtual labs, students use ready-made models of natural phenomena, while in software for natural process simulation, they have to create these models by themselves. It requires a higher level of abstraction, deeper understanding of the processes and mathematical modeling skills. Developing computer models with this software takes a lot of time, so it is advisable to organize such activities within the framework of a research project. At the same time, complete virtualization of lab work using this software goes beyond the scope of physics learning.

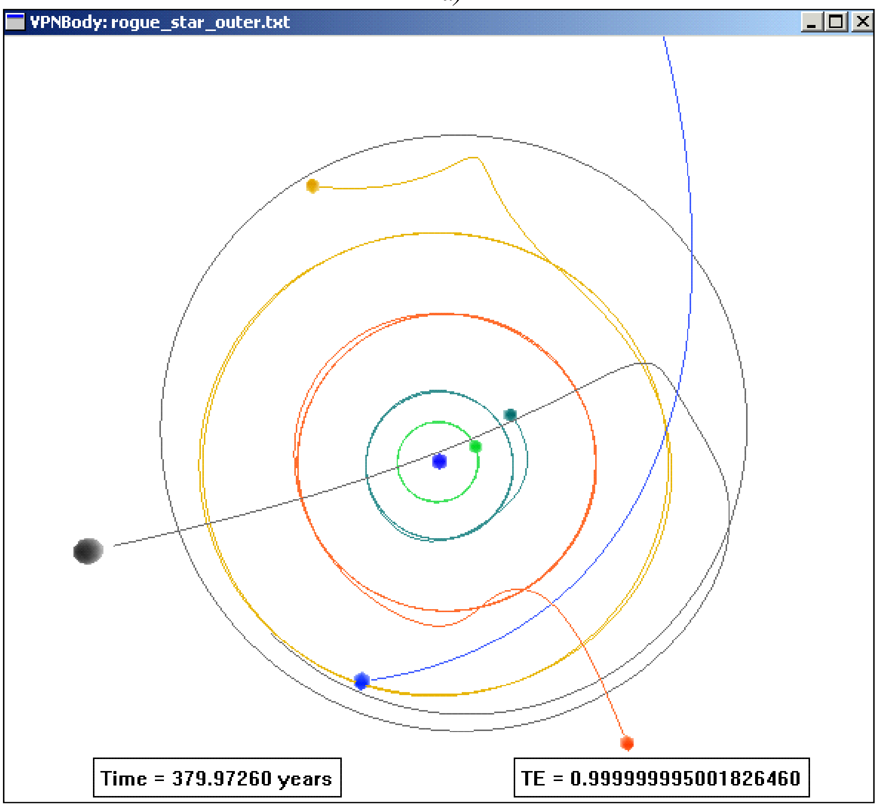
Methods for describing models, which use the software for natural process simulation, can vary from a textual description (Figure 6) to the direct execution by means of a graphical interface [17].

```
TIME_STEP 90 DAYS # крок моделювання
MAX_TIME 600 YEARS # повний час моделювання
METHOD Candy_Rozmus_Opt # метод інтегрування

OBJECT_DATA # опис об'єкту "блукаюча зірка"
  Name Rogue_Star
  Free
  MASS 1.50 SOLAR_MASSES
  COLOR 1 0.85 0
  Orbit_color 1 0.85 0.0
  POSITION -125 200 0 AU
  VELOCITY 0.325 0.0 0 AU/Yr
END_OBJECT_DATA

# опис інших об'єктів Сонячної системи (Сонця, планет)
```

a)



b)

Fig. 6. The fragment of description the computer model of the process of the wandering star invading in the Solar system using VPNBody (a) and the results of simulation (b)

Marek Pawel Checinski proposes to use the FireFly (PC-Gamess) for calculating the properties of molecular structures and MacMolPlt for visualization the results of these calculations [2]. The author examines the basic features of both tools and makes recommendations on how they can be used. Francisco Esquembre points out that computer simulation tools have all the benefits of learning modeling and, in addition, help students to clarify the Physics concepts. The author also notes that the level of abstraction of the modeling tools can vary from the “pure programming” to the construction of high-level blocks. The choice of modeling tools is determined by the task. So Esquembre recommends using Modellus for simple models and Easy Java Simulations for more complex tasks [3, p. 17].

Consequently, software natural process simulation in relation to virtual laboratories is not a broader but a different class of the software that has its own specific purposes and ways of using. One of the possible approaches to the delimitation of this software is the classification given in Table 1.

Table 1. Classification of adjacent software by controllability of code and data

Software	Controllability of code	Controllability of data
Programming languages and libraries	The code is created by the user with the use of library objects; algorithms are created or used from the library	The data structures are determined by the user or by the author of the library; the data is entered by the user
Software for natural process simulation	The code can be created by the user according to the proposed interface or the ready-made program modules can be used.	The data structures are determined by the software engineer; the data is entered by the user
Virtual labs	The code is created by the software engineer	The data structures are determined by the software engineer; the data is entered by the user
Virtual simulators	The code is created by the software engineer	The data and its structure are determined by the software engineer

3 Conclusions

Such software as virtual labs, software for natural process simulation, programming languages and libraries in school researches can be used to simulate phenomena which cannot be learned in a school lab (for example, for modeling a radioactive decay or for demonstrating the states of relativistic mechanics). Moreover, virtual labs in school practice are usually used in those cases when students cannot perform an experiment in real labs. For example, it is convenient for distance learning. However, a comparison of the results of the study obtained in the natural research with the results obtained by means of the virtual lab can be useful. It can also be useful to compare the results of different models of the same phenomenon. Such comparisons can help students to understand the limits of the application of physics laws, to understand the correspondence principle and the possibility of the existence of several adequate mathematical interpretations of the same phenomenon.

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Cloud service ThingSpeak for monitoring the surface layer of the atmosphere polluted by particulate matters

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Abstract. The article describes the cloud service ThingSpeak as a tool for monitoring and estimates the atmospheric air pollution. The main components of open instruments of environmental monitoring were implemented via microcontroller development system – Teensy 3.2, sensor module (temperature, humidity, pressure) BME280, SenseAir S8 carbon dioxide sensor module, PMS3003 air pollution sensor, Wi-Fi module ESP-01 and online ThingSpeak platform for storing and processing data. The prototype of an open source software system is developed, which, due to its openness, integration capabilities, ease of design and informativeness, provides monitoring of the human respiratory zone in two districts of the city of Ternopil on the content of suspended particulate matter PM_{10} and $PM_{2.5}$. The estimation of the influence of sources of pollution on the level of content suspended particulate matter in the atmospheric air was carried out with the help of multidimensional statistical methods, in particular using statistical procedure by principal component analysis, which allowed to process a large set of data and to obtain information on quantitative indicators and the nature of pollution. The analysis of particulate matter contents in the context of the cloud computing concept reflects the real-time monitoring metrics through the ThingSpeak services, which serves as a place not only for collecting, analyzing data, but also for discussing the results, thereby training students-biologists to monitor the quality of the surface layer of the atmosphere.

Keywords: ThingSpeak, Luftdaten.info, microcontroller, sensors, particulate matter.

1 Introduction

Today, the problem of contamination of the surface layer of atmosphere, especially by particulate matter (PM) of dust, is actual. The State Sanitary and Epidemiological Service of Ukraine (SES), which existed before March 2017, carried out the analysis and provided information on a large group of harmful substances, including the content of atmospheric air, the amount of substances in the form of solid suspended particles (fine particles and fibers) or suspended particles (TSP) [7]. A systematic analysis of atmospheric air relative to the content in it differentiated by the composition of dust is not carried out, although today the functions of the SES have been entrusted to the Ministry of Health and the State Committee for Supervision of Civil Service and Ukraine has undertaken liabilities [10, p. 51] concerning the reduction of emissions of the main substances polluting the atmospheric air.

To understand the objective picture of air pollution by particles of different aerodynamic diameters, there is a need for obtaining and using real observational data. One of the promising approaches to solving the problem of monitoring of suspended particles with a diameter of less than 10 μm is, first of all, the development of open-source environmental monitoring tools (open hardware, software, etc.) that are as reliable as professional ones. As a result, it provides an opportunity to attract a wide range of volunteers from among citizens, to address issues of atmospheric air pollution in the region, popularize the concept and implement the basic principles of "Civic Science" at a wide range of people. Examples of the integrity and success of such an approach are the Luftdaten (Germany), Exploring Salt Lake City's Air Quality (USA), etc., in which enthusiasts provide measurements from different parts of the world.

However, most scientific tools and systems developed on their basis require deep technical knowledge make them inaccessible to the public and limiting the likelihood of their use. Apart from the fact that such means are fairly expensive, their original data is stored locally in special, patentable formats, which limit their exchange for the purpose of analysis and comparison of the results. Therefore, in order to improve communication, one should focus on creating or using an existing open, easy-to-use on-line platform that provides visualization, data sharing, contributing to the formation of a community of users that stimulate its continuous improvement.

2 Analysis of recent research and publications

Research on the theory and practice of pollutant monitoring is supported with the works of domestic and foreign scientists. Iryna F. Voitiuk, Taras M. Dyvak, Mykola P. Dyvak, Andrii V. Pukas [15] dedicated their work to the identification of the real concentrations of harmful emissions. Among them firstly the measuring instruments of the SES to determine the concentrations of harmful substances are noted with a rather low accuracy – 20–50%; secondly, the measurement process is carried out by taking air in certain points of the city and at different moments of time can be significantly different, due to the impact of the intensity of transport flows, weather conditions, intensity of air flow, etc.; thirdly, the measurement process is highly expensive, so it is conducted in separate parts of the city and quite rarely.

The Air Quality Index, or AQI, was developed by the U.S. Environmental Protection Agency (EPA) to provide a simple, uniform way to report daily air quality conditions. Minnesota AQI numbers are determined by hourly measurements of five pollutants: fine particles ($PM_{2.5}$), ground-level ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) [1].

Andriy I. Herts, Nataliia V. Herts, Ivan M. Tsidylo studied the possibility of using intelligent measuring instruments on the basis of microelectronic sensors in solving atmospheric air pollution problems [3].

At present, there are a number of free resources for atmospheric air data visualization that have a fairly convenient interface where anyone can add a sensor and publish data. In particular, the Open-SenseMap.org has a user-friendly interface, an API, the ability to visualize data through interpolation and visual overview of data in time, etc. The Luftdaten.info server, the Madavi.de server, and a number of others that provide data storage in CSV format and data visualization.

An analysis of literary sources has shown the need to create a prototype of hardware with open source software, which, due to openness, integration capabilities, ease of design and information access, will allow monitoring of the surface layer of the atmosphere (human breathing zone) and send them to the above-mentioned resources.

Little or no attention is has been paid to the problem of integrating the application of monitoring system design tools into the educational process of preparing students of biology. In particular, in our case, the use of intelligent sensors, transmitters, means of microelectronics, etc., analysis and assessment of air pollution included as a requirement of time, to the methodology of scientific and / or professional activities and provided by the educational curriculum of student biologists. This, in the long run, will allow to increase the number of involved people from ordinary citizens to monitoring, exchange of data on the state of the air environment of urbanized areas in order to improve the air quality management system.

To substantiate and implement the prototype of the monitoring system using intelligent metering and cloud services for training students-biologists in the analysis and assessment of air pollution by suspended particles PM_{10} and $PM_{2.5}$, for example, at two monitoring stations in the city of Ternopil.

3 The results of the research

In order to control air pollution in real time, we have implemented an inexpensive air quality monitoring system using the Wireless Sensor Network (WSN), which is deployed in two monitoring air quality control systems. These are: Post 1 – the intersection of the streets of Dovhaya, Halytska, Zbarazka, Brodivska; Post 2 – a crossroads of streets of Zhyvova, Mykulynetska, Hayova, Zamonastyrska, Ostrozka. The proposed air quality monitoring system uses the air quality index, which can be easily interpreted. In addition, the public can access the results of air quality monitoring in real time. The assessment of atmospheric air condition in the city of Ternopil is carried out at the average monthly concentrations in multiplicity of the excess of average daily limit-permissible concentrations (LPC) by priority pollutants [7, p. 803].

3.1 Hardware for use with ThingSpeak services

The measurement system we have built up consists of intelligent, in most cases, digital sensors or measuring transducers connected to the signal processing system (see

Figure 1). To do this, we used the capabilities of the microcontroller of the hardware computing platform Teensy 3.2 [13].

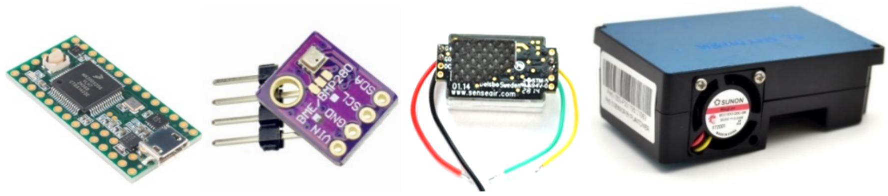


Fig. 1. The main components of the prototype for ThingSpeak

All data coming from the central system (Figure 2) contains temperature information (–40 to +85 °C, ±0.5 °C), relative humidity (0–100%, ±3%), atmospheric pressure (300–1100 hPa, ± 1.0 hPa), the level of CO_2 (0.04% to 2%), the concentration of the suspended particles ($PM_{2.5}$, PM_{10}, μg/m^3) in the surface layer of the atmosphere. This data is being output and analyzed real time, by means of cloud computing service Thingspeak [4].

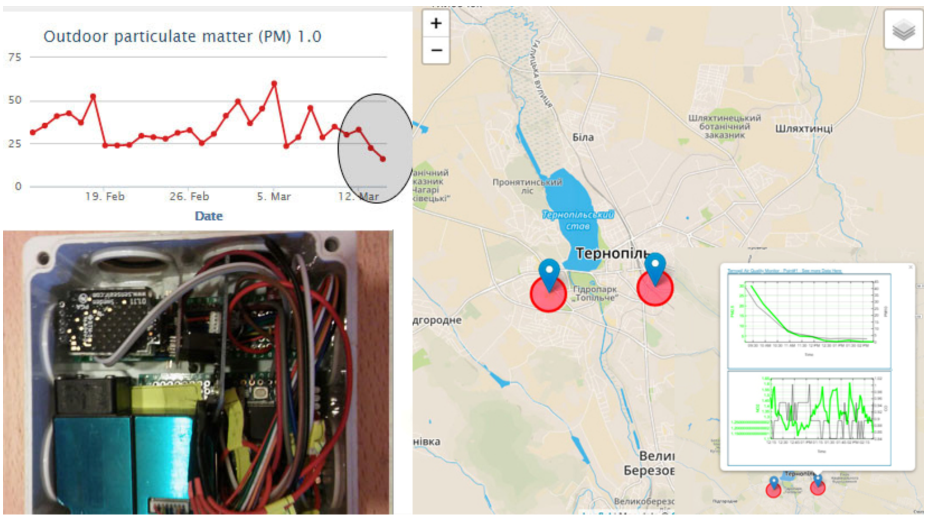


Fig. 2. General view of the system of analysis of suspended particles in the surface layer of the atmosphere

All data (and over the period of research in 2017 and 2018 there have been more than 500,000 measurements at Post 1 and 120,000 at Post 2) was accumulated in the system of cloud computing, collection and analysis of data Thingspeak, where a selection of trends can be set for the defined period.

Between the cycles, that is every 2 minutes, a request was made to the Thingspeak server and the data was sent via ESP8266 (ESP-01 module), from the above-mentioned sensors to the external data storage and visualization services.

In addition to the Thingspeak site's capabilities for analyzing and outputting data, the R-Studio software was used. A correlational analysis was carried out with the drawing of a heatmap on which the data was graphically represented so that the individual values contained in the matrix were presented in the form of colors.

Estimates of the contribution of pollution sources to the level of PM in the atmospheric air, were carried out with the help of multidimensional statistical methods, in particular, the method of the main components. This allowed us to process a large set of data and to receive information on the quantitative parameters and the nature of the pollution.

3.2 Hardware to use the services of Luftdaten.info

Since 2000, the Federal Government of Germany has carried out regular measurements of dust pollution with PM_{10} particles (aerodynamic diameter of 10 µm or less) throughout the country. And since 2008, measurements have been made with particles $PM_{2.5}$. At present, in Germany, the content of PM_{10} dust must not exceed 50 $\mu g/m^3$, which can be exceeded for a maximum of 35 days per year. For our research, we, along with the above-mentioned hardware, used the recommendations of the project.

To carry out measurements, we used the following hardware (see Figure 3): NodeMCU ESP8266; dust sensor SDS011; temperature and humidity sensor DHT22; short tube with diameter of 6 mm; distribution box OBO; Bettermann T 60 IP66; micro USB + power cable; Dupont cable set.

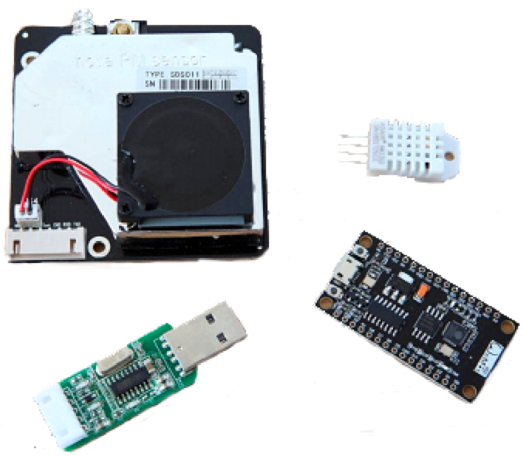


Fig. 3. The main components of the prototype for Luftdaten

The main component is the NodeMCU ESP8266 card [8] with the installed SoC and the WLAN module. SoC called ESP8266, complemented by 128 KB of RAM and

4 MB of flash memory. The operating system called XTOS is adapted to work with the SDS011 dust sensor [6].

The sensor of PM is a laser sensor, which, by means of photometry, determines the amount of suspended dust particles. The effect of attenuation or dispersion of a laser beam is used to do the measurements. The measurement range of SDS011 is from 0 to 999.9 μg/m^3. The sensor can detect particles with a diameter of 0.3 microns and larger, including $PM_{2.5}$ and PM_{10} with an error of 10%. The sensor drains the air through the vents, and then outputs the result in a few seconds. In our study, we read the sensor values every 145 seconds. The operating temperature range is –20 to +50 °C.

Results of the sensor SDS011 depend on temperature and humidity, therefore, for the interpretation of the correct values we measured them as well. To do this, a humidity and temperature sensor DHT 22 or BME280 was used. The sensors determine the humidity in the range from 0 to 100% with an error of 2–5% and the temperature in the range from –40 to +80 °C with an error of 0.5 °C.

The above-mentioned inexpensive sensors, in comparison with the existing professional ones, have a number of shortcomings. Nowadays such sensors cannot replace the professional ones, but they are capable of acting as an additional source of information about air quality. Most of them are generally less sensitive and accurate, but the data from the PM sensors show a rather high correlation (r^2 = 0.7–0.9) with measurements obtained with the help of the equipment used by the US Environmental Protection Agency (USEPA) [2].

On the other hand, such an inaccuracy of the sensors can be offset by an increase in the spatial density of the measurements achieved through the creation of their network. It should be borne in mind that in the case of the use of identical base components of the sensors, the results obtained may differ and be different in the light of differences in approaches to data correction and calibration. Therefore, the need for data normalization and calibration of hardware remains relevant.

Among the advantages of building a sensor system integrated through a web-platform into a single network is that in this case it serves as a place not only for the accumulation, analysis of data, but also for the place of discussion of the results. Such a policy, open access and open data, facilitates the exchange of data with interested parties, the community and local authorities, research institutions, etc.

3.3 Analysis of data concerning the content of PM in the air by means of cloud computing

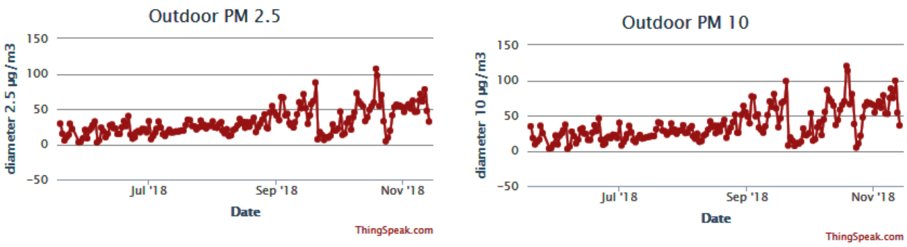
The system, which we offer is capable of displaying real-time data that is available through the cloud-based ThingSpeak or Luftdaten.info service for any user who is connected to the Internet.

To analyze the data, we used data from our Post 1, which covered the area of the East-Center massif and came from February to November 2018. At the Post 2 sensors received data concerning the content of PM in the massif Center-Druzhba. During the research period, more than 500,000 measurements were obtained. Duration of measurements – 24 hours a day, the frequency of data acquisition was every 2 minutes.

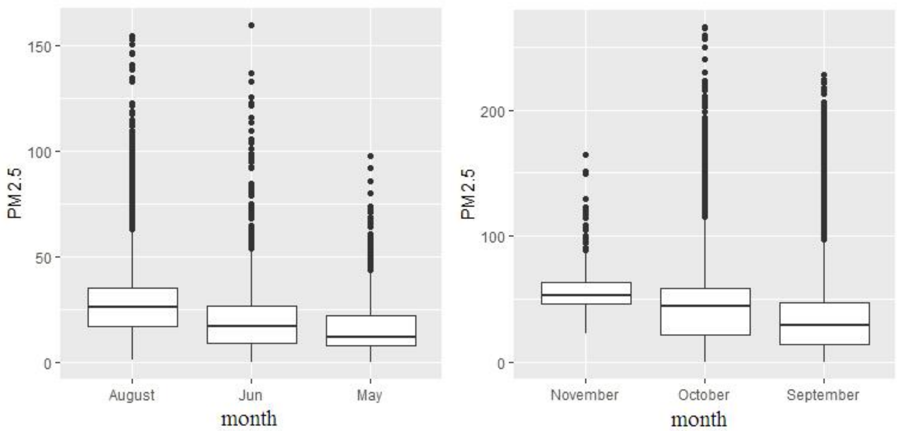
Along with obtaining data describing the content of PM in the air, the proposed system is able to accumulate data on relative humidity and air temperature. On the one hand, this makes it possible to assess the presence or absence of a temperature dependence between the content of PM and the physical characteristics of atmospheric air; on the other hand, it allows to detect the measurement errors associated with the work of the sensor itself.

Post 1 was additionally equipped with sensors that described such parameters of the air pool of Ternopil City as the content of CO_2, NO_2, NH_3 and CO in the air.

Using ThingSpeak cloud services (see Figures 4 and 5) we made graphs and calculated the average values of each of the parameters that were evaluated and output in the on-line mode.



a)



b)

Fig. 4. Dynamics of changes in $PM_{2.5}$ and PM_{10} in the Ternopil air pool (Post 1): *a* – each point as the average for a certain time period; *b* – Box Diagram of Dynamics of $PM_{2.5}$

For a more detailed analysis, we used RStudio. This allowed us to obtain data in a format that made it possible to calculate and evaluate their statistical reliability. Generalized data from Post 1 is presented in Table 1, where the average values for three months and annual values are calculated. For data analysis, we have taken European yearly standards for content of $PM_{2.5}$ and PM_{10}, which are 10 and 20 μg/m^3, respectively.

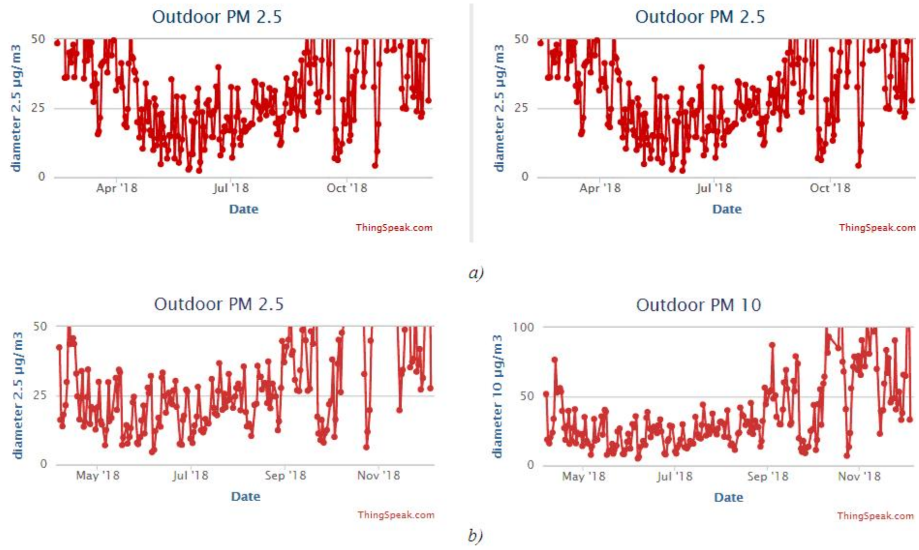


Fig. 5. Dynamics of the content of $PM_{2.5}$ and PM_{10} in the air pool of Ternopil, (μg/m^3); *a* – Post 1; *b* – Post 2

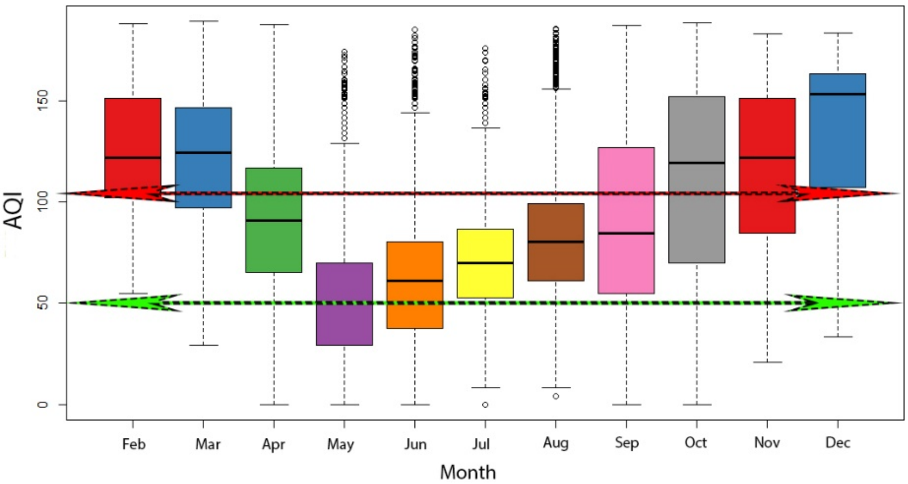
Table 1. The content of carbon monoxide and carbon dioxide in the atmosphere of the city of Ternopil (May–November 2018)

Month / Parameter	**May**	**July**	**August**	**September**	**October**	**November**
PM_1, μg/m^3	10±0.06	12.5±0.05	19±0.06	23±0.11	29±0.12	35±0.08
$PM_{2.5}$, μg/m^3	16±0.08	19±0.07	28±0.09	36±0.21	45±0.10	54±0.12
PM_{10}, μg/m^3	18±0.11	20±0.09	31±0.10	41±0.2	52±0.2	66±0.18
$PM_{2.5}$, μg/m^3 in 3 months	21.56±0.07			42.98±0.12		
Annual readings	29.72±0.08					
PM_{10}, μg/m^3 in 3 months	24.11±0.06			50.37±0.14		
Annual readings	35.21 ±0.10					
CO_2, pmm	428±0.70	422±0.13	436±0.21	429±0.13	424±0.11	429±0.12
Air temperature, °C	20±0.03	21±0.02	24±0.02	18±0.03	13±0.02	11±0.11
Relative humidity, %	55±0.12	67±0.09	65±0.07	67±0.07	69±0.08	82±0.06

The formula 1 [1] was used to calculate the air quality index (Figure 6)

$$I = \frac{I_{high} - I_{low}}{C_{high} - C_{low}}\left(C - C_{low}\right) + I_{low} \qquad (1)$$

where: I – air quality index (AQI), C – concentration of pollutant, C_{low} – lower concentration limit when $\leq C$, $Chigh$ – upper concentration limit when $>C$, I_{low} – index point corresponding to C_{low}, I_{high} – index point corresponding to the C_{high}.



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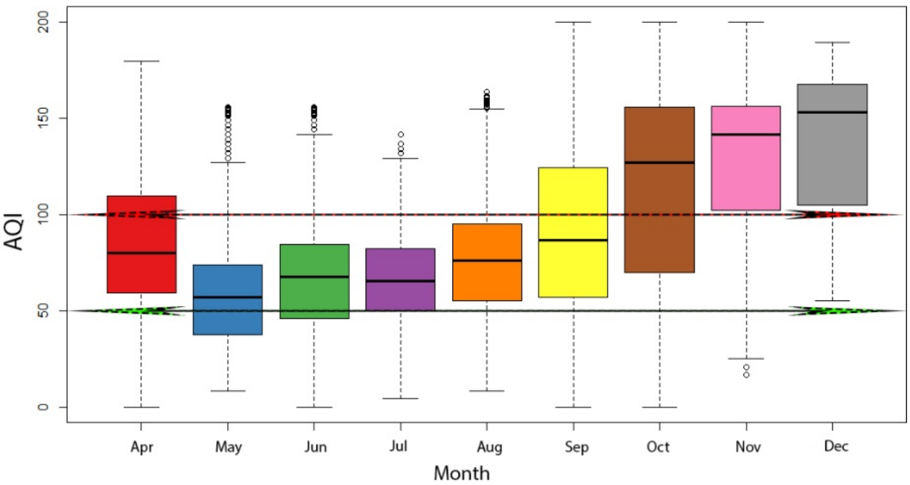


b)

Fig. 6. The air quality index (AQI) for the indicators of $PM_{2.5}$ in Ternopil city in the period from February till December 2018 (green line – 0-50 – AQI – good, above the red line – 101-150 AQI – harmful to risk groups): *a*) – Post 1; *b*) – Post 2

Consequently, the average annual content of PM of 2.5 and 10 μm in the air of the city of Ternopil (see Table 1) exceeds the approved European standards [11] in 3 and 1.5 times, respectively.

The maximum permissible concentration for Ukraine is determined according to the existing normative documents [7] at the level of 150 μg/m^3. However, this value refers to the undifferentiated sum of substances in the form of solid suspended particles (microparticles and fibers) or particulate matter. That is, all the particles in the air are taken into account. Based on WHO recommendations, we used the following relationship between TSP and PM_{10}: PM_{10} = 0.55TSP. That is, 82 μg/m^3 is the average daily maximum permissible concentration which in 1.5 times exceeds the European and world standards in general.

The air quality index (AQI) that we calculated varies within 50–140, that is within the scale of "satisfactory – harmful for the risk group". Thus, the winter-autumn period is critical for people with chronic diseases.

Comparing the daily and nightly average monthly values of the PM content in the air pool of Ternopil (see Table 2), it was found that the content of the PM at night always exceeded the one in the daytime. If in the spring-summer period this difference can be partially neglected, then in the autumn period it becomes significant and reliable.

Table 2. The content of PM in the atmospheric air of the city of Ternopil dependending on time of day (daytime / night), (May-November 2018), μg/m^3, m ± se

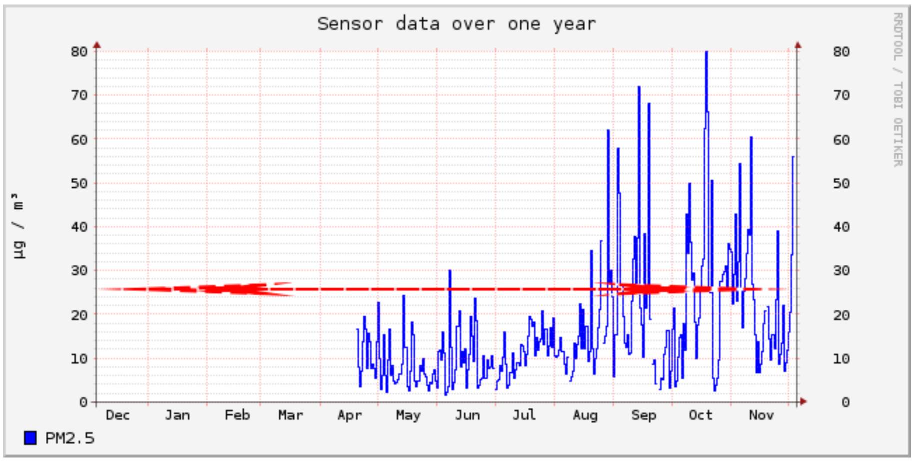
	May		July		August		September		October		November	
	Daytime	Night	Daytime	Night	Daytime	Night	Daytime	Night	Daytime	Night	Daytime	Night
$PM_{2.5}$	14,05 ±0,09	19,41 ±0,16	15,83 ±0,08	21,88 ±0,12	20,59 ±0,09	34,20 ±0,13	24,31 ±0,16	46,40 ±0,32	39,57 ±0,25	49,93 ±0,26	24,31 ±0,16	56,31 ±0,16
PM_{10}	16,06 ±0,11	22,55 ±0,20	16,88 ±0,09	24,18 0,14	22,47 ±0,11	39,08 ±0,16	24,31 ±0,16	53,55 ±0,36	46,09 ±0.30	58,69 ±0,31	64,10 ±0,27	68,53 ±0,24

The obtained data confirm the opinion of other authors [9], which argue that for some parameters such as CO, benzene and toluene, there is a different "behavior" over the course of a day than for PM_{10}. This suggests that the concentration of CO, gasoline and toluene is mainly related to transport systems, while PM is mainly influenced by a number of factors. They associate 90% of the data variance with the movement of vehicles, especially private ones. Our analysis indicates the presence of a string of other sources of these pollutants.

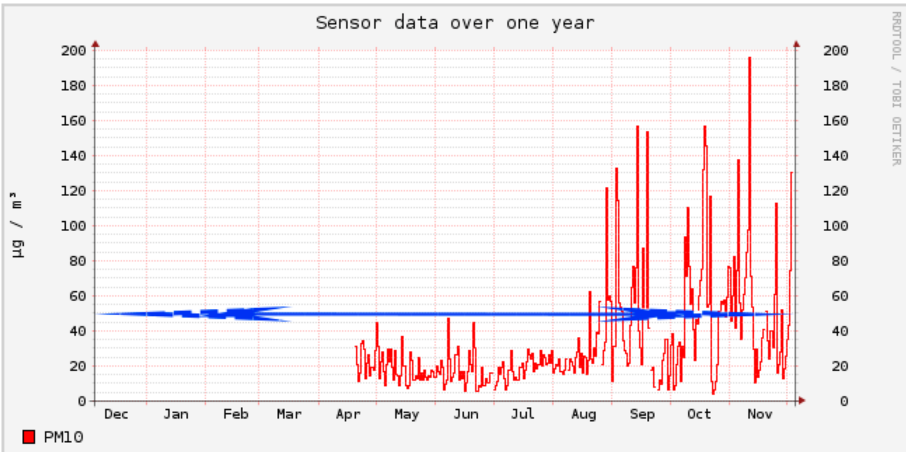
Similar results during the first decade of December are presented using the Luftdaten service (see Figure 7).

In order to find out whether the parameters of the prototype proposed by us are independent of temperature and relative humidity of the air, we carried out a correlation analysis, which was visualized as a heat map (see Figure 8).

As shown on the heat map, there is a weak (from 0.25 to 0.5, depending on the observation point (observation post)) positive correlation between the content of the PM and the relative humidity of the ambient air. It is known that in the fog, the concentration of particles in the air can greatly increase due to surface inversion and high humidity. Fogs are often associated with winter smogs, in which over a long period of time there occur high concentrations of harmful substances contained in the surface air layer [12].



a)



b)

Fig. 7. Dynamics of the content of $PM_{2.5}$ and PM_{10} in the air pool of the city of Ternopil in the period from April till December 2018 a) the red line – 25 µg/m^3 – the average daily norm for $PM_{2.5}$; b) the blue line – 50 µg/m^3 – the average daily norm for $PM_{2.5}$

The air temperature and atmospheric pressure, which vary during the day and depending on the season, are negatively correlated with the content of fine particles in the air. There is a slight (r^2 = 0.21) positive correlation between NO_2 and PM_{10}, although, in our opinion, the accuracy of measurements of CO, NO_2 and NH_3 is significantly influenced by the temperature factor.

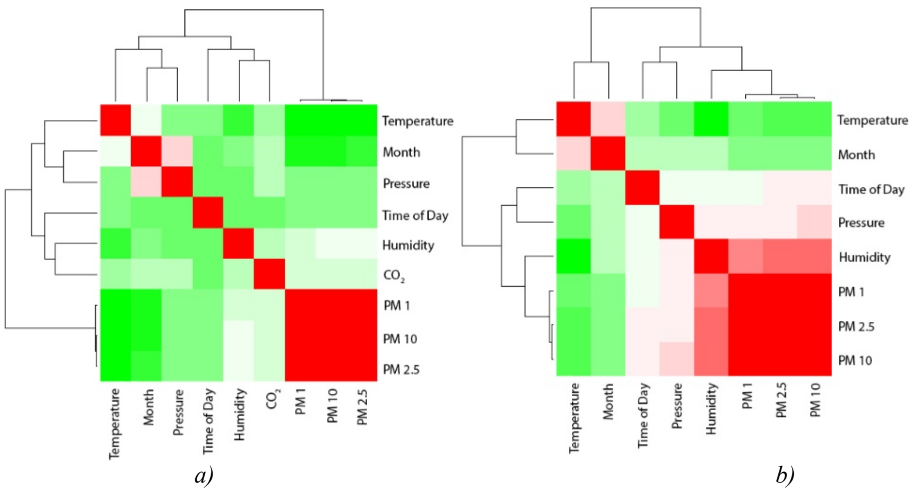


Fig. 8. Heat map and graph of the dependence of the content of PM in the atmosphere on the temperature and relative humidity of air: *a)* – Post 1, *b)* – Post 2

4 Conclusions and prospects for further research

Portable, compact devices for rapid analysis of biological systems, identification and quantitative measurements of their metabolites, analysis of the chemical composition of foodstuffs, soils, etc. have already been developed. They have been widely used in the investigation of biophysical processes of living organisms, in the study of biologically and chemically active substances, in the system of health care, environmental protection, ecology, and in environmental monitoring in particular.

The results obtained from our monitoring system, which includes sensors for determining the level of PM, temperature, humidity, CO_2, show their effectiveness in solving a number of topical issues. First of all, it provides an opportunity to evaluate the inhalation effect of suspended particles with a diameter of less than 10 microns, which is not carried out in Ukraine at all or is carried out non-systematically. Secondly, it changes the strategy of monitoring atmospheric air using cloud services for registration, analysis and interpretation of the data array. Thirdly, it is able to assess the daily, not just monthly or quarterly effects of toxic substances of the air pool on the population, which complies with European norms.

The international monitoring and epidemiological studies [16], which are currently documented and scientifically confirmed, have proven a negative impact on human health (an increase in the proportion of diseases and mortality from respiratory and cardiovascular pathology) caused by aerodynamic PM_{10} and $PM_{2.5}$ [5]. Their presence in the atmospheric air is mainly due to combustion of fuels in stationary plants (40–55%), technological processes in industry (15–30%) and motor vehicles (10–25%) [14].

All this leads to the creation of automated installations, which are a set of means for registration, transmission and processing of data, etc. Together with hardware-based computing capabilities of modern cloud services, and in conjunction with the use of intelligent algorithms based on knowledge bases, new functionalities are created in ecological and biological research and prompt detection of areas where there is an excess of concentrations of harmful emissions.

Such decisions will allow students-biologists to develop the ability to solve complex tasks and problems that require the updating and integration of natural and philosophical knowledge, often under conditions of incomplete / insufficient information and contradictory requirements. Such ability is provided for by the list of general competences in accordance with the requirements of the national qualification framework.

The prospect of further research in the direction of expanding monitoring capabilities and teaching them to students-biologists is seen in obtaining additional data on environmental concentrations of chemically active gaseous substances (CO, NO_x), greenhouse gases of CO_2 and CH_4, non-methane volatile organic substances and so on. All this requires further up-to-date research and the search for inexpensive, high-quality sensors, the market of which is constantly replenished with new samples.

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The use of cloud technologies when studying geography by higher school students

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Abstract. The article is devoted to the topical issue of the cloud technologies implementation in educational process in general and when studying geography, in particular. The authors offer a selection of online services which can contribute to the effective acquisition of geographical knowledge in higher school. The publication describes such cloud technologies as Gapminder, DESA, Datawrapper.de, Time.Graphics, HP Reveal, MOZAIK education, Settera Online, Click-that-hood, Canva, Paint Instant. It is also made some theoretical generalization of their economic, technical, technological, didactic advantages and disadvantages. Visual examples of application are provided in the article. The authors make notice that in the long run the technologies under study should become a valuable educational tool of creation virtual information and education environments connected into common national, and then global, educational space.

Keywords: cloud technologies, future teachers, educational institutions, augmented reality technologies.

1 Introduction

1.1 The problem statement

The essential characteristic of nowadays society is the existence of the universal information space based on global computer networks and information technologies. So it has become vital for an educated person to be highly competent in working with large masses of information. This determines the need for the integrated use of Internet information opportunities in education.

The modern educational policy strives to train a highly skilled professional who can be mobile and flexible professionally in the information society, can easily navigate in the global information space, and, what is more important, be capable of effective self-education throughout the life time. Everything mentioned above is the key to the success in the fast-moving world [3].

The training of future teachers in general and teachers of geography, in particular, is no exception. The higher educational institutions try to fulfill the social demand to train competitive pedagogical staff linking it with the further search for ways to improve the quality of education and the level of competence. One of the ways to do these is to implement cloud technologies in the educational process.

Cloud technologies are the fundamentally new services that allow you to remotely use the tools of data processing and storage, provide Internet users with access to computer resources of the server and use software as an online service [42].

