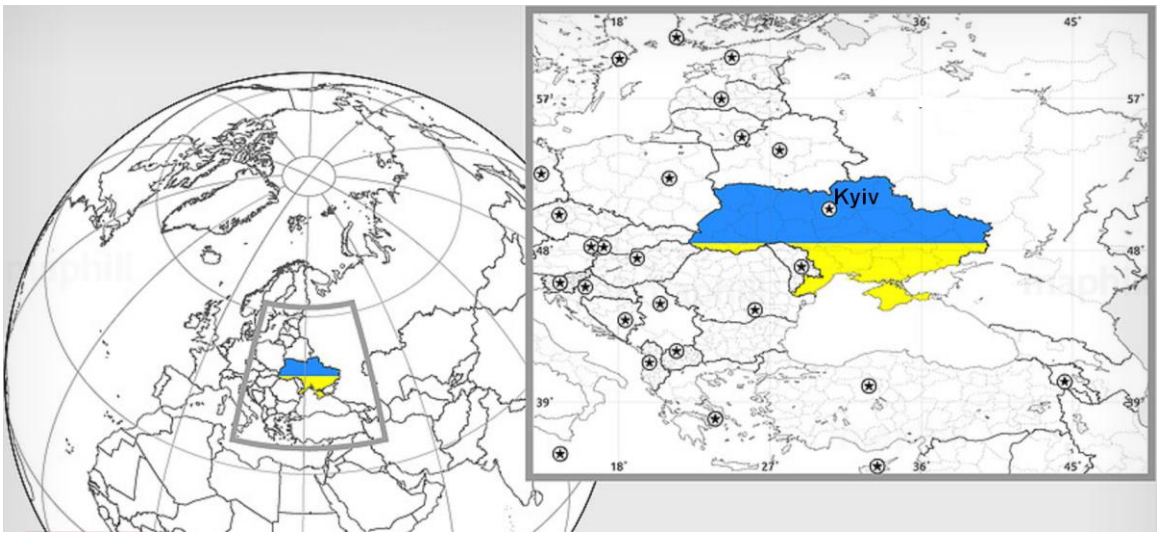
DHW 2021



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Digital Humanities Workshop (DHW 2021)

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Preface

This volume contains papers presented at 2021 Digital Humanities Workshop (DHW 2021) which was held during December 23, 2021 in Kyiv, Ukraine.

This year we received 39 paper submissions from 5 countries around the world, and 21 high-quality papers were accepted as oral presentations. Each contributed paper was rigorously peer-reviewed by reviewers who were drawn from a large pool of program committee members as well as other international reviewers in related fields.

The success of DHW 2021 depends on the contributions of many individuals and organizations. With that in mind, we thank all authors who submitted papers to the workshop. The quality of submissions this year remains high and we are satisfied with the quality of the output and workflow. The organizing committee also thanked the members of the program committee and the chair of the meeting for their strong support. The organizing committee is responsible for reviewers, who voluntarily contribute valuable time to evaluate the manuscript and provide authors with useful feedback.

Finally, no conference will succeed without the strong support of its participants. We would like to thank all the authors and attendees for participating in the workshop. We hope you have a stimulating and fruitful time at the workshop, and memorable experience in Kyiv.

Rusudan Makhachshvili, Iryna Mintii, Olena Protsenko, Serhiy Semerikov

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December 23, 2021

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Digital Humanities Event Horizon

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ABSTRACT

This is an introductory text to a collection of selected papers from the Digital Humanities Workshop (DHW 2021), held in Kyiv, Ukraine, on the December 23, 2021. It consists of short introduction, papers' review and some observations about the event and its future.

CCS CONCEPTS

• **Human-centered computing**; • **Applied computing** → **Digital libraries and archives**;

KEYWORDS

Digital Humanities Workshop, DHW

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1 INTRODUCTION

The seminal overview of meta-trends, changing the world by Snyder [20] identified universal connectivity as a transcendent premise of technological trends development. Through the span of the following predictive Global Trends frameworks, provide the hindsight in the lens through which technological growth and advances features in the global development trendsetting. The paradigm of these aspects is evolving from technological breakthroughs (Global Trends 2025 [1]) to accessibility of technology (Global Trends 2030 [2]) to transformative technology (Global Trends 2040 [3]), accordingly.

The sub-trend of the technological society development is manifested through the elaboration of an interdisciplinary paradigm of digital humanities – a diverse, open for augmentation, transdisciplinary range of areas of knowledge, applied activities and education in Arts and Humanities, centered on digital adaptation, production, processing, manipulation and dissemination of relevant thematic content: Digital history; Digital philology; Digital art; Digital education; Digital sociology; Digital music etc.