1.2 Theoretical background

In the scientific literature there are widely represented the general scientific aspects of the problem under study, as well as those relating to specific teaching methods. In particular, scientists examine the essence of the concept, types of educational clouds, forms and necessary components of cloud technologies (Svetlana H. Lytvynova [14; 15]); theoretical foundations, possibilities and methods of using cloud technologies in the educational process are studied by Oksana S. Makovoz [16], Oksana M. Markova [17], Yevhenii O. Modlo [23], Vadym S. Nazarenko [26], Pavlo P. Nechypurenko [22], Tetiana S. Perederii [16], Maryna V. Rassovytska [30], Serhii O. Semerikov [18; 33], Vladimir N. Soloviev [35], Andrii M. Striuk [30; 33], Mariya P. Shyshkina [32], Illia O. Teplytskyi [34] researches the benefits and prospects of using cloud technologies in the educational process of a modern school.

The use of cloud technologies in computer science classes is studied by Anna I. Gazeikina [10], Olha V. Korotun [13], Oksana M. Markova [19], Susana N. Seytveliyeva [36], Viktoriia G. Shevchenko [37], Mariia V. Stupina [40]; in maths classes by Georgii A. Aleksanian [1], Maiia V. Popel [29], Tatiana A. Vakalyuk [42]; in history classes by Olena V. Burlaka [7], in languages classes by Irina A. Belysheva [3], Olena V. Pakhomova [28], Lucie Renard [31], Nataliia V. Skrynnik [38]; in physics classes by Maksym V. Khomutenko [12], Oleksandr V. Merzlykin [15]; for the formation of self-educational competence of future specialists (Tetiana V. Voloshyna [43]) and etc.

The use of cloud technologies during the study of geography is mostly represented in the works of foreign scientists, in particular Anna Badia i Perpinyà, Montserrat Pallarès Barberà and Joan Carles Llurdés i Coit [2]; Richard G. Boehm and Cheryl A. Frazier [8], Andrew J. Milson [21], Jacqui Murray [25], Tiani Page and Beverly J. Christian [27], Michael Zimmer [44].

The analysis of works on methods of geography teaching suggests that the most commonly used in secondary schools are general-purpose cloud technologies such as Google Apps, LearningApps.org, scribing technologies, blogs, online puzzle-maker generators, ribbons, tests, etc. They help develop geography knowledge and provide educational communication while studying.

Higher schools often use GIS technologies (Google Earth, Google Maps, DataGraf, Microsoft Map, Map Info, ArcGIS) that allow students to work with cartographic material [24].

At the same time, it should be noted that both approaches may be considered onesided, since only complex systematic use of cloud technologies (both general purpose and GIS technologies), provided that the pedagogically balanced combination of traditional and innovative technologies of classroom, distance and mobile learning will contribute to effective achievement of didactic goals and thorough study of geography. Moreover, the scientists and teachers fail to notice the advantages of those cloud technologies that help work with accounting and statistical data that are widely included in study of economic and social geography. The cloud technologies mentioned above aid to memorize the large amount of geographical nomenclature and the creation of not only maps, but also dynamic charts, logical reference schemes, etc. In this article, we consider the selection of such cloud technologies that can be helpful not only for students of geography major, but also for everyone who deal with geography study in higher school.

1.3 The objective of the article

The purpose of the proposed publication is to characterize the content of some cloud technologies that should be used in geography students training in higher school.

2 Presenting the main material

The first cloud technology to be considered is *Gapminder*. We cannot deny the leading role of maps while geography studying, but we want to draw attention to the resource Gapminder. It is developed by the Gapminder Swedish fund, with Hans Rosling as a co-founder, that collaborates with educators all around the world. Using the Trendalyzer software Gapminder visualizes statistics in the form of interactive charts. This cloud environment enables a student to analyze databases provided by the following organizations: World Bank, FAO, International Labor Organization, World Health Organization, UNAIDS, IARC, etc. The statistics can be optionally illustrated from 1800 to 2018 at the global, regional or local (individual country) levels. With the help of the time tape (as well as maps, ratings, sex-age pyramids, presentations, videos), one can trace the nature of the dynamics of demographic phenomena and processes, carry out a comparative analysis of various quantitative or qualitative demographic indicators (population, child mortality, urbanization, welfare of the countries, education of the population, poverty and many others), Fig. 1.

Carmine Gallo rightly calls well-known statistician Hans Gösta Rosling a star among the TEDers, since his presentation at the TED conference in 2006 was unrivaled and “became an online “viral sensation” [9]. We are convinced that the introduction into accounting and statistical data while studying economic and social geography (especially the geography of the population) is bound to be started with Gapminder and fragments of the video collection “Do not panic. The truth about population” by Hans Rosling. Being presented by the distinguished TEDer, “grey” statistics which students do not really enjoy turns into a clear and distinct language of convincing facts that create a coherent demographic picture of the world.

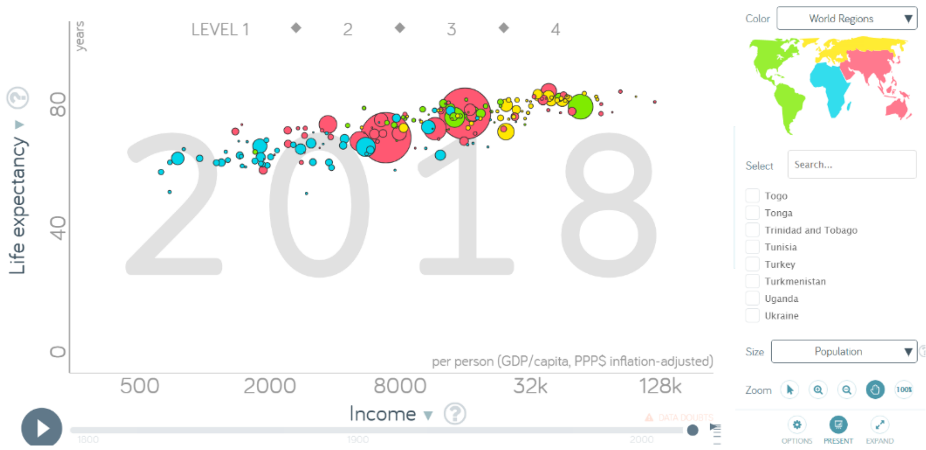

Fig. 1. Interactive graph "The population of the world", built in Gapminder

The second cloud technology under consideration is DESA Technology (Department of Economic and Social Affairs) / Population division, United Nations). This resource makes it possible to build and analyze randomly demographic profiles and probabilistic forecasts that reflect key demographic indicators from 1950 to 2017 for countries or different world regions, Fig. 2.

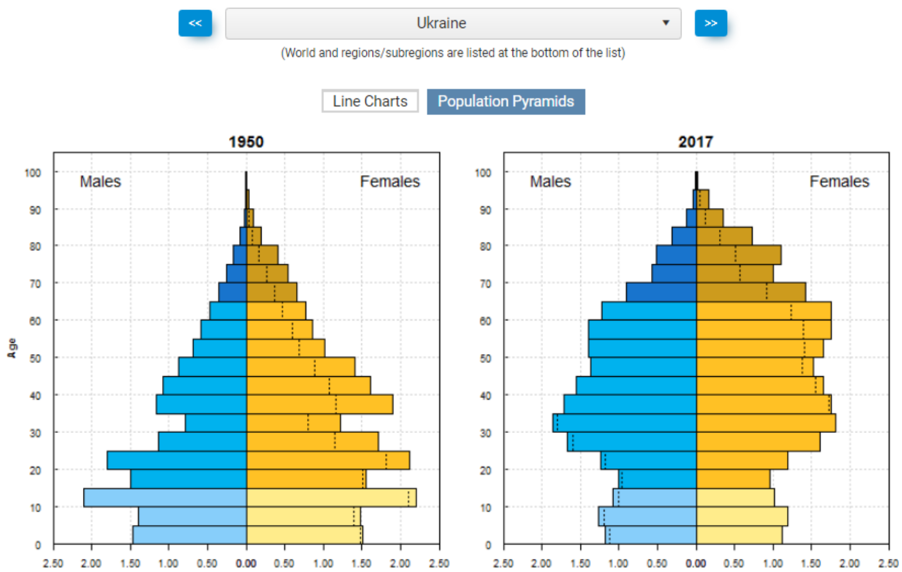

Fig. 2. Gender-age pyramids of the population of Ukraine, DESA

The third cloud technology is *Datawrapper.de.* This service contains an online designer and can create an interactive table or map in four steps: download, data validation, visualization and publication.

The benefits of this cloud technology are: the simplicity and speed of a final product creation; the access to the finished charts and maps folder and a wide set of templates; the import data from Excel, CSV, PDF; the export data (PNG, PDF), and the possibility to integrate data into the environment of any site; the facility to create a new personal account, etc. However, full-customized version with custom maps, print-export and CMS integration is possible only on subscription terms. Nevertheless, the technology successfully handles with the simple geographic tasks that require data visualization.

The next resource is *Time.Graphics.* This cloud technology was developed by Yevgeny Mustafin in 2017. It is aimed to visualize the chronology of events in the form of a timeline by adding photos, audio and video materials. The resource can be used while studying any discipline (history, biology, literature, foreign language). When studying geography, it is helpful to illustrate the stages of formation of the world, region, or country political map, the process of getting country independence, the periodization of the era of Great geographical discoveries, the history of the economy branches development, etc.

The main advantages of this technology are: the timeline speed making, the intuitive interface, the wide range of backgrounds and the colors of the presentation formats of the tape, the different tools to import data (Google ArtProject applications, Google Docs, Google Maps, Google Drive, Google Sheets, Google Slides, YouTube, etc.) and export the final product.

One more cloud technology worth mentioning is *HP Reveal (Aurasma).* It is a cloud-based augmented technology [41] created in Cambridge in 2011. This platform is free of charge and easy to use. The key point of HP Reveal technology is the uploading of an aura that is a visual trigger with overlaid multimedia content. By using a camera on a smartphone or tablet, the technology recognizes real images and displays overlaid animation, video, 3D model, or webpage (Fig. 3).

Fig. 3. Aura "Panama Canal", created by HP Reveal

The main advantage of this technology is the expanded didactic capacity of any printed publications, school textbooks, manuals, etc., achieved by visualizing its educational content. The main obstacle in its implementation may be as that a personal mobile device be equipped with the Aurasma App (HP Reveal), to a certain extent restricting the access to aura. Aurasma can be used while studying many higher school disciplines, but let us dwell on geography studies.

All the concepts that students master while studying geography can be divided into concrete and abstract ones with their own specifics. Thus, for the disclosure of specific concepts (river, mountain, enterprise, etc.), the inductive method is traditionally used, and for the comprehension of abstract concepts (climate, weather, historical and geographical region, specialization or concentration of production) is more often applied deductive one. Since concrete concepts are often available for direct perception, students encounter less difficulty with them than with abstract concepts. So 3D models, videos and interactive images are ultimate teaching tools, because the vivid outlook on some geographical phenomena or process contributes better to the conscious comprehension of abstract complicated concepts.

The next *MOZAIK education.* This is a service software of the Hungarian company specializing in educational interactive software for almost three decades. The resource is available in 30 languages and has both free and paid content.

Taking into accounts the specifics of geography studies, a media library that is a cloud storage and contains digital lessons, 3D scenes, videos, images, audio, task letters, tools and games offered for primary, secondary and higher schools can be of great value and importance.

The advantages of the considered service include: the high resolution of the video and 3D models (Fig. 4), which demonstrate components of the geographical phenomenon or process, their integral representation in the form of a video animation; review normal, anaglyph or stereoscopic modes; scaling the user interface of a 3D player; tools to work with the legend, separate layers of the image, additional information and facilities to make virtual trips.

In addition, the "Tools and Games" category includes three-dimensional maps and tasks, interactive maps, three-dimensional images of the Earth, a collection of aerial photographs, a constructor for quick and easy creation of diagrams using built-in templates, interactive test editor, etc.

However, free viewing of 3D content is limited to 5 units per week. Premium mozaWeb subscription is needed for full access to the library contents, search and playback of 3D models, videos, audio materials or images. The subscription enables further e-learning and working with interactive tutorials.

The next point in cloud technology collection is *Settera Online.* This popular service is adapted in 32 world languages and is intended for studying the geographical nomenclature. Swedish programmer Marianna Wartoft developed Settera Online in 1998. The service exists both in the computer version and in the form of mobile applications for iOS, Android and iPad.

This cloud application can replace the traditional method of learning numerous geographical names into an interactive one [4]. Before now, a student showed geographical positions and locations on the map in the classroom to demonstrate his knowledge. Now students have to find the geographical position of the country or capital, recognize its outline in a limited time, and then send the answer to a teacher for a check. If the answer is error-free and done on time, the map will paint white, assuming one error – yellow, and two errors – red. So, in order to cope with the task in the set time, students have to perform the task online at least ten times. The number of practicing promotes better memorization of the geographical names eventually.

Fig. 4. Ferrous metallurgy, 3D scene MOZAIK education

The advantages of such method of nomenclature study are obvious. They are: an individual pace of a task performance; objectivity of assessment; developed mapping skills; rational use of classroom time.

Click-that-hood is a cloud technology for studying and verifying the names of units of administrative and territorial division of countries (states, regions, provinces, lands, prefectures, voivodships, etc.), a technique similar to that of Settera Online.

A very popular present day form of data visualization is the infographic, which does not take much time to view and provides the reception of large volumes of information in an accessible and comprehensible form. The leading Ukrainian resource that supplies accounting and statistical data in the form of infographic directories is *BusinessViews* [39]. Unfortunately, the authors cannot propose a free cloud-based technology that provides geographic knowledge in the same way as BusinessViews does. However, the Canva cloud technology can serve as an alternative.

Canva is a graphical design software that visualizes information in the form of a presentation, a graphic, a map, a booklet, a postcard, etc. The benefits of this service are free registration or access through Google and Facebook; user-friendly interface; wide selection of ready-made templates and filters; access to a folder of photos, illustrations, fonts, styles, etc.

In this article we do not characterize special cartographic editors that can be used for studying geography, since a separate publication will be dedicated to the consideration of this issue. However, some of the cloud technologies mentioned above help create maps, including Gapminder, Datawrapper.de, Canva. Google *Instant Paint* Image Editor has also a potential for creating geographic mappings. The method of work in the environment of this service is similar to Paint. Although it is not possible to create proper geographic maps, however, charts or logical reference schemes reviling geographic knowledge of a student can be quite informative (Fig. 5).

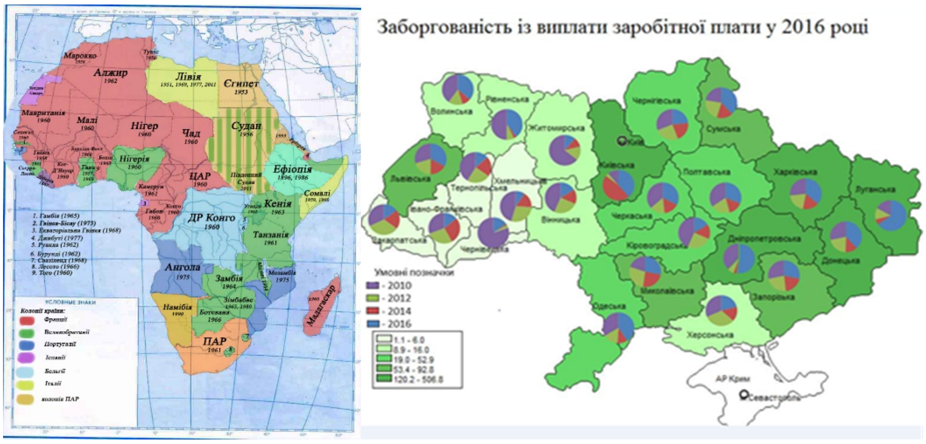

Fig. 5. Cards created in Paint Instant

Unfortunately, the format of one article does not allow to consider all available cloud technologies that can be used for studying geography. However, the implementation of the services described by the authors can significantly expand the methodical arsenal of teachers and higher students and make the educational process more efficient.

Today, it is impossible to format a student coherent geographic picture of the world in a higher school only by traditional didactic means. Geography is a science to be studied when traveling and instantly perceiving the object of study [5; 6]. That is why cloud technologies make it possible to visualize geography learning in a virtual environment and even substantially increase the perception of geographic processes not available in direct observation. What previously seemed to be difficult, and sometimes inconceivable, is quite possible at the moment (for example, to look at the volcano's burning stove or blast furnace, to observe the formation of the Earth or the work of a nuclear power plant, etc.). What is more, the generation of students who cannot live without gadgets, should learn how to use them rationally rather than be deprived of them.

The analysis of the cloud technologies observed above and their implementation in educational purposes internationally proves their long-term benefits due to the number of advantages. We fall into line with Anna I. Gazeikina and Alevtina S. Kuvina [10], and we consider their pluses can be summarized in the following groups:

- economic benefits (free of charge or privileged access to the majority of services; less number of auditorium and equipment required for training; reduction of the number of personnel required for maintenance);
- technical benefits (minimum hardware requirements on condition of access to the Internet, lack of technical support for the work of the platform and configuration);
- technological benefits (high quality and intuitive interface of the majority of cloud technologies; personal data protection and delimitation of common information access; rapid integration of created products into the educational process; no attachment of the service user to the territorial location);
- didactic benefits (a wide range of online tools and services that can be implemented with a different didactic purpose and at different stages of the classroom; the variety of interactions; simplification of information creation, accumulation and exchange; the expansion of out of classroom training opportunities; the increase in the academic performance and students' internal motivation, etc.).

However, the implementation of cloud technologies in the educational process has also some disadvantages. They can be the following: limited access to the services or subscription requirement; limited functions of online software in comparison with the local one; the absence of Ukrainian cloud service providers; high quality requirements for enforced path; the dependence of non-stop operation and important data storage on the service provider; possible errors and leakage of information with user increase; lack of legislative framework for the use of cloud technologies; low level of computerization of Ukrainian institutions of higher education; insufficient development of theoretical and methodological principles of cloud technologies implementation in the educational process; the unwillingness of some teachers to combine traditional and innovative educational technologies, as the implementation of the latter requires additional efforts; underestimation of the importance of cloud technologies in the professional development of teachers and students [4; 10; 16; 26].

We want to emphasize that cloud technologies should gradually become a thorough didactic means, enabling educational institutions to create their own virtual information and education environments, with the prospect of integrating into a common national, and then global, information space.

3 Conclusion

1. Nowadays decision-making is often based on the information of various Internet sources [11], so an educated person is required to be highly competent in dealing with large amounts of information. Due to the relevance of this problem for the IT society, one cannot overestimate the didactic prospects of cloud technologies, as they contribute to: efficiency of handling with the students' real life problem situations, which can be sorted out with digital devices and gadgets [26]; mastering the skills to find, systematize, analyze a large amount of necessary information; the reasonable

use of cloud technologies, the skills to assess the benefits and risks of cloud technologies for self-development, environment or society.

2. We see the prospects of further scientific research in the study of the practical cloud technologies implementation while the geography study in higher school.

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Pedagogical techniques of Earth remote sensing data application into modern school practice

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Abstract. The article dwells upon the Earth remote sensing data as one of the basic directions of Geo-Information Science, a unique source of information on processes and phenomena occurring in almost all spheres of the Earth geographic shell (atmosphere, hydrosphere, lithosphere, etc.).

The authors argue that the use of aerospace images by means of the information and communication technologies involvement in the learning process allows not only to increase the information context value of learning, but also contributes to the formation of students' cognitive interest in such disciplines as geography, biology, history, physics, computer science, etc.

It has been grounded that remote sensing data form students' spatial, temporal and qualitative concepts, sensory support for the perception, knowledge and explanation of the specifics of objects and phenomena of geographical reality, which, in its turn, provides an increase in the level of educational achievements.

The techniques of aerospace images application into the modern school practice have been analyzed and illustrated in the examples: from using them as visual aids, to realization of practical and research orientation of training on the basis of remote sensing data.

Particular attention is paid to the practical component of the Earth remote sensing implementation into the modern school practice with the help of information and communication technologies.

Keywords: Earth remote sensing data, aerospace images, Geo-Information Science techniques.

1 Introduction

1.1 Scientific relevance of the research

Earth remote sensing data (RS) is a unique source of information about the processes occurring in the Earth's geographic shell, and therefore their role in the study of geography is constantly increasing. Aerospace images are more effective than the terrestrial information system in terms of their information, since they enable to obtain information with the required spatial-temporal resolution and the image of the Earth's surface in spectral ranges of various radiations.

Aerospace images are of undoubted interest for the educational process. Using remote sensing data, one can visualize the natural and anthropogenic processes and evaluate their dynamics; inform about the placement of objects on the Earth’s surface; to monitor (constant monitoring) the state of geographic objects and processes, to formulate hypotheses or to identify patterns.

The unusual character and novelty of such information is of great interest in terms of new technologies, and as a consequence, and of a more in-depth study of basic educational subjects. According to Svetlana S. Karimova and Michael B. Veselov [8], the main educational advantages of remote sensing data are: a large degree of visibility, which is generally unattainable for traditional geographic maps; high resolution; high realism; reflection of their objective reality; great depth of consideration of the investigated object or phenomenon; increasing the possibilities of demonstrating the complexity and interconnection of the processes; increased attention to the physical foundations of the studied processes, etc.

The use of aerospace images in the school geography course began in the early 1950s, when the results of aerial photography appeared in the Soviet school atlases and textbooks. However, wide-ranging use of geospatial data did not receive the results of remote sensing, due to the lack of methods for using Earth images from space in the learning process, as well as the closure of most remote-sensing materials for open use.

Since the mid-80s of the last century, theoretical and practical researches based on modern technologies have been actively conducted abroad, using remote sensing data as educational resources.

At the beginning of the third millennium, qualitative changes in the use of remote sensing data for educational purposes began to take place. Openness and accessibility of information, active computerization of the educational process and the widespread use of Internet technologies contributed to the formation of a new pedagogical direction – space geography. Space geography makes a special emphasis on the formation of the most complete and close to the true reality of the visual image of various geographic objects through the study of their portrait space models. In the process of decoding these models, an understanding of the inter-component natural connections, the economy and the population with the natural environment is fixed [3; 10; 13; 16; 17].

The main mechanism for the introduction of satellite imagery in school practice is the various educational programs initiated by large space companies and organizations (NASA, OSC, Rocketdyne, etc.). Their essence is to encourage the pedagogues of some certain educational institutions to integrate the application of remote sensing data into the school curriculum. For this purpose, educational establishments are provided with the necessary programs and software, computer equipment and receivers of satellite signals.

1.2 Recent research and publications analysis

A significant contribution to the development of the theory and methodology of aerospace images use as an educational resource belongs to such scholars as: Alexander V. Barladin [1] (preparation of remote sensing data for using in multimedia presentations), Alexander M. Berlyant [2] theoretical foundations of geoinformatics), David Richard Green [7] (using GIS technologies at school), Lyudmila M. Datsenko and Vitaliy I. Ostroukh [4] (studying the foundations of geoinformation systems and technologies in special-field profile education), Nakis Z. Khasanshina [9] (the potential of geo-informational technologies in teaching geography), Ihor V. Kholoshin [11] (pedagogical techniques of Earth remote sensing data application into modern school practice), Rimma D. Kulibekova [12] (geoinformation technology as a means of information culture formation with the future geography teacher), Witold Lenart, Anna Wozniak, Malgorzata Witecka [19] (GIS at school), Vladimir S. Morkun, Serhiy O. Semerikov and Svitlana M. Hryshchenko [14] (methods of using geoinformation technologies in mining engineers' training), S. Simone Naumann, Alexander Siegmund, Raimund Ditter and Michelle Haspel [15] (theory and practice of the Earth's remote sensing), Oleh M. Topuzov [18] (informatization of geographic education) and others.

However, the question in what form, with the use of information and communication technologies and methodical techniques, the use of remote sensing in the teaching of the school geography course is possible, remains open.

1.3 Article objective

The objective of the proposed study is to analyze pedagogical techniques for the introduction of Earth remote sensing data into the practice of a modern school using ICT.

2 Research results

Aerospace images have all the necessary features that are characteristic of geography training [6]. Let us describe some of them. First, they contain training information that allows them to be used as a source of knowledge, and secondly, they can be used during practical work to develop skills and abilities.

The information obtained in the study of aerospace images determines the specifics of their use in the learning process and opens new opportunities for remote sensing data as educational resources (Table 1). For example, the opportunity to see how geographic objects look in real form from a height in the range of 100 meters to tens of thousands of kilometers significantly increases the visibility of learning, making it more figurative, bright and memorable.

The complex nature of the information that is read from aerospace images (relief, fauna and flora, meteorological factors, socio-economic aspects) provides a comprehensive approach to information analysis, through the acquisition of knowledge on related disciplines: biology, geology, medicine, ecology and etc. As a result, the students master such methods as analysis and synthesis, make logical generalization and conclusions that significantly activate the student's creative activity, increase their motivation to acquire new knowledge.

Table 1. Patterns of students' skills formation and pedagogical result due to the remote sensing data characteristics

Earth remote sensing data characteristics	Skills formation	Pedagogical result
Real image of the objects being studied	Formation of the investigated object (phenomenon) image on the basis of decoding aerospace images	It makes learning more figurative, bright and memorable
Complex character of information read from aerospace images	Mastering the methods of analysis and synthesis, the ability to build logical inferences and draw conclusions.	It activates the student's creative activity, increases motivation to acquire new knowledge
Monitoring the territory in time and space	Analysis of spatial and temporal information, modeling and predicting situations	It develops the potential of students' cognitive activity, involves them in research work
Great practical value of the information obtained when decoding aerospace images	Assessment of the studied areas state (accounting for the dynamics of changes in natural and anthropogenic factors)	It strengthens the influence that brings up training, forms practical skills and an active life position

One of the advantages of remote sensing data is the ability to monitor the territories for a long time, to provide the learning process with the sources of knowledge and the means necessary to carry out practical training. Based on these data, students are given the opportunity to study objects and phenomena in space and time, modeling and predicting the situation. It develops the potential to cognitive activity, involves them in research work.

Remote sensing data is a source of unique information of great practical significance. By its very nature, the aerospace image is a spatial model that replaces real objects and phenomena. At the same time, the picture performs a dual role: it is a means of research, on the one hand, and an object of research, on the other. A detailed study of the images helps to form an objective holistic image of the studied areas with their spatial-temporal characteristics, which is necessary for a comprehensive assessment of their state. Realizing the reality by analyzing airborne images in the process of studying geography proceeds in several stages [11] (Fig. 1).

The first stage – the understanding of aerospace images, involves the formation of knowledge among students about the main characteristics of images, the main features of reflecting various geographical objects, processes and phenomena on them. In fact, at this stage, the students lay the foundation for the practical use of remote sensing data.

The second stage – images decoding, is the ability to distinguish and recognize geographical objects (phenomena), as well as to identify their qualitative and quantitative indicators. This is the main focus in realizing reality through aerospace imagery, because it is at this stage that students learn about the basic characteristics of reality.

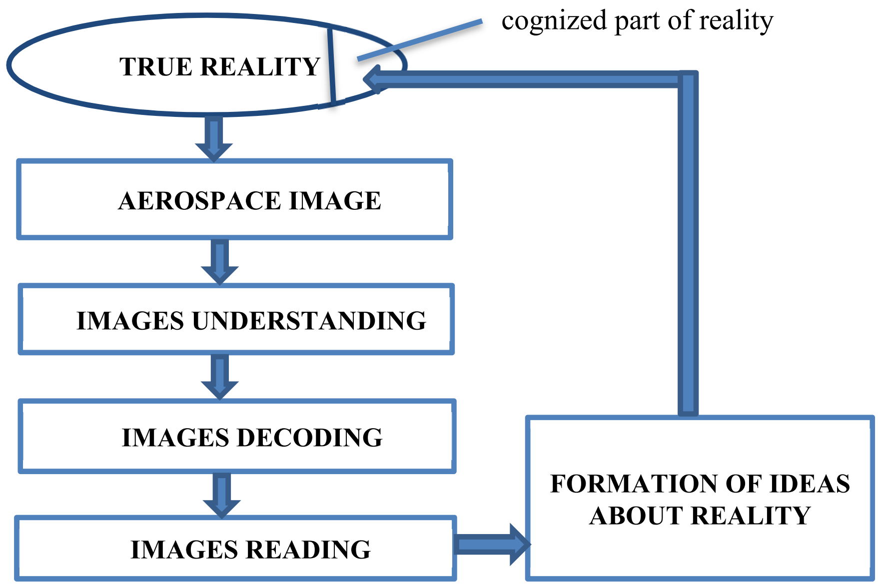

Fig. 1. Scheme of reality cognition by studying aerospace images in the process of geography training

The third stage – the reading of aerospace images involves mastering the means of compiling descriptions of geographical objects and phenomena based on the results of decoding Earth images from outer space. At this stage, the students form the basis of images decoding in terms of their location, state, interconnection and dynamics of real objects and phenomena. Creating an image, analyzing and interpreting it using inductive and deductive generalizations leads to the expansion and enrichment of knowledge about the investigated reality, which promotes the formation of practical skills and active life position. At the same time, the teacher must be able to explain to students that the image created by them may differ significantly from reality, since the picture only conveys a part of it.

In the learning process, Earth remote sensing can perform various functions.

2.1 Earth remote sensing data as a means of visual aids

The main visual guide when studying geography is the map. Given its advantages, it should be noted at the same time that the cartographic representation of objects is very arbitrary and does not accurately reflect the objective reality. Aerial imagery forms students' visual image of the objects and phenomena studied, which contributes to a more specific perception of their essence and a more qualitative memory of the of the educational material contents.

In the process of geographical representations visual formation, the means of remote sensing can be divided into four stages:

1. visual representation of definite geographical objects and phenomena characteristics;
2. occurrence of representations about geographical objects and phenomena;
3. preservation and reproduction of representations about geographical objects, phenomena or their certain characteristics;
4. regular application of the received ideas into the process of concepts formation.

It is possible to apply several ways of presenting remote sensing data using information and communication technologies. The most convenient, expedient and obsolete form of aerospace images is their presentation on various digital media. Low cost, saving a large amount of information, and most importantly, high visual characteristics, contribute to the dominance of this form of data representation of remote sensing data. The image is displayed on the computer monitor screen, although the use of the computer-plus-projection device demonstration is particularly effective. Designing aerospace images on a large screen greatly enhances the visibility of learning, as well as increases motivation to mastering it.

It is important that the teacher uses aerospace images not only as static information, but also creates the foundation for mental operations. Thus, using multi-dimensional space images, historical or geological materials, students can be taught elements of geographic modeling and predicting.

Aerospace images make it possible to grasp the role of geography as an actual contemporary science, which, while studying the environment, can significantly affect the development of many aspects of human activity and the interaction of man with nature. The teacher by specific examples (Aral Photos, Gulf Coast catastrophe, etc.) demonstrates how remote sensing data can monitor the anthropogenic impact on nature.

Aerospace images as visual aids can be used at different stages of the lesson for different purposes. The most typical is the use of shots when explaining the learning material by a teacher to form a geographic image of objects and phenomena. It is also advisable to use the remote sensing data before studying the topic. In this case, they will act as a means of forming initial ideas and motivating cognitive activity. In addition, photos can be used to fix the training material and to control the data received.

Fig. 2 shows an example of the MyTest program, which is a consortium of electronic tests. As a means of visualizing test questions, aerospace images are used.

With MyTest (and the like, e.g., Test Designer), you can organize and test students' knowledge of both single topics and entire school geography courses. No less effective is the use of the program for educational purposes. In this case, the educational mode of the program's operation is used.

Taking into account the simplicity of the program, a teacher with basic information preparation can independently develop tests for lessons with the use of remote sensing data.

Generally speaking, the methodology for using aerospace images as a means of visualizing geographic information is largely similar to the method of working with graphical visual aids such as pictures and photographs [5]. Let us note the basic requirements that need to be taken into account when using images as high-quality visual aids:

- the content of aerospace images must be consistent with the content of the material being studied and illustrated at the appropriate time of the lesson;
- the visibility of the images should be used with a reasonable dose of the transmitted information;
- images should be of high quality;
- the remote sensing data collection should be organized on the principle of "from simple to complex" during the study of geography;
- the objects or phenomena depicted in the photographs are to have a geographic binding;
- the information transmitted by the images should not affect the integrity of the lesson;
- the teacher should think over the explanations and comments on the aerospace images.

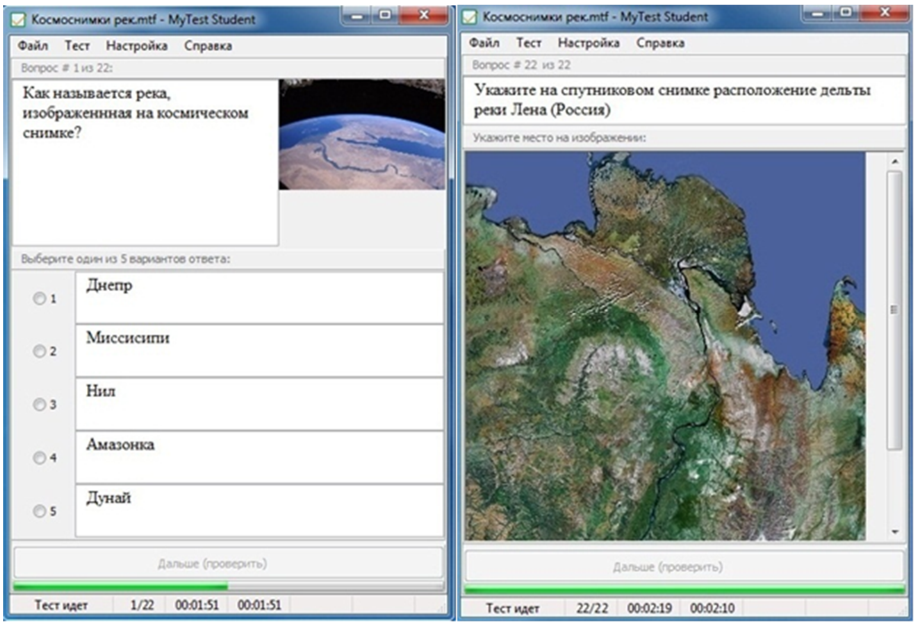

Fig. 2. MyTest program windows with different types of questions on the theme “Rivers” with the use of satellite images

2.2 Earth remote sensing data as an interactive learning tool (ILT) on geography

Electronic georesources, developed on the basis of satellite images of the Earth, are unfolding new opportunities in the process of geographical education – interactive learning, i.e., learning with feedback, bilateral exchange of information between the subject and the object of the learning process.

Currently, a significant number of interactive learning tools (ILTs) are known in pedagogical practice and geography is one of the leaders in their use [9]. Earth Remote Sensing Data is a unique basis for the creation of interactive geoservices, the skillful use of which allows them to be considered as an ILT with unique educational functions. As an example, we can name the following satellite-based interactive geoservices: Google Earth, Google Maps, NASA World Wind, EINGANA, etc.

By the nature of the transmitted spatially-bound information, all interactive geoservices based on remote sensing data, can be divided into two groups: complex and thematic.

Complex resources (Google Earth, Google Maps, NASA, World Wind, etc.) contain different geoinformation layers (weather conditions, ocean conditions, firewalls, earthquakes, etc.). Thematic georesources (Gismeteo, Meteoweb, Map of Life and etc.) are mono-informational and devoted to certain processes or phenomena (atmospheric processes, traffic flows, migration of animals, etc.). This also includes various spatially-bound social networks.

Wide functionality of such georesources allows them to be used in all the courses of school geography, in various forms of organization of the in-study process, with the involvement of different teaching methods. The most common form of application of ILT based on remote sensing data - classroom, it fits into a traditional lesson, and allows you to organize new types of educational activities. Here are the main types of lessons:

A. Lesson to learn new teaching material. The teacher creates in advance labels with information layers that allow you to consistently display static aerospace images, interactive terrain models, photos and video materials on the screen (interactive whiteboard). Unconventional types of lessons in the formation of new knowledge using ILT can include lessons, integrated lessons or research lessons. The basic organizational form of this kind of lessons is working with the class.

B. Lesson of skills and abilities formation and improvement. The teacher develops applications in which, using interactive georesourses functions, each student performs individual practical work. The main organizational form is to work with georesources in small groups, although using an interactive whiteboard, the students can work in class collectively.

C. Lesson of knowledge generalization and systematization. At the lessons of this type, the teacher offers students creative tasks for laboratory work in the computer class. Independent work on the task, reinforces the cognitive interests of the students, makes their work creative, and in some cases brings it closer to the nature of the research. Unconventional types of lessons of knowledge generalization and systematization can be attributed to students' workshop conferences using data remote sensing and other types of geoinformational technologies.

D. Lesson of knowledge, skills and abilities control and correction. The lessons of this type are to control the level of students' assimilation of theoretical material, the formation of skills and abilities; correction of knowledge, accumulated skills and abilities. To this end, the teacher develops control interactive questions based on the use of Google Earth georesourse. An individual or group survey can be as well used in the classroom.

The choice of a lesson form and type depends on its purpose, features of the given class, the studied topic, etc. Of course, extra-curricular work greatly expands the educational potential of the ILT on the basis of remote sensing data. Independent work, optional classes and classes allow students to bring their educational work with interactive aerospace imagery to a completely new level.

2.3 Earth remote sensing data as a source of geographic knowledge and skills

The knowledge obtained by analyzing aerospace images, for example, includes such as: spatial position of geographic objects; their morphometric characteristics; qualitative and quantitative indicators; the establishment of causal relationships, patterns, etc. This information is the basis for conducting practical and laboratory classes, as well as students' research work.

The most characteristic feature of the remote sensing data use during the practical work is thorough the images study, with qualitative and quantitative characterization. The knowledge gained during the work with aerospace images within the scope of practical work includes the following: definition of geographical objects size (length, width, perimeter, area, volume) and distances in the area; identification of quantitative and structural indicators (the Earth surface temperature, the spectral brightness of the vegetation, the composition of the forest fund, etc.). It is extremely important that the analysis of aerospace images is to be combined with the use of the whole set of geographic knowledge, including geographic maps, statistical indicators, and field observations.

Laboratory work is a more complex form of practical and research orientation of training realization with the use of remote sensing data. The complication of dealing with aerospace images enhances the influence on the schoolchildren's way of thinking. Tasks performed during laboratory work with the use of geoinformational technologies, promote the students' cognitive activity through the integration of theoretical knowledge and practical skills.

One of the main tasks of laboratory work is to master working skills with aerospace images: their reading and decoding. Of course, laboratory classes should be multileveled, that is, to differ in the complexity of solvable subject and didactic tasks or the method of their conduct.

The complexity of the work to be carried out should gradually increase. At the same time, the design of a series of laboratory works using these remote sensing data should be elaborated taking into account the main areas of students' practical activity.

The Earth image from space for aerial photography is a special means of studying geography, which allows you to create skills about the actual outlines of geographical objects and processes, describe their spatial position, compare different mapping of the terrestrial surface in aerospace images with other sources of geographic information (plan, map, etc.); perform spatial-temporal analysis and so on, thus enriching the world view of the student.

Students can realize the acquired skills by creating a map of the dynamics of the natural environment. The environment is changing: new settlements are emerging and the existing ones disappear; new roads, engineering structures are emerging, new mining areas are being developed; forests are cut down and land use structures are changing. Under the influence of natural and anthropogenic factors shore lines, vegetation and new objects arise. In this regard, the great practical significance is the creation of maps, the main thematic load of which are the boundaries of areas of the territory, exposed to natural or anthropogenic character and, as a consequence, determine the long-term changes in landscapes. The maps of the dynamics are intended to solve tasks connected with the monitoring of the territory and obtaining information about the activity that takes place in the territory.

To create maps of dynamics space images that capture the mapping area received with a certain time interval have been used.

The main purpose of research work organization is the discovery and support of gifted bright students, as well as the development of their intellectual and creative abilities. It is extremely important to choose the right topic for the research. It should be noted that the purpose of the work must be concrete, understandable and accessible. It is necessary that the student in the process of performing the work would realize the practical significance of their research. Taking into account the specificity of the information that is provided by the Earth's observation data, it is necessary to outline the range of issues that could lay the basis for the student's research work.

First and foremost, it is territorial research aimed at solving specific problems in a particular region (for example, monitoring natural and anthropogenic areas). Analyzing time-varying images of the same territory allows students to create dynamic maps that reflect environmental changes: environmental violations, human-induced changes, deforestation, etc.

The second vector of students' research activity is the compilation and refinement of cartographic materials, as well as the registration of the land fund. These works are more applicable and are of great particular interest.

The third direction of the Earth remote sensing data use as a basis for conducting pre-research work is a detailed study of space images in order to identify atypical or unique objects and processes on the Earth's surface.

3 Conclusions

1. Earth remote sensing data represent an inexhaustible source of unique information, which opens to the students the door to the world of unknown before. The teacher's task is to enable students to open these doors, since the use of remote sensing data during geography studies has a number of advantages over the traditional teaching materials (e.g. high resolution, high degree of visibility, realism, etc.).
2. The prospects of further scientific research in the use of GIS technologies during the study of geography in profile school and extra-curricular work are regarded as those of top priority.

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Cloud ArcGIS Online as an innovative tool for developing geoinformation competence with future geography teachers

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Abstract. The article dwells upon the scientifically relevant problem of using cloud-based GIS-technologies when training future geography teachers (based on ArcGIS Online application). The authors outline the basic principles for implementing ArcGIS Online in the educational process (interdisciplinary integration, the sequence of individualization in training, communicability, distance education and regional studies), and provide an example of an interactive map created with the help of the specified cloud GIS, since this kind of map is the most popular a form of research by geography students. In the article it is noted that integration of ArcGIS Online into the educational process allows the teacher to follow a clear pedagogical strategy, taking into account possible variants of its use (demonstration, direct mastering of GIS in a computer class and independent work in an individual mode). Considering cloud GIS as a new stage in the development of geoinformational education, the authors emphasize their key benefits (round-the-clock access, work with GIS package in the cloud, the ability to use other maps as well as the creation of their own maps and web-applications) and disadvantages (monetization of services, underestimation of the GIS role in the curriculum of the higher school, the lack of Ukrainian content, etc.).

Keywords: ArcGIS Online, cloud technologies, geoinformation competence, future geography teachers.

1 Introduction

1.1 Scientific relevance of the research

Nowadays, for most educators, it is clear that GIS-based training should take its decent place in the educational process as well as methods of learning about the world (in all time and space scales); as a method of solving actual natural or social problems and as a way of presenting spatial disproportions in the processes and phenomena development. However, as it is stated in the report of the National Research Council of

Great Britain (NRC), for the successful implementation of GIS into training, five interrelated conditions are to be ensured, including: financial support, technical support, methodological assistance, GIS introduction into the curriculum and support of community [17]. Note that the provision of these conditions during the study of geography has a number of difficulties that must be overcome by the teacher.

In the context of the above mentioned, it is worth noting the large-scale work being done by ESRI on interactive teaching of educators in the field of GIS-education of various levels and profiling. In particular, a great deal of attention is paid to the introduction of educational materials based on the ArcGIS Online cloud system. In some countries in Europe and the world, cloud-based GIS is already being actively used in the educational process, starting with secondary school education.

1.2 Recent research and publications analysis

The analysis of scientific literature on the problem we are investigating convincingly testifies that many works of domestic and foreign authors are devoted to the use of cloud technologies in geoinformational education. Thus, studies by Olga V. Bondarenko [5], Jack Dangermond [6], Iryna M. Khudiakova [8; 9], Svitlana V. Mantulenko [3], Oksana M. Markova [10], Oleksandr V. Merzlykin [12], Vladimir S. Morkun [15], Pavlo P. Nechypurenko [16], Serhiy O. Semerikov [13], Kateryna I. Slovak [14], Andrii M. Striuk [11], Tetiana V. Zaitseva [19], Vladimir I. Zaselskiy [4] etc., have proved that today, in order to improve the learning process, powerful technologies such as cloud computing are needed that, by supporting traditional forms of education, they are a new stage in the development of education and an economically viable, effective and flexible way to meet the needs of those who are being trained to acquire new knowledge.

In the writings of Dmytro S. Zanko [18], Oleksandr V. Barladin [2], Witold Lenart [17] etc. practical tips and examples on using cloud GIS in higher education institutions while teaching a range of professional-cycle subjects (cartographers, informants, etc.) are provided. However, until now, there is no clarity as to how to integrate cloud technologies into the daily teaching of future geography educators.

1.3 Article objective

The aim of the proposed study is the theoretical substantiation of the principles and methods of using cloud GIS, in particular ArcGIS Online, for the formation of geoinformation competence in future geography teachers' training.

2 Presenting main material

Geographic information systems in geographic education began their way from the late 1970s to the university level and interest in them grew in an avalanche. So, the number of geographic curriculum programs that the American and Canadian universities launched in 1984 equaled about 10. By the end of 1990, their number exceeded 2000, and the use of the field has expanded at the expense of history, computer science, biology, mathematics and other sciences [7].

Pioneers in the use of GIS during the higher learning of geography have become the Harvard University Computer Graphics Laboratory (the USA) and the Department of Experimental Cartography at the Royal College of Arts (the UK). In these institutions, new computer algorithms and programs designed to handle spatial information were developed through attempts and experiments. Thanks to this, active students and teachers have gained the first experience of integration of GIS technologies into the educational process, which has become actively distributed among other world institutions of higher education.

In particular, in 1995 a joint project of hundreds of American universities "Ecological and Spatial Technologies" (EAST) was launched, which used the strategy and technology of problem learning to stimulate the intellectual development of students based on GIS. Since then, GIS technology has begun to develop so smoothly that educational opportunities simply did not have time for them. GIS software products began to generate profits and were quickly bought off.

In the mid-1990s, it became clear that there were not enough specialists able to carry basic geoinformational knowledge to future teachers. This was due to the development of the "Project for the training of GIS NCGIA" by the National Science Foundation of the United States. This project was based on the premise that the educational materials being developed would be widely distributed among educators teaching GIS. The core of the course, about 1000 pages, has been acquired by many educational institutions in the world (over 5 years more than 70 countries had about 1300 copies of the study course). The project is translated into many languages of the world. Until the 1990s, according to the international survey, more than 450 universities in the USA, Europe and Australia were registered providing the opportunity for GIS education [1]. As a result, partnership agreement between schools and higher education institutions contributed greatly to solving the problems of primary GIS education.

The active and comprehensive introduction of GIS to the school system around the world already began at the beginning of the twenty-first century. Analyzing the current use of geographic information systems in schools around the world, it should be noted that the US historical leadership in the development of GIS education was in the undoubted leadership of the use of GIS in secondary schools in the country. Undoubtedly, ESRI's policy has been the main factor in this, which has made GIS education of its highest priority in schools, colleges and universities [7].

In this article, we would like to draw the attention of the educational community to the potential of ArcGIS Online Clouds offered by ESRI.

ArcGIS Online is a complete geographic information system hosted on a cloud-based server with a broad functionality. With ArcGIS Online, you can create web-maps, use ready-made resources, publish mapping services, spatial analysis, distribute data, and access cards from any device. At the same time, ArcGIS Online can be used as a platform for building your own geographically-bound applications. Through the built-in map viewer, galleries of base maps and space images are provided free of charge, and their range, detail and relevance are constantly expanding [1; 2].

If you add to this the benefits of cloud technologies, such as access to personal information from any computer, reliable cloud storage, a significant reduction in the cost of purchasing licensed software, as well as the technology of distributed data processing in which the computer resources and capacity are provided to the user as an Internet service, then it becomes clear that ArcGIS Online is a great tool for working with geospatial data at different stages of future geography teachers' training.

It should be borne in mind that the criterion for motivating the use of GIS-technologies is their influence on the students mastering the material in different conditions. In this regard, in each case, the purpose of the GIS application and its functional definition must be clearly specified. It is expedient, the use of this technology can only be considered reasonably motivating if pedagogical efficiency cannot be achieved using other, more accessible means of study.

Let us determine the basic principles of using ArcGIS Online in an educational process:

1. *Interdisciplinary integration.* Today, maps, tables, graphs and charts – all these kinds of representations of information generated by GIS are widely used in disciplines related to geography: chemistry, history, computer science, biology, mathematics, etc. It allows students to integrate knowledge from these disciplines. Integration occurs through work with electronic maps and databases, the topics of which are related to the discipline, and the tool is GIS.

For example, the use of students' knowledge in mathematical statistics helps to identify causal relationships between different natural components of the geographical environment. Knowledge in chemistry is essential to highlight issues of the migration of chemical elements during environmental research. The use of knowledge in biology reveals the interrelations between elements of natural landscapes. ArcGIS Online allows one to combine these diverse data into a single geospatial model. The use of GIS is especially encouraged by the development of computer literacy for future geography teachers: file management, database work in the cloud, satellite positioning systems, remote sensing data, etc.

2. *The principle of consistency* ensures the gradual and promising learning of cloud GIS technologies; in other words, the assimilation of knowledge takes place from simple to complex. The educator should not speed up the process of familiarizing and mastering ArcGIS Online by students. Only competently organized, step-by-step and metered training is the key to a successful work with this service.

So, at the initial stage, students should familiarize themselves with the cloud-based GIS interface, log into the system and create a user's personal page. At the next stage of training, future educators will get acquainted with online map creation, work with layers and attributes, which will eventually lead to the stage of registration and editing of thematic maps and organization of the general access to the elements.

As a result, students must independently create cartographic web-based applications. The development of cartographic web-applications for learning purposes is based on the use of ready-made templates in the cloud, which are a convenient way of publishing web-maps and combine location with web-based applications, as well as provide multimedia and interactive features.

3. *Individualization of training.* Work in the cloud refers to personality-oriented technologies that help the teacher to individualize the process of learning, to organize an individual educational process for each student. This significantly transforms the activities of the subjects of the educational process – the teacher and students. They have to engage in fundamentally new activities in connection with the change of educational activities and the specific restructuring of its content.

Individualization of training with GIS involves the differentiation of the teaching material, the system of tasks of varying complexity and volume. It is advisable to highlight the main and varied study materials. It is expedient to actively use GIS-projects, with their division into separate small tasks, stages. In addition, each subsequent task becomes feasible for the student, providing the previous one has been accomplished [7].

4. *The principle of communicability.* Observance of this principle involves such class orientation, when the purpose of learning (mastering GIS-technologies) and the means of achieving the goal (spatial and temporal analysis in the study of natural, socio-economic, man-made processes, objects and phenomena) are closely interrelated. First of all, this involves activating the students' creative activity: the widespread use of collective forms of work, problem situations, creative tasks, etc. Cloud technology is still more likely to be conducive in the organization of joint activities and interaction of subjects of the educational process, the ability of future educators to take into account different opinions and strive for the coordination of different positions.

Each student, at the time of registration in the service ArcGIS Online, gets their own design site, where they store their own attributes and data, maps and other useful information.

5. *Principle of distance learning.* By implementing cloud-based GIS technologies in training, students are not required to have a physical presence at the place of their education. This technology allows students to use educational materials of any kind, as well as perform work with teachers or a group. ArcGIS Online allows teachers and students to share their research results through the use of supported GIS data and services, thus creating an information space that other users can access.

Obtained thematic maps can be published on the Internet as content pages or as web-based applications using built-in mapping templates for electronic maps. Among these templates, attention is drawn to the ones with synchronized windows, which allow you to view various subject-specific data in terms of a single territory.

6. *The local area study principle* is realized in the practical orientation and research competence of GIS-technologies. On the one hand, it determines a comprehensive study of this or that local area, and on the other hand, the use of ethnographic material

in teaching. Both of these tasks are interrelated: the first solution opens the way to the second.

The regional orientation of cloud GIS can be engaged in a wide range of geographic research areas: mapping and plans of its terrain, analyzing the meteorological situation, studying the spatial distribution of biological species, socio-ecological research. The material required for conducting research using GIS can be obtained by applying literary, cartographic and statistical methods, as well as by method of direct observations during the local area studies, travels and excursions.

An interactive map is the main form of research for future geography teachers through the help of cloud-based ArcGIS Online. The main functions of this online service provide a simple and accessible form of geospatial information visualization in the form of interactive maps (Figure 1), as well as their publication on the Internet.

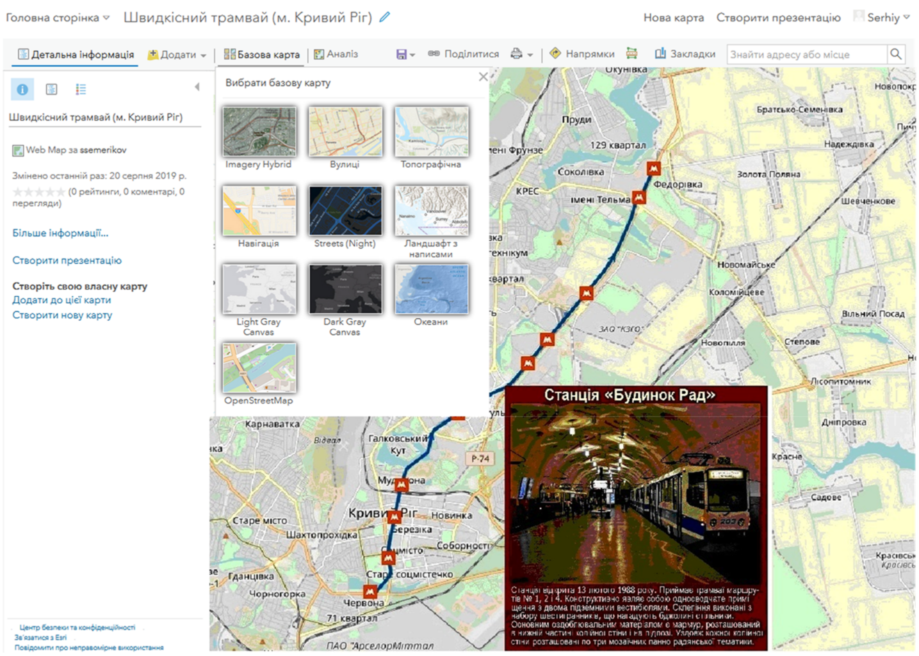

Fig. 1. The view of the interactive map “High-speed tram at Kryviy Rih”, designed by means of using ArcGIS Online cloud

The use of innovative teaching aids requires the teacher to master new forms and methods of activity. The integration of such high-tech information media as cloud GIS into the educational process should be based on a clear pedagogical strategy:

1. Cloud GIS, as interactive learning tools, allows teachers to manage the flow of information, focusing on the most interesting or more complex moments of the material being studied, allowing them to model geographic phenomena and

processes, demonstrating them dynamically. Consequently, they facilitate the understanding of the essence of these phenomena and processes.
2. In the learning process, the teacher should not act as a software expert. ArcGIS Online is a rather complex cloud service, and in this connection it is impossible to know all its features. Therefore, the teacher should constantly be engaged in self-education.
3. The teacher should not be afraid to change pedagogical approaches to learning using cloud GIS. He must be in the creative search for new ideas, be prepared to make adjustments to the teaching methodology taking into account both the dynamics of the level of students' general knowledge as well as their level of preparation in geoinformation.
4. Re-perform is the key to the success of GIS education. If the required function is not provided for some reason, it is actually useful, because it forces the student to go through this path over and over again, fixing the algorithm of the task in their brain.
5. An important task for a teacher when using ArcGIS Online is to create a competitive learning environment among future educators as it significantly enhances their motivation. It is important that, in selecting forms and methods for organizing a competitive learning environment, the teacher takes into account the personal characteristics of the students.
6. When using cloud-based GIS in the training of geography teachers, the teacher should share his or her experience among the colleagues, both during direct consultation and in specialized seminars, conferences, webinars, online forums, electronic and print magazines, etc. On the one hand, it will allow them to distribute the results of their own work, and on the other hand – take into account the progress of other teachers, avoiding unnecessary mistakes in their own activities.

Like traditional maps, ArcGIS Online is a three-way learning tool: a means of visibility, an object of study, and a source of knowledge. Accordingly, the following options for using GIS in the educational process are available:

1. *Work in the demonstration mode.* Cloud GIS have a unique ability to create a visual spatial image of various objects, processes and phenomena, and the teacher should be able to use it. ArcGIS Online has a huge number of basic maps that the teacher can use in his or her work. The gallery contains a variety of topographical, demographic, socio-economic maps and satellite images of the world. In addition, these maps can be used as a basis for creating your own maps.

The layer-by-layer form of information organization, the ability to complement cartographic information by various schemes and charts, demonstration of dynamic processes, 3-D models and much more, allow the teacher to form a new way in the students' geographic concepts during the study of new material.

2. *Work in a computer class.* The conduct of practical classes or research should be regarded as the most effective work with cloud computing ArcGIS Online in the computer class. The following activities are available in terms of content and proposed methods of organization:

- frontal work, carried out by the whole group, when all students perform the same task;
- group work, for which students are divided into small groups (3-5 people);
- pair work, when two are studying a question;
- individual work, carried out by the student himself or herself.

3. *Work in an individual mode.* The individual work of future geography teachers with cloud GIS is possible mainly in the form of distance learning organization of the educational process, which is aimed at the development of the students' personality, their autonomy, creativity. The most effective form of training in this case should be recognized as a project activity.

The project method is to create conditions for independent mastering of cloud-based GIS-technologies by geography students during the realization of specific projects. They participate in this process starting from the project idea itself up to its practical implementation. As a result, students, with the help of a teacher, learn to search, summarize and analyze information independently, enter it into a cloud database, build their own map sets.

The themes of projects should be determined by the sphere of interests of future teachers and depend on the level of their individual training. So, in the first stages, it may be some task that demonstrates the relationship between cartographic and attribute information. These are various information GIS projects, where information about different historical, social and natural objects of the studied territory is displayed. In the future, the teacher should focus on projects that use the analytical functions of GIS (over-lined operations, buffering, zoning, etc.).

The main advantages of cloud GIS as an educational tool are:

- round-the-clock access to personal information from any computer connected to the Internet;
- no need to install a GIS package on your computer;
- access to spatial resources (various maps from physical and geographic to socio-economic and political, satellite images, historical maps, interactive maps, etc.) prepared and published by other users;
- personal data storage in the cloud: map packs, layers, tabular (attribute) data, etc.;
- the possibility of creating interactive maps, as well as creating web-based applications based on pre-made templates without the use of programming tools;
- ease of cooperation integration between the users within an educational organization.

At the same time, it is necessary to describe the problems associated with the widespread use of ArcGIS Online in geography teacher training:

- monetization of the resource: the full-fledged use of the resource is possible only on a paid basis, and not all educational institutions of higher education can afford it;
- a small number of class hours in the curriculum of future geography educators, dedicated to the study of GIS-technologies and their full-fledged mastery;
- absence of the possibility of joint editing of web-maps in an on-line mode;
- absence of Ukrainian-language content for the resource.

3 Conclusions

1. To summarizing, it should be noted that cloud GIS is a new stage in the development of geoinformational education. Thanks to them, work with GIS is more efficient and affordable. Cloud ArcGIS Online has proven to be a fairly simple, well-developed and user-friendly educational resource.
2. The prospects for further research are seen in the formation of training and methodological base for integrating the elements of cloud GIS into various training courses for future geography teachers.

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The use of mobile Internet devices in the formation of ICT component of bachelors in electromechanics competency in modeling of technical objects

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Abstract. Computer simulation of technical objects and processes is one of the components of the system of professional training of a modern electromechanics engineer. It has been established that despite the fact that mobile Internet devices (MID) are actively used by electrical engineers, the methods of using them in the process of bachelor in electromechanics training is considered only in some domestic scientific studies. The article highlights the components of the methods of using MID in the formation of the ICT component of the competence of the bachelor in electromechanics in modeling of technical objects, providing for students to acquire basic knowledge in the field of Computer Science and modern ICT and skills to use programming systems, math packages, subroutine libraries, and the like. For processing tabular data, it is proposed to use various freely distributed tools that do not significantly differ in functionality, such as Google Sheets, Microsoft Excel, for processing text data – QuickEdit Text Editor, Google Docs, Microsoft Word. For 3D-modeling and viewing the design and technological documentation, the proposed comprehensive use of Autodesk tools in the training process.

Keywords: Mobile Internet Devices, ICT Competencies, Electromechanics, Bachelors in Electromechanics.

1 Introduction

In previous papers we are discussed:

- the essence [11], content [17] and structure [16] of the competence of the bachelor in electromechanics in the design of technical objects as the system's property of the person formed in the process of learning, which contains the following components: cognitive-content (epistemological) – knowledge; operational-technological (praxeological) – skills, experience; value-motivational (axiological) – motivation, value relation; social-behavioral – sociability, ability to adapt, ability to integrate;
- on the basis of certain directions of professional training modernization of bachelor in electromechanics [12] a system of competences of a bachelor in electromechanics in modeling of technical objects was developed, which includes three groups of competences: general science (in information and communication technologies, in applied mathematics, in fundamental sciences), general professional and special professional;
- it is shown that the leading tools of forming the competence of the bachelor in electromechanics in the simulation of technical objects are MID – multimedia mobile devices that provide wireless access to information and communication Internet services for the collection, systematization, storage, processing, transmission, submission of all possible messages and data [14];
- the model of the use of MID in the formation of the competence of the bachelor in electromechanics in the modeling of technical objects [15] is developed. The implementation of this model in the study of bachelor in electromechanics of technical objects modeling is an appropriate method of use, the components of which are:

  a. the method of using MID in the formation of the general scientific component of the competence of the bachelor in electromechanics in the modeling of technical objects;
  b. the method of using MID in the formation of the general-professional component of the competence of the bachelor in electromechanics in the modeling of technical objects;
  c. the method of using MID in the formation of a specialized and professional component of the competence of the bachelor in electromechanics in the modeling of technical objects.

2 The purpose and objectives of the study

The need to implement the developed model of the use of MID and defined the *purpose of the article* – to develop a methods of using MID in the formation of ICT component of bachelor in electromechanics competency in modeling of technical objects. To achieve this goal, the following *task* must be solved: to identify the leading mobile software tools for ICT competency development and illustrate their use in the disciplines "Computing and programming" and "Engineering and computer graphics".

3 Results of the research

Smartphones are one of the most common among high-end Internet devices. According to the [9], at the beginning of 2018 in Ukraine mobile operating systems for Internet devices occupied the following parts of the market: Android 76.76%, iOS 18.78%, all others (SymbianOS, Windows, etc.) – 4.62%. Since November 2012, the part of SymbianOS and Android has equaled, and for now the part of Android in the domestic mobile operating systems market is steadily increasing, reaching 76.15% in February 2019 (Fig. 1). A similar analysis across different regions of the world shows a similar tendency, which gives an opportunity without loss of universality to illustrate the provisions of the developed methodology using the software tools running the Android operating system.

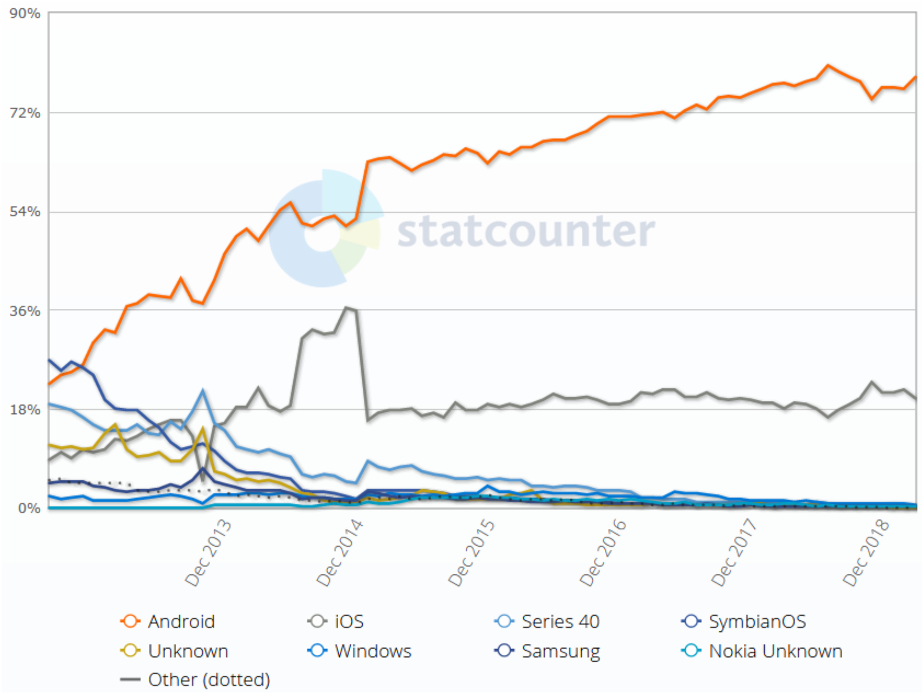

Fig. 1. Distribution of operating systems of MID in Ukraine (2009-2019) (according to [10])

The formation of such component of the competence of the bachelor in electromechanics in the modeling of technical objects, as competence in ICT, provides for the acquisition of basic knowledge in the field of computer science and modern information technologies by students; skills of using software and skills in computer networks, data transfer systems, ability to create databases and use Internet resources; the ability to use programming systems, mathematical packages, subroutine libraries, etc.

To process the table data in the course "Computing and programming" you can use a variety of freely distributed tools that have insignificantly different functionality. So, in content module 2 "Computing in Spreadsheet Environment", Google Sheets [8] provide an opportunity:

- create new spreadsheets or edit existing files;
- share spreadsheets and collaborate in the same spreadsheet at the same time;
- work anywhere, anytime – even offline;
- add and respond to comments;
- format cells, enter or sort data, view charts, insert formulas, use find/replace and more;
- everything is saved automatically as user type;
- get insights, insert charts instantly and quickly, and apply formatting in one tap – with Explore;
- open, edit and save Excel and Calc spreadsheets [7].

The last actions are more natural to do with the help of the spreadsheet Microsoft Excel, whose mobile version is not inferior to desktops for functionality. Microsoft Excel contains a large number of templates that allow you to create spreadsheets quickly. The feature of the version of Microsoft Excel for MID with touch control is the ability to complete drawings, add handwritten notes and mathematical formulas using the tools tab "Drawing" (Fig. 2). As with Google Sheets, Microsoft Excel provides file sharing for viewing, editing, and commenting.

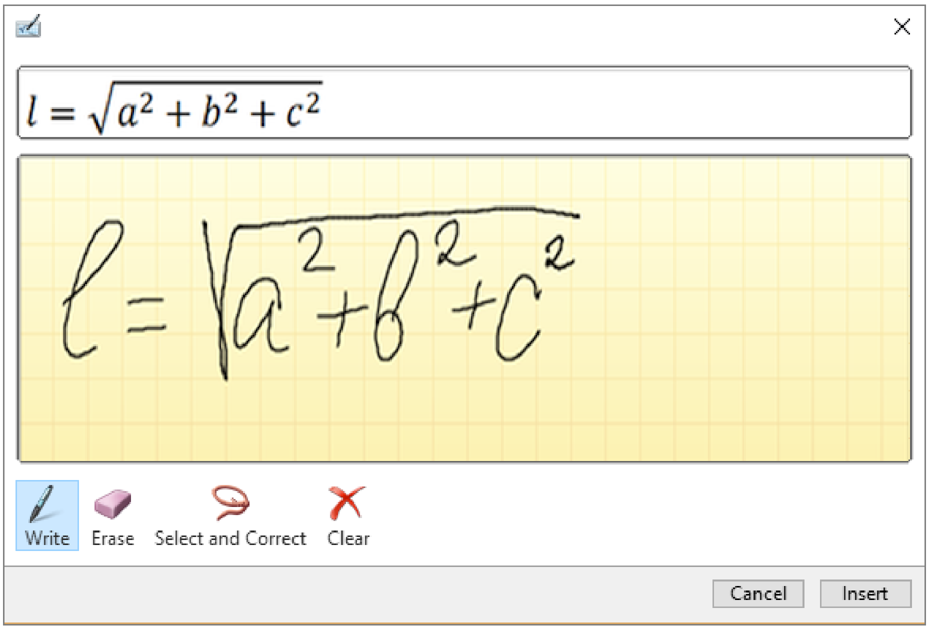

Fig. 2. Insert a handwritten formula in Microsoft Word 2016

Despite the fact that Microsoft Excel is a commercial product, for the most common MID with a screen size of 10.1 inches or less, Microsoft's license agreement provides the creation of a free account, the use of which enables the creation and editing of documents on devices. In addition, in studying content module 3 "Macros. Computing Automation" Microsoft Excel is a more convenient tool than Google Sheets. In particular, laboratory work 5 "Construction of macros" involves performing approximation of functions, construction of the trend line and statistical processing of experimental data.

You can start to perform laboratory work on any MID, for example, a tablet PC running with Android or Windows 10 – the version of Microsoft Excel, which is part of the Office 365 package, is freely available for educational institutions, and works with the same functionality under the managing of both mobile operating systems.

To start working with Visual Basic for Application in Microsoft Excel, you must initialize the spreadsheet by giving students access to the development tools (Fig. 3).

The next step is to create a workbook in Microsoft Excel. The new default book contains three worksheets. We will add two more to them, giving them the name: «Data», «X», «~X», «(~X)X», «(~X)Y», «SLAE». The choice of names is justified by the model used to approximate the results of the experiment using the least squares method.

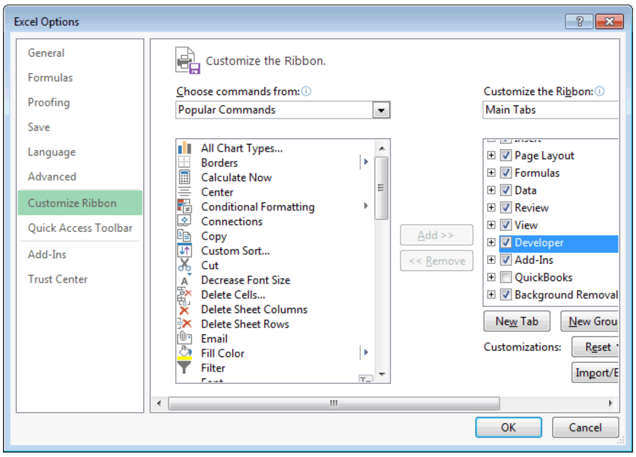

Fig. 3. Configure the Developer pane in Microsoft Excel

In the first two columns of the "Data" sheet we will place experimental data – a column of independent variables x_{exp} and a column of dependent variables y_{exp}: A1 is x_{exp}, B1 is y_{exp}, A2:A12 are 11 values of x_{exp}, B2:B12 are corresponding 11 values of y_{exp}.

11 is not a fixed value – the number of points is set in the corresponding cell of the sheet «Data»: E1 is <u>Number of points</u>, F1 is an integer that determines the number of experimental data.

As an approximation model, we use the polynomial approximation:

$$y_{calc} = a_0 + a_1x_{exp} + a_2x_{exp}^2 + a_3x_{exp}^3 + a_4x_{exp}^4 + a_5x_{exp}^5 + a_6x_{exp}^6 + \ldots + a_{10}x_{exp}^{10}$$

10 is the maximum degree of polynomial – to select a smaller one, we set it in the corresponding cell of the sheet "Data": E2 is Polynomial order, F2 is an integer from 1 to 10, which is a polynomial order, E3 is Coefficients.

According to the chosen model, the order of the polynomial should not be equal or less than the number of points of experimental data – in the first case, instead of approximation, we get interpolation, and the second model just will not work. The designation of the coefficients (a_0, a_1, ..., a_{10}) will be placed in the range of E4:E14.

The calculated value of the polynomial will be placed in the cells of column C: C1 is y_{calc}, C2 is =$F$4+$F$5*A2+$F$6*(A2^2)+$F$7*(A2^3)+$F$8*(A2^4)+$F$9*(A2^5)+$F$10*(A2^6)+$F$11*(A2^7)+$F$12*(A2^8)+$F$13*(A2^9)+$F$14*(A2^10). The cell C2 is copied to the following cells (C3, etc.) as many times as there will be experimental points (more precisely, one time less).

To determine the deviation of the experimental data of y_{exp} from the approximated y_{calc} we use the square of their difference: D1 is $(y_{calc} - y_{exp})^2$, D2 is =(C2-B2)^2. The cell D2 is copied to the following cells (D3, etc.) as many times as it was done in the previous case.

This initial completion of the output data and computational formulas is completed. The next step is to implement the least-squares method using Visual Basic for Application. The call to the corresponding program will be realized by the event "change of values on the worksheet" (Worksheet_Change). Considering that the user can change the output data faster than the calculation is performed, it is necessary to secure from the new call of the computing subroutine until the completion of the current calculations. To do this, we create the corresponding variable:

```
Public recursion As Byte
```

Worksheet_Change is a subroutine called when changing values on a worksheet:

```
Private Sub Worksheet_Change(ByVal Target As Excel.Range)
 If recursion = 0 Then
  recursion = 1
  Call createx
  Call transpx
  Call xtmulx
  Call xtmuly
  Call solve
  recursion = 0
 End If
End Sub
```

Sequential calls to all other procedures are performed with Worksheet_Change only if its non-recursive non-execution is performed. Each procedure places data on its own worksheet in order for the user to verify the correctness of the implemented algorithm.

In the first step of the algorithm from the column with the experimental data x_{exp} creates a matrix **X**, the number of rows of which is equal to the number of points of experimental data, and the number of columns is the order of the polynomial + 1. In the first column of the matrix **X** the data of the x_{exp}, column, rised to the chosen order in the polynomial, in the second – the same data, elevated to the chosen order of the polynomial – 1, in the third – the same data, elevated to the chosen order polynomial – 2, etc. For the correct execution of these actions, the last column of the matrix **X** will contain the data of x_{exp}, elevated to zero degree, that is, 1:

```
Private Sub createx()
 n = Range("Data!$f$1").Value
 p = Range("Data!$f$2").Value
 For i = 1 To n
  For j = p To 0 Step -1
   Worksheets("X").Cells(i, p - j + 1).Value =
        (Worksheets("Data").Cells(1 + i, 1).Value) ^ j
  Next j
 Next i
End Sub
```

The second step of the algorithm involves the transposition of matrix **X**. Despite the fact that Microsoft Excel provides the built-in transposition function, the corresponding subroutine illustrates copying data from the worksheet «X» to the sheet «~X»:

```
Private Sub transpx()
 n = Range("Data!$f$1").Value
 p = Range("Data!$f$2").Value
 For i = 1 To n
  For j = 1 To p + 1
   Worksheets("~X").Cells(j, i) = Worksheets("X").Cells(i, j)
  Next j
 Next i
End Sub
```

The third step of the algorithm involves the construction of the main matrix of the system of normal equations, which is created by multiplying the transposed matrix from the sheet «~X» into the output matrix **X**. Analysis of the code of the subroutine gives an opportunity to conclude that the multiplication procedure of the matrices can be expressed through a series of scalar products of the vector lines on the vector column:

```
Private Sub xtmulx()
 n = Range("Data!$f$1").Value
 p = Range("Data!$f$2").Value
 For k = 1 To p + 1
  For j = 1 To p + 1
   s = 0
   For i = 1 To n
    s = s + Worksheets("~X").Cells(k, i).Value
          * Worksheets("X").Cells(i, j).Value
   Next i
```

```
   Worksheets("(~X)X").Cells(k, j).Value = s
  Next j
 Next k
End Sub
```

The fourth step of the algorithm is necessary to determine the right-hand side of the system of normal equations – the column of free members, which is formed by multiplying the transposed matrix **X**, located on the sheet «~X», on the matrix-column **Y**, formed from the column $y_{\exp}$:

```
Private Sub xtmuly()
 n = Range("Data!$f$1").Value
 p = Range("Data!$f$2").Value
 For k = 1 To p + 1
  s = 0
  For i = 1 To n
   s = s + Worksheets("~X").Cells(k, i).Value
         * Worksheets("Data").Cells(1 + i, 2).Value
  Next i
  Worksheets("(~X)Y").Cells(k, 1).Value = s
 Next k
End Sub
```

The last step of the algorithm is to solve the formed normal system of linear algebraic equations with the left part, located on the sheet «(~X)X», and the right side of the sheet «(~X)Y». The results of the solution of the system and unknown coefficients of the polynomial:

```
Private Sub solve()
 srow = Range("Data!$f$2").Value + 1
 scol = srow + 1
 For i = 1 To srow
   For j = 1 To srow
    Worksheets("SLAE").Cells(i, j) =
                Worksheets("(~X)X").Cells(i, j)
   Next j
   Worksheets("SLAE").Cells(i, j) =
                Worksheets("(~X)Y").Cells(i, 1)
 Next i
 Rem selection of the main element
 For i = 1 To srow
  emax = Worksheets("SLAE").Cells(1, i).Value
  num = i
  For j = i To srow
   If Abs(Worksheets("SLAE").Cells(j, i).Value) > Abs(emax) Then
    emax = Abs(Worksheets("SLAE").Cells(j, i).Value)
```

```
   num = j
  End If
 Next j
 If num <> i Then
  For k = 1 To scol
   temp = Worksheets("SLAE").Cells(num, k)
   Worksheets("SLAE").Cells(num, k) =
                Worksheets("SLAE").Cells(i, k)
   Worksheets("SLAE").Cells(i, k) = temp
  Next k
 End If
Next i
For i = 1 To srow
 If Worksheets("SLAE").Cells(i, i).Value = 0 Then
  MsgBox ("Perhaps the matrix is degenerate")
 End If
Next i
Rem Gauss's row echelon form
For i = 1 To srow
 sw = Worksheets("SLAE").Cells(i, i).Value
 For j = 1 To scol
  Worksheets("SLAE").Cells(i, j).Value =
       Worksheets("SLAE").Cells(i, j).Value / sw
 Next j
 For k = i + 1 To srow
  c = Worksheets("SLAE").Cells(k, i).Value
  For j = 1 To scol
   Worksheets("SLAE").Cells(k, j).Value =
        Worksheets("SLAE").Cells(k, j).Value –
        Worksheets("SLAE").Cells(i, j).Value * c
  Next j
 Next k
Next i
Rem Gauss's reduced row echelon form
For i = srow - 1 To 1 Step -1
 s = 0
 For j = i + 1 To srow
  s = s + Worksheets("SLAE").Cells(i, j).Value
     * Worksheets("SLAE").Cells(j, scol).Value
 Next j
 Worksheets("SLAE").Cells(i, scol).Value =
              Worksheets("SLAE").Cells(i, scol).Value - s
Next i
Rem rewrite the results on the first sheet
For i = 4 To 14
```

```
  Worksheets("Data").Cells(i, 6) = ""
 Next i
 For i = srow To 1 Step -1
  Worksheets("Data").Cells(srow - i + 4, 6) =
               Worksheets("SLAE").Cells(i, scol)
 Next i
End Sub
```

The last procedure implements the Gauss method for solving systems of linear algebraic equations, the theoretical basis of which at the time of laboratory work (Fig. 4) students have already mastered in the course of higher mathematics.

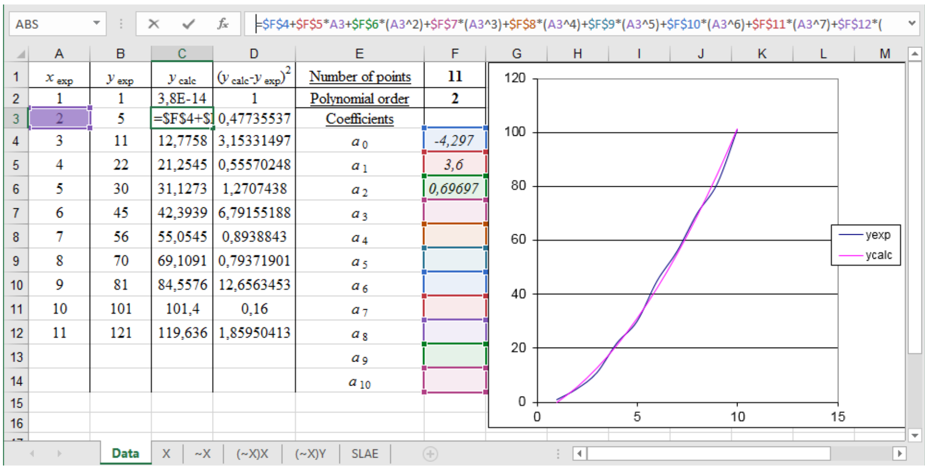

Fig. 4. The result of the laboratory work “Construction of macros”

Note that both spreadsheets provide the ability to perform actions on both stationary and mobile Internet devices, which creates conditions for their use in different forms of organization of the educational process. So, in a lecture on “Computer Science and Programming”, the teacher can demonstrate work in the spreadsheet, giving students the opportunity to share the edited document. Under this approach, the role of the latter changes from the passive observer to the active participant (Fig. 5).

For the processing of text data in the course “Computer Science and Programming” you can use a variety of freely distributed tools that are significantly different in functionality – from the simplest text editors to advanced word processors.

The first category includes the QuickEdit Text Editor, which provides the ability to highlight syntax elements in more than 50 programming languages, Byte Mobile’s Text Editor for editing HTML files, and more.

The second category includes word processors, among which you can distinguish Google Docs [6] that provide text documents with features equivalent to those provided by Google Sheets, and, in addition, the ability to open, edit and save Microsoft Word documents (Fig. 6).

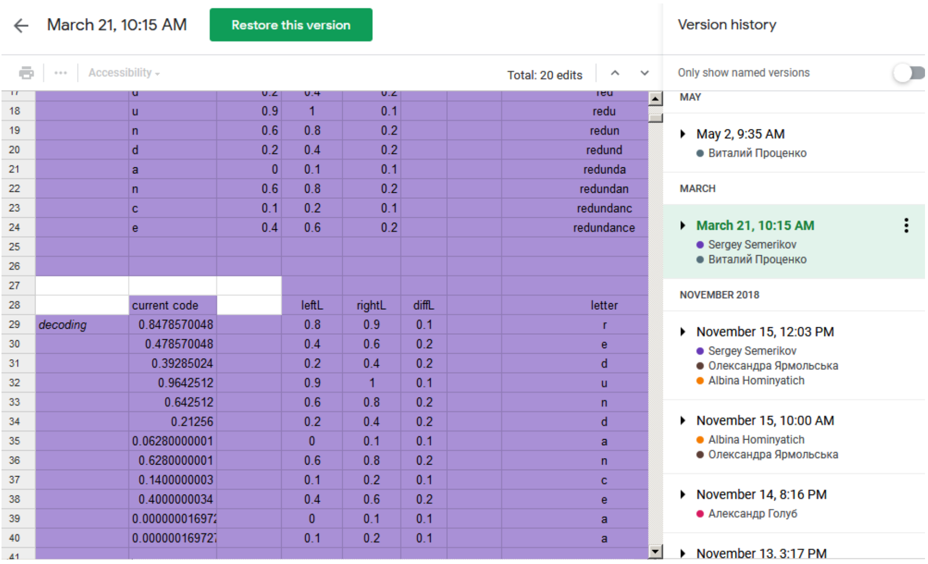

Fig. 5. Tracking student engagement in collaborative work in Google Sheets

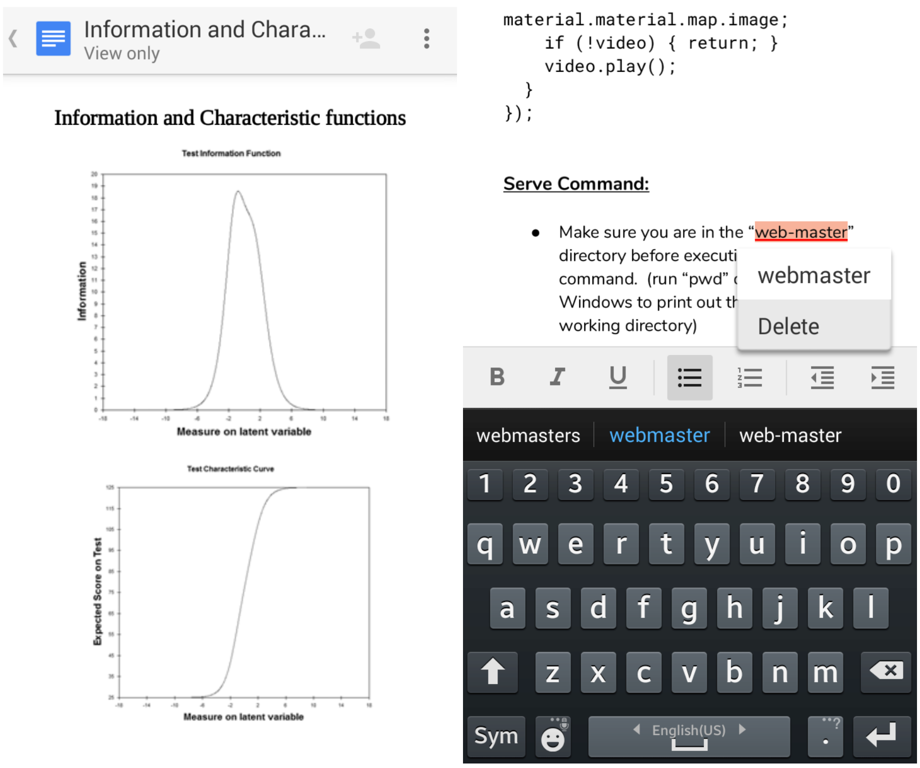

Fig. 6. View and edit Microsoft Word documents in Google Docs

The second academic discipline, in the learning of which is the formation of such an ICT component of the competence of the bachelor in electromechanics in the modeling of technical objects, is “Engineering and Computer Graphics”. In this discipline, bachelors in electromechanics learn to express technical ideas with the help of drawing. So, as a result of studying the discipline, the student must know the rules of execution and reading of design and technological documentation, be able to perform and read the drawings of technical objects, to prepare technological and design documentation in accordance with the standards.