Dynamic transformation of the knowledge economy, enhanced by Industry 4.0/5.0 development and rise of the networked society in the Digital Age, emergency digitization of all social communicative spheres due to pandemic measures have imposed dramatic changes onto transdisciplinary overlap in different areas of human knowledge and experience, induced by the cross-sectorial job market demands of skills, activity workflow and measurable outcomes and key performance indicators.

The COVID-19 pandemic induced amplified digitalization measures in the social and industrial sphere. This end-to-end digital shift in the social and professional communication processes (communication, content, outcomes and outputs, skills) heralded the introduction of meta-disciplinary dimensions of learning and workflow arrangement – digital, hybrid and, blended. These meta-disciplinary dimensions can be considered conduits of vertical (endocentric) and horizontal (exocentric) transdisciplinary of digital humanities.

DHW (**D**igital **H**umanities **W**orkshop) is a peer-reviewed international workshop focusing on applications of digital technologies to the study of the humanities with the recognition that the printed word is no longer the main medium for knowledge production and distribution. The goal of DHW is to bring together researchers working on new ways of doing scholarship that involve collaborative, transdisciplinary, and computationally engaged research, teaching, and publishing.

Figure 1: DHW 2021 logo.

DHW 2021, December 23, 2021, Kyiv, Ukraine

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DHW 2021 topics of interest are:

- Theoretical, epistemological, methodological or historical aspects of Digital Humanities
- Digital approaches and applications in literary and linguistic fields, including computational text analysis, stylometry, authorship attribution, natural language processing and computational linguistics, digital philology and textual scholarship
- Digital approaches and applications in archaeology, architecture, and art history, including image processing, 3D modeling, digital restoration
- Digital history, geographic information systems applications in spatial humanities and historical studies, public history
- Digital approaches in music, film, theatre, and media studies; electronic art and literature, games studies, hacker culture, networked communities, digital divides, digital activism, open/libre networks and software, etc.
- Cultural heritage, digital cultural studies and research undertaken by digital cultural institutions
- Social, cultural, and political aspects of Digital Humanities including digital cultural studies, digital geopolitical studies, multilingualism and multiculturalism in Digital Humanities
- Emerging technologies such as physical computing, single-board computers, quantum computing, minimal computing, wearable devices, and haptic technologies applied to humanities research
- Institutional aspects of Digital Humanities, interdisciplinary aspects of scholarship, open science, public humanities, societal engagement and impact of Digital Humanities
- Digital Humanities pedagogy and academic curricula
- Digital Research infrastructures, digital libraries and virtual research environment, critical infrastructure studies, media archaeology, etc.
- Any other theme pertaining to the Digital Humanities

Digital Humanities Workshop 2021 that took place December 23, 2021, is a dream come true. Ukraine is now officially on the map of the centers of research in the digital humanities of Europe, with its clearly delineated outline of the digital dimensions of the humanities studies of language, learning and governance, in line with the Manifesto of Digital Humanism. DHW 2021 are research teams from 5 countries (Ukraine, Greece, Sweden, Estonia, Serbia).

DHW 2021 transpired as an open dialogue on broad philosophical issues of digital boundaries and measures in today's humanity (culture, education, communication, technology) and a detailed discussion on the technological features of digital processing of language signs, art objects and various types of human communication with the digital environment.

Taking into account the context of the erupted military intervention on Ukraine in February 2022, and the ensuing information warfare in various digital ambients (social media, news coverage, digital communications), the specific value of the DHW 2021 outcomes and outputs is allocated to the enhanced role of digital humanism as a tool of the internationally broadcast strife of Ukraine for freedom and sovereignty. For the first time in modern history the full inventory of interconnected areas of digital humanities (from fact-checking via digital archives, to AI-powered content

Figure 2: Social media on Russian aggression in Ukraine.