Maryna V. Rassovytska and Andrii M. Striuk, based on the results of the study more than 30 mobile software tools for training engineering and computer graphics [18] have proposed a model for the integrated use of Autodesk tools in the process of training in engineering (Fig. 7).

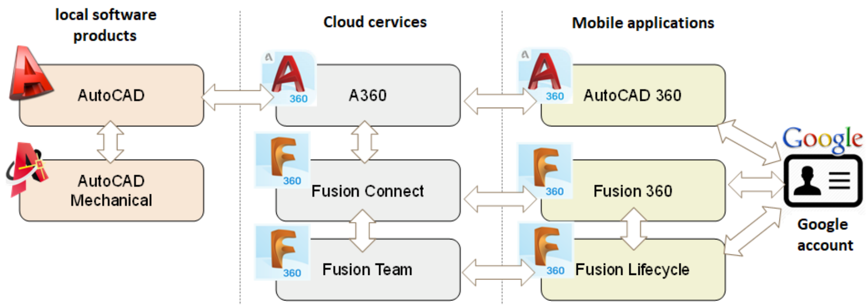

Fig. 7. Comprehensive use of Autodesk products in the training of future mechanics (by [18, p. 358])

For bachelors in electromechanics, the proposed model can be modified: instead of AutoCAD Mechanical we propose the use of Electrical (formerly – AutoCAD Electrical) [4], the method of which for the design of electric circuits is described in [3]. The use of Electrical in the teaching of engineering and computer graphics of bachelors in electromechanics provides the ability to form the skills of circuit design, the creation of qualitative documentation for electrical circuits, collaborative work with potential customers and suppliers, management of electromechanical projects, etc. The Electrical component includes graphic image libraries for electrical circuits and error checking tools that enable detection of problems before the start of the design phase of a technical system. Developers of Electrical indicate that it supports integration with Autodesk Inventor, and both of them together form an integrated solution for the design of mechatronic systems.

Autodesk provides Autodesk Inventor with a special free education license (free education license) intended solely for use by students and teachers for educational purposes. Functionally, this version of Autodesk Inventor is does no differ from the full, with one exception: all files created or edited in it have a special flag (so-called educational flag) that will be placed in all views.

For MID running Android in 2019, a number of Autodesk tools are available.

AutoCAD - DWG Viewer & Editor [2] is a mobile version of the Autodesk main product – AutoCAD: a DWG file viewer with easy-to-use drawing and editing tools that enables you to view, create, edit and publish AutoCAD schemas and drawings on MID. Mobile AutoCAD can work in conjunction with desktop versions, which enables you to work continuously in a specialized computer classroom, general purpose audience, at home and on the road (Fig. 8).

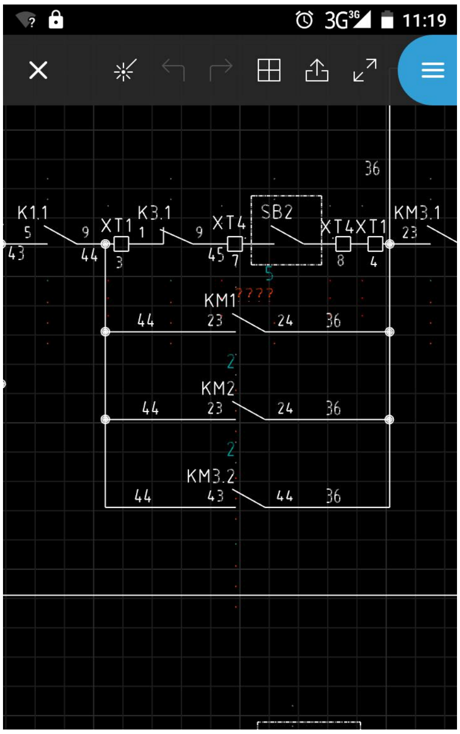

Fig. 8. Using the AutoCAD mobile version – DWG Viewer & Editor for viewing and editing electrical circuits

Compared to the desktop version, AutoCAD mobile provides an opportunity:

— view and edit DWG files from device storage, email, or external cloud storage like Google Drive, Dropbox and OneDrive;
— select, move, rotate, and scale objects. View coordinates and properties;
— work offline and sync your changes once back online;
— share your CAD designs in the field.

All new AutoCAD users automatically receive a free 7-day free trial and students can sign up for a premium plan free of charge.

A360 - View CAD files [1] is a specialized browser for various 2D and 3D models created in AutoCAD (DWG), DWF, Inventor (IPT, IAM, IDW), Revit (RVT), SolidWorks (SLDPRT, SLDASM, ASM) Navisworks (NWD, NWC), CATIA (CATPART, CATPRODUCT), Fusion 360 (F3D) and others. You can store model files in the same Autodesk cloud – https://a360.autodesk.com. This provides additional opportunities for collaborative work on models.

Fusion 360 [5] is a collaboration tool that combines the capabilities of CAD systems, CAMs and engineering calculations (CAEs). Unlike previous features, Fusion 360 provides the ability to execute 3D-designing of free-form models. The features provided by this tool are significantly dependent on the resolution of the screen of a MID: the larger it is, the more Fusion 360 elements become available to the user – from layer-by-view on a high-speed Internet device to engineering calculations on a device with a screen of 10 inches.

4 Conclusions

Thus, in the process of forming the ICT component of the competence of the bachelors in electromechanics in the simulation of technical objects, it is expedient to use the following MID software:

- cloud-based spreadsheets as modeling tools and text editors for program description of models;
- mobile computer-aided design systems for creating and viewing physical properties of models of technical objects;
- mobile communication tools for organizing joint modeling activities.

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Distance learning courses in developing future music teachers' instrumental performance competence

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Abstract. The scientific and methodological background of creation and development of the distance learning courses for the future music teachers is substantiated. The components and structure of future music teachers' instrumental performance competence are defined; the content of the course is revealed. The materials are based on the authors' teaching experience within the distance learning course "Basic Musical Instrument (Piano)". The main blocks of the distance course design and development are considered among them to be theoretical, practical, individual work, and control blocks. The specificity of distance learning methods in the future music teachers' instrumental and performance training is substantiated and three main methods are distinguished. The method of involving information and communication technologies, including multimedia; project method, and features of knowledge and skills controlling are elaborated. The results of implementation and experimental research of using distance learning courses for developing future music teachers' instrumental performance competence are described. The influence of different methods use on students' success is explored.

Keywords: distance learning course, instrumental performance competence, method, ICT, project, test.

1 Introduction

One of the characteristic features of contemporary artistic education is its updating in accordance with the requirements of the information space, which is now actively formed within the university information and communication educational environment. A typical phenomenon of artistic education is developing and active implementing of electronic educational resources, using the information and multimedia sources, electronic textbooks and manuals, educational and methodical software tools, etc. Gradually, the distance learning tools are also involved in artistic education, and distance learning courses are being developed so that future music teachers can study historical and theoretical, and methodological artistic disciplines. The search for new forms and methods of teaching different types of art, effective in the context of distance education, is relevant for contemporary artistic pedagogy.

2 Literature review and problem statement

Informatization of the artistic component of the future music teachers' professional training has become an integral part of the educational process, as it is proved by numerous scientific and pedagogical studies of domestic and foreign scholars (Jacques Arveiller [1], Richard Ashley [14], Natalia V. Belousova [2], Nataliia D. Bieliavina [3], Olena A. Chaikovska [4], Rocio Chao-Fernandez [5], Irina B. Gorbunova [6], Ihor A. Haidenko [7], Andreas Kameris [24], Aleksandr V. Kharuto [9], Igor M. Krasilnikov [11], Aleksei V. Krasnoskulov [12], Nadiia V. Novikova [15], John Michael Ortner [16], Sergei P. Polozov [17], Oleksandr M. Rybnikov [19], Jonathan Savage [21], Galina R. Taraeva [22], Larysa I. Varnavska [23], Irina V. Zabolotskaia [25] and others). Scientists emphasize the importance of using ICT in music education for its transformation into a highly artistic and high-tech process. New software tools, which flexibly combine pedagogical tools of traditional music education and the possibilities of ICT, are actively developed and allow using of the musical computer as a professional tool for a future specialist.

The beginning of the 21st century has been marked by the development and widespread use of computer programs and multimedia for music education: Theano Koutsoupidou develops practical tips for using online distance learning tools in teaching music [10]. Nathan B. Kruse, Steven C. Harlos, Russell M. Callahan and Michelle L. Herring present their experience in Skype music lessons in the academy [13]. J. Savage, the author of several projects on the music education of children by ICT tools, develops new approaches to implementing the computer technologies, taking into account the curriculum, the educational goal, and effective management of the educational process [20; 21]. Rocio Chao-Fernandez, Sara Román-García and Aurelio Chao-Fernandez offer different strategies for learning music by the use of ICT in the context of the music education methodology at secondary school [5].

The design, development, implementation of distance learning courses in the field of artistic education, and their support with electronic educational resources are left out in the researches of the modern scholars. It is known that there are some distance learning courses on music and art in the educational environments of the faculties of culture and arts in Ukraine ("History of Music", "Fundamentals of Musical Composition in Choreography", "Relevant Issues of Contemporary Musical Performance", "Modern Ukrainian Music" are offered to students of the National Academy of Managerial Staff of Culture and Arts; distance learning courses "Polyphony", "Vocal", "Methods of Music Education" and some others are introduced into the future music teachers' professional training at the National Pedagogical Dragomanov University). However, the scientific understanding of using the distance learning elements or creating distance learning courses for the disciplines of the artistic educational industry has only just begun to develop in Ukraine. Liudmyla H. Havrilova presents her experience of introducing distance learning courses into the future primary school teachers' artistic training on the example of the distance learning courses "History of musical art of Ukraine" and "Multimedia technologies in artistic education". The author analyses the peculiarities of creating electronic educational resources, multimedia textbooks and manuals on the history of musical art and their systematic involvement in the e-training of future music teachers [8].

3 The aim and objectives of the study

The main purpose of the article is to consider the experience of designing and applying distance courses while the students' professional instrumental and performance skills are being developed, and to analyse the specific of distance learning methods in the future music teachers' instrumental and performance training as well.

The research described in the article was conducted in the context of the implementation of the research theme of the Primary Education Theory and Practice Department of the Donbas State Pedagogical University "Professionalism of the Teacher: Theoretical and Methodological Aspects" (the state registration number 0115U003313), where the use of distance courses is considered as one of the conditions of increasing the efficiency of the vocational training process for students, and, in particular, future music teachers.

At the preparatory stage of the study, we developed the distance course "Basic Musical Instrument (Piano)" and at the main stage of the study its approbation was carried out in the course of future music teachers' vocational training at the Faculty of Primary, Technological and Professional Education of the Donbas State Pedagogical University and the Art Faculty named after A. Avdievskyi of National Pedagogical Dragomanov University. 52 bachelor students of the specialty 013 Primary education (specialization "Music") participated in the experiment. In order to solve the problems of the research, a set of methods was used: theoretical (analysis of scientific and methodological sources on the problems of using distance courses in the vocational performance training of future music teachers, systematization and generalization of the information collected) and empirical (conversations, questionnaires, pedagogical experiment).

4 Results of the study

4.1 Review of the distance course "Basic Musical Instrument (Piano)"

The educational discipline "Basic Musical Instrument (Piano)" provides the students with individual classes and with the possibility of adjustment and adaptation in accordance with abilities and preliminary musical training. The course is aimed at the further development of pre-acquired instrumental and performance skills and the students' preparation for the use of the musical instrument at the musical art lessons and in the extra-curriculum activities at secondary educational institutions. The distance course "Basic Musical Instrument (Piano)" like the discipline complements naturally the system of future music teachers' professional performance training, implementing the principles of blended learning and contains the following blocks: 1) theoretical; 2) practical; 3) independent work; 4) control.

Among the main tasks of the course "Basic Musical Instrument (Piano)" we distinguish the following:

1. Forming the interest in pedagogical activity and independent work in instrumental and performance training of the future specialists.
2. Creating a professional basis for further independent work of the future music teachers by means of playing a musical instrument.
3. Optimizing of music teacher vocational training in the integrated unity of musical and performance and pedagogical components.
4. Accumulating the musical repertoire for various forms of educational and extracurricular activities in school and cultural and educational institutions.
5. Developing the readiness to solve the problems of selecting and interpreting didactic and expedient samples of national and foreign musical art, taking into account age-related abilities of schoolchildren.
6. Acquiring students' aesthetic tastes and value orientations.
7. Forming the individual performing style of the future musical art teachers.

The expected result of studying the discipline and working in the distance course "Basic Musical Instrument (Piano)" is to develop students' professional instrumental performance competence, which involves fluent playing the musical instrument (piano) and the ability to use it in educational, concert, and performance activities; to acquire the skills of reading music from a sheet, transposition, music selection by ear; to master the methods of teaching musical instruments playing; to develop the ability to organize instrumental music for students at musical lessons and in extracurricular activities. In the structure of the future music teachers' instrumental performance competence, traditionally, we distinguish cognitive, operational, and motivational components.

The content of the course "Basic Musical Instrument (Piano)" is organized in 5 modules, which combine 10 themes:

Module 1. Formation of piano and technical skills, professional accompaniment skills

Theme 1. Development of professional musical skills. Complication of technical tasks for the development of a pianist apparatus. Work on music of great form: a variety of techniques in sound production, dramaturgy of contrasting images.

Theme 2. Mastering the necessary skills for concertmaster's work. Professional accompanying skills, familiarity with the textual features of the classical romance, the specifics of reading from the sheet of solo, ensemble works and works of school repertoire.

Module 2. Piano technique development

Theme 3. Intonational, dynamic, timbral, and rhythmic function of articulation. Analysis of the characteristic features of the musical composition from the school programme, the definition of the necessary requirements for intonation (articulation, timbre, etc.) and rhythmic difficulties.

Theme 4. Generalization of application formulas. The mastery of the technical perfection of the musical programme by working on certain types of techniques that require systematic rehearsal work. Analysis of the application and the detection of patterns.

Module 3. The structure of polyphonic technique

Theme 5. Polyphonic multidimensionality as a property of piano texture. Formation of cantil, flexibility, and naturality of intonation skills. Development of polyphonic hearing: the ability to hear the individual expression of each voice. Rehearsal work on intonation of polyphonic texture.

Theme 6. Development of polyphonic hearing. Concept of polyphony for school repertoire. Improving the skills of performing the song for your own support. Harmonize the melody using improvisation elements.

Module 4. Development of piano performance skills

Theme 7. Development of performance skills in the work of polyphonic works of great shape. Continuation of mastering the skills of polyphonic thinking, polyphonic control, its interaction with performances techniques, various types of polyphonic techniques. Ability to master the drama of the musical image in the works of a great form. Formation of large-scale musical thinking.

Theme 8. Development of stylistic and genre interpreting skills. Ability to use knowledge about the form, character, and dynamics of the piano works development. Understanding the meaning of the timbral colour, realizing the artistic design of each of the works of the program.

Module 5. Competence in the field of musical and pedagogical performance

Theme 9. The mastering of musical works from the school repertoire. Knowledge of the reproduction specifics of piano works of different eras, styles, and genres, taking into account the peculiarities of the students' perception.

Theme 10. Realization of pedagogical and executive plan while performing plays for listening. Ability to combine the melodic line and accompaniment, mastering the skills of joint playing music. Ability to perform musical works for listening perfectly, technically, and artistically.

The course "Basic Musical Instrument (Piano)" is preceded by the information block containing general information about the course, a forum for communication with the students, and a glossary for the course providing basic concepts and their interpretation. There are the tasks for creative projects, recommendations for the conclusion of an e-portfolio, tentative repertoire and a list of recommended literature available for downloading (Fig. 1).

The theoretical block of the course aims at forming and developing the cognitive component of the future music teachers' instrumental and performance competence and contains the text materials of lectures accompanied with multimedia presentations, charts, tables, as well as multimedia content (audio, video fragments, photo materials, reproductions of works of fine arts etc.). The lecture material is presented in a short form and supplemented with the musical compositions for listening (Fig. 2).

Practical block of the distance learning course "Basic Musical Instrument (Piano)" aims at forming the operational component of the students' instrumental and performance competence and contributes to forming and developing skills and abilities of listening to music, fluent playing the musical instrument, skills of reading music from the sheet, transposition, selection of music on rumour, performance of musical and analytical activity, developing creative musical thinking.

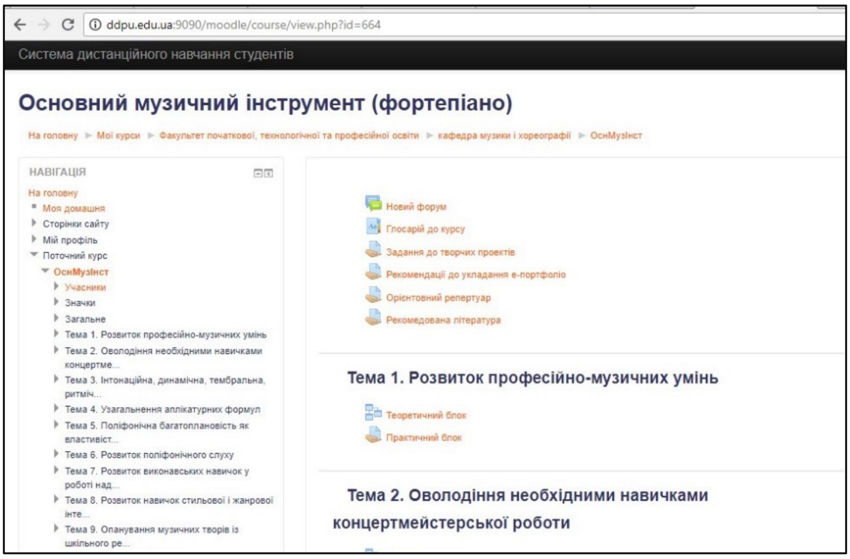

Fig. 1. The information block of the distance learning course “Basic Musical Instrument (Piano)”

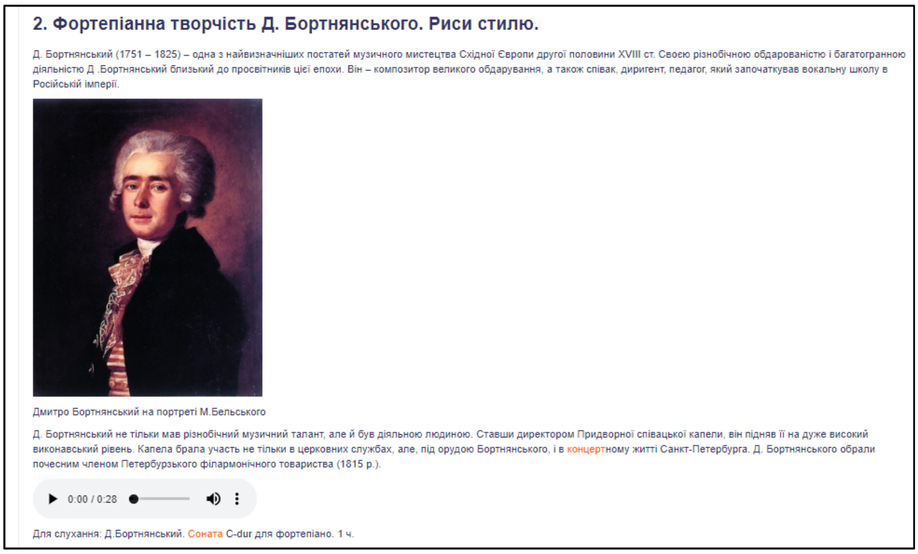

Fig. 2. The fragment of the lecture in the distance learning course “Basic Musical Instrument (Piano)”

The block of independent work, which contains tasks that require a comprehensive solution through the use of Internet resources, work with multimedia content, its processing, both individually and in group activities, is aimed primarily at the formation of the motivational and value component of the future music teachers' instrumental and performance competence.

The control of musical knowledge and instrumental skills, acquired while mastering the "Basic Musical Instrument (Piano)" distance learning course, takes place in the form of a test (MOODLE's learning environment provides an opportunity to check the knowledge of the theoretical material effectively, as well as mastering the musical compositions of Ukrainian composers by hearing through test tasks of different type, developed in the module "Test") with instant receipt of test results.

4.2 Specificity of distance learning methods in the future music teachers' instrumental and performance training

The method of involving information and communication technologies, including multimedia. In order to create a complete performance interpretation, immersion in the content of a musical work requires not only technical perfection but also professional performance skills, the level of which depends directly on a whole complex of musical knowledge, skills, formed aesthetic needs, values orientations, and other personality traits. Therefore, the performer must know and systematize musical forms in their historical development, instrumental studies, and relevant musical literature (biographies of composers, information about musical works), understand the problems of musical aesthetics. The development of artistic trends and creative schools, various aspects of the composer creativity influence spiritual life of society. In addition, musical and instrumental performances involve the use of interdisciplinary connections with history, literature, culture study, and various arts (painting, theatre, cinema, and choreography). Consequently, musical performance interpretive activity is one of the most diverse kinds of musical activity, which includes a considerable amount of information.

Modern technologies, in particular, multimedia and other computer technologies, make it much easier to search for information and help deepen awareness of a particular musical phenomenon due to the other types of information (textual, graphical, static and dynamic visual).

The involving ICTs was in the following areas:

- studying (or profound immersion) the composer's life and work, his individual works on the Internet; studying the scientific articles; listening to audio files; viewing video materials, providing "immersion in an era";
- searching for musical and performance interpretations of the work performed by well-known and little-known pianists in order to analyze the musical performances and compare author's interpretations;
- creating their own verbal interpretations aimed at the certain audience, on the basis of generalization of information from various Internet sources and conducting of thorough analysis of composer and performance expressive means;

- using the resources of musical notices of Internet libraries (Knot's library: http://nlib.org.ua/; Sheet music classical library: http://nlib.narod.ru/; B. Tarakanova Book archive: http://notes.tarakanov.net; D. Roizman's book archive: http://roisman.narod.ru/compnotes.htm and many others);
- involving the electronic context of multimedia encyclopedias and other information publications (New Media Generation, Masterpieces of Music from Encyclopedia, "Sonata: World Culture in the Music of the Mirror of Music" multimedia collection (http: //www.sonata-etc.ru/main.html), KorAx multimedia encyclopedia "Musical Instruments"; "Virtual Museum of Musical Instruments" "Terra Musicalis"; Encyclopedia Music Conservatory from Voyetra Technologies, etc.);
- recording the performance of a musical composition using a video camera or phone for further analysis of the performance interpretation (alone or with the teacher);
- involving visual associations, searching for works of painting and other types of fine art, using of associative ties, artistic analogies to deepen the interpretation of the content of the musical composition.

The method of involving information and communication technologies contributes to the development of certain musical and interpretive performance skills:

- developing musical thinking autonomy, mastering skills of self-presentation and communication with different audiences;
- creating auditory model of performing musical work interpretation;
- forming the ability to use the media in training and to evaluate critically their own media activity.

Project method. We determine the algorithm of the creative project activity of the participants in the experimental study for developing the readiness of the future music teacher to perform and interpret the activities in musical and instrumental learning:

- nominating the participants of the artistic and performing project and the choice of the topic;
- setting the problem, purpose and targets of the artistic project;
- defining the type and content of artistic and project activities;
- selecting the methods and tools of implementing artistic and creative project;
- students' independent performing and interpreting activity.

Choosing the project topics, students are offered two types of projects: single-subject project on discipline "Basic Musical Instrument (Piano)" (design and interpretation activities within the repertoire and performance tasks in the classes of musical specialty) and a multi-subject project within the professional disciplines ("Workshop on the school repertoire", "Additional musical instrument", "History of musical styles", "Analysis of musical works", etc.). The specific themes of the projects are agreed with the participants of the experimental study for developing the future music teachers' readiness to perform and interpret the activities in musical and instrumental education. In the information block of the distance learning course, students are offered topics of various content, taking the individual level of project group members and their musical tastes into account.

The projects are carried out in the academic year and are evaluated by the teachers at the stage of both current and final control. Students discuss their projects in the forum and send interim and final reports on project implementation using the module “Task”.

Project “Harmony of Music and Painting in the Work of M. Churloniss”. To implement the project, a group of students is divided into teams:

- search engineers (main activity is information retrieval: search for information about the life and work of the famous Lithuanian composer and artist on the Internet, as well as search for piano pieces – Fugue C minor, Preludes in the minor, Preludes in C major in the performance of various pianists and paintings M. Churloniss “Fuga”, “Signs of the Zodiac”, etc.);
- art critics (main activity is musical and analytical: musicology, musical-pedagogical and interpretive analysis of the certain works of M. Churloniss for piano; the creation of analytical schemes; aesthetic and stylistic analysis of paintings and analysis of the principle embodiment of musical expressiveness in the artist’s paintings).

The final stage of the project “Harmony of Music and Painting in the Work of M. Churloniss” is an executable interpretation of three musical works by the composer, and they are accompanied with a multimedia slide show, which presents the author’s pictures that are closely associated with the musical text. The performers’ laconic and accurate comments go along with the sound of music.

The project “Pictures at an exhibition” by M. Mussorgsky: implementing the principles of integrating musical and pictorial. The purpose of this project is to direct the students’ interpretation to the search for adequate sonorities, colours and shades, and the departure from the traditional canons of interpreting the famous piano cycle by M. Mussorgsky.

For this purpose, we nominate the project teams:

- search engineers (main activity – information retrieval: searching for information about the life and work of M. Mussorgsky and his friend V. Hartman on the Internet, searching for the most vivid piano and orchestral interpretations of the cycle “Pictures from the exhibition”, as well as searching for reproductions of works, inspired the composer to create music);
- art critics (main activities – musical and analytical: musicology analysis of individual works of the cycle, as well as analysis and evaluation of performance interpretations found);
- IT specialists (the main type of the activity is creating the informational multimedia support for the interpretive interpretations of M. Mussorgsky’s piano cycle, their visualization by means of computer technologies);
- performers-interpreters (main activity – interpretative: musical performance with brief comments on the content, means of expressiveness and musical form).

The project is implemented in the form of a concert performance by students-performers who offer their own interpretations of famous works by M. Mussorgsky’s “Walk”, “Two Jews”, “The Chants’ Ballet”, “Dwarf”, “Baba Yaha”. Their play is accompanied with a brief poetic story (art critics choose poetry lines) and a visual series (listeners can at the same time listen to music and review the works by V. Hartmann, inspired by the composer). The main content accent of performing interpretation is made not on the "figurative" aspect of works, but on the embodiment of feelings and emotional essence of events, that is, their "expressive" reproduction.

Specific features of controlling the knowledge and skills, acquired during the study of the course "Basic Musical Instrument (Piano)". In order to test the formation of the key knowledge gained while studying the distance course "Basic Musical Instrument (Piano)", it is enough to conduct an ordinary test in the MOODLE learning environment using different test types (Fig. 3).

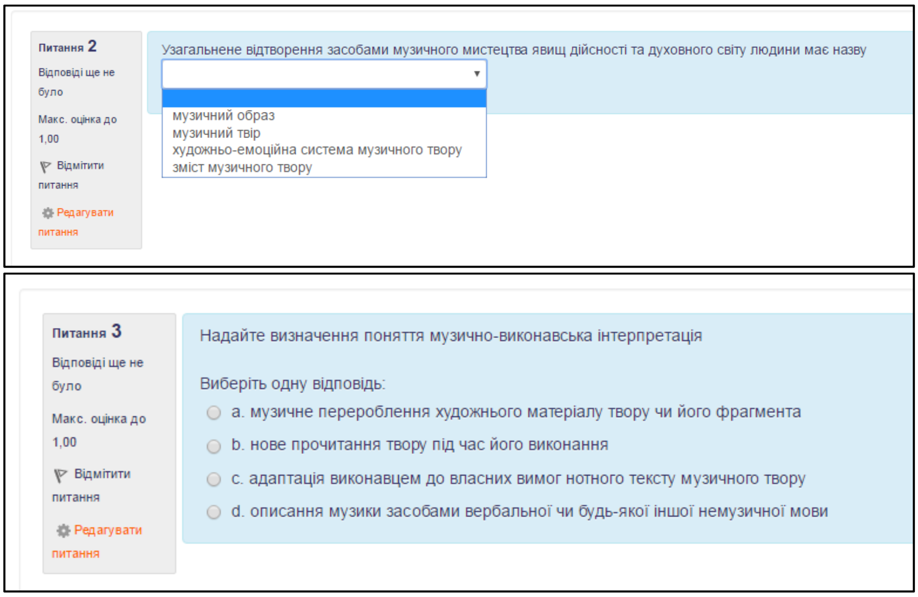

Fig. 3. The examples of the question in the test

The verification of specific musical knowledge, as well as the formation of special skills to percept music, the development of music listening skills, the recognition of musical works while listening requires the musical quiz conducting (recognition of works with the definition of their authors, parts or a specific topic of the great work). The quiz is developed using the possibilities of the service "Test" of the learning environment MOODLE in two versions:

- the task of the closed form (listen to the piece of music and choose the correct answer among the proposed ones);
- the task of the opened form (the "essay" question type: after listening to the fragments of the musical composition, you must enter the answer to the designated place, indicating the author, the exact title of the work and section, the act of the opera, part of the symphony or topic, etc.) (Fig. 4).

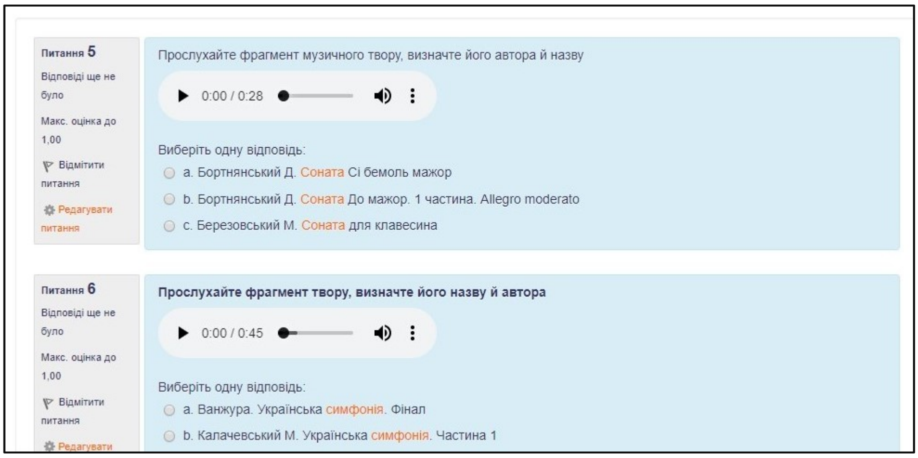

Fig. 4. Questions of the musical quiz (service “Test” of the MOODLE)

The practice of using e-tests as a tool of control proves that they are more appropriate for monitoring the cognitive component of the future music teachers’ instrumental and performance competence than the operational and motivational ones.

4.3 Analysis of the efficiency of the distance course implementing into the future music teachers’ instrumental and performance training

In the end of the academic year, the evaluation of the distance course efficiency has been held. Respondents were separated into two groups: experimental group (27 students) and control group (25 students). The experimental group worked in the distance course “Basic Musical Instrument (Piano)” in addition to the classes. The students of the control group were involved in studying according to traditional methods and techniques. They attended individual and group classes on the basic musical instrument, ensemble and concertmaster class, and others, which corresponded to the typical curriculum. Classes with students of control groups were conducted using traditional methods, without the involvement of information and communication technologies and distance learning.

The level of the motivational component of the future music teachers’ instrumental performance competence was assessed with the interviews. The interviews were conducted informally through discussion as a part of observation. The results are presented in the table (Table 1) and demonstrate higher indicators of the students’ interest in instrumental and performance work. It was also noticed that student attendance in the experimental group had increased by 12% compared to the control one.

In order to assess the cognitive component of the future music teachers’ instrumental performance competence, the results of testing, implemented in the virtual learning environment MOODLE, were involved. The results are presented in the table (Table 2) and prove that the pedagogical experiment significantly improved the artistic and professional thesaurus of future teachers and increased the level of students' skills in the field of instrumental and performing interpretations.

Table 1. Level of the motivational component of the future music teachers' instrumental performance competence

Level	Experimental group		Control group	
	Students	%	Students	%
High	9	37	6	24
Upper middle	12	44	9	36
Lower middle	5	19	8	32
Low	1	4	2	8

Table 2. Level of the cognitive component of the future music teachers' instrumental performance competence

Level	Experimental group		Control group	
	Students	%	Students	%
High	10	37	5	20
Upper middle	13	48	10	40
Lower middle	4	15	8	32
Low	0	0	2	8

The level of the operational component of the future music teachers' instrumental performance competence was assessed with the final exam, which involved verbal communication and musical performance. The results are presented in the Table 3.

Table 3. Level of the operational component of the future music teachers' instrumental performance competence

Level	Experimental group		Control group	
	Students	%	Students	%
High	10	37	6	24
Upper middle	15	44	9	36
Lower middle	5	19	10	40
Low	0	0	0	0

Overall, our results demonstrate a strong effect of implementing the distance learning course "Basic Musical Instrument (Piano)" into future music teachers' vocational training, since the level of each component of the instrumental performance competence has increased in the experiment group.

5 Conclusions

Implementation of the distance course "Basic Musical Instrument (Piano)" into the system of future music teacher training at SHEI "Donbas State Pedagogical University" makes it possible to draw conclusions:

1. Students' work in the distance course "Basic Musical Instrument (Piano)" should be combined with the curricular activities, piano playing practice, and direct contact counselling. Therefore, this combination of forms and methods of distance and traditional education represents a blended model [18], rather than purely distance learning. In this mode of work, the teacher begins to fulfil duties of a tutor, who accompanies and directs the instrumental and practical training of students in the e-learning environment and in curricular instructions.
2. In view of the positive results of implementing distance courses in the instrumental and performance training of future music teachers, the prospects of further scientific research are to develop and use new forms and methods of distance learning: scribing, intellectual maps and comics as varieties of modern educational infographics, etc.

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E-learning resources for successful math teaching to pupils of primary school

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Abstract. Ukrainian primary schools are undergoing significant changes as for Reform 'New Ukrainian School', it reflects rapid updating information technology and high level of children' informational activity. Primary schools are basically focused on development subject knowledge and general study skills. One of the ways of their developing is to use tools and apps. There are the examples of using interactive tools and apps for teaching Math for young learners by teachers-to-be in the article. The article presents as well the experimental data about training teachers-to-be to use tools and apps. Interactive tools and apps provide real task variability, uniqueness of exercises, operative assessment of correction, adjustment of task difficulty, a shade of competitiveness and gaming to the exercises. To create their own apps teachers-to be use the tools that are the part of the integrated Microsoft Office package using designing environments, and other simple and convenient programs. The article presents experimental data about the results of training teachers-to-be to create apps. A set of criteria for creation apps was made and checked at the experimental research such as ability to develop apps, knowledge and understanding the functional capabilities of apps, knowledge of tools for creating apps and their functional capabilities, ability to select and formulate tasks for young learners, ability to assess adequately the quality of the developed apps.

Keywords: tools and apps, teaching Math, young learners, primary school, experimental research.

1 Introduction

As for ongoing Reform 'New Ukrainian School' in Ukrainian primary schools and education changes occurring in the society, the particular attention should be paid to the primary level of education. Primary schools are the foundation for creating intellectual and general study children' skills, development their cognitive activity, and independence. It is the elementary school that affects all subsequent nature of the relationship of young learners with the educational environment and society.

There are some reasons for changes. The present stage of education system development in primary school is undergoing the significant changes. These changes are associated with a wide penetration of information and communication technologies in all areas of human activity, rapid updating of information technology and high level of children' informational activity. The evidence to this is as follows:

- reduction of the age of a child's first encounter with a computer. As a rule, a child who comes to primary school, already has the first experience of using a computer. This is facilitated by the presence of household digital devices in the family such as photo and video cameras, mobile phones, smart phones that are compatible with a computer and assume data processing by a computer. In addition, current software market is filled with entertaining and educational multimedia programs for children aged 3-4 years. However, the lack of purposeful use of information technologies in educational activities that meet child's needs, is mainly compensated by gaming activities on the computer;
- the emergence of mobile devices connected to the Internet. The capacities of such mobile devices are not used in training process. However, young learners tend to be well acquainted with such devices and use them solely for entertainment. In addition, other technical devices of algorithms automation could be used in the learning process: household and office equipment, robotic machines, automated construction sets, etc.;
- presence of specific skills to use information technology for personal use with young learners of primary school age. Currently, young learners get familiar with the computer components and software tools for themselves as a need arises for writing and editing papers or reports (text processors, program browsers, image editors), for communication (social networks, communication software), for finding new applications for mobile phones and so on. However, existing skills can be used to develop the necessary substantive and general study skills;
- approaches of presentation new information to children in the classroom need to change. Young learners expect beautiful, bright illustrations, presentations, videos to be used, game situations to be created and so on. This is due to the changes in the media – modern TV programs are bright, emotive, dynamic, in order to maintain the audience's attention; stories in publications for children are accompanied by high-quality illustrations, videos, etc.; modern books expect the reader's action to color, to find the path of the character, find differences, etc.;
- presence of a large number of applications and devices that can always help a young learner such as calculators and translation tools in mobile devices and computers; electronic reference books; spelling dictionaries, built into text editors. Prohibition to use such applications can be changed for the selection of such tasks, which provide for educational research and give young learners an opportunity to use various means to test their own suggestions;
- willingness of teachers, especially in primary schools, to use the new information technologies in education. In primary school a teacher and a textbook remain the

primary source of information, and that is the teacher who determines the level of acquired knowledge, the level of general study skills.

The named reasons condition the need for new approaches to implementation of information and communications technologies in teaching young learners. Primary school is focused on the development subject knowledge and general study skills such as skills of writing, reading, doing sums, spelling and others, assured command of which is a prerequisite for further successful studying in school.

Achieving success in building subject and general study skills is a natural need of every young learner. Each child comes to school with an aspiration to be successful and to gain recognition of personal achievements. For a young learner the expectations of success are connected with the efforts to gain recognition on the part of people important for him/her – parents, teachers, principal, classmates and getting approval from them. Experiencing success by young learners affects the quality of education, the development of the inner child's world, the formation of self-confidence.

As we know, success is a feeling of joy, satisfaction from the fact that the result, which the personality was striving for in his work, either matches his expectations, hopes, or exceeds them. Success is always connected with actions, it is not an end in itself. This is the result of achieving the desired goal, accepted, recognized and meaningful to a child, experience of feelings of joy after overcoming difficulties. Achievement provides for getting a specific result, and recognition can be public, local or individual [12]. The success supports a child's interest in learning, encourages him/her to overcome the difficulties, urges to achieve new goals.

One of the modern ways of forming a general study and subject skills by primary school children are tools and apps. Tools and apps are educational software that designed to shape and consolidate practical skills after preliminary mastering of theoretical data by young learners.

2 Literature review

The literature also holds many studies related to the positive effects of educational use of information and communication technology (ICT) in general [13] and cloud technology in particular [9]; instructional design principles, their interrelationships, overall process of designing effective teaching with ICT [4]; engineering design thinking, teaching and learning with ICT [5]. Some issues about primary learning were discussed such as developing technological pedagogical content knowledge in pre-service science teachers [1]; using ICT in primary school curriculum [8]; e-learning for primary teachers [7]; using ICT in primary Mathematics [11].

We wrote some articles concerning such a significant investment in the theory as didactic potential of digital educational resources for young learners [2]; on cloud-based complex of computer dynamic models and their transdisciplinary facilities [3]; and in practice as use of GeoGebra in primary pupils training [10].

3 Methods

In this research theoretical, empirical and statistical methods are used. Theoretical methods (analysis and synthesis) serve to analyze opportunities, advantages and disadvantages of tools and apps as new means to teach Math for young learners in primary school.

Empirical methods (observation, testing, pedagogical experiment) provide conducting the experiment itself, detailed and achievement tests in order to collect data for examining the efficiency of use systematic tools and apps to teach Math for young learners in primary school.

Statistical methods helped make statistical analysis of the pedagogical experiment data; the experiment was conducted at H. S. Skovoroda Kharkiv National Pedagogical University (Ukraine) at Computer Science lessons during 2016-2018 with 82 teachers-to-be for primary school.

4 Results

4.1 Interactive teaching tools in ensuring the success of young learners in Mathematics study

As mentioned above, using tools and apps to teach Math for young learners in primary school is relatively new teaching means for Ukrainian educationalists. Definitely, tools and apps can provide successful learning.

To educate young learners there are many tools and apps developed that facilitate the acquisition of skills in Math, in native language, in foreign languages, etc. However, a tool is only relevant if it allows you to work out exactly what caused the difficulty in a particular lesson, when the specifics of teaching material is taken into account, especially the perception of young learners.

Tools and apps unlike traditional manuals provide real variability of interactive tasks, uniqueness of exercises designed to form appropriate skills. In particular, for training young learners in performing calculations and doing sums, tools and apps are able to generate an unlimited number of numeric values to each task type, which allows diversifying the learning objectives, avoiding memorizing answers.

Tools and apps feature operative assessment of correctness of each task. Immediately after each task a child can get a reaction, indicating a correct solution. This immediate response is important in the early stages of training young learners when they expect approval for successful tasks or reassurance if making errors. Immediate reaction of the software will improve learners' confidence in their abilities, willingness to effort to improve their results. However, with getting experience in work with the software, instant control must be reduced in order to maintain and encourage learners' initiative.

An important feature is the adjustment of task difficulty. The difficulty level can be preset designated by a teacher or selected by a learner. Of particular interest there are tools and apps that implement adaptive algorithms and basing on learners' performance of first proposed tasks adjust automatically the level of subsequent tasks. Such adaptive interactive tools and apps are useful especially in primary school, because the difference in learners' background, in level of their habits and skills is the most notable among children in a class there are those who perform calculations easily, read quickly, etc., and those who are only acquainted with basic rules, learn to form syllables.

Automatic control of the difficulty level of tasks enables a teacher to identify quickly gaps in learners' knowledge and eliminate them. To learners whose skills, which are being trained, are already formed at a high level, tools and apps provide an opportunity to test their skills in doing exercises of increased difficulty. Thus, tasks for each learner are in the zone of their proximal development.

Tools and apps feature the ability to provide a shade of competitiveness and gaming to the exercises. It is worthy of note that game is not the main activity for primary school children, but it takes a significant place in child's life along with educational activities. Playful learning requires substantial intellectualization of primary school child's activities such as prompt realization of task, analysis of possible solutions, and search for the optimal variant. Moreover, the game encourages a learner to show initiatives, to develop activity, stimulates memory development, initiative thinking, releases emotions.

Using computer can realize the benefits of playful learning to the full extent. Exploring the specifics of computer games in education, there are the benefits as we know: increase learning motivation, encouragement of initiative and creative thinking, inclusion all learners into activities, getting experience of cooperation and teamwork, establishment of interdisciplinary connections, creation an informal environment for learning, favorable conditions for different strategies formation for solving problems, etc.

The emotional appeal of computer games, competitive game aspect, variety of events, exciting plot, realistic graphics, ability to control characters by oneself can instigate learners to achieve only a gaming purpose. Therefore, an important prerequisite for using computer games in education is to provide conversion of a gaming purpose (to help the character, to win, to release someone, to get the prize) into achieving educational goals.

For example, amid spectacular finding a way out of the labyrinth, there may be a process of mastering of subject skills. Playful presentation of a task, its dynamic nature, the practical purpose (to color a picture, to collect the keys, to rescue the princess, etc.) turns a routine work on developing skills into an interesting game that motivates learners to perform typical tasks. In addition, ability to compare the results of their own work with other learners' ones, gives such activities as sport excitement and an incentive to improve the obtained results.

There are some principles of construction interactive authors' apps. With the development of tools, the availability of information sources a teacher-to-be is able to create interactive authors' apps that take into account the specifics of training learners of a particular grade on a particular topic, their individual characteristics and hardware of educational process. Authors' apps can be directed to practice exactly the skills that cause difficulties for learners.

4.2 The principles of construction interactive authors' apps

Based on the analysis of existing experience of using tools and apps in the practice of primary education, we have identified the following principles of their construction to ensure successful teaching primary school children.

The first principle to be taken into consideration at app design is the following: *developed apps should generate learners' interest*.

The matter is a child who works with an interactive model is unobtrusively involved in educational and cognitive activity. It is important to emphasize that a learner is got involved in this activity by not direct teacher's instructions, but on his own desire to resolve the situation occurred on a computer screen. Plot design of a training material encourages him/her to educational activities. These actions require revealing subject knowledge and skills as well as the ability to apply them to a new environment. The combination of training and practical purpose that is achievable and understandable for a child gradually transforms into the learning motive. Such a transformation is promoted by the circumstance that at summarizing the child's work with a didactic model, his attention is focused on the importance of the knowledge and skills that have helped to achieve a successful outcome.

In primary school it is crucial to include pure life realities into the learning content. It provides implementation of the didactic principle of training and practice connection.

Tools and apps must allow applying a learning task with all its attributes: for example, travelling cars, a chocolate bar that is being eaten, a pie which is being divided etc. A learner can move the car, divide the chocolate bar, cut the pie in different ways.

Tools and apps allow expanding the diversity of training tasks, suggesting the problem having various solutions. So, a learner is assigned not only to solve the problem correctly, but also to make a rational choice of the solution method. The second principle to be taken into consideration at app design is the following: *apps should be visually presented to create pleasant emotional background*.

Child's emotions at classroom activity have a significant impact on it. Emotions initiation of primary schoolchildren usually is associated with a particular situation. It might be nice visual design, familiar objects or characters, valid comments. All this calls up a learner's pleasant feelings.

Development of positive emotions and aesthetic senses is also promoted by the series of techniques. They include friendly interface of didactic interactive models, harmoniously picked up colors, using special techniques to attract and focus learner's attention, to develop his imagination, thinking, and memory. A positive emotional background of a child's learning with interactive models is also guaranteed by the possibility to cancel his actions at any moment and to return to the previous step. A learner has an opportunity to feel free doing his trials at searching right or effective task solving. He is not afraid of any negative consequences. It promotes creation of a learner's positive emotions, forming his persistence and confidence. The third principle to be taken into consideration at app design is the following: *problem definition should involve learners into critical analysis of input data as for their adequacy, redundancy, actuality*.

For this purpose, the developed apps have redundant information, so that a child could choose what he/she needs. For example, additional measurements, additional data etc. The fourth principle to be taken into consideration at app design is the following: *apps should allow learners to operate free, for example, to perform transformations of geometric solids (rotate, drag, resize them).*

The peculiarity of young learners' perception is a close connection with an action. For schoolchildren, especially in their 6–7 years, to perceive the subject means to do something with it, for instance, to touch, to rotate, and to change. Practical actions play a significant role for the development of child's cognitive processes. Therefore, apps should allow manipulation with learning objects.

Apps which are focused on learners' research activities should provide possibility of the figures transformations such as rotation of geometric shapes, overlapping some shapes on others for their comparing and resizing. Making changes with shapes meets child's need to experiment. At the same time it allows to see results of his activities and to make his/her own conclusions.

Some additional principles to be taken into consideration at interactive models design are: developed apps should provide support (step by step assistance) of learners' activity to achieve success and completeness at tasks performing; developed apps should provide an opportunity to verify the correctness of the obtained result.

On the one hand, to succeed in learning it is important for a child to have an opportunity to achieve his intended result. Timely assistance is crucial for learners who have just started learning. Developed apps contain elements that provide necessary support for a learner. Every child who works with the model can get help in time. A child can get help after his request in the form of textual commentary, additional constructions, and solution. The system of multi-level assistance in tools and apps focuses on achievement the result by each child.

On the other hand, training should be accompanied by overcoming difficulties feasible for a learner. Depriving a learner of difficulties we, however, deny him feeling joy and pleasure of success gained through his/her own efforts. Difficulties in the learning process are essential to meet learner's needs in cognitive activity. Therefore, learner's assistance at difficulties should be dosed, not excessive, but sufficient to support his efforts and aimed at making him/her overcome obstacles himself/herself. Learners in their learning activities should not act on a pattern and algorithm and retain the right to initiative, possible errors and their correction. A learner should be relaxed in his own actions. The experience in this activity is now appreciated higher than well learned rules in solving typical tasks as this experience teaches a learner how to acquire knowledge.

Taking dosage help for learners in apps is a complex task and is currently being implemented fairly rarely, but this assistance will help developing initiatives to identify creative abilities, creating strong-willed child. Successful and progressing schoolchildren can employ maximum available to overcome difficulty level tasks for schoolchildren.

4.3 Interactive tools for construction authors' apps by primary teachers-to-be

We would like to show the basic tools for construction interactive authors' apps. A teacher-to-be, creating apps, independently, can use modern tool kits to create interactive exercises and didactic computer games. The interface of many tool kits, oriented to design author's didactic resources, is simplified and intuitive for an average user and it does not require additional training. In addition, as a rule, these tools include a set of templates for rapid development and offer the available examples.

To develop apps a teacher-to-be can use programs that are part of an integrated Microsoft Office package, spreadsheets and applications to create presentations.

The choice of these applications is due to several reasons:

- wide spread of Microsoft Office package among different specialists;
- preparedness of teachers-to-be to use office technology in teaching;
- presence of large collections of teaching resources developed by teachers for their own educational activities. Ready didactic resources are available to teachers and can be adapted to the conditions of a particular grade and lesson;
- teachers' experience of usage software package for the preparation of teaching and learning materials, documents, etc.;
- possibilities to integrate various forms of information in apps, so, slide or book may contain author's drawings prepared in appropriate graphics software, sounds, prepared in music editors, text fragments.

There are the examples of authors' apps. Apps developed by our students from H. S. Skovoroda Kharkiv National Pedagogical University, teachers-to-be for young learners for primary school to teach Math in Microsoft Excel spreadsheet are presented in the form of tests, didactic games, crossword puzzle (Fig. 1).

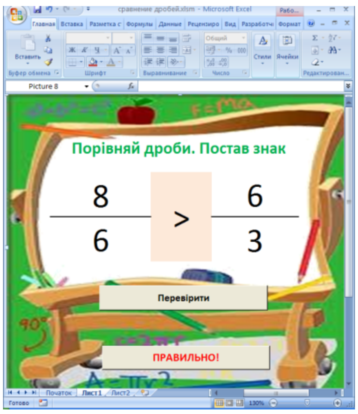


Fig. 1. Apps for learning fractions developed in Microsoft Excel

Basically, such capabilities provide convenience to create training systems in Microsoft Excel:

- data exchange between applications which facilitates the process of preparing the environment for apps and enables to provide an attractive appearance;
- modifications and additions to the tasks when they are needed;
- programmable generation of numerical values in the text of tasks and answers. This allows to prevent memorizing the answers by learners and provides variation of the tasks.
- simplification of the analysis of the assignment correctness by the relevant functions;
- presentation of the test results in the form of tables, charts, graphics, etc.;
- storage of test results and the ability to further analysis;
- availability of templates to create tests that are available to teachers-to-be at any time.

The advantage of using presentation software to develop automated tests is the possibility of their attractive design, providing a soundtrack, the ability to support each task or question with a desired scheme or pattern. In addition, the PowerPoint environment allows the construction of matching tasks, where the correspondence between the elements of two sets is defined, the tasks of ordering the sequence of actions.

Of special convenience for a teacher-to-be is access to ready-made templates that have a programmed tasks check. In the environment of Microsoft PowerPoint presentation the apps developed by our students are presented (Fig. 2, Fig. 3). The apps include controls designed for automatic creation of tasks for learners and elements that analyze user actions.

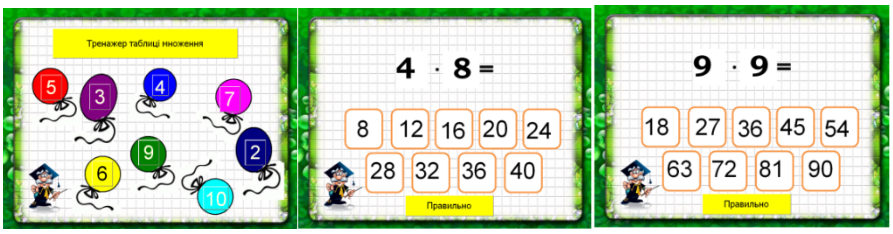


Fig. 2. Apps for learning multiplication tables developed in Microsoft Power Point

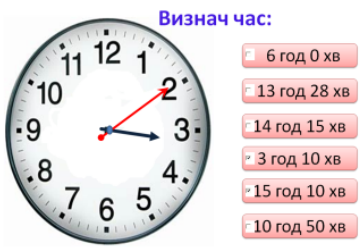
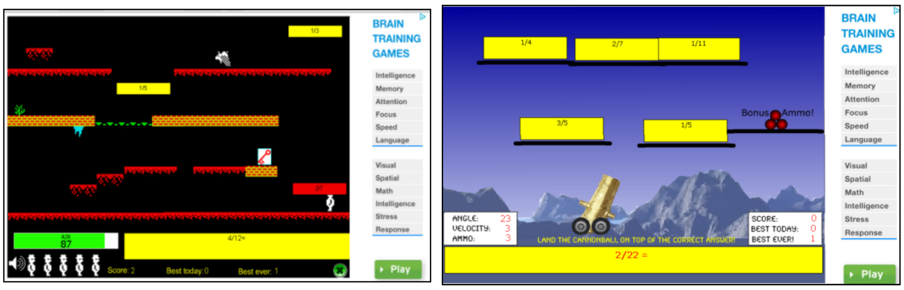


Fig. 3. Apps for learning analog clocks developed in Microsoft Power Point

However, the development of apps in these packages requires knowledge of the programming language Visual Basic for Application and it is a painstaking task for a teacher-to-be. To create apps primary school teachers-to-be can use designing environments which include a substantial set of templates and patterns associated with school material. In particular, such app designers can be useful for a teacher-to-be. They are the designers: Classtools.net, Zondle, Learningapps.org, Studystack and others.

Within the environment Classtools.net (http://classtools.net/) a teacher-to-be can develop interactive posters, charts, diagrams, computer educational games to support any school subject such as Math, Science, Reading and more. The environment is an online resource that offers a set of templates for creating teaching tools. In particular, the template "Arcade Game Generator" used by our students (Fig. 4a) enables to create computer games such as quizzes in the form of arcade games (search for pairs of questions and answers, hitting the target with the answer), pattern "Dustbin Game" used by our students (Fig. 4b) creates tasks related to the grouping of elements, template "Post It" allows to create interactive posters in which an explaining text is shown when you hover your mouse on a specific part of the image. Options of patterns are improved and their number is constantly growing.



a *b*

Fig. 4. The template "Arcade Game Generator" (a) and pattern "Dustbin Game" (b)

Of special convenience for teachers-to-be is that developed apps can be stored on the server for the organization of joint work of learners, on the local computer for future use in the classroom, or printed out.

The didactic games designer Zondle (http://www.zondle.com) allows a teacher-to-be to create apps for any subject. The designer offers template games to fill in with the subject content. In this case, a teacher-to-be needs only to prepare assignments and choose a template of the offered. Designer offers to use certain types of tasks, among them the tasks that include:

- select the correct answer from the offered;
- enter the correct answer from the keyboard;
- confirm the correctness of a statement;
- insert missing words into the statement and others.

The environment also provides an option to develop the game scenario, chose the characters and fill in substantive tasks by oneself. Creating author's games does not require programming and additional training.

In Fig. 5 the examples of education games made by our students for young learners are shown, reviewing the multiplication table and the formation of ideas about true and false statements.

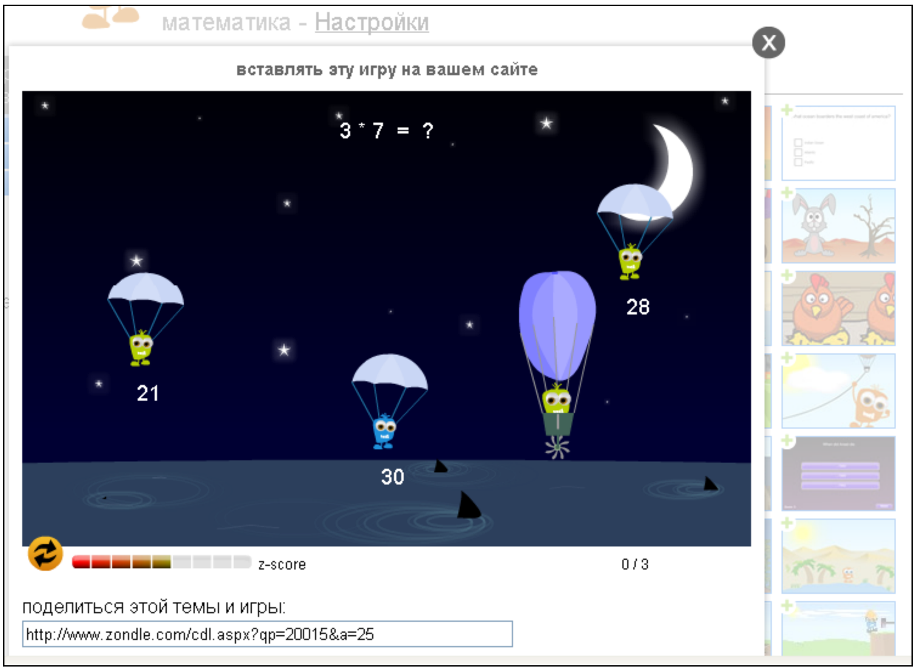


Fig. 5. Example of education games in Mathematics in Zondle environment.

The developed educational games are stored in a network that allows to use them in extra-curricular activities for learners. The designer of interactive exercises Learningapps.org (http://learningapps.org) allows you to create training exercises that require practical actions from user: to place in the correct order, to choose the correct answer, to solve a crossword puzzle, to solve a puzzles, to group etc. Many templates are offered to a teacher-to-be as well as a set of ready-made interactive exercises that can be used as templates. They help in creation of such didactic exercises that would be appropriate in a particular grade, in the study of a particular topic. Ready projects can be stored on a local storage or network.

In Fig. 6 some examples of developed interactive exercises made by our students are shown, they illustrate mathematical operations to learners and train their verbal counting.

The designer of education games Studystack (http://www.studystack.com/) allows not only to create interactive exercises using the set of templates, but also offers practical tasks already available from a variety of subjects: Mathematics, Nature, Art, History, etc. Projects are stored on the server, which allows using them both in the school and home training. The designer has been working since 2001 and has accumulated a significant amount of ready interactive exercises for children from preschool to high school. The advantage of using this designer is ease of preparation of training exercises: a teacher-to-be simply enters tasks text and correct answers, on which base different versions of interactive exercises are created automatically such as quizzes, crosswords, hit on target games and hangman games, etc.

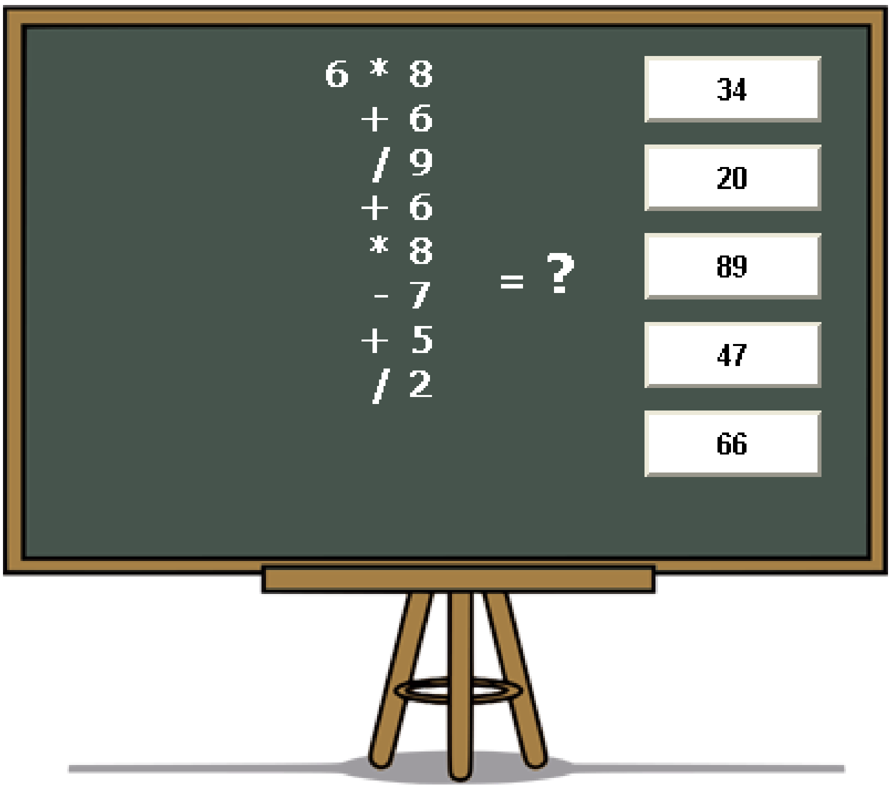


Fig. 6. Examples of interactive exercises created in the Learningapps.org environment

To create apps a teacher-to-be can also use an environment GeoGebra (http://www.geogebra.org). It is very popular nowadays [6]. Some examples of apps developed by our students for young learners on GeoGebra are shown in Fig. 7–11.

All apps were developed by teachers-to-be for primary school during their studies at H. S. Skovoroda Kharkiv National Pedagogical University. Apps in figures are original and tested by the students during teaching practice. They are always available for primary school teachers. We think that the experience for the development of these apps will be useful for teachers-to-be, and working teachers in their professional activities.

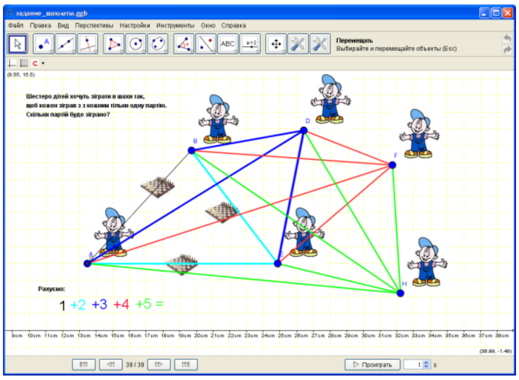


Fig. 7. Apps for task about chess: Six children want to play chess, so that everyone plays with each player once. Find how many parties will be played

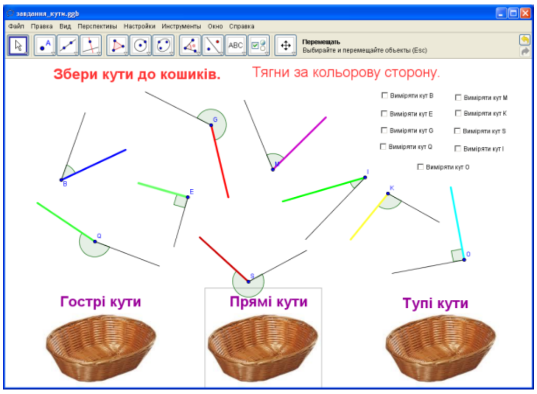


Fig. 8. Apps for tasks about angles. Children collect right, obtuse and acute angles into baskets

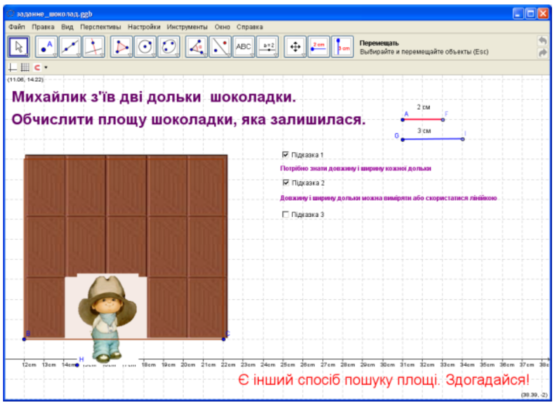


Fig. 9. Apps for a task: Mykhailyk has eaten 2 pieces of the chocolate bar. Find the square of the chocolate bar that remained

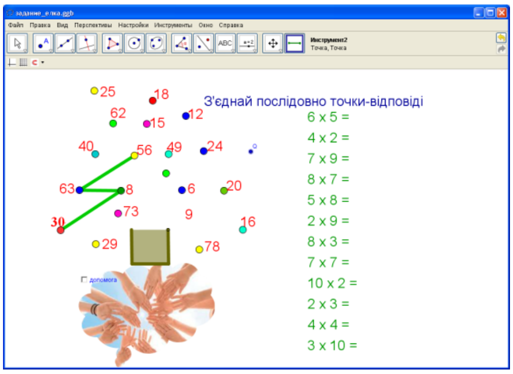


Fig. 10. Children solve arithmetic tasks and connect in series points-answers. As a result, children get a Christmas tree

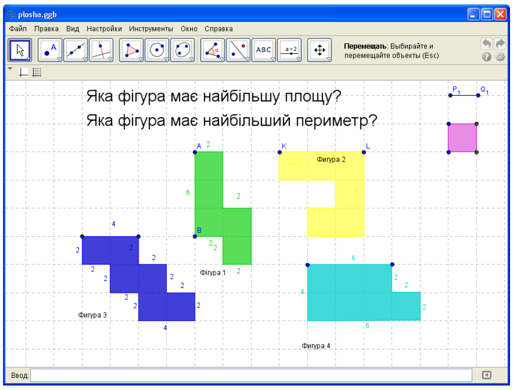


Fig. 11. Apps for a task about square and perimeter of shapes. Children determined which of the shapes has the largest square and the largest perimeter

5 Discussion

The main results of effectiveness of tools and apps are confirmed by many scholars, namely:

- instead of being knowledge-focused, tools and apps are built around the skills [1] necessary to carry out specified Math tasks in primary school; the focus is on what young learners can do at Math lessons rather than on what they know;
- young learners are expected to demonstrate practice-added skills which are assessed by looking at outcomes of apps rather than process [8];
- young learners' performance is evaluated during the instructional process against common learning standards [68], and all forms of assessment are standards-based and criterion-referenced [7]. After all, teachers-to-be will be able to deliberately choose the most effective direction in learning young learners with tools and apps.

6 Conclusions

Use of tools and apps is an effective way of developing successful general study skills for young learners. Tools and apps feature the ability to provide real variability of tasks, uniqueness of exercises, operative assessment of correctness in each task, adjustment of task difficulty, ability to provide a shade of competitiveness and gaming to the exercises. Tools and apps can be created by the universal software tools, such programs that are part of an integrated Microsoft Office package or special designing environments.

The capabilities of the tools and apps are covered, which ensure successful acquisition of knowledge, for developing young schoolchildren's skills. Considered tool kits enable a teacher-to-be to design independently author's apps that meet the needs of a particular lesson, enable to achieve the lesson goal with the peculiarities of the educational process in primary school.

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Cloud calculations within the optional course *Optimization Problems* for 10th-11th graders

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Abstract. The article deals with the problem of introducing cloud calculations into 10th-11th graders' training to solve optimization problems in the context of the STEM-education concept. After analyzing existing programmes of optional courses on optimization problems, the programme of the optional course *Optimization Problems* has been developed and substantiated implying solution of problems by the cloud environment CoCalc. It is a routine calculating operation and not a mathematical model that is accentuated in the programme. It allows considering more problems which are close to reality without adapting the material while training 10th-11th graders. Besides, the mathematical apparatus of the course which is partially known to students as the knowledge acquired from such mathematics sections as the theory of probability, mathematical statistics, mathematical analysis and linear algebra is enough to master the suggested course. The developed course deals with a whole class of problems of conventional optimization which vary greatly. They can be associated with designing devices and technological processes, distributing limited resources and planning business functioning as well as with everyday problems of people. Devices, processes and situations to which a model of optimization problem is applied are called optimization problems. Optimization methods enable optimal solutions for mathematical models. The developed course is noted for building mathematical models and defining a method to be applied to finding an efficient solution.

Keywords: optimization problem, cloud calculation, CoCalc.

1 Introduction

1.1 Problem statement and its topicality substantiation

Modern society is evolving fast. The character of current changes is conditioned, first of all, by rapid informatization of people's life. The scientific-technical and informational advance of the 20th-21st centuries has caused transition from the industrial society to the informational one. These changes are going on. Experts predict the so-called smart society appearing in the nearest decade. Rapid paces of life dictate their terms of success to people.

A person has to be able to make his/her activity and surrounding processes efficient in terms of time expenditures for study, work and transport losses. The problems of optimizing control over a small group of classmates working on a project or managing a business, etc. should also be solved.

1.2 Analysis of the latest researches and publications

Development of optional and selective courses with the inter-subject integral content is one of the most urgent issues of subject-oriented instruction of senior school students. These courses allow students, on the one hand, to better visualize prospects of a chosen future profession, on the other hand, – to satisfy their educational needs to the fullest.

It is worth noting that in solving optimization problems, the notion of an optimization problem model is as important as that of an optimization problem. Correspondingly, a target function is a mathematical function to be optimized in a problem, while limitation is a set of requirements to problem parameters in the form of equations or inequalities. If the target function is linear and linear limitations are imposed on its arguments, a corresponding optimization problem refers to the problem class of linear programming.

From the practical point of view, optimization problem solution means that a person in his/her activity aimed at achieving a set goal always strives for the best or the most efficient ways of action if there is an opportunity to choose out of an endless variety of methods the one that helps to achieve it. Ways of action or strategies are often characterized by a value. In this case, the problem of choosing the best strategy implies finding an extremum – the minimum or the maximum of this value.

It is also important to admit that the mathematical apparatus of optimization problem solution is used not only as a tool of ordinary calculation. It is also essential for decision making while choosing the most efficient variant to achieve the best result.

It is essential to accentuate the importance of optimization problem solution aimed at demonstrating applicability of inter-subject connections between mathematics and other subjects. It should be noted that complex optimization problems associated with long calculations should be solved professionally, while 10^{th}-11^{th} graders are able to deal with less complicated ones. Such problems include those of the external ballistics theory (determining the maximum missile range, building a safety parabola equation), optimization problems in studying the topic *Percentage*, etc.

Thus, optional courses dealing with optimization problems allow showing 10^{th}-11^{th} graders how to formalize decision making problems, solve them by applying mathematical tools and how to apply obtained solutions to practice.

At present, there are not so many authors' optional courses dealing with optimization problems. Yet, the available ones do not accentuate application of information technologies to providing instruction which is a sign of meeting modern requirements to training organization under the STEM concept. Some researchers [2; 4; 5; 6; 7; 9; 10; 11] think that CoCalc can be one of software tools to be applicable to solving optimization problems.

1.3 Research methods

Research methods include theoretical analysis and synthesis of data from research and scientific-pedagogical literature concerning the research problem, analysis of regulatory and legal documents in education that regulate optional courses, investigation into training programmes, teaching aids, programmes of standard and optional courses for 10^{th}-11^{th} graders in similar subjects.

2 Inside the optional course *Optimization Problems*

The STEM-concept in education is aimed at forming students' basic ideas of understanding unity of informational principles of building and functioning of various systems and management processes in nature, engineering and society.

Considering these postulates, we have developed the course *Optimization Problems*. Its relevance is explained by rapid updating of science-intensive technologies calling for highly-qualified specialists of a new type – active, creative, able to enrich their knowledge on elaborating and mastering new generations of machines and industrial processes. According to the competence-oriented approach, there appears a necessity for new interpretation of subject instruction and new conditions of incorporating instruction into formation of students' competences. Therefore, it is required to find critically new characteristics of subject instruction. New educational standards aimed at self-development, self-identity and self-realization make educators look for new approaches and forms of training organization as well as new content of traditional training forms. In view of this, principles of training organization are changing. Out-of-class forms of training are prioritized, while principles of independent work organization are becoming more extensive. Independent work is a cognitive activity associated not only with knowledge acquisition, but also with practical experience in the context of competences.

The developed course considers the whole class of conventional optimization problems that vary in their content. They can be associated with designing devices and technological processes, distributing limited resources and planning business functioning as well as with everyday problems of people. Devices, processes and situations to which a model of optimization problem is applied are called optimization objects. Optimization methods enable optimal solutions to mathematical models. The developed course is noted for building mathematical models and defining the method to be applied to finding an efficient solution.

The specific feature of the suggested course is simple presentation of the training material based on concrete examples and problems. Studying linear programming by applying mathematical materials and solving optimization problems which are understandable for senior school students is of particular interest in this course. In this case, optimization problems are treated as those reduced to finding the maximum or the minimum value. These problems are also called extremal ones as finding the maximum and the minimum value is neither more nor less than finding an extremum – the maximum or the minimum of a function.

While solving such problems, scientific thinking and the ability to see a situation as a whole are formed. Cognitive interests and abilities to find a way out of critical situations with minimum losses are also developed. It is evident that an employee possessing these qualities is much more valuable for society.

Basic principles of optimization problem solution by using computer technologies can be taught at Informatics classes with enhanced mathematics study as they require fundamental mathematical training. As the range of topics is very wide, it is reasonable to treat solving even one of them as a project.

Let us look into some variants of projects to be proposed to students within the optional course *Optimization Problems*. First, students should be provided with basic algorithms in CoCalc [4; 8]. While doing a project, students get acquainted with methods of optimization problem solution. One should accentuate the recommendations for improving functioning of a process to be simulated while discussing project results.

There are several stages in teaching optimization problem solution.

Optimization problem 1. *Any port in a storm* [1]: there is significant danger to boats caught out in the open sea during a storm. Ideally, boats will dock before the storm hits and wait it out. The map above shows 20 orange boats out at sea. With a storm approaching, each boat needs to be directed to one of three docks. Docks have a limited number of spaces available for boats (indicated by the rectangular spaces). Altogether, there are 20 boat spaces available. The boats are clustered into three areas and each area varies in distance to the docks (as indicated by the black arrows). All boats must be assigned to one space in a dock. **Question: What is the minimum possible total distance traveled by all boats?** More detailed information is presented in Fig. 1.

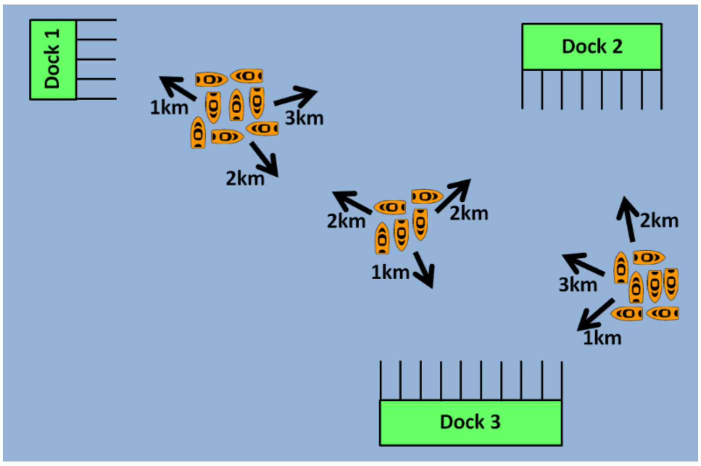

Fig. 1. Figure to the Optimization problem 1

Students must build a mathematical model of the problem. To solve the problem we offer students the following code in CoCalc [8]:

```
A=matrix(QQ, [[…,…,…],[…,…,…]],[…,…,…]]); A
m=A.nrows()    #p
n=A.ncols()    #q
isoptimal=0
isunbounded=0
XVar=[]
TVar=[]
for i in range(n-1):
  XVar.append('X'+`i+1`)
for j in range(m-1):
  TVar.append('T'+`j+1`)
p=-1
q=-1
isfeasible=1
problemfeasible=0
#Atemp=matrix(QQ, m,n)
while (isoptimal==0 and isunbounded==0):
  isoptimal=1
  isunbounded=1
  isfeasible=1
  problemfeasible=1
  p=-1
  q=-1
  #checks to see if current position is feasible
  for i in range(m-1):
    if A[i,n-1]<0 and p<0:
      p=i
      isfeasible=0
      isoptimal=0
      isunbounded=0
  #Checks to see if problem is feasible
  if isfeasible==0:
    problemfeasible=0
    for k in range(n-1):
      if A[p,k]<0 and q<0:
        q=k
        problemfeasible=1
  if problemfeasible==0:
    print('The problem has no feasible solutions')
    p
    q
  else:
    #checking last row to see if optimal (step 1),
    #it's optimal when all are negative
    for i in range(n-1):
```

```
      if A[m-1,i]>0:
        isoptimal=0
    if isoptimal==1 and isfeasible==1:
      print('This is optimal, ignore everything after
this')

    #finding the right [p,q] to pivot on and will only
    # pivot if point is feasible
    if isoptimal!=1 and isfeasible==1:
      q=-1
      #finding position q to pivot on
      for i in range(n-1):
        if A[m-1,i]>0 and q<0:
          q=i; q

      #checking column q to see if all negative (step 4)
      for k in range(m-1):
        #A[k,q]
        if A[k,q]>0:
          isunbounded=0

      if isunbounded==1:
        print('This is unbounded')
      p=-1
      #finding position p to pivot on (step 5)
      for j in range(m-1):
        if A[j,q]!=0:
          if A[j,n-1]/A[j,q]>=0 and A[j,q]>0:
            if p<0:
              p=j; p
            if p>=0 and A[j,n-1]/A[j,q]<A[p,n-1]/A[p,q]:
              p=j; p
      print('pivot on position')
      p
      q
    #the temporary matrix pivots on [p,q]
    Atemp=matrix(QQ, m,n)
    for i in range(m):
      for j in range(n):
        if i==p and j==q:
          Atemp[i,j]=1/A[p,q]
        if i==p and j!=q:
          Atemp[i,j]=A[i,j]/A[p,q]
        if i!=p and j==q:
          Atemp[i,j]=-1*A[i,j]/A[p,q]
```

```
        if i!=p and j!=q:
          Atemp[i,j]=(A[i,j]*A[p,q]-A[i,q]*A[p,j])/A[p,q]
    Xp=XVar[q];Xp
    Tp=TVar[p];Tp
    XVar[q]=Tp
    TVar[p]=Xp
    Atemp
    A=Atemp
    XVar
    TVar
```

Optimization problem 2. *Cell Towers* [3]: as the head of analytics for a cell phone company, you have been asked to optimize the location of cell towers in a new area where your company wants to provide service. The new area is made up of several neighborhoods. Each neighborhood is represented by a black house icon in the accompanying image. A cell tower can be placed on any square (including squares with or without a neighborhood). Once placed, a cell tower provides service to 9 squares (the 8 adjacent squares surrounding it and the 1 it sits on). For example, if you placed a cell tower in B2, it would provide service to A1, B1, C1, A2, B2, C2, A3, B3, and C3. The company recognizes that it may not be worthwhile to cover all neighborhoods, so it has instructed you that it needs to cover only 70% of the neighborhoods in the new area. Each cell tower is expensive to construct and maintain so it is in your best interest to only use the minimum number of cell towers. **Question: What is the minimum number of cell towers needed to provide service to at least 70% of the neighborhoods?** More detailed information is presented in Fig. 2.

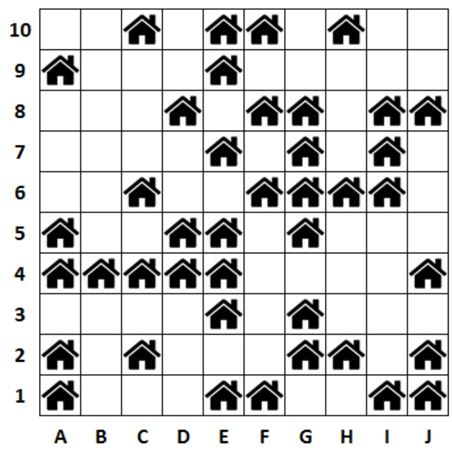

Fig. 2. Figure to the Optimization problem 2

Students must build a mathematical model of the problem. To solve the problem, we offer students the same code as in optimization problem 1.

Optimization problem 3. For the project, students can be offered the task of finding the optimal route with restrictions. More detailed information is presented in Table 1 and Fig. 3. There are a certain number of containers in each quarter, each with a capacity 1,1 m^3. Just such containers 110. The following additional conditions are met: the volume of the truck body is limited and equal 43 m^3. The point of departure of a filled truck is point B. The truck starts its journey from Base to Point A. The following flights provide a quarterly cycle (from Point B to Point B). The last point of arrival van-tag with an empty body – Point A. Students should independently ask questions and solve the problem.

Table 1. The number of containers in the area.

No	Number of containers	No	Number of containers
1	4	16	1
2	5	17	3
3	6	18	3
4	4	19	2
5	5	20	4
6	3	21	5
7	2	22	2
8	5	23	6
9	4	24	2
10	3	25	1
11	6	26	1
12	3	27	4
13	3	28	3
14	7	29	5
15	8		

To solve the problem, we offer students the following code in CoCalc:

```
g = graphs.ChvatalGraph()
g = g.minimum_outdegree_orientation()
p = MixedIntegerLinearProgram()
f = p.new_variable(real=True, nonnegative=True)
s, t = 0, 2
for v in g:
  if v != s and v != t:
    p.add_constraint(
      sum(f[(v,u)] for u in g.neighbors_out(v))
      - sum(f[(u,v)] for u in g.neighbors_in(v)) == 0)
```

```
for e in g.edges(labels=False):
  p.add_constraint(f[e] <= 1)
p.set_objective(sum(f[(s,u)] for u in
g.neighbors_out(s)))
p.solve()  # rel tol 2e-11
```

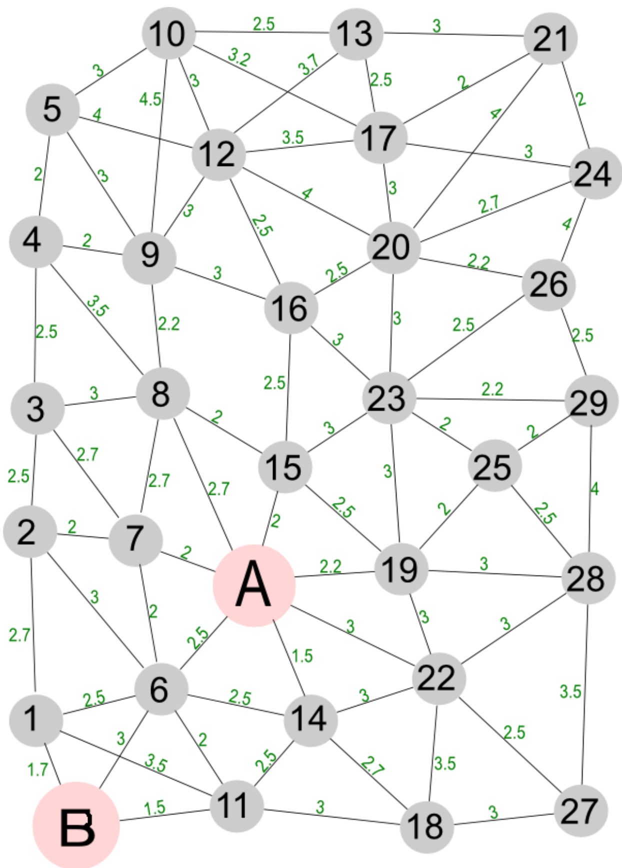

Fig. 3. Figure to the Optimization problem 3

Stage 1. Studying theoretical principles. It includes the notion of an optimization problem and the necessity to solve such problems in modern life. There are some problem examples provided.

Various situations require absolutely different solutions depending on the chosen or set criterion.

For example, it is possible to spend 50 minutes driving from one city to another. But if part of the route is covered by railway and then by bus, it will take 30 minutes only. It is evident that the latter solution is better if it is necessary to get to one's destination in the shortest time possible. In other words, this solution is the best by the criterion of time minimization. According to another criterion (for example, reduction of expenditures or the number of changes), the former solution is better. Thus, to solve problems, it is essential to analyze quantitative parameters – minimum expenditures, minimum deviations from the standard, maximum speeds, revenues, etc.

Stage 2 is studying the general plan of optimization problem solution. Here, the notions of a target function, admissible solutions, and the system of limitations are introduced.

The general plan of optimization problem solution includes:

- investigation into an object to define parameters required to solve the problem;
- descriptive simulation, i.e. determining basic connections and dependencies between parameters;
- mathematical simulation;
- choice or development of the method for solving the problem;
- computerized implementation of the solution;
- analysis of the solution obtained.

One of the problems is considered in the form of a mathematical model as a theoretical basis to receive practical solutions on the computer. Next, a practical method is selected and implemented. After obtaining the result, one should analyze it considering various variants of optimizing the process by the ready-made algorithm with initial data changed.

Stage 3. Theoretical and practical implementation of solving any optimization problem by applying systems of computer mathematics or other tools.

The ability to solve optimization problems is essential for modern people. This should be taught. Introduction of the project course *Optimization Problem* could be a way out.

If the current variant of training is used without any chance of introducing an optional course like this, the work can be organized as follows. Mathematical models can be created at Mathematics classes, while algorithms of solving these problems by means of CoCalc can be implemented at Informatics classes. Abilities acquired through studying under this mode will help students become successful in new social conditions.

The course programme was based on existing programmes of optional courses of similar character as well as teaching aids and programmes of optional courses.

The developed course is connected with secondary school basic courses of *Mathematics* (sections Linear Equations and Inequities, Solution of Systems of Linear Equations and Inequities) and *Informatics* (Mathematical Simulation, Spreadsheets).

The developed course is aimed at theoretical and practical study of basic notions and methods of optimization as well as basic principles of the decision making theory to form students' ideas of applying the mathematical apparatus to solving problems of finding efficient solutions. While achieving the set aim, a number of tasks are solved:

- getting students acquainted with basic principles of the decision making theory and optimization methods;
- demonstrating application of optimization methods to practical activities;

- introducing methods of solving linear programming problems and their application to students;
- forming students' abilities of solving decision making problems by applying studied optimization methods.

The optional course *Optimization Problems* comprises 35 hours designed for a semester. The recommended number of hours per week in the 10th grade is 2, in the 11th grade – 1.

The course consists of two main content modules:

1. The role of the theory and methods of decision making in the modern world (17 hours);
2. Linear optimization (17 hours).

The content of the first module includes general statement of the decision making problem in various spheres of human activity as well as some decision making methods. Presentation of theoretical materials of this section should be illustrated by concrete examples and problems. This module covers the following topics:

- The decision making theory (basic notions and definitions);
- The decision making theory in economics;
- Mathematical simulation of decision making;
- Collective decision making. Models of collective choice;
- Decision making in the organization theory.

The second module includes the most important, yet at the same time, simple section of the decision making theory – linear programming. It enables students to comprehend applicability of systems of linear equations and inequities, methods of studying and building function diagrams, mathematical modules of real-life objects and processes to human activity. Presentation of theoretical materials of this section should also be illustrated by concrete examples and problems. This module covers the following topics:

- Basic principles of linear programming;
- Linear optimization problems;
- The graphical method of solving linear programming problems;
- The simplex-method of solving linear programming problems;
- Solving linear programming problems by means of CoCalc.

The suggested programme of the optional course is of a rough character and open to changes to enable a teacher to correct and modify the course depending on the type of an educational institution where the course is taught. It should be noted that the course programme includes some modules and topics that can be used as independent optional courses if their content is expanded.

The course programme provides theoretical and practical classes and independent work (solo work on problem solution). The distance mode of training is recommended.

After mastering the programme material, a student can get an idea of practical application of the decision making theory and optimization methods to everyday life and professional activity. Besides, there are the following requirements to students' knowledge and abilities to be formed after mastering the course:

- The student knows basic notions of the decision making theory, methods of decision making and optimization, basic problems of linear programming, the simplex-method of solving linear programming problems;
- The student is able to correctly choose a relevant solving method to optimize a problem and implement it;
- The student possesses methods of solving problems of linear programming, abilities of applying CoCalc and modern mathematical tools to solving practical problems.

3 Conclusions

After analyzing existing programmes of optional courses on optimization problems, the programme of the optional course *Optimization Problems* has been developed and substantiated implying solution of problems by the cloud environment CoCalc. It is a routine calculating operation and not a mathematical model that is accentuated in the programme. It allows considering more problems which are close to reality without adapting the material while training 10^{th}-11^{th} graders. Besides, the mathematical apparatus of the course which is partially known to students as the knowledge acquired from such mathematics sections as the theory of probability, mathematical statistics, mathematical analysis and linear algebra is enough to master the suggested course. The developed course deals with a whole class of problems of conventional optimization which vary greatly. They can be associated with designing devices and technological processes, distributing limited resources and planning business functioning as well as with everyday problems of people. Devices, processes and situations to which a model of optimization problem is applied are called optimization problems. Optimization methods enable optimal solutions for mathematical models. The developed course is noted for building mathematical models and defining a method to be applied to finding an efficient solution.

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Using the e-learning course "Analytic Geometry" in the process of training students majoring in Computer Science and Information Technology

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Abstract. As a result of literature analysis the expediency of free access of bachelors majoring in Computer Sciences and Information Technologies to modern information educational resources, in particular, e-learning courses in the process of studying mathematical disciplines is substantiated. It was established that the e-learning course is a complex of teaching materials and educational services created for the organization of individual and group training using information and communication technologies. Based on the outlined possibilities of applying the e-learning course, as well as its didactic functions, the structure of the certified e-learning course "Analytic Geometry" based on the Moodle platform was developed and described. Features of application of cloud-oriented resources are considered: Desmos, Geogebra, Wolfram|Alpha, Sage in the study of the discipline "Analytic Geometry".

The results of the pedagogical experiment on the basis of Borys Grinchenko Kyiv University and A. S. Makarenko Sumy State Pedagogical University are presented. The experiment was conducted to verify the effectiveness of the implementation of the e-learning course "Analytic Geometry". Using the Pearson criterion it is proved that there are significant differences in the level of mathematical preparation of experimental and control group of students.

The prospect of further scientific research is outlined through the effectiveness of the use of e-learning courses for the improvement of additional professional competences of students majoring in Computer Sciences and Information Technologies (specialization "Programming", "Internet of Things").

Keywords: e-learning course, computer sciences, information technologies, analytic geometry, professional training.

1 Introduction

In conditions of modernization of higher education in accordance with the requirements of the information society development, an important problem remains the free access of individuals of education to modern information educational resources. A number of scientific studies which disclose the tendencies of the development and reformation of modern professional education in the context of the building of an information society have been recently implemented [18; 20]. The influence of information and communication technologies on the improvement of content, forms and methods of teaching has been revealed (Yurii O. Doroshenko [3], Svitlana H. Lytvynova [7], Oleksandr V. Merzlykin [8], Nataliia V. Morze [9], Zarema S. Seidametova [15], Serhiy O. Semerikov [19], and etc.).

Mentioning the undeniable value of the research carried out, another important problem of using electronic educational resources should be outlined, in particular, e-learning courses in the process of studying mathematical disciplines at the university. It should be noted that the issue of extremely low mathematical training of university students worries not only the authors of this scientific work. In recent years, a series of studies aimed at improving the mathematical training of students through ICT has been implemented. Yurii V. Horoshko [5] has developed a system of information modeling in training of future teachers of mathematics and informatics, Yurii S. Ramskyi [12] has developed a methodical system for the information culture formation by future teachers of mathematics. Besides the method of using mobile mathematical environments (Kateryna I. Slovak [17]) and the system of computer mathematics Sage during independent work of high school students (Svitlana V. Shokaliuk [16]), systems of computer mathematics (Oksana I. Tiutiunnyk [21]) are developed. The implemented studies are aimed at improving professional training, mainly students of Engineering and Economic specialties. The problem of improving the professional training of bachelors majoring in Computer Science and Information Technologies through ICT requires further careful consideration.

2 The objective of research

The purpose of our research paper is to prove the effectiveness of using the e-learning course "Analytic Geometry" in order to improve the mathematical training of bachelors majoring in Computer Science and Information Technology.

3 Research methodology

The purpose of research has made us use the complex of the relevant methods: scientific literature analysis in order to establish the state of the problem development, the definition of the categorical and conceptual apparatus of investigation; synthesis, generalization, systematization for theoretical substantiation and practical development of e-learning course; empirical: diagnostic (conversation, content analysis, testing) for monitoring the dynamics of the mathematical training level of students; a pedagogical experiment in order to prove the effectiveness of using the e-learning course; mathematical methods (Pearson criterion) to assess the significance of positive changes in experimental work results.

The research was carried out within the framework of 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.

Experimental research base: Borys Grinchenko Kyiv University and A. S. Makarenko Sumy State Pedagogical University.

4 Results and discussion

According to the provision on the certification of an e-learning course at the higher education institution level the e-learning course (ELC) is a system of teaching materials and educational services created for the organization of individual and group learning using information and communication technologies [10].

Following the provisions of the ELC, the procedure for the creation, certification and use in the e-learning system at Borys Grinchenko Kyiv University, we note that the main difference between ELCs from the electronic version of the training manual is the following: a clear structuring of educational and methodological materials; the system of interaction between the teacher and the student, students among themselves, organized using the resources of the ELC throughout the time of studying the discipline; system for monitoring the implementation of various types of educational activities [11].

The position of Nataliia V. Morze and Oleksandr V. Ihnatenko is very close to us. They point out that by introducing in the educational process of an e-learning course the educational institution has the opportunity:

- to accumulate and analyse the statistics of students' academic achievements – real-time statistics can be passed on to the teacher, supervisor, and curator, which will enable students majoring in Computer Science and Information Technology to evaluate the results of their own activities;
- to standardize educational content – one e-learning course can be accompanied by several teachers while its content does not change, only the teaching method changes;
- promptly administer – the training administrator can promptly grant or cancel the student's access to the required content;
- to provide interactive cooperation between the teacher and students, students with each other at all stages of the educational process – during the study of theoretical material, its consolidation in the process of performing practical tasks, discussing problem situations and issues, joint implementation of educational projects and their public defence, control the results of educational activities, reflection and self-assessment of students' academic achievements, etc. [9].

The literature analysis confirms that the study of mathematical disciplines by means of ELC implements the following didactic functions:

1. Creation of favourable organizational and methodical conditions for training of future specialists in Computer Sciences and Information Technologies:

    - implementation of the visibility principle: demonstration of the dynamics of the studied processes, graphical interpretation of the studied patterns, conditional

graphic means (tables, diagrams, flowcharts, charts, diagrams, organizational charts, maps, etc.), modern multimedia (audio and video fragments, animation));
- simulation and imitation of processes that are studied and researched, phenomena with the transition to "reality-model" and vice versa;
- providing access to educational materials;
- creation of a stable cognitive motive aimed at the need for obtaining, processing and transmitting information, the use of ICTs at the stage of training and future professional activities;
- the principle of differentiation and individualization of education.

2. Improvement of psychological and pedagogical conditions of educational activity:

- creating interest;
- ensuring an adequate emotional state of students.

3. Implementation of the education content in the conditions of informatization of education.
4. Management of educational activity and formation of the structure of philosophical, behavioural and creative qualities [3].

The teaching experience of the authors of the research paper shows that in order to improve the quality of mathematical training for bachelors majoring in Computer Science and Information Technologies it is worth using an e-learning course as a system of electronic teaching materials designed for the organization of individual, frontal and group training. E-learning courses are posted on the server of e-learning courses at Borys Grinchenko Kyiv University at the address: http://elearning.kubg.edu.ua/. The portal's work is organized on the basis of the use of a Moodle platform.

The Moodle-based platform allows teacher to create and edit text, graphical, animated, multimedia blocks in the body of the course using the built-in courseware, create and edit test tasks, view course-tracking statistics by registered students, and discuss topics in the forum.

Bachelors in Computer Science and Information Technology based on the Moodle platform can study the material in a given teacher sequence, perform tasks, ask questions at the forum for the teacher of the course, use the teaching materials posted by the teacher. All course progress statistics are kept, accessible to both the student and the teacher.

The structure of the certified e-learning course "Analytic Geometry" on the basis of the Moodle platform consists of the following blocks:

1. General information about the course: a work program, a thematic plan, evaluation criteria, printed sources and Internet sources, a glossary, a course guide (presentation of the course, a course card, information about the authors, methodical recommendations for the course work);
2. Each of the modules is represented by the following components:

- *Module guide* which includes methodological recommendations for the content module, mental map of the module and a forum for discussing issues that arise during the study;
- *Theoretical educational material* in the form of structured lecture material, which is provided by means of “book”, multimedia presentations, audio and video teaching materials; practical work, which includes a list of main tasks;
- *Tasks for independent work* which include a description and a list of individual tasks for independent study; the deadlines for their implementation and the form of submission, as well as the criteria for evaluation;
- *Modular control* which includes a list of typical tasks for modular control work;

3. The final certification, which includes the list of questions for the exam on the discipline “Analytic Geometry”, as well as the example of the examination card (Fig. 1).

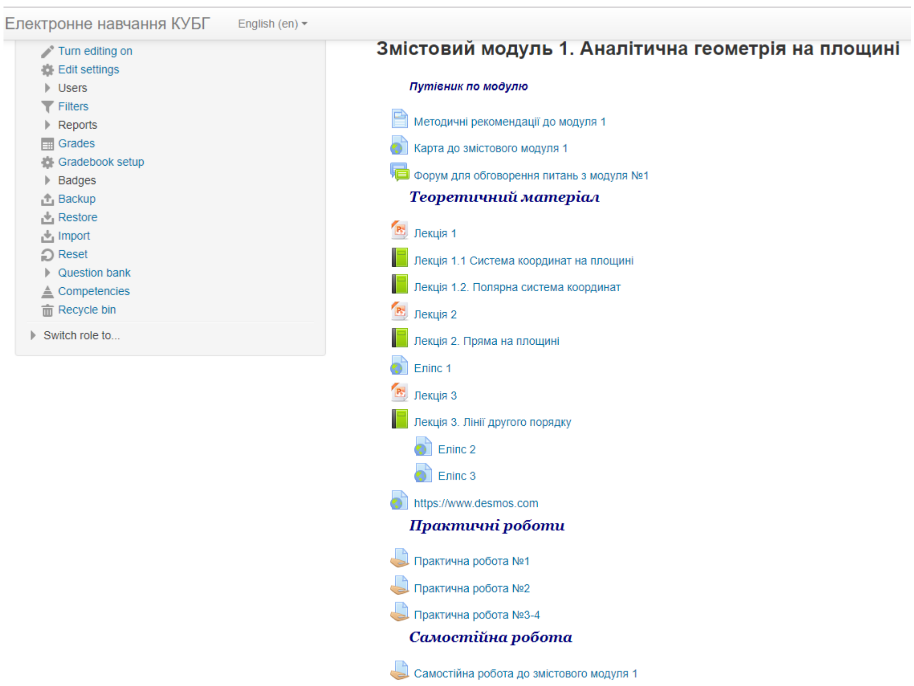

Fig. 1. Content module of ELC “Analytic Geometry”

In addition, the ELC has links to cloud-based resources for the study of higher mathematics.

We have a deep conviction that this kind of ELC structure is convenient for students. This contributes to the realization of their activity within the framework of educational activities (lectures, consultations, practical and individual classes). As practice shows, students also use the developed ELC in the implementation of individual study and research tasks, writing coursework and master's work.

Our selected cloud-oriented technology application in the study of geometry is related to the SaaS model [4]. We share the scientific views of Tatiana V. Batura, Fedor A. Murzin and Dmitrii F. Semich that the main advantages of implementing such a model are the reduction of capital stock in hardware and work resources; reducing the risk of investment loss; a smooth update, and the lack displays as the need for reliable safety features [1].

Let's also turn to the scientific position of Svitlana H. Lytvynova, who points out that cloud-oriented resources for educational institutions have significant advantages, that is: inexpensive computers for users; increased productivity of computer users; reduce costs and increase the efficiency of IT infrastructure; less maintenance problems; less software costs; constant updating of programs; increasing available computing power; unlimited amount of data storage; compatibility with most operating systems; improved document format compatibility; ease of teamwork of user groups; access to documents anywhere and anytime; always the latest version of services; availability of different devices; ecologization and economical spending of natural resources; the stability of the data to the loss or theft of equipment [7, p. 38].

Here are examples of cloud-oriented resources: Desmos, Geogebra, Wolfram|Alpha, Sage, etc [6]. Let's consider the peculiarities of the application of the indicated services in the study of the discipline "Analytic Geometry".

The Desmos Graphic Calculator is an online Internet service that is available at the link https://www.desmos.com/calculator, which builds function graphs using the formulas in the Cartesian and Polar coordinate systems, the graph of the function with the parameters, binding inequalities and contains a set of mathematical patterns and etc. In studying the discipline "Analytic Geometry" it is expedient, in our opinion, to apply this resource within the topic "Analytical geometry on the plane". The resource allows students to demonstrate different types of equations of direct on the plane, as well as equations of curves of the second order on the plane (ellipse, hyperbola, and parabola).

The Wolfram|Alpha [22] computer mathematics system is useful in solving tasks on geometry: construct a vector on a plane and in space, find a vector module, angle with axes, polar coordinates of a vector, calculate the sum and difference of vectors (on a plane and in space), to calculate the scalar product of vectors (on a plane and in space), calculate the vector product in space, find the angle between two vectors (in degrees, radians), the point of intersection of two straight lines on a plane, find the point of a symmetric given relative to the line, the coordinate of the middle of a segment, etc.

Let's consider the use of computer mathematics systems on an example of accomplishing a task: find a point on a plane symmetrical to a point (5, 7) relative to the straight line

$$-x + y + 1 = 0.$$

To do this, you have to offer students the following algorithm:

1. Go to https://www.wolframalpha.com/.
2. Enter the command:

```
reflect (5,7) across -x+y+1=0
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3. Get the result (Fig. 2).

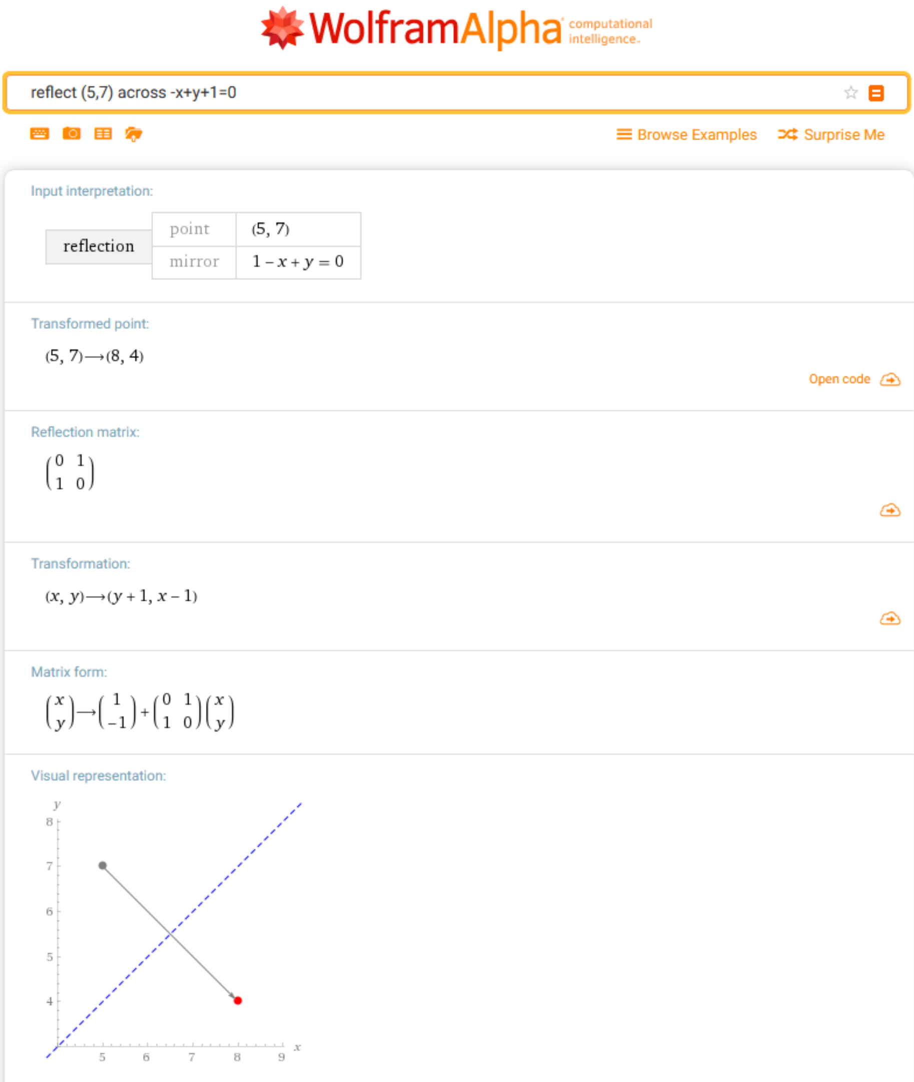


Fig. 2. An example of solving a task in wolframalpha.com

One of the powerful tool for learning mathematics is the GeoGebra Dynamic Geometry System. We agree with the scholars that the functionality of the program and the web-support of GeoGebra users provide an opportunity to use it effectively when studying the vast majority of the topics of the mathematics course. It is important that the program has a wide set of tools for creating dynamic computer models of mathematical objects, which makes it possible to use it not only for solving mathematical problems, but also for organizing heuristic learning, forming skills and abilities of research activity, development of creative abilities of students, creation of dynamic visual manuals, etc. [13].

Let's look at software for algebraic and geometric studies Sage (Software for algebra and geometry experiments). It is an open source distributed mathematical computing environment for performing numerical calculations and symbolic transformations as well as visualization of data [1]. In particular, in the course of geometry it is expedient to use a graphical environment for the demonstration of the operation on vectors, a vector, vector length determination, vector construction, arithmetic operations on vectors, calculations of scalar product vectors, etc.

During 2017-2018 an experimental study was carried out to verify the effectiveness of the implementation of e-learning course "Analytic Geometry". Its goal was to determine the level of mathematical training for students majoring in Computer Science and Information Technology. The experimental research base was Borys Grinchenko Kyiv University (experimental group (EG) in the number of 37 students), A. S Makarenko Sumy State Pedagogical University (control group (CG) in the number of 28 students). An analysis was made of the academic discipline "Analytic Geometry" which is compulsory for students to study both in experimental and control groups. Students of the experimental group were offered an e-learning course. Students in the control group studied higher mathematics traditionally, using a teaching methodology that does not involve the use of e-learning courses and digital resources.

The volume of the educational material of the disciplines "Analytic Geometry" is defined as an independent variable of this study. Assessment of the academic achievements of the experimental and control group students was carried out according to the modular rating system, which is based on the principle of operational reporting, compulsory modular control, accumulation system for assessing the level of knowledge, skills and abilities, expanding the number of final scores to 100. Calculation of rating points by types of current control of load: 18 hours of lectures, 24 hours of practical work and 6 hours of modular control were carried out according to the table 1. The main methods of pedagogical diagnostics which were enabled: methods of verbal verifying of theoretical knowledge, methods of written verification of the learning curve, skills and assumptions – an independent work performed on each practical lesson, and a test work which is given in the form of modular test. Since in the educational process of higher education institutions students receive an official assessment of their academic achievements, which are recorded in the academic class register, the records of the success studies depending on the form of control, therefore the method of studying the products of the activity was used for the study of these data. Analysis of the results of independent work and modular tests allowed to find out the significance of qualitative assessment of academic achievements of students (table 2).

It should be noted that Borys Grinchenko Kyiv University has a unified system for assessing academic achievements of students. The transfer of the final rating grade to the ranking indicators of success in European ECTS assessments is carried out using the algorithm: the transfer coefficient is calculated: $k = \frac{60}{231} = 0,2597$; received during the semester the final rating point of each student is multiplied by the coefficient *k*.

Table 1. Calculation of rating points by types of current (modular) control

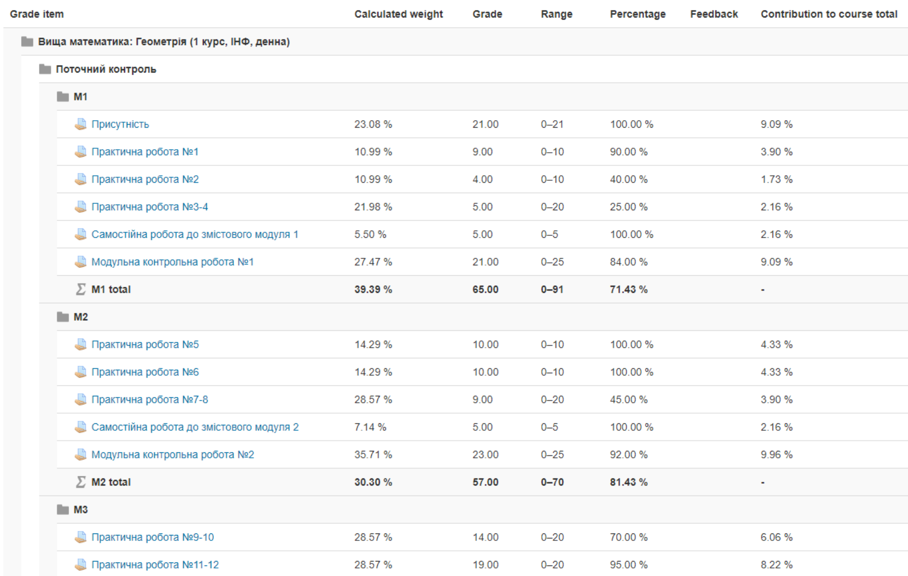
No	Type of students activity	Max points number per unit	Module 1		Module 2		Module 3	
			Number of units to be calculated	Max points number per type	Number of units to be calculated	Max points number per type	Number of units to be calculated	Max points number per type
1	Visiting lectures	1	3	3	4	4	2	2
2	Visiting practical classes	1	4	4	4	4	4	4
3	Performing tasks for independent work	5	1	5	1	5	1	5
4	Work on practical (seminar) classes	10	4	40	4	40	4	40
5	Performing of modular tests	25	1	25	1	25	1	25
6	Laboratory classes (admission, performing, protection)	10	–	–	–	–	–	–
	Max number of points by type of current control	–	–	**77**	–	**78**	–	**76**

Table 2. Methodology of calculations of module and semester assessments of the student

No	Student's grade	Max grade	M 1	M 2	M 3
1	Maximum final semester modular grade (MS)	**60**	–	–	–
2	Maximum totals for content modules (MM)		**20**	**20**	**20**
3	The actual number of points received by the student by type of current control (*example*) (AP)		*70*	*70*	*70*
4	Final student's actual grades for content modules M = AP*MM/MS *(example)*		18	18	18
5	Final semester modular student grade $S = M_1+M_2+M_3$ *(example)*		**54**		
6	Examination rating grade of students, (E) *(example)*	**40**	**40**		
7	Final Semester rating student's grade A = S + E *(example)*		**94 / A**		

Thus, during a semester the student can score a maximum of 60 points according to the ECTS system. Other 40 points can be scored on the exam (the theoretical part of the test is presented in the form of tests).

Educational results of the students are recorded in the ELC evaluation register "Analytic Geometry". In the e-register assessments the teacher sets the categories for the assessment of all types of educational activities and their extent (in percentages) relative to the final assessment from the discipline is determined. Each student has a personal register, which shows all categories of evaluation and the results of their own educational achievements (Fig. 3). Within each evaluation module, a 100-point scale is performed. Moodle provides the automatic transfer of points in accordance with the volume of the module in the final assessment of the discipline and representation of the letter mark. In our opinion, such a tool contributes to tracking their own educational activities by each student and analyzing the results of the student's progress with a teacher.



Grade item	Calculated weight	Grade	Range	Percentage	Feedback	Contribution to course total
Вища математика: Геометрія (1 курс, ІНФ, денна)						
Поточний контроль						
M1						
Присутність	23.08 %	21.00	0–21	100.00 %		9.09 %
Практична робота №1	10.99 %	9.00	0–10	90.00 %		3.90 %
Практична робота №2	10.99 %	4.00	0–10	40.00 %		1.73 %
Практична робота №3-4	21.98 %	5.00	0–20	25.00 %		2.16 %
Самостійна робота до змістового модуля 1	5.50 %	5.00	0–5	100.00 %		2.16 %
Модульна контрольна робота №1	27.47 %	21.00	0–25	84.00 %		9.09 %
M1 total	**39.39 %**	**65.00**	**0–91**	**71.43 %**		-
M2						
Практична робота №5	14.29 %	10.00	0–10	100.00 %		4.33 %
Практична робота №6	14.29 %	10.00	0–10	100.00 %		4.33 %
Практична робота №7-8	28.57 %	9.00	0–20	45.00 %		3.90 %
Самостійна робота до змістового модуля 2	7.14 %	5.00	0–5	100.00 %		2.16 %
Модульна контрольна робота №2	35.71 %	23.00	0–25	92.00 %		9.96 %
M2 total	**30.30 %**	**57.00**	**0–70**	**81.43 %**		-
M3						
Практична робота №9-10	28.57 %	14.00	0–20	70.00 %		6.06 %
Практична робота №11-12	28.57 %	19.00	0–20	95.00 %		8.22 %

Fig. 3. User report

The experiment was conducted in two stages: the recording and forming. At the recording stage (May 2017 – September 2017), a set of diagnostic procedures (questionnaires, knowledge sections and conversations of students with teachers) was developed to identify the level of knowledge, skills and abilities of students in discipline. Matching levels are defined for the level of success: the initial level – the grade on the ECTS scale E and D, the average – C, the sufficient – B, and the high – A.

The experimental group was the object of scientific research. During the forming stage of the experiment (October 2017 – July 2018) a complex of methodological materials was offered at the Moodle system on the basis of the e-learning course. At the end of the discipline the educational results were checked in the form of final control.

As a result of the experiment the obtained results indicate the effectiveness of using the e-learning course. Thus, the number of students with a high level of knowledge, skills and abilities in the EG – 26.67%, in the CG – 11.11%; 39.33% for the students of the EG and 42.74% for CG on the sufficient level; 17.3% of EG of respondents and 21.37% of CG is on average level; the initial level is 16.67% of students of EG and 24.79% of CG.

To verify the truth of the hypothesis H_0, H_1 the Pearson statistical criterion χ^2 was used:

H_0 – argues that there are no significant differences in the level of mathematical training of experimental and control students' groups;

H_1 – argues that there are significant differences in the level of mathematical training of experimental and control students' groups.

Determination of criteria statistics χ^2 is carried out according to the formula:

$$\chi^2 = \frac{1}{n_1 \cdot n_2} \sum_{i=1}^{k} \frac{(n_1 Q_{1i} - n_1 Q_{2i})^2}{Q_{1i} + Q_{2i}},$$

n_1, n_2 – volume of samples; Q_{1i}, Q_{2i} – the number of elements of the corresponding samples related to the i-th level; k – number of levels.

The substitution of the values for the formula made it possible to obtain the size of the criteria statistics for the levels of success of the students of the EG and CG groups $\chi^2 = 10.9$.

At the level of significance α=0.05 the critical value for the four levels is 9.49. Determined statistic data $\chi^2 = 10.9$ exceeds the critical value of 9.49. Consequently, in accordance with the rules of decision making the values obtained refute the hypothesis H_0 and give reasons for the hypothesis H_1.

Comparison of the generalized results of the students' success levels before and after the formative stage of the experiment is presented in the table 3.

Table 3. Results of evaluation of students' level of success before and after the formative stage of the experiment

Levels	EG_1, %	EG_2, %	CG_1, %	CG_2, %
Initial	20.67	16.7	25.64	24.79
Average	17.33	17.3	28.21	21.37
Sufficient	43.33	39.3	34.19	42.74
High	18.67	26.7	11.97	11.11

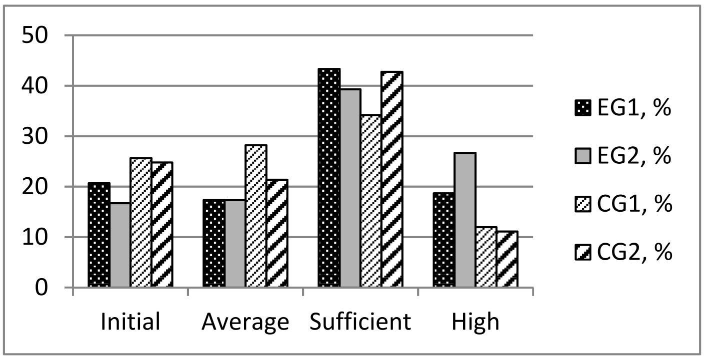


Fig. 4. Comparative data of success styles levels before and after the formative stage of the experiment

Table 3 shows the designation: EG_1 – experimental group (before experiment), EG_2 – experimental group (after experiment), CG_1 – control group (before experiment), CG_2 – control group (after experiment). As can be seen from Table 3 the number of students with a high level of knowledge in discipline in the experimental group increased by 8.03%, in CG – decreased by 0.86%; at a sufficient level the indicator dropped by 4.03% in the EG, but increased by 8.55% in CG; on average, the indicators decreased in both the EG and the CG, respectively, by 0.03% and 6.84% and at the initial level, the indicators decreased by 3.97% in the EG and by only 0.85% in the CG. The graphic representation of the results is reproduced in Fig. 4.

5 Conclusions

1. The importance of free access of bachelors majoring in Computer Science and Information Technologies to modern information educational resources, in particular e-learning courses, in the process of studying mathematical disciplines is substantiated. It was found out that the e-learning course is a complex of teaching materials and educational services created for the organization of individual and group training using information and communication technologies. The possibilities of applying the e-learning course, its didactic functions (creation of favourable organizational and methodical conditions for educational activity, improvement of psychological and pedagogical conditions of educational activity, implementation of the content of education in the conditions of informatization, the management of educational activities and the formation of the structure of ideological, behavioural and creative qualities) are outlined.
2. The structure of the certified e-learning course "Analytic Geometry" based on the Moodle platform has been developed and described. Features of application of cloud-oriented resources are considered: Desmos, Geogebra, Wolfram|Alpha, Sage in the study of the discipline "Analytic Geometry".
3. In order to verify the effectiveness of the implementation of the e-learning course "Analytic Geometry" on the basis of Borys Grinchenko Kyiv University and A. S. Makarenko Sumy State Pedagogical University an experimental study was carried out. Using Pearson's criterion, it was found that there are significant differences in the level of mathematical training of experimental and control groups of students.

The prospect of further research is to demonstrate the effectiveness of using e-learning courses in order to improve the additional professional competences of students majoring in Computer Science and Information Technologies (specialization "Programming", "Internet of Things").

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Practical use of cloud services for organization of future specialists professional training

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Abstract. The article is devoted to the peculiarities of the practical use of cloud services for the organization of qualitative professional training of future specialists. It is established that in order to implement state policy, there is an essential need for using various ICT, in particular cloud services, which are not only economically acceptable in the new educational environment, but also a powerful tools of obtaining new knowledge, skills and abilities.

The advantages and disadvantages of using cloud services in the educational process of higher education are substantiated; the examples discuss the methods of using cloud services in the process of studying fundamental disciplines. The object of the study is the professional training of students in higher education institutions. The subject of research is the process of organizing professional training of future specialists with the use of cloud services.

To achieve the set goals, a set of general scientific (analysis, synthesis, comparison) and specific scientific (bibliographic, problem-based) was used. Observation and conversation manipulation allowed to highlight the advantages and disadvantages of using cloud services and draw conclusions from the problem under investigation.

The foreign experience of using cloud services has been researched and the features of the application of traditional and distance technology training abroad have been determined.

It describes the use of the blog as a media-educational technology during the advent of pedagogical practice. The methods of using cloud-based services on the example of creation of a distance course “Linear algebra and analytic geometry” are considered.

The prospects of research, which consist in getting acquainted with cloud technologies of the humanitarian profile future specialists at the second higher education, are determined. It has been established that the practical application of cloud technologies in the educational process will promote more qualitative and progressive learning; the formation of a close interaction between the teacher and student; development of professional skills and abilities of independent work.

Keywords: cloud services, high school, specialists.

1 Introduction

The 21st century is safe to call the century of cloud technologies. It is for the cloud-based services themselves, namely, their skillful use by teachers and students in the educational process depends on the quality of the material being learned. Educational changes that produce today are not only changes in the effective use of modern techniques, but also the complex use of communication tools, both in the study of humanities and fundamental disciplines. Therefore, innovative youth education is, first and foremost, a preparation for active and full-fledged life in the new conditions of today, which is the key to the successful development of Ukrainian society.

The normative legal documents of Ukraine that determine the priority directions of educational activity in the field of ICT include: Laws of Ukraine "On Education" (2017), "On Higher Education" (2014); Decrees of the President of Ukraine "On Measures to Ensure Priority Development of Education in Ukraine" (2010), "On the National Strategy for the Development of Education in Ukraine until 2021" (2013), "On Measures for the Development of National constituent of the global information network of the Internet and ensuring wide-ranging access to this network in Ukraine" (2000); Order of the Cabinet of Ministers of Ukraine "On Approval of the Strategy for the Development of the Information Society in Ukraine" (2013) and others.

Referring to the text of the aforementioned documents once again convinces in the understanding of the domestic scientific community the feasibility of using modern cloud services aimed at improving the educational process, ensuring the openness and quality of education, training young people in the use of progressive information tools, as well as creating an information security system in the field of management of educational institutions. Therefore, today, in order to implement the state policy, there is an urgent need to use various ICT, in particular cloud services, which, in the new educational environment, are not only economically acceptable, but also a powerful tools of acquiring new knowledge, skills and abilities.

It should be noted that ICT have found their wide coverage in domestic and foreign scientific and pedagogical discourse. To domestic scientists whose work is a significant contribution to improving the methods of using the cloud technologies in education include the Maiia V. Popel [12; 17] and Mariya P. Shyshkina [17; 21], who in their works violate the problems of cloud-oriented systems use in the educational process of higher educational institutions. The solid work in this direction is also found in the writings of Yurii V. Tryus [26]. The scientist raises issues related to the cloud services use in the teaching of mathematical discipline, namely freely distributed web-oriented systems of computer mathematics and technologies of mobile mathematics learning. Vladimir N. Kukharenko is emphasizing some aspects of students distance learning and the webinars use in the educational process. The researcher believes that mass distance courses are possible under the condition of the formation of students of the personal learning environment and the skills of the curator of the content, that is, the ability to work with large unstructured information, create electronic magazines, service, write blogs [10].

Oksana M. Markova [13; 24], Serhiy O. Semerikov [16; 25] and Andrii M. Striuk [9; 22] study the experience of using cloud services by foreign scientists, as well as prospects for the use of information and communication technologies in Ukraine. Scientists have come to the conclusion about the continuity of the development of cloud technologies over the past 55 years and their close relationship with the development of ICT in general [14]. Yuliia V. Yechkalo [27] explains the possibilities of using basic Google services during the study of physics at a high school, and draws attention to the fact that services today are an effective means of assimilating a significant amount of information [5].

Important contributions to the research and distribution of cloud services are made by foreign researchers such as Davide Salomoni [20], Gustavo Gutiérrez-Carreón [7], and others; the questions of on-line learning of students are explored by Robert W. Mendenhall [15], William G. Bowen [2] and others; network technologies are described in detail in the works of Tianping Dong [4], Faten Karim [8]; the use of cloud technologies in teaching mathematics is considered in the works of Georgii A. Aleksanian [1] and others; the trends and prospects for using cloud-based services in education are studied by Ghazal Riahi [19] et al.

In their publications, scientists draw attention to the fact that the knowledge of the cloud technology, the availability of computer software and open access to Internet resources expands the range of opportunities for both teaching and learning. However, Michele D. Dickey [3] and Gordon Freedman [6] who are working on the use of distance learning technology increasingly insist that the use of cloud services should be not only effective, but also accessible to the general public of students.

Consideration of domestic and foreign works allows us to state that despite the considerable number of scientific works aimed at the large-scale study of ICT, the use of cloud services, namely their advantages and disadvantages, remains controversial and requires profound analysis and theoretical generalization.

We believe that the scientific achievements of domestic and foreign scientists today serve as a powerful theoretical basis for the use of cloud services for the organization of professional training of future specialists in various fields of activity.

2 Methods

The purpose of the research is to determine the peculiarities of the practical use of cloud-based services for the organization of qualitative professional training of future specialists. The purpose is led to the choice of a set of scientific methods, in particular the following:

- general science: analysis, synthesis, comparison, generalization, classification and systematization allowed to study and group the research material, to show the scientific views on the use of cloud services for the organization of high-quality professional training of future specialists, provided the opportunity to formulate conclusions;
- special scientific: informational and bibliographic methods ensured the development of scientific literature, normative-legal documents, materials of periodicals; the problem-chronological method helped to determine the degree of research problem.

3 Results

Modern youth as humanitarian and technical specialties widely uses information and communication means, in particular cloud services, although the application of them began in the early 1960s, but they gained the greatest popularity in the early 2000s. It is worth noting that the future mathematics teachers of Kryvyi Rih State Pedagogical University in the process of studying the methods of teaching mathematics widely use the cloud technologies (sites, blogs, electronic courses, mobile mathematical environments) that help to change the educational environment, and also make education more qualitative in conditions of constant competition of higher educational establishments.

3.1 Use of cloud services during the pedagogical practice of students in school

Traditionally, during the pedagogical practice, students are offered to maintain a prescribed form of a paper version of the psychological and pedagogical diary, which reflects not only the content of the work carried out by the students, but also the results of his research activities and the execution of individual tasks. A feature of the modern approach to gaining knowledge by students is blogging [18]. Therefore, the practical significance of using cloud technologies is determined by such advantages as: attraction of like-minded people, time saving, constant filling, since mobile devices are always on hand at hand, constant control of the written, the teacher can always read the blog and write their comments or timely point out certain disadvantages. In turn, experience shows that the massive use of the blog as media-educational technology [28] in the learning process affects the content of the material that is taught by students on the Internet. According to our belief, the youth cannot always write everything truthfully and frankly covering the details, thereby realizing that the blog may be available to a wider range of users than the paper version of the diary. This experience has shown that the use of cloud services opens up a wide range of opportunities for interpersonal communication and professional growth of students. Instead, the cloud services help the teacher not only control the effectiveness of the classes, but also make adjustments during the practice.

Thus, a blog can act as a subject educational environment for the student himself who conducts it and for readers who read it. In our belief, the practical use of the blog opens up wide opportunities for implementing their own ideas and initiatives. The use of this service allows:

- students freely and openly communicate with each other during the practice;
- teachers and other members of the group will evaluate the work of students, since the blog in this case serves as a tool for organizing and conducting control.

What is important is that cloud services are an effective tool through which reflexive, research-based teaching methods are implemented through the re-viewing of necessary information, reading of publications and participation in online discussions.

In table 1, features of the practical use of cloud services during pedagogical practice in the form of advantages and disadvantages are presented.

Table 1. Advantages and disadvantages of using cloud services in the educational process while undergoing pedagogical practice in school

Advantages	Disadvantages
Feedback between student and supervisor	Constant control written by the student, which leads to a decrease in sincerity
Making comments from readers and like-minded people	High standards of reporting quality
Save time	As user grows, information leakage increases
Constant updating of data	

3.2 Use of cloud services at Intel program "Learning for the Future"

In order to consolidate the knowledge gained and develop the skills of independent research, students are encouraged to master the international Intel program "Learning for the Future". The purpose of the program is to help young people develop their own projects on selected subjects and develop their mathematical learning skills through ICT and project methods.

The program implementation is involves the modular student training with a clear algorithm for learning. It is aimed at creating projects with a wide range of cloud-based services. This approach to teaching gives the teacher the opportunity to apply various forms of organization of the training process, such as: independent work with computer, work in pairs, interactive work in small groups, collective discussion of issues, etc.

It can be noted that the content of the program is aimed at the formation of the following student's abilities: to handle a large amount of information; to find and select the required information; to create new knowledge; to carry out research and project activities; to work with information resources, including cloud services.

In general, the program is aimed to improve the mathematical competence, the implementation of teaching tasks, which in turn contributes to the qualitative development of competitive professionals capable of adapting in the new educational environment.

In table 2, features of the practical use of cloud services cloud services at Intel program "Learning for the Future" in the form of advantages and disadvantages are presented.

Table 2. Advantages and disadvantages of using cloud services in the learning Intel program "Learning for the Future"

Advantages	Disadvantages
Maintaining the relevance of information	Not for every topic you can and need to create projects
Rapid correction	High requirements for the quality of communication channels
Ability to properly prepare for classes	
Accounting software usage	

3.3 Features of the study of mathematical disciplines using cloud technologies

Depending on the course offered by the student to study, it is recommended to use a variety of computer mathematics systems that are freely available on the Internet to save time, since more and more credits are related to the independent study of the learning material. At Calculus study, the graphic editors should be used to construct areas and integration surfaces, but one should not forget that students should use graphic editors only when they can build it and define the boundaries of the area or the surface of the integration on their own, and it is time to use graphic editors to save time. Also, when studying the probability theory and mathematical statistics, they can use software tools to calculate the numerical characteristics of random variables that require cumbersome numerical computations, and so on. We have also taken into account the students' ability to work with spreadsheets, edit mathematical formulas, etc.

We believe that when using cloud services in solving mathematic problems it is expedient to apply problem and research methodology of training using individual and group activities. In this case, cloud services give an opportunity, regardless of the choice of program, to get the desired results.

In table 3, features of the practical use of cloud services during the study of mathematical disciplines in the form of advantages and disadvantages are presented.

Table 3. Advantages and disadvantages of using cloud services in the study of mathematics

Advantages	Disadvantages
Ability to prepare for the classroom qualitatively Rapid correction Ability to customize the software for the needs of a particular course Saving time	There is no opportunity to work out the skills of mathematical calculations and transformations Constant monitoring of the data entered

3.4 Application of cloud technologies in students' research activities

Cloud services are a powerful tool for improving the quality of higher education in its development and modernization. Therefore, students, which is constantly moving cloud services, will promote:

- qualitative preparation for various forms of educational work;
- interest in educational subjects;
- the desire to acquire skills and skills in a relatively short time;
- the emergence of interest in learning and the desire to succeed;
- curiosity, the desire to know the essence of the observational facts, the phenomena surrounding them in life.

You can also improve the quality of writing master's theses by utilizing cloud services. It is advisable to use cloud services to create online questionnaires, interactive tasks, and electronic courses on selected topics of research.

In table 4, features of the practical use of cloud services during the research activity of students in the form of advantages and disadvantages are presented.

Table 4. Advantages and disadvantages of using cloud services during research activities of students

Advantages	Disadvantages
Wide opportunities for creating and testing non-standard hypotheses	Verification of information from online resources
Online surveys to conduct research	
Use of services to create interactive exercises on the topic of research	
Familiarity with the expertise of a large number of industry experts	Borrowing someone else's experience

3.5 Features of creating electronic courses

Cloud technologies play an important role in the organization of all elements of the educational process, including the independent work of students, through the information support of the learning process.

The use of cloud services in the educational process provides an opportunity for effective implementation of the principle of continuity of education and openness, as well as the ability to implement independent educational activities of students. We define the requirements for the organization of independent work during training with the use of cloud services:

- control effectiveness;
- provision of feedback;
- high activity of interaction between students and teachers, between students themselves;
- individualization and differentiation of learning;
- the possibility of using a collective form of independent work;
- a more comfortable atmosphere of independent work (establishing a democratic style of communication between students and teachers);
- providing each student with the necessary materials for self-study (lecture material, glossary, useful links, assignments, online teacher tutorials, Internet resources, etc.).

In our opinion, the problem of developing and implementing electronic distance learning courses in the educational process is more urgent for a more successful organization of independent work of students.

An electronic course "Linear algebra and analytic geometry (part 1)" [11] for future mathematics teachers meets the new State Standards and Programs, in particular for university.

The purpose of the course is to familiarize students with the theoretical foundations of linear algebra, which are necessary for the further study of courses of special disciplines, to teach students to experience the formation and development of practical skills and abilities that are needed for the analysis, research and solving problems.

After studying the course, students should get:

- knowledge of basic properties, theorems of linear algebra and examples of their application;
- knowledge of mathematical methods and algorithms for problem solving and their application;
- ability to prove the basic theorem;
- ability to use methods and techniques of linear algebra.

The proposed course contains three modules. Study course is provided by the curriculum in 18 weeks. For each of the course topics, the following components have been developed and proposed:

- the purpose of studying a specific topic;
- the content of the topics being studied;
- self-training plan for the student;
- tasks and questions for self-control;
- tests;
- typical mistakes made by students when studying a particular topic;
- list of used and recommended literature;
- additional links on the Internet (list with electronic bible libraries, some educational courses, catalogs and search engines).

In the process of mastering the course, students will have consultations, chats, forums, topic discussions, etc., both with the teacher and with the students.

The course has a system of hyperlinks for didactic-methodical literature on the course, which will enable students to at a higher level learn the teaching material and reduce the time spent by students at the computer.

The propaedeutic of the study of the electronic course are:

- knowledge of elementary mathematics;
- availability and ability to work with e-mail;
- access to the Internet;
- ability to work in different editors (text, spreadsheets, etc.).

In the process of studying this course, the students undergo the following types of control: incoming, current (control questions at the end of study of each topic), intermediate (presented in the test form for each course topic), final (exam). At the same time, current and intermediate control is carried out remotely, and the final one – in direct communication with the teacher (not necessarily with the testator) of the course.

This experience has shown that the use of electronic courses in disciplines, not only makes it possible to master the subject qualitatively and systematically, but also allows them to perform tasks of increased complexity, to solve non-standard tasks.

The mentioned problems in their scientific investigations are actualized by Serhiy O. Semerikov. The scientist emphasizes the need to use a variety of cloud technologies in the learning process and draws attention to the fact that it is technologies that open up new prospects for learning, especially for those who live in isolation or in remote places or face learning difficulties [23, p. 189]. In particular, the scientist singles out the following features of e-learning:

- the possibility of interaction between the teacher and the student in the dialogue mode, which in some cases can be closer to the dialogue interaction in traditional educational technologies;
- fast sending / receiving of educational materials in electronic data;
- operational access to Internet information resources;
- the possibility of checking and controlling knowledge in remote mode;
- the possibility of organizing laboratory workshops in a virtual mode through the implementation of remote network access to real laboratory equipment;
- creation of "virtual groups" for operational interaction between students;
- the possibility of accumulation of statistical data and, on the basis of their analysis, the management of the training;
- improving the quality of teaching and management;
- introduction of automated quality management training;
- individualization of vocational training through the creation of individual training schedules for individual students [23, p. 191–192].

Expediency and possibilities of using cloud services are of interest not only to domestic, but also foreign scientists. In particular, William G. Bowen [2] believes that the rapid growth of online learning in the United States is an indication that cloud clusters occupy an important place among the many areas of educational development by opening up opportunities and perspectives for young people. Interestingly, our study is a test conducted among students to test residual knowledge. Test results have shown that there are no sharp differences between experimental groups (traditional and remote learning technologies). However, one cannot ignore the fact that the group that was learning to use cloud services in terms of performance was better.

In the context of our research, research by Robert W. Mendenhall [15] is interesting, which points out that the quality of education is largely independent of the way services are provided; alongside there is a high-quality, distance and quality traditional classroom in the classroom, but in both cases there is a low level of self-esteem of the material. Scientist points out that the disadvantages of distance learning still exist, many of them can be identified as follows:

- most universities have not yet found new ways to use cloud services for high-quality conversion;
- for educational institutions with distance learning it is difficult to calculate the number of hours and minutes that students spend on direct learning;
- the most important aspect of this issue is the use of time in an audience: whether students can acquire the knowledge they need to be successful by other means.

Mendenhall draws attention to the fact that the distance learning form demonstrates its advantages over other forms:

- in an online tutorial that really uses a variety of cloud-based services, the role of a tutor can vary from mentoring to effective teaching;

- using cloud services to evaluate the student’s learning can clearly identify the student’s level of knowledge of the program material and how much time it takes for the tasks in and out of the audience;
- cloud services allow to fundamentally change the model for individualization of training and thus improve learning and reduce costs.

As a result, Mendenhall emphasizes that the use of distance learning is a matter of higher education quality [15].

In table 5, the peculiarities of the practical use of cloud services in the application of electronic courses in the form of advantages and disadvantages are presented.

Table 5. Advantages and disadvantages of using cloud services in the electronic courses

Advantages	Disadvantages
Continuous reflexive and evaluation activity	Lack of “live” communication between members of the educational process
Convenient remote control navigation system	High requirements for the quality of communication channels
Wide opportunities for interaction between members of the education through the system of messages, forums, chats	
Ability to pass the distance course at a convenient pace	

4 Conclusions and perspectives for further studies

Research has shown that the benefits of using cloud services are far more than disadvantages, so their use in the educational process will only improve the quality of learning and will in the future serve as a powerful incentive for the professional development of students. It should be emphasized that the use of cloud services should be deliberate and methodically feasible. Therefore, the disadvantages of using cloud services in the educational process can be eliminated or their impact reduced to a minimum.

To summarize, qualitative professional training of specialists will be effective if institutions of higher education can safely use cloud services, thus inducing teachers to master modern methods and techniques of their practical application. At the same time, the result of scientific research have shown that it is cloud services that open up wide opportunities for the realization of creative abilities for both teachers and students.

The research carried out within the framework of this work does not exhaust all aspects of the practical use of cloud services for the organization of high-quality professional training of future specialists. Given the urgency of the issue raised for the domestic education system, further issues of relevance to the issues related to the possibilities of using cloud services during the study of the disciples of the humanitarian cycle.

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Implementation of cloud service models in training of future information technology specialists

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Abstract. Leading research directions are defined on the basis of self-analysis of the study results on the use of cloud technologies in training by employees of joint research laboratory “Cloud technologies in education” of Kryvyi Rih National University and Institute of Information Technology and Learning Aids of the NAES of Ukraine in 2009-2018: cloud learning technologies, cloud technologies of blended learning, cloud-oriented learning environments, cloud-oriented methodological systems of training, the provision of cloud-based educational services. The ways of implementation SaaS, PaaS, IaaS cloud services models which are appropriate to use in the process of studying the academic disciplines of the cycles of mathematical, natural science and professional and practical training of future specialists in information technology are shown, based on the example of software engineering, computer science and computer engineering. The most significant advantages of using cloud technologies in training of future information technology specialists are definite, namely, the possibility of using modern parallel programming tools as the basis of cloud technologies. Conclusions are drawn; the direction of further research is indicated: designing a cloud-oriented learning environment for future specialists in computer engineering, identifying trends in the development of cloud technologies in the professional training and retraining of information technology specialists, developing a methodology for building the research competencies of future software engineering specialists by using cloud technologies.

Keywords: cloud technologies, cloud service models, future information technology specialists.

1 Introduction

During the research, the authors studied a problem of using the cloud technologies in education in 2009-2018 and obtained results for the following areas:

1. cloud learning technologies:

- the concept of cloud learning technologies was defined, their relationship with learning technologies, ICT, cloud technologies and ICT learning is established [7];
- the historical aspects of cloud services development are analysed [6];
- the functional identity of the concept of computer and cloud services are proved, the original sources of cloud services are clarified, the continuity of cloud technologies over the past 55 years and their relationship with the development of ICT, in general, are drawn [5];
- the transformation of the main application areas of cloud technologies in education is reflected [19], current trends in the cloud technologies development in education are identified [10];

2. cloud technologies of blended learning:

- the application conditions of the blended learning in training of software engineering specialists are determined [33];
- the blended learning software tools for training bachelor of software engineering are defined [22], in particular, cloud-based means of presenting educational materials and organizing collaboration between subjects of the educational process [32];
- the blended learning organizational conditions for training information technology specialists by using cloud-oriented means are determined [36];
- the model of using Google Apps in blended learning of computer science for engineering specialities students is developed [30];
- the concept of an augmented reality educational object is introduced, its role in the organization of traditional, mobile and blended learning is defined, a model for organizing access to augmented reality learning objects is proposed, and approaches to their design and implementation are considered [27];
- the theoretical and methodological principles of the blended learning of system programming for future specialists in software engineering are developed [41];

3. cloud-oriented learning environments:

- the general components of the cloud-oriented learning environment of computer science disciplines of engineering students are highlighted [17];
- the model of using cloud-based ICT tools is constructed [38];
- a cloud-based learning environment of a separate division of a higher education institution is designed [29];
- the content and criteria for the development of teachers competence of vocational training disciplines in the design of a mobile-oriented learning environment is determined [37];
- a cloud-oriented learning environment for future specialists in electromechanical engineering based on the integrated use of mobile Internet devices is proposed [12];

- the place of augmented reality in the mobile-oriented environment of professional and practical training is determined [13];

4. cloud-oriented methodological systems of training:

- it is shown that cloud technologies have the greatest influence on the technological component of the methodical system of informatics disciplines, but at the same time their development influences the goals and content of training information technology specialists [31];
- the influence of cloud ICT on the methodical system of training for software engineering specialists is considered, the main tasks of organizing learning are determined, which can be solved using cloud ICT, a model of a cloud-oriented methodical system for training software engineering specialists is proposed [28];
- the model of using cloud-oriented ICT tools is proposed [35];

5. the provision of cloud-based educational services:

- the features of the deployment of educational cloud infrastructure using Amazon Web Services are specified [43];
- the conditions for appropriate and integrated use of cloud computing services and technologies are analyzed; a system of cloud-oriented learning tools for training information technology specialists is designed [40];
- the advantages of using cloud technologies for different categories of participants in the educational process and the model of providing cloud services that are appropriate to use in the process of studying educational disciplines of mathematical cycles, natural science, professional and practical training of future information technology specialists are defined [8];
- the didactic potential of the CoCalc environment for studying mathematics and computer science using cloud technologies [9] is determined; the main components of CoCalc that can be used in the development of cloud software and methodical systems and distance learning course are illustrated [23];
- the expediency of using the Xcos on Web modelling system as a means of forming competencies in the modelling of technical objects by future bachelors of electromechanics is justified [12; 11];
- the principles of use of mobile and cloud services in the professional training of future specialists in mechanical engineering are defined [16];
- a system of cloud technologies is designed for teaching the basics of mathematical informatics to future information technology specialists [9];
- a cloud-oriented system for teaching computer science informatics disciplines for engineering students is designed [18];
- a historical and technological analysis of the experience of using augmented reality tools for the development of interactive training materials is carried out [37]; a methodology is developed for using BlippBuilder web service to develop learning objects of augmented reality [26];

6. professional training of specialists in software engineering:

- the particularities of training masters of software engineering are determined [3];
- the use of cloud technologies in the professional training of software engineering specialists will contribute to the fundamentalization, strengthening of an active approach to the study of the disciplines of the professional and practical training cycle, the active use of project methods and contextual learning, elements of problem-based learning and learning in collaboration is defined [25];
- the role of neural network modelling in the education content of the special course “Fundamentals of Mathematical Informatics” is determined, it is aimed at bridging the gap between theoretical informatics and its applications: software, system and computer engineering [4; 20; 21];
- the main stages of software engineering development are analyzed, the differences in professional training of specialist in software engineering are outlined [2], the fundamental components of training future software engineers and the problem of the rapid obsolescence of the technological content of training are highlighted; it is certain that mastering the fundamentals of computer science (informatics) is the foundation of software engineering training [39].

2 Purpose of the study

The analysis of educational and professional training programs for specialists in information technologies in Ukraine has been provided with an opportunity to determine the model of cloud services provision that is appropriate to use in the process of studying the educational disciplines of mathematical cycles, natural science, professional and practical training for future information technology specialists:

- SaaS – “Higher Mathematics”, “Theory of Probability and Mathematical Statistics”, “Algorithms and Computing Methods”, “Discrete Mathematics”, “Ecology”, “Computer Logic”, “Database Organization”;
- PaaS – “Physics”, “Theory of Electric and Magnetic Circuits”, “Computer Electronics”, “Programming”, “Computer Circuitry”, “Parallel and Distributed Computing”, “Software Engineering”;
- IaaS – “Computer Architecture”, “System Programming”, “System Software”, “Technology of Computer System Design”, “Computer Systems”, “Computer Networks”, “Computer Systems Information Security”.

The list indicates the lowest level of the deployment model that can be used when studying the relevant discipline. An unexplored component of the problem is the implementation of these models in the training of future information technology specialists.

3 Discussion of findings

For the academic discipline “Higher Mathematics” can be applied one of the Web-oriented systems of computer mathematics or a set of ICT tools for teaching higher mathematics (lecture demonstrations, dynamic models, simulators and educational expert systems), which are provided with general Web access. Kateryna I. Slovak [19] theoretically substantiated and experimentally tested feasibility of using mobile mathematical environments in teaching Higher Mathematics – open modular network mobile information and computing software, which provides the user (lecturer, student) with mobile access to information resources of mathematical and educational purposes, creating conditions for the organization of the full cycle of study (storage and presentation of training materials; conducting educational mathematical research; support of individual and collective work; evaluation of educational achievements and etc.) and the integration of classroom and extracurricular work in a continuous learning process.

The defining characteristics of a mobile mathematical environment include:

- access mobility (on a wide range of computer devices, which provides the ability to use netbooks, tablet computers and smartphones as learning tools);
- software mobility (the ability to transfer the environment to different software and hardware platforms without significant modification);
- networking (storage mathematical objects on network servers, which provides an opportunity to unify access to them as in the classroom and outside it);
- openness (the ability to change the information and computing component of the environment);
- modularity (the ability to add, replace and exclude components of the environment);
- object orientation (the possibility of prototyping, creating, modifying, inheriting, encapsulating mathematical objects);
- the natural use of effective pedagogical technologies for organizing collaboration on educational projects in educational communities.

The main components of the author's mobile mathematical environment "Higher Mathematics" are the computational core (mathematical package) and information support, which contains methodological and additional information materials. The research [19] shows that as a computing core of a mobile mathematical environment advisable to choose Web-SCM Sage, which gives an opportunity: to implement the main types of software in a single environment (lecture demonstrations, dynamic models, simulators, educational expert systems), the use of which is aimed at enhancing the educational (including independent) activities of students; to automate the computational process of solving applied tasks, focusing on building a model and interpreting the results of a computational experiment. Considering that information support, which is a part of the mobile mathematical environment, is subject-oriented, Kateryna I. Slovak demonstrates a class of mobile mathematical environments which have the same computational core and variable information support (Fig. 1). Therefore, the replacement of the methodological component of information support in the author's mobile mathematical environment "Higher Mathematics" provides the opportunity to create new environments from the subjects of the physical and mathematical cycle.

The minimum level of the cloud service delivery model, which is necessary for the implementation of such an environment, is SaaS, by which can be accessed to Web-

SCM Sage. PaaS model is required to support the console interface to such an environment. Finally, an independent deployment of the environment can be automated by the virtualization of a computer with an installed operating system and all the components of the environment according to IaaS model (in such way environment developed by Kateryna I. Slovak is distributed via the Internet).

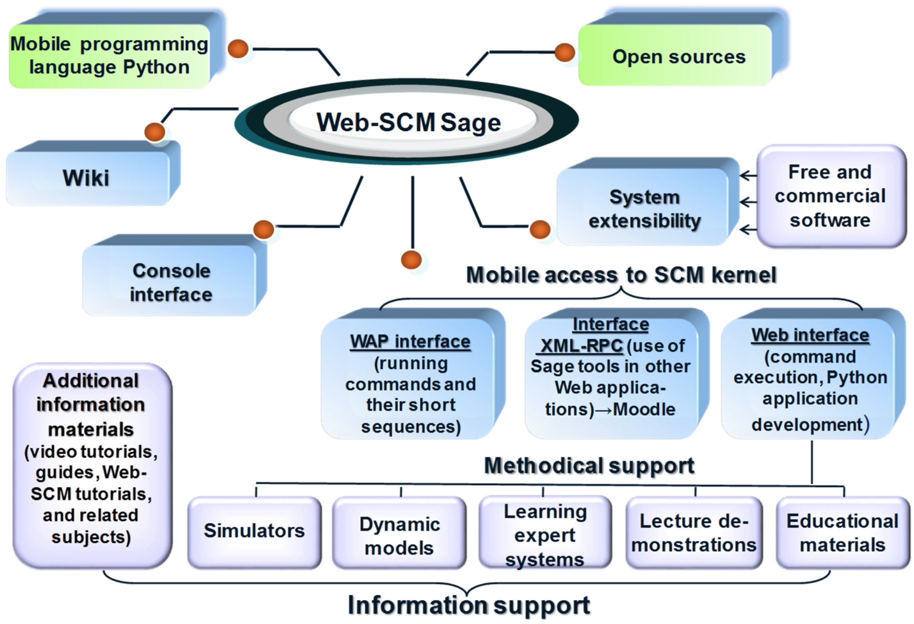

Fig. 1. Architecture of a mobile mathematical environment based on Web-SCM Sage [24, p. 9]

In [17] we can find examples of implementation the SaaS model in education by using online integrated programming environments, and see that most Internet IDE has a rather specific character (unlike general-purpose IDEs such as Eclipse): IDE is not just provided service but it is also a tool for users who use other services.

Examples of such services include Coghead, ZohoCreator, BungeeBuilder, MicrosoftPopFly and YahooPipes. All of these services are proprietary, some of them use their own languages, and all services are required to be placed exclusively on their servers. However, there are several services which are based on standard languages and have a more general character. For example, in Heroku uses the Ruby language and it can be used to develop and deploy Ruby applications. Cloud9 provides the ability to create programs in more than 40 programming languages, including C#, C/C++, Clojure, CoffeeScript, ColdFusion, Groovy, Java, Javascript, Lua, OCaml, PHP, Perl, Python, Ruby, Scala. The online IDE is a good tool for engaging in programming: its use gives to the user an opportunity to quickly start coding and get results instantly. Although online IDEs are not full-fledged integrated environments, working with them gives an idea of how the programming environment may look like. The immediate benefits of an online IDE are the lack of the need to install them and instantly deploy a project. In addition, their application opens new opportunities for exchange of educational materials and cooperation [22, p. 264-269].

Thus, when using the online IDE, a software development service is provided according to the SaaS model. At the same time, the online IDEs act as appropriate platforms, accesses to which are provided according to the PaaS model. The last one is important for the training of specialists in information technology because it creates conditions for practising real skills (in particular, the administration of computer systems and networks) in a virtualized environment [14]. An outstanding example of such an environment is the image of a virtual machine (Virtual Appliances), which is distributed through the VMware Solution Exchange, the Virtual Education Laboratory (VEL) produced by iNetwork, Inc. This product provides a remote computer service for educational experiments in the information technology industry. The cloud-oriented infrastructure of VEL is built on the VMware platform, and the reliability of its work is provided by several data processing centers.

Due to using VEL, teachers can create their own network configurations as laboratory tasks for students who are given the opportunity to experiment with different operating systems without the need for a physical presence in a computer classroom. VEL gives an opportunity to master the methods of network monitoring, detecting penetrations, developing mobile programs for Android-based smartphones, providing wireless and mobile security, auditing threats, etc. for future computer engineering specialists [44]. Consequently, computer services are provided for the IaaS model whilst using virtual machines in the training of specialists in information technology.

The choice of the SaaS model for teaching the basics of databases is determined by the minimum requirements for the software of the academic discipline. Considering that access to relational databases is traditionally provided by queries in the SQL language, the minimally necessary software should provide the ability to execute queries in the SQL language and review execution results, create databases, revise, create and modify table structures, fill and edit data, search for data templates, their import and export, database server administration, etc. via a web interface.

These requirements are fully met by phpMyAdmin [1] and part of the Google cloud platform – Cloud SQL.

Hassan Rajaei and Eman A. Aldakheel [13] give an example of using cloud technologies according to the PaaS model in the process of learning database management systems. Students are given the opportunity to create their own databases, link databases that are located on different servers, and receive data using the SQL language. The authors suggest using IBM Cloud and Windows Azure for this. Thus, there are images of DB2 DBMS among the adjusted virtual machine images from IBM. Students create their own databases by selecting and supplementing a DB2 image. After initial setup of DB2, students can increase security by creating private and public keys and defining different levels of database access (owner, administrator, and user). After that, students can rise to the SaaS level using a Web browser to create queries in SQL via the phpMyAdmin interface or created by themselves. In addition, they can use remote access from their own computers using public and private keys according to the DaaS model.

Two of the four main components of the Windows Azure cloud platform (Fig. 2) are associated with databases: Storage services (access to tables, unstructured large data, files and queries) and Azure SQL Database (Azure Search, Document DB, Redis Cache and StorSimple) provide access to non-relational and relational DBMS, respectively.

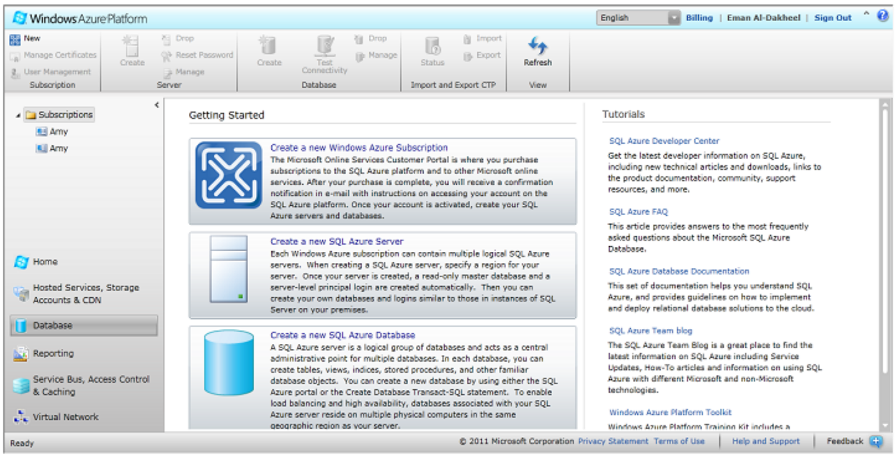

Fig. 2. Windows Azure features for working with cloud DBMS

Operating system training is one of the traditional applications of IaaS-based virtual machines: a virtualization environment that includes servers, software, and network equipment. To access IaaS, customers must pay the cost of the selected service, which is determined by the consumption of computer resources such as operating time in the operating system, data processing system usage time, disk space, and network traffic.

One of the most developed infrastructures is Amazon Web Services. Amazon's cloud computing infrastructure (Amazon Web Services (AWS)) provides an opportunity to freely choose the operating system, programming model, and configuration of the computing system. AWS services provide simplified management of simple (Amazon SimpleDB) and relational databases (Amazon RDS), queries (Amazon SQS), payments (Amazon FPS), storage (Amazon S3) and data delivery (Amazon CloudFront), virtualization (Amazon EC2), messaging in the cloud (Amazon SNS), between clouds and the organization’s private network (Amazon VPC).

The central component of AWS is Amazon EC2 (Amazon Elastic Compute Cloud), which uses Amazon Machine Image – a virtual machine image that contains the operating system (Linux, Windows, etc.) and the software that a cloud service user needs. To use an image in EC2, its image file system is compressed, encrypted, digitally signed, and divided into 10 megabytes parts, which are uploaded to Amazon S3 server for storage.

The “elasticity” of the EC2 service is provided by:

- payment only during the service activity;
- taking into account the geographical location of the client and servers.

Amazon EC2's elastic computing unit (Elastic Compute Unit (ECU)) is an abstraction of computer resources that corresponds to the 2007 model of the Opteron and Xeon processors with a clock frequency of 1.0-1.2 GHz.

EC2 uses a Xen virtual machine monitor, each of which runs on a virtual private server. The simplest among the standard types of EC2 virtual machines are the minimum (tiny) configurations of t1.micro and t2.micro, which provide 640 MB and 1 GB of RAM, respectively.

Starting from December 2010, Amazon provides new users with a free resource credit in the amount of 750 hours per month of t2.micro configuration running under Linux or Windows and 30 GB of disk space that can be used throughout the year. After a year of using or running out of credit, the user switches to paid services (payment is made only for the resources actually used).

To monitor the performance of the cloud, Amazon provides the Cloud Watch service, through which users monitor CPU, disk, and network usage. When system resources are low whilst using Amazon's Auto Scaling feature, they are automatically added, which ensures that the virtual machine runs continuously on the cloud.

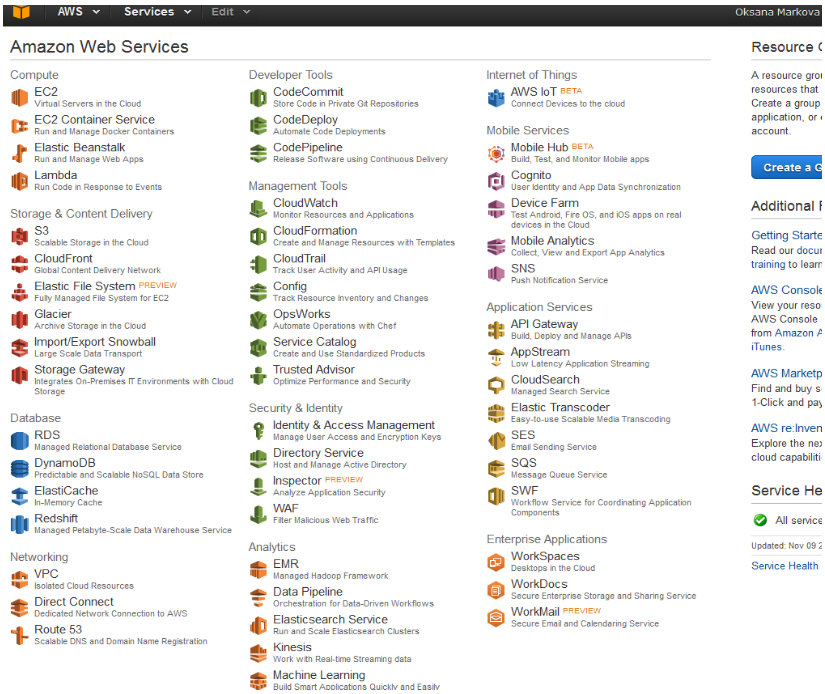

Fig. 3. AWS Management Console

To get started in EC2, you must refer to the website at http://aws.amazon.com/ec2/ and register as a user (Fig. 3). The next step is to download your own operating system image or select one of the free images offered – for example, Amazon Linux AMI

(AMI – Amazon Machine Image) 2015.09.1, which includes a set of AWS tools, interpreters of Python, Perl, Ruby, Java, MySQL DBMS, PostgresSQL, etc.

AWS provides secure access to the operating system using public key cryptography over SSH (Fig. 4).

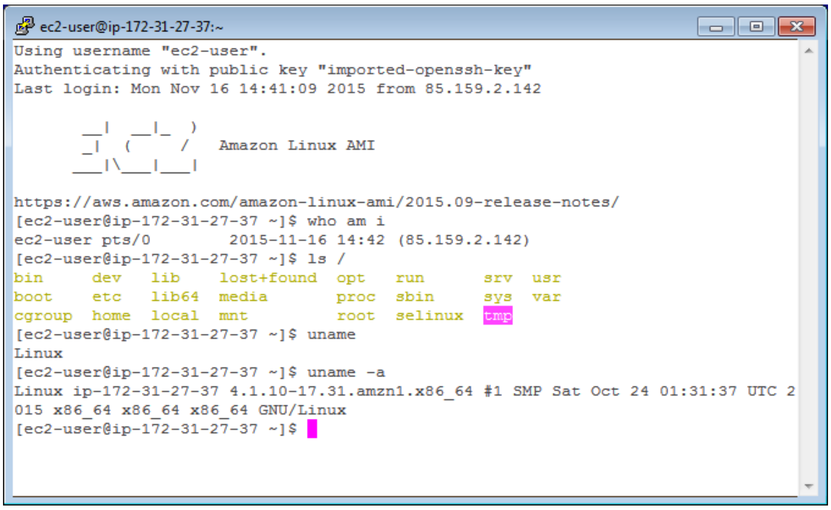

Fig. 4. Access an adjusted operating system image over a secure connection

As noted by Hassan Rajaei and Eman A. Aldakheel, the course "Operating Systems" is one of the most beneficial courses for future specialists in the field of computer technology, since most cloud service providers offer variety operating system images. Students can perform multiple exercises and programming assignments on the available operating system images. In addition, they can design their own operating system and implement its image in a virtual machine on the cloud. Due to virtualization techniques, no harm will be done if student's version crushes (in contrast to damage a real machine which occurs through the provision of system administration tools to students) [15, p. 10]. Thus, the use of virtual machines in the course "Operating Systems" creates conditions for students to acquire professional competencies at a high level.

Students can study the "behaviour" of various time scheduling algorithms in operating systems using any programming language, virtual memory, device management, etc. This is possible only through modeling with the traditional approach. An interesting example of such a virtual machine was developed as part of the "Agapa" system: a module for conducting virtual laboratory work from system programming provides an opportunity to demonstrate step-by-step program execution by the central processor. The interface of the module (Fig. 5) simulates the operation of the program-customizer. In separate windows of the working area are displayed: the source code of the program in the form of hexadecimal codes and mnemonic commands to the assembler; the contents of the current memory segment in hexadecimal codes and ASCII characters; the contents of the main processor registers; status of flag register; the contents of the software stack. The ability to load the source code of programs into the module significantly expands the possibilities of using the module in conducting virtual laboratory work on the discipline “System Programming”. The module is used by the lecturer while working with students to demonstrate the work of examples that contain fragments of programs or algorithmic structures [41, p. 143-144].

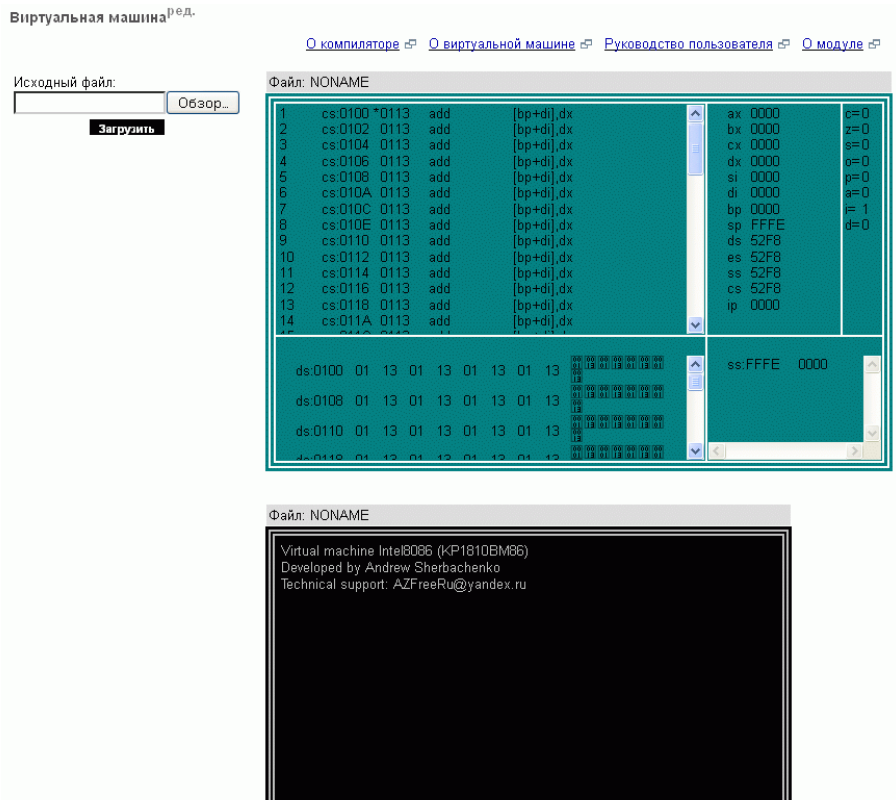

Fig. 5. Module for virtual laboratory in system programming

One of the distinct advantages of using cloud technologies in preparing future information technology specialists is the possibility of using modern parallel programming technologies, which serve as the foundation for high performance computing, which, in turn, are the basis of cloud technologies. The use of virtual machines hosted on the cloud in the course “Operating Systems” provides the opportunity to demonstrate both platform-dependent and mobile parallel programming technologies.

Cluster, grid and other high-performance computing systems are traditionally used to solve modeling problems, which are one of the cornerstones of computer science in general and mathematical computer science in particular.

In order to teach students the basic technologies of parallel computing and parallel programming paradigms, it is advisable to use cloud technology tools to perform lab work, in which students must acquire competence in issues such as scalability and performance of computing systems, limitations on parallelism, overhead costs for synchronization, distribution and load balancing of computing modules, etc. Traditionally, the acquisition of competences from parallel programming occurs in labs that are performed on a local cluster or corporate cloud. Amazon and other leading cloud service providers provide high-performance distributed cloud servers which can improve students' understanding of distributed cloud systems.

One of the most efficient parallel programming technologies is the Message Passing Interface (MPI) standard and its implementation in the corresponding programming libraries, which provide the ability to create multi-current programs, use shared memory, etc. through the message passing mechanism. In fig. 6 shows the work results of the program example of using MPI in the operating system Amazon Linux AMI with the OpenMPI library installed, which combined the technologies and resources of many other projects (FT-MPI, LA-MPI, LAM / MPI and PACX-MPI) and is used on most supercomputers which are among the TOP500. The use of cloud technologies in teaching parallel programming using the OpenMPI library provides students with the opportunity to test, customize and deploy their own programs on scalable distributed systems in order to identify hidden errors and other problems that arise during parallel programming.

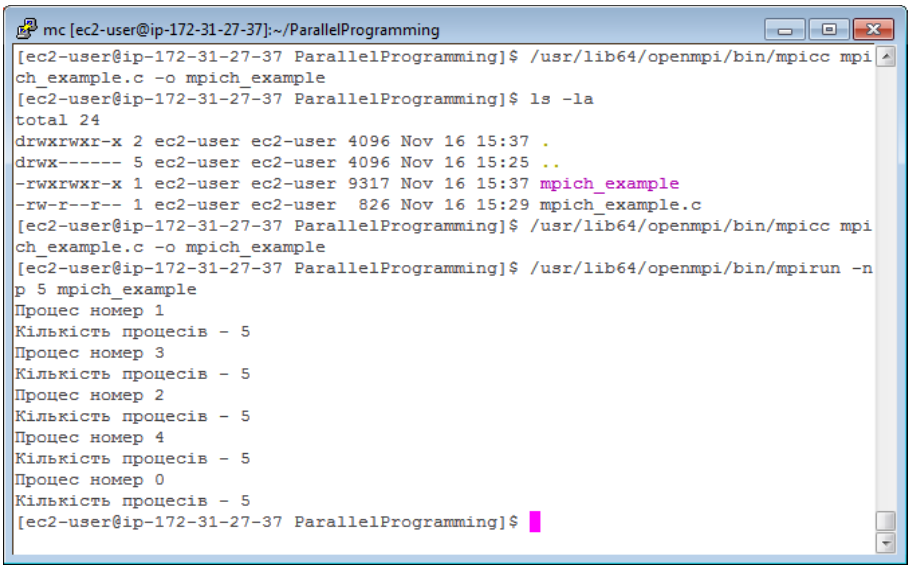

Fig. 6. An example of a parallel program in the cloud environment

4 Conclusion and directions for further research

1. In training informatics disciplines of future information technology specialists, it is feasible to use the following cloud service delivery models: “software as a service”,

"platform as a service", and "infrastructure as a service" based on the informatics technology of virtual machines and pedagogical distance learning technology.
2. One of the clear advantages of using cloud technologies in the preparation of future information technology specialists is the possibility of using modern parallel programming tools as the basis of cloud technologies.

Research does not exhaust all aspects of the analyzed problem. The further scientific search for its solution is appropriate in such directions:

- designing a cloudy oriented learning environment for future computer engineering specialists;
- trends in the development of cloud technologies in the professional training and retraining of information technology specialists;
- method of forming research competencies of future specialists in software engineering by means of cloud technologies.

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Blogger and YouTube services at a distant course "Database management system Microsoft Access"

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Abstract. The article is devoted to the coverage of the course "Database management system Microsoft Access", an educational blog review "The development of a creative child. ICT", which is used as an auxiliary tool for promoting a course and teacher in the Internet, structural analysis of this blog is made. The channel location is set on YouTube video hosting and how it is used in the course on databases. Attention is drawn to the fact that theoretical and practical material is considered on real, implemented informational and analytical systems. To prepare students for the Olympiads and provide methodological help teachers of computer science are looking at tasks from databases that were offered at the All-Ukrainian Olympiads on Information Technologies, especially II, III and IV stages (offline and online Olympiads), which are located in open access to the blog and YouTube channel. The main focus of the article is devoted to the practical side of teaching teachers of computer science, experience in using the above technologies.

Keywords: DBMS, Access, Microsoft, Google, YouTube, Blogger, training method.

1 Introduction

Most of the modern educational approaches are closely linked to the new information and communication technologies (ICT). In addition, new state training standards of teacher training point to the need teacher's preparedness to create, develop, filling the educational environment, which is possible in the presence of a high level possession of ICT and information culture. In this case, it is not only a matter of course among teachers of Computer science, and about all employees of education.

One of the tests at the All-Ukrainian Contest "Teacher of the Year" in all nominations were an examination of the level of ownership of ICT and evaluation of the Internet resource of participant in order to stimulate their creation, development and raising the level of information culture. However, it has been two years since this form has been canceled due to the fact that all educators should already have free access to ICT. Thus, the system of postgraduate pedagogical education should demonstrate how, in addition to well-known approaches, to use new technology. At the same time, these technologies should not be overloaded by redundant options and do not require special technical training, material and technical base. No less importance in working with adults is their own professional and life experience, psychological and cognitive specifics. Therefore, the usage of ICT and cloud services in particular [12; 14; 15; 16; 17; 19; 21; 24; 29] should be considered taking into account: the educational needs of the teacher, his psychological features, regulatory framework, achievements of modern ICT, accountability future requirements of society and the educational sector, the real state of the present material and technical base, readiness of scientific and pedagogical workers and the administration of the university to such activities, the achievements of native and world science.

Problems of introduction and usage of innovative and informative technologies in the educational process, forms and methods of teaching informatics are devoted to the research of scientists Valerii Yu. Bykov [1], Roman S. Hurevych [4], Andrii M. Hurzhii [5], Nataliia M. Kiianovska [7], Oksana M. Markova [13], Nataliia V. Morze [18], Serhii A. Rakov [22], Yurii S. Ramskyi [6], Serhiy O. Semerikov [8], Illia O. Teplytskyi [26], Yurii V. Tryus [28], Yuliia V. Yechkalo [25], Myroslav I. Zhaldak [31] and others. Questions of distance education, relevant information and pedagogical technologies are considered in works by Vladimir N. Kukharenko [10]. Pedagogical peculiarities of adult education are given attention in research Boris S. Gershunsky [2], Irina A. Kolesnikova [9], Ivan F. Kryvonos [32], Larysa B. Lukianova [11], Klaus W. Vopel [30], Ivan A. Ziaziun [33] and others. Aspects of continuity and postgraduate education are considered in the works of Nina V. Bordovskaia [23], Irina A. Kolesnikova [9], Viktor V. Oliinyk [20], Artur A. Rean [23], Ivan A. Ziaziun [33] and others. In his works Serhiy O. Semerikov [27] emphasizes the need to increase the role fundamental informatics education in order to form the informatics competences of pedagogical workers. In the dissertation of Yurii V. Horoshko [3] efficiency use of self-developed software products and organizations of the educational process of training computer teachers around reviewing these products is emphasized.

2 Research problem

This way, we need to adapt the methodological system of learning informatics in institutions of postgraduate pedagogical education with taking into account the above-mentioned aspects, namely, the educational needs of teachers, their psychological and age-specific features, new pedagogical and informational technology, available material and technical base.

Let us consider the distance course “Database management system Microsoft Access”, which is included in the annual plan of advanced training courses Chernihiv Regional Institute of Postgraduate Pedagogical Education named after K. D. Ushynsky.

3 Discussion and results

The purpose of studying the course is the formation of knowledge, skills and techniques of receptions processing of data, as well as design and creation of elements information systems using a wide range of instrumental options modern database management systems (DBMS) for development components of the information culture of listeners and the disclosure of their creativity the potential.

The tasks of mastering the course are:

- formation and development of the base of the subject competencies in the ICT for their qualitative use in educational cognitive and professional activities and information expansion worldview;
- training in conducting major operations on information objects, in particular, the creation and processing of various information objects in the DBMS;
- development of algorithmic, logical and critical thinking;
- development of scientific thinking, aimed at conducting research, self-extraction and processing of data pedagogically weighed use DBMS;
- teaching the observance of safety conditions during work with information systems.

The obtained knowledge will help in preparation for the all-Ukrainian student Olympiads and Internet Olympiads on information technologies.

Students must have sufficient knowledge and skills to successfully master the material the primary skills of working with the operating system (windows, menus, switches etc.) and other programs, including Microsoft Office (Word, Excel), are free have a graphical user interface, have basic knowledge and skills work in DBMS Access. It is also desirable to sort and filter data, calculate the results using the functions in the table processor. It will allow to focus on the peculiarities of the database management system data.

The course is designed for teachers of computer science who deal with students who take participation in the I, II and III stages of the Olympiad on information technologies and all of them is interested in designing databases using Access 2010 DBMS.

Like most universities, we use the distance learning platform Moodle with all its sections: theoretical material, forum, testing, note about success and others.

Theoretical and practical material is presented as text documents and divided by topics. Documents with lecture material have the title “Lecture”.

Theoretical and practical material is considered on real, implemented information-analytical systems. Among them you can select “Institute”, “Dean’s Office”, “Science”. To prepare students for the Olympiads and the provision of methodological assistance to the teachers of informatics are considered tasks with databases, which were offered at all-Ukrainian Olympiads on informational technologies, namely II, III and IV stages (offline and online Olympiads).

When performing laboratory work it is important not to miss the execution tasks set. Each subsequent laboratory work is based on the material of previous work. After performing the laboratory work according to the schedule pass the course you need to put a mark (5 points) in the document-progress report.

Almost every topic is given tasks for independent work and control question. They are provided for self-control success. Upon completion of theoretical and practical material passing proposed (according to the schedule) implementation of practical tasks and testing from the module. The test results of the course listener will be seen immediately. The results of the practical tasks must be sent to the electronic post of author of the course.

After completing submission of performance results, a breakdown is proposed practical tasks as a video tutorial. On the basis of which each evaluates its own completed work and displays the result in the Certificate of Success document. Depending on the complexity of the tasks and the need, video tutorials are added different topics.

At the end of the passage of all modules it is suggested to execute the project with development of the information-analytical system. The listener can independently define the theme or choose from the suggested ones.

Taking into account the peculiarities of the work of institutions of postgraduate education and higher education qualifications of teachers in accordance with the Laws of Ukraine "On education" and "On higher education" teacher has the right to independently choose a place and a teacher from whom take courses. Thus, the author of the course and the relevant structural units of the institute must disseminate information about available courses available. Educational platform should not be completely closed and at the same time open (authenticated access to materials). Centralized (authenticated) access to the materials is provided by the Moodle platform.

We use one of the distribution channels for the course information educational blog "Development of a creative child. ICT" which acts as an advertising platforms for specific courses and demonstration of the teacher's work. Let's do it a small overview of this online resource.

The main purpose of resource development is the formation and development in its users of informational culture, informational competencies, creative abilities based on the use of ICT in educational and everyday activities. Among the tasks that are solved using this blog, we select the following:

- assistance to teachers in the interest of students to modern technology; demonstration achievements of modern science and technology;
- dissemination among teachers of modern innovative methods, forms and means training (world and domestic);
- distribution of advanced pedagogical experience of pedagogical and scientific-pedagogical workers;
- providing methodological and scientific assistance and support;
- popularization of world experience in the development of creative abilities; motivation to creative approach to educational activities;
- distribution of software and pedagogical support, definition methodical, technological, technical requirements and recommendations for development educational toolkit (information systems, didactic material, etc.).

The selection of material is aimed at different audiences:

- teacher subjects: elementary, secondary and high school;
- teachers of computer science, which are engaged in preparing students for all-Ukrainian student Olympiads, tournaments and external independent evaluation with informatics (information technologies);
- students and other users who are interested in the achievements of mankind with modern computer technology and programming.

The main page of the blog is shown in Figure 1.

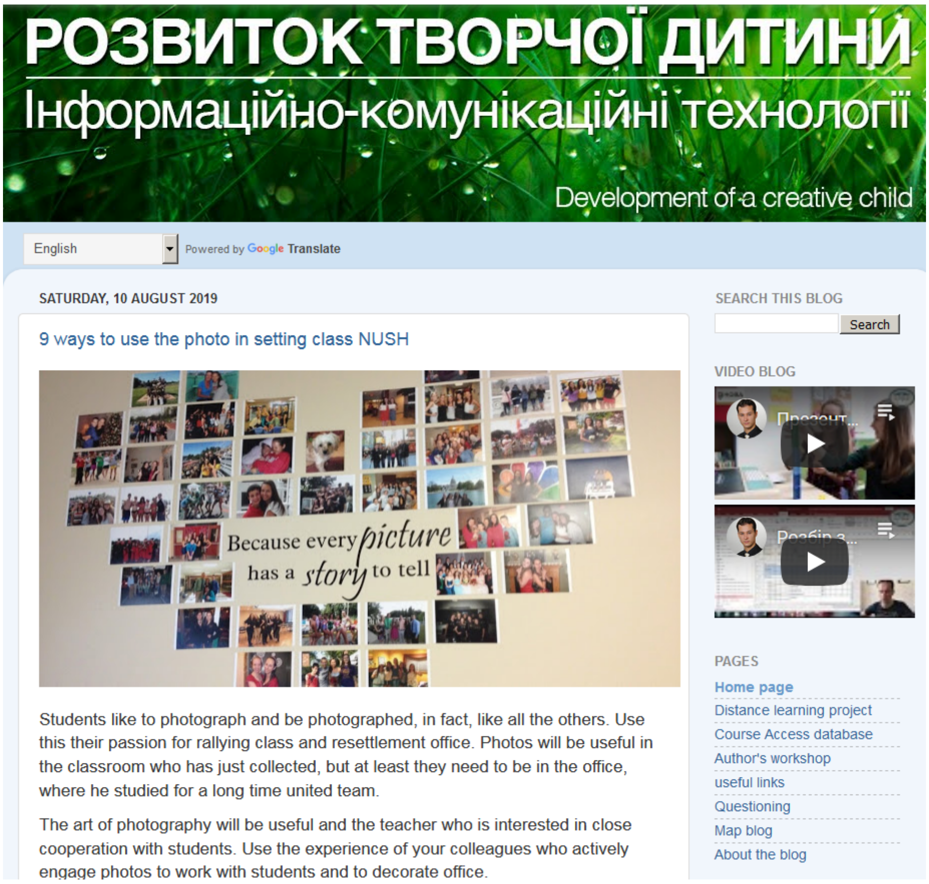

Fig. 1. The main page of the blog "Development of the creative child. ICT" (http://tvorchistd.blogspot.com)

Blog Structure:

Statistics. The total number of views since the installation of the meter is more than 380,000. Launched in May 2013, it has 600 publications, 7 pages and 8 sections.

The layout includes the following technologies and gadgets: Google translate to choose a language; blog search; pages; sections (labels, labels, labels) with posts in this topic (8 categories); banners; 7 popular publications; subscription by e-mail; regular readers; supporters; code for posting a blog banner on other resources; total view count, counter from HotLog and flagging the states from which the blog was viewed; demonstration of recent views; archive as a field with a list; feedback form; recommended publications for each post; video author's window on YouTube; data about the author – Dmytro A. Pokryshen.

Design. This blog uses the "Venetian Window" template. Above is the logo of the blog in Ukrainian and English, has its own icon. The main part consists of two columns: the first reflects the publications (12 last), the second is for gadgets.

Pages. Among the pages is the *Home*, which contains all the messages in the chronological sequence. There are 12 posts in total, each of which has recommended similar publications.

Useful links that include links to various resources on the Internet are divided into categories: Creativity sites, Internet resources on informatics, Specialized websites of children's literature, Educational information resources, Internet sites of libraries and electronic libraries, Internet sites of museums and art galleries of Ukraine. The list of links is constantly updated. A characteristic feature of the links placed is that they are really useful to educators and are different from the generally accepted extension of references to administrative organizations.

The *Blog* page contains blog information, the purpose of creating and using it, the task, the author information.

The *Questionnaire* page contains an entry form, an initial questionnaire, and, if necessary, conducting additional research, placed relevant links to forms questionnaires.

The *Access 2010 Database Course* contains information about the proprietary course, the purpose, the task, the curriculum, the link to the registration form and the distant platform.

The *Distance Learning project* page is intended to introduce distance learning courses conducted by the Dmytro A. Pokryshen and the department of informatics and ICT in the education of Chernihiv Regional Institute of Postgraduate Pedagogical Education named after K. D. Ushynsky, their description and reference to the remote platform where the didactic materials of courses are already located : ICT in education, Web 2.0 social services in the professional orientation of pedagogical workers.

Educational Internet resources for school teachers in introducing a healthy lifestyle for students, Designing information-analytical systems, Programming and algorithmization, Fundamentals of UX, UI and Web design. At this stage, a project is being developed to support the organization of distance learning in general education institutions. All courses offered are copyright.

Sections. For Teacher Assistance, Downloads, Olympics, Primary School, Secondary School, Senior School, Theoretical Material, Interesting Video Content – the title of the section corresponds to the topics of the messages posted there.

In the section of interesting video materials posted fragments of television programs or a link to them on the YouTube channel with comments on them. Among them, many cognitive programs are produced by Discovery Chanel, a selection of videos about the world of the future, Google projects, video tutorials, an overview of modern technologies, the possible development of society and technology, and much more. Placed videos range from a few seconds to full-length movies.

The section of the theoretical material refers to more general messages that will be useful to different categories of users. Here are some definitions of modern scientific terminology, fragments of interviews with scholars and people who deal with ICT, the achievements of modern computer technology, and other useful material are considered.

The sections of elementary, secondary and senior schools include theoretical and practical material relevant to the relevant age group.

Section *The teacher's assistance* is devoted to advanced pedagogical experience, modern forms, methods and means of teaching and materials with which you can interest students to study. Materials mostly relate to computer science and science and mathematics.

The section of the Olympiad contains materials related to the preparation and outcomes of All-Ukrainian and International Olympiads and informatics (programming) and information technologies tournaments. Among the materials you can find tasks, author's solutions, suggested solutions for participants of these events, methodological and pedagogical recommendations, normative documents, lectures from the leading IT specialists of the world.

Pages on the blog banner have a language selection box (Google Translate technology). With the help of which you can make a machine translation of all posted messages to the desired language, which makes it easier to view materials from users from other countries. As the site statistics show, the audience includes users from different countries, such as Ukraine, Russia, USA, Poland, Germany, France, the Netherlands, and others (Fig. 2).

Not all materials posted on the blog are authored, so links to the original hyperlink to the source are provided.

Blog "Development of a creative child. ICT" is positioned as an electronic tool for educational purposes that can be used by teachers, postgraduate pedagogical education institutions, heads of schools and faculties and students. This blog is quite popular among informatics teachers and students of Chernihiv region during preparation for participation in all-Ukrainian Olympiads and tournaments on informatics, IT.

The blog is located at the Internet at tvorchistd.blogspot.com on Google's Blogger platform. When using search engines with keywords development of a creative child, the first link will be on the proposed blog (Fig. 3).

Since September 2015, a blog has been linked to the Dmytro A. Pokryshen's YouTube channel with video blog posts that are relevant to the educational subject. At the moment, the video blog consists of several playlists: an author's workshop, a promising pedagogical experience, video blogs, Access 2010 databases. In the first place there are materials from workshops and trainings, photo reports from events held in Chernihiv Regional Institute of Postgraduate Pedagogical Education named after K. D. Ushynsky; in the second interview with pedagogical and scientific-pedagogical workers who share their pedagogical experience; in the third general purpose material.

Fig. 2. Page of the statistics of the blog "Development of a creative child. ICT"

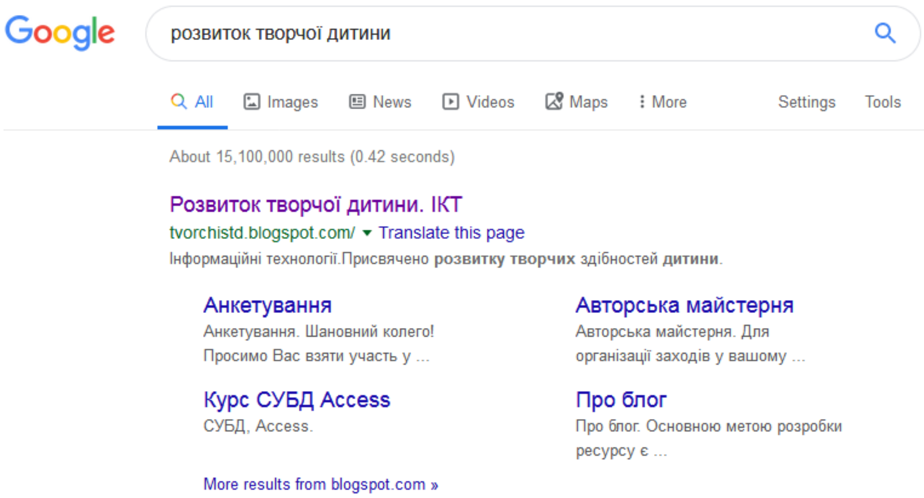

Fig. 3. Search results in Google search

In the latter – published video materials that address the problem of training DBMS Access 2010, preparation for the Olympiad on IT, methodology for solving database problems. A link to video blogs can be found by Dmytro A. Pokryshen's name on YouTube (Fig. 4).

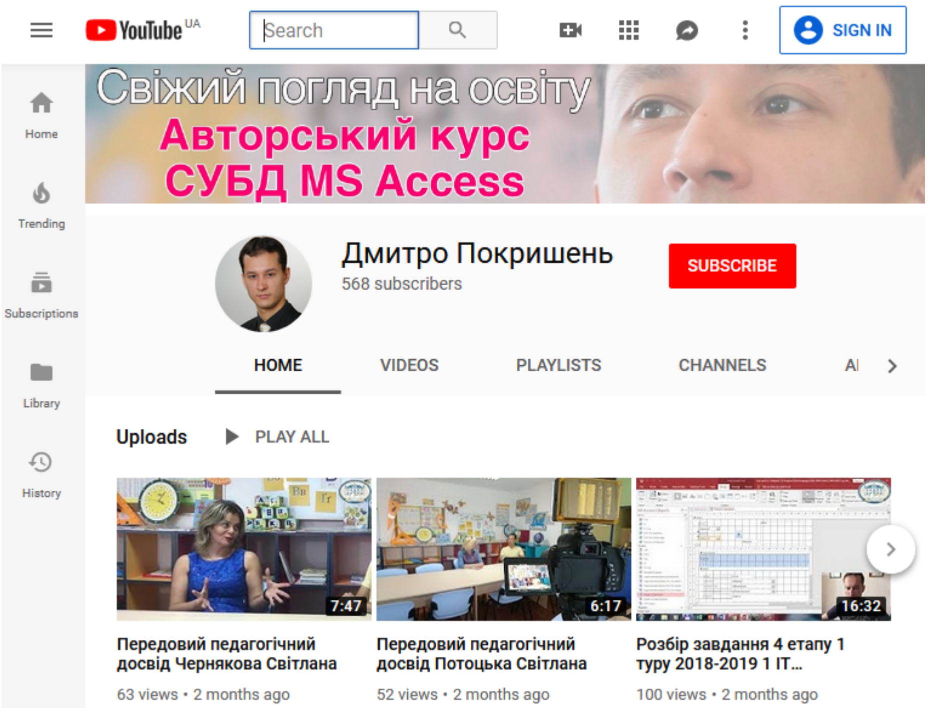

Fig. 4. Channel on YouTube
(http://www.youtube.com/channel/UCBtS1s2ryw2s0qwSwrX5haw)

The use of the video channel is also one of the areas for promoting educational courses. For modern youth very actively uses video hosting YouTube.

Short video completed for up to five minutes with explanations for a specific topic showed their effectiveness. With the help of this service it is easy to organize long-term live streaming to the network with a record, chat and comments to them. With a webcam with a built-in microphone (or a regular laptop), the technological part of recording, broadcasting and capturing the screen is reduced to a few clicks. And using a smartphone to shoot and mount a video lesson for up to 5 minutes is not a complicated process.

Among the shortcomings is the low number of views, because it is not solving content, but rather highly specialized, taking into account the Ukrainian-language material supply, the audience is narrowing even more. The analysis of narrow-petitioned blogs has shown that the availability of 500 regular readers is a good result.

4 Conclusion

So while studying the distance course "Database management system Microsoft Access" by combining various content management platforms, namely Moodle, Blogger, YouTube, we meet the educational needs of educators on the use of the DBMS and prepare students for the nationwide Olympiads on IT, taking into account their professional features, we use new pedagogical and information technologies, and all this does not require a large and complex material and technical base.

Each of these tools is not separated from each other, but harmoniously complements and allows you to look at them from the other side. The teacher is trained in such a course, in addition to obtaining substantive knowledge from the database, sees the use of various technologies in the educational process. The availability of such competences is provided by the basic standard of teacher training. Thus, the role of teacher of postgraduate pedagogical institution from the usual source of knowledge changes for a specialist who is a leader in new technologies.

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Import test questions into Moodle LMS

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Abstract. The purpose of the study is to highlight the theoretical and methodological aspects of preparing the test questions of the most common types in the form of text files for further import into learning management system (LMS) Moodle. The subject of the research is the automated filling of the Moodle LMS test database.

The objectives of the study: to analyze the import files of test questions, their advantages and disadvantages; to develop guidelines for the preparation of test questions of common types in the form of text files for further import into Moodle LMS.

The action algorithms for importing questions and instructions for submitting question files in such formats as Aiken, GIFT, Moodle XML, “True/False” questions, “Multiple Choice” (one of many and many of many), “Matching”, with an open answer – “Numerical” or “Short answer” and “Essay” are offered in this article. The formats for submitting questions, examples of its designing and developed questions were demonstrated in view mode in Moodle LMS.

Keywords: Moodle LMS, Import Questions, Aiken, GIFT, Moodle XML, Moodle Quiz.

1 Introduction

Pedagogical testing, due to its high technological and informative content, has surely become a leading method of research into the structure of educational achievement [4, p. 13]. Evidence of it is the introduction in the system of general secondary education external independent assessment and state final certification [7]. Computer-based testing is considered to be the most standardized and objective method of monitoring and evaluating learning outcomes [9]. Requirements for computer testing include:

1. testing variability;
2. prompt submission of student diagnostic results;
3. prompt processing of test results;
4. application of adaptive testing algorithm;
5. accumulation of test results and analysis of their dynamics;

6. dynamic design of tests [4, p. 18].

Computerized testing at Moodle LMS enables to meet most of these requirements – generating test questions randomly from an existing bank, automatically mixing the order of test questions and answer options (alternatives), having different assessment options (“adaptive mode”, “deferred feedback”, “immediate feedback”, etc.), recording the results of each test attempt at evaluation logs and more.

A considerable number of questions are required to provide meaningful validity for the test. However, developing of such questions in Moodle LMS directly in the browser is time consuming – it takes a lot of time and attention. You can significantly reduce the time for filling a bank of test questions of considerable volume by preparing and importing questions in the form of a text file that corresponds to one of the modern formats for the exchange of test tasks – Aiken format, Blackboard, Embedded answers (Cloze), Examview, GIFT format, Missing word format, Moodle XML format and etc.

The purpose of this article is to highlight the theoretical and methodological aspects of preparing the test questions of the most common types in the form of text files for further import into Moodle LMS.

2 Import questions from file

This article examines the peculiarities of preparing for import test questions of the most commonly used types – “True/False”, “Multiple Choice” (“one of many” and “many of many”), the question of “Matching”, an open-ended question (“Numerical” or “Short answer”) or “Essay” in Aiken, GIFT and Moodle XML formats (Fig. 1).

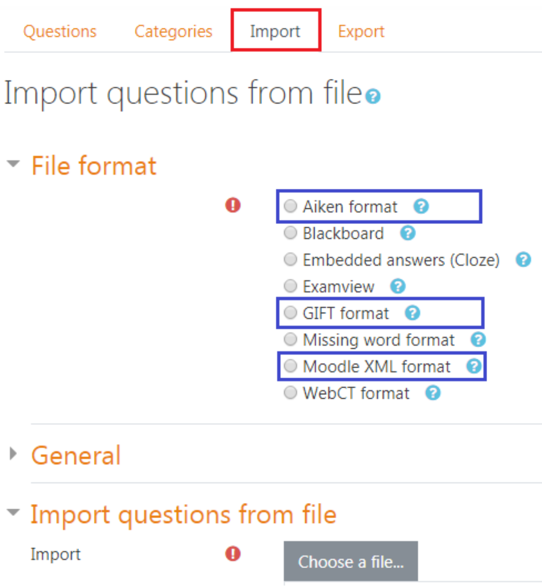


Fig. 1. Import page of questions from the file

The Aiken format is extremely simple [1]. However, only “Multiple Choice” questions can be prepared in this format with one correct answer. The detailed algorithm for preparing and importing questions in Aiken format is shown in Table 1.

Table 1. The algorithm of actions for import in Aiken format

<table>
<tr><td align="center">Step 1</td></tr>
<tr><td>Open the window for any text editor (or processor) to work</td></tr>
<tr><td align="center">Step 2</td></tr>
<tr><td>Make a list of test questions and answer options consistently (one after another) strictly in the format:

<code>The text of the question</code>
<code>A. correct answer</code>
<code>B. wrong answer 1</code>
<code>C. wrong answer 2</code>
<code>D. wrong answer 3</code>
<code>ANSWER: A</code>

Note.

1. The number of alternatives to choose the correct answer cannot exceed 10
2. There is no need to waste time choosing the correct answer (variation A, B, C, or D), since in Moodle, mixing or not mixing alternatives is configured and performed automatically on the test options page</td></tr>
<tr><td align="center">Step 3</td></tr>
<tr><td>Save the file as a text document *, ** in Unicode encoding mode (UTF-8)

Note.
* In text editor Notepad: File → Save → File type: Text documents; Encoding: Unicode (UTF-8)
** In text processor MS Word: File → Save → File Type: Plain Text; Encoding: Unicode (UTF-8)</td></tr>
<tr><td align="center">Step 4</td></tr>
<tr><td>In Moodle (on the relevant course page), import the saved file to the bank issues by selecting the format of the Aiken file (Fig. 1):
4.1. Control Panel → Bank Issues → Import
4.2. File format: Aiken
4.3. Import questions from a file: Import → Select file ... → ...
4.4. After the message is resolved from the import file and the successful import of all issues is completed, click Continue</td></tr>
</table>

The GIFT format is much more powerful than Aiken, because besides preparing different types of questions (“True/False”, “Multiple Choice”, “Matching”, “Numerical”, “Short Answer”, “Essay”, etc.), it also has the ability to add question names, percentages, graphics, comments [2], and etc.

The detailed algorithm for preparing and importing questions in GIFT format is shown in Table 2.

Table 2. The algorithm of actions for import in GIFT format

Step 1
Open the window for any text editor (or processor) to work.
Step 2

Make a list of test questions and answer options according to the sample and instructions in Table 4:
 	
`The text of the question`
`{`
`answers`
`}`
 	
or (if necessary, enter the name of the question):
 	
`:: The title of the question :: The text of the question`
`{`
`answers`
`}`

Step 3
Save the file as a text document in Unicode encoding mode (UTF-8)
Step 4
Import saved file (in case of use of images – archive) to the bank of questions, choosing the format of the file GIFT (Fig. 1)

Preparing Moodle XML questions is not easy at first sight. An example of a file fragment (resulting from export) is shown in Fig. 2.

The ability to work with an intuitive interface while creating questions of various types (with the addition of images, question names, comments, category creation, etc.) in the MS Word text processor environment necessitates the use of the Moodle Quiz macro (Fig. 3) [6].

The detailed algorithm for preparing and importing questions in Moodle XML format using the Word template with the Moodle Quiz macro is shown in Table 3.

Table 3. The algorithm of actions for import in the format of Moodle XML

Step 1
Open the template with the macro moodle_quiz_v21 [56] in the MS Word processor window, if necessary, unlock the macros. For successful execution of actions in the tab of tabs MS Word will appear tab Moodle Quiz (Fig. 3)
Step 2
Make a question using the appropriate tools of the Moodle Quiz tab (see Table 4)
Step 3
Use the tool Check Layout (Fig. 3) to verify the correct test pattern

Step 4
Use the tool Export to XML (Fig. 3) to export the doc file to the XML format
Step 5
Import the saved file to the bank by selecting the format of the Moodle XML file (Fig. 1)

```
<question type="truefalse">
        <questiontext format="html">
                <text>Для створення публікацій використовують MS Publisher?</text>
        </questiontext>
        <image></image>
        <image_base64></image_base64>
        <generalfeedback>
                <text></text>
        </generalfeedback>
        <penalty>0.1</penalty>
        <hidden>0</hidden>
        <answer fraction="100">
                <text>true</text>
                <feedback>
                        <text>
                        </text>
                </feedback>
        </answer>
        <answer fraction="0">
                <text>false</text>
                <feedback>
                        <text>
                        </text>
                </feedback>
        </answer>
        <name>
                <text>Питання Так/Ні – відповідь Так</text>
        </name>
</question>
```

Fig. 2. The fragment of the file in Moodle XML format

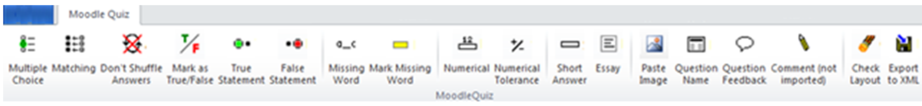


Fig. 3. The Moodle Quiz tab

Table 4 provides standards (protocols) and examples of processing different types of questions in text files-documents for importing test questions in GIFT and Moodle XML formats.

Table 4. Instructions for submitting questions files in GIFT and Moodle XML formats

GIFT format	**Moodle XML Format (using Moodle Quiz in MS Word)**
The question "True/False" (Fig. 4)	

Format:
 	
`Question {TRUE}`
 	
or else
 	
`Question {FALSE}`
	The tool True Statement (Fig. 3) – for the answer to the question Yes. And False Statement (Fig. 3) – for the answer to the question No.

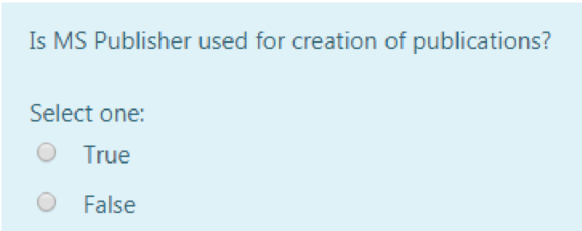
<table>
<tr><th>GIFT format</th><th>Moodle XML Format (using Moodle Quiz in MS Word)</th></tr>
<tr><td>Question Yes/No?
{TRUE}</td><td></td></tr>
<tr><td colspan="2">

Fig. 4. Example of the question “True/False”</td></tr>
<tr><td colspan="2">The question “Multiple Choice” (Fig. 5, 6)</td></tr>
<tr><td>Format:

Question {= ~ ~~}

Example:

The question with one correct answer?
{
= The correct answer
~ Wrong answer 1
~ Wrong answer 2
~ Wrong answer 3
}

Format:

Question {~% number% ~% number% ~}

The questions with several correct answers?
{
~% 50% Correct answer 1
~% 50% Correct answer 2
~% -50% Wrong answer 1
~% -50% Wrong answer 2
}</td><td>The tool Multiple Choice (Fig. 3)

The question with one correct answer?
Correct answer
Wrong answer 1
Wrong answer 2
Wrong answer 3

The questions with several correct answers?
Correct answer 1
Correct answer 2
Wrong answer 1
Wrong answer 2

Note: You can see the answer to the opposite (from right to wrong) using the tool Mark as True/False (Fig. 3).</td></tr>
</table>

<table>
<tr><th>GIFT format</th><th>Moodle XML Format (using Moodle Quiz in MS Word)</th></tr>
<tr><td>Note: if there are three correct answers to the question, then each of them should add %33.333%, if four – % 25%, etc.</td><td></td></tr>
<tr><td colspan="2">

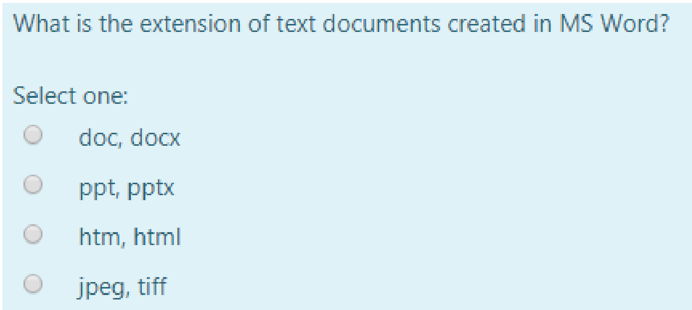


Fig. 5. Example of the question “Multiple Choice” (one of many)

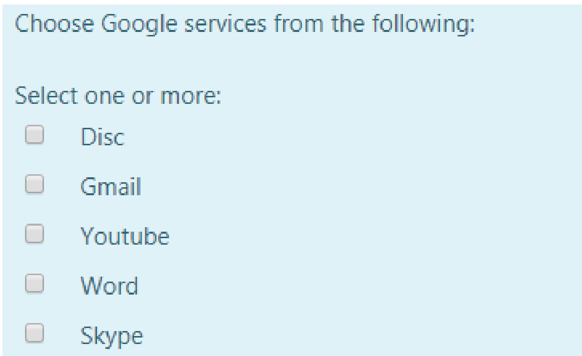


Fig. 6. Example of the question “Multiple Choice” (many of many)

</td></tr>
<tr><td colspan="2">The question “Matching” (Fig. 7)</td></tr>
<tr><td>Format:

<code>Question {= Questions -> Answer}</code>

<code>Questions about matching:</code>
<code>{</code>
<code>= Question 1 -> Answer 1</code>
<code>= Question 2 -> Answer 2</code>
<code>= Question 3 -> Answer 3</code>
<code>= Question 4 -> Answer 4</code>
<code>= -> Answer 5</code>
<code>}</code></td><td>The tool is Matching (Fig. 3). Pressing the Enter key means the beginning of the introduction of question 1, pressing Enter again – the beginning of the input Answers 1, etc.
In the end, leave one question blank and enter an additional answer.

<code>Questions about matching:</code>
<code>Question 1</code></td></tr>
</table>

<table>
<tr><th>GIFT format</th><th>Moodle XML Format (using Moodle Quiz in MS Word)</th></tr>
<tr><td></td><td>Answer 1
Question 2
Answer 2
Question 3
Answer 3
Question 4
Answer 4

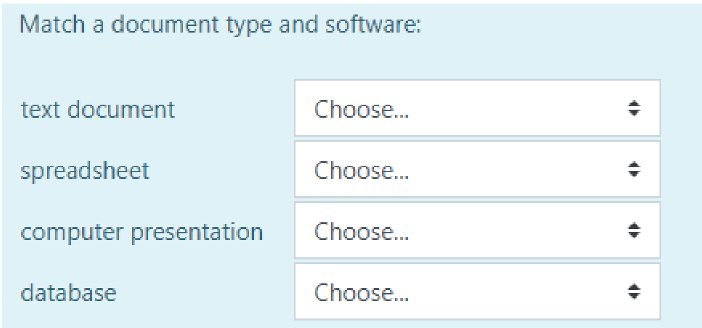
Answer 5</td></tr>
<tr><td colspan="2">

Fig. 7. Example of the question “Matching”</td></tr>
<tr><td colspan="2">The question “Numerical” (Fig. 8)</td></tr>
<tr><td>Format 1:

Question {# number}

Format 2:

Question {#min value..max value}

Numerical question 2 + 2?
{# 4}</td><td>The tool Numerical (Fig. 3). To enter an answer – Enter. To enter accuracy – the tool Numerical Tolerance (Fig. 3).

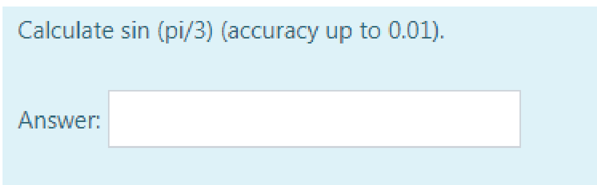
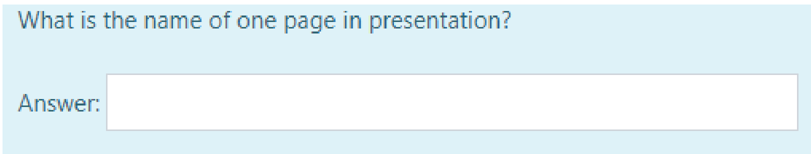
Numerical question 2 + 2?
4</td></tr>
<tr><td colspan="2">

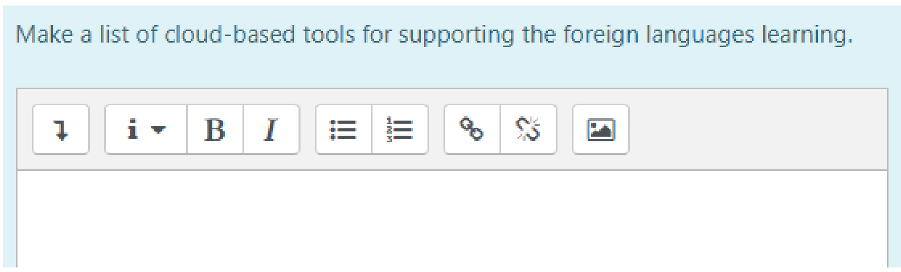
Fig. 8. Example of the question “Numerical”</td></tr>
</table>

GIFT format	**Moodle XML Format (using Moodle Quiz in MS Word)**
The question “Short Answer” (Fig. 9)	

Format:
`Question {= answer}`
`The question with a short answer?`
`{`
`= yes`
`}`
	The tool Short Answer (Fig. 3). Pressing the Enter key means entering the answer.
	`The question with a short answer?`
	`Yes`

 **Fig. 9.** Example of the question “Short Answer”	
The question “Essay” (Fig. 10)	

Format:
`Question {}`
Example:
`Task - essay.`
`{`
`}`
	The tool Essay (Fig. 3).
	`Task-essay`

 **Fig. 10.** Example of the question "Essay"	
Adding images (in the text of the question or answer variants)	
1. All the images used in this file are saved in the folder (case sensitive)	Tool Paste Image (Fig. 3) (pre-copy the image to the clipboard)

GIFT format	Moodle XML Format (using Moodle Quiz in MS Word)
2. Place the `<img src \ = "@@ PLUGINFILE @@ / folder / name.png">` tag on the image, where name is the name of the image 3. When you finish editing, create a zip archive containing the folder and the file with the questions 4. The format for importing questions in Moodle LMS – GIFT with medials format (choose zip-archive)	

Note (for GIFT files).

1. Questions are separated by an empty line, the question itself can not contain empty lines.
2. The text of the question should not contain special characters ({,}, =, ~, #) since they divide the parts of the question. If necessary, they must be preceded by the symbol "\" before each of these characters. It will be deleted when it is imported.
3. If it is necessary to write certain explanations for test users, developers can write a comment starting with the characters "//". The starting point for commenting on answer options is the "#" character.
4. Formatting the text of questions or variants:

```
[html] <p> Questions about formatting </ p>
{
}
```

The main tags for formatting are given in Table 5.

Table 5. Tags for formatting text (GIFT format, [8])

Syntax	Action
`<h1>` Text `</h1>`	heading 1 level
`<p>` Text `</p>`	text paragraph
` `	new line
`<hr>`	horizontal line
`<b>` Text `</b>`	bold text
`<i>` Text `</i>`	text outline in italics
`<sub>` Text `</sub>`	lower index
`<sup>` Text `</sup>`	top index

`<ol>`
`<li>` List item 1`</li>`
`<li>` List item 2`</li>`
	numbered list

Syntax	Action
`<li>` … `</li>` `</ol>`	

`<ul>`
`<li>` List item 1 `</li>`
`<li>` List item 2 `</li>`
`<li>` … `</li>`
`</ul>`
	marked list

`<a href="URL-link" >` hyperlink text `</a>`	hyperlinks

3 Conclusions

The choice of file format for importing questions depends on the needs of the test developer, and may vary depending on the situation (Table 6).

Table 6. Compare file characteristics for importing issues

Format / Characteristic	Aiken	GIFT	Moodle XML (macro Moodle Quiz)
Minimalistic interface	+	+	–
Different types of questions	–	+	+
Images, sounds	–	+ (GIFT with media format)	+
Automatically formatting	–	–	+
Free software	+	+	–

Yes, the undeniable advantage of the Aiken format is its simplicity, but the questions prepared in this format are the same. The GIFT format, like Moodle XML, provides the ability to fill questions with different types of questions; however, in GIFT format, all tags should be manually written. The downside of the moodle_quiz_v_21 macro is development for commercial software – MS Word.

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