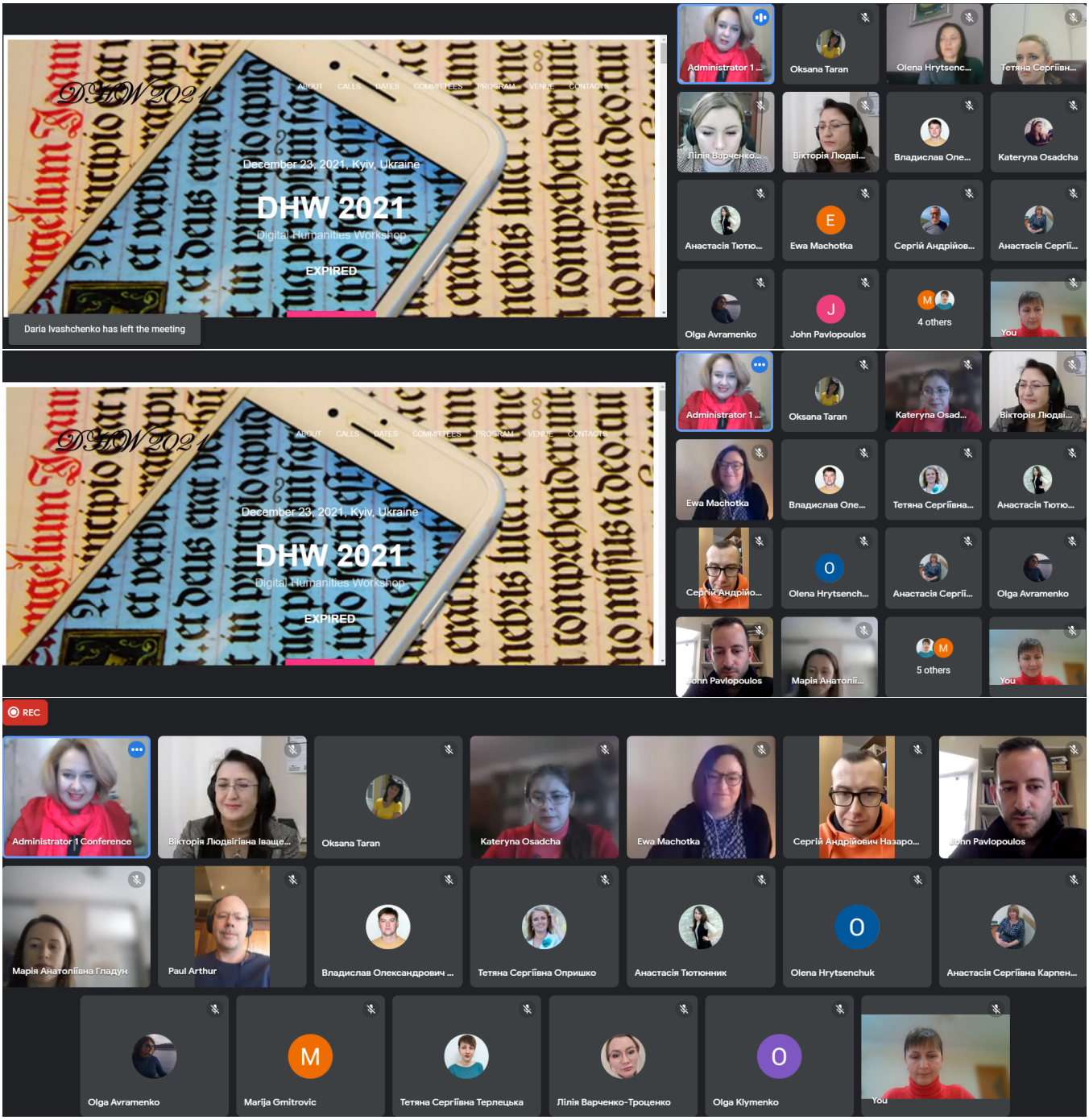
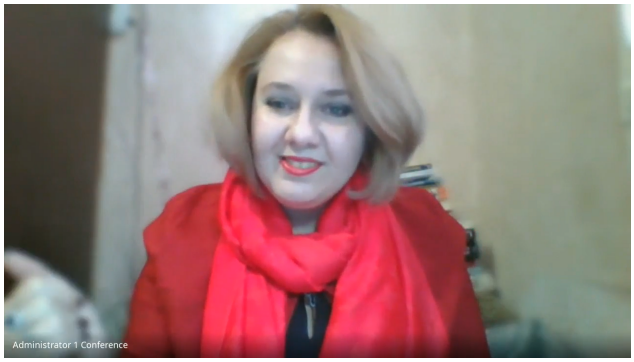


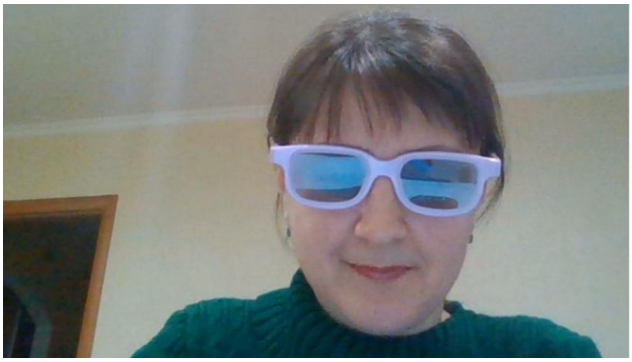
Figure 3: DHW 2021 highlights.

distribution algorithms and fake-news detection, to viral blogging and SMM, to big data processing and sociological analysis, to corpus analysis and computer assisted translation, digitally enhanced logistics coordination etc.) are implemented to achieve maximum advantage in the information warfare waged both on the cyberfront and in actuality. This development clearly heralds the branching out of digital humanities into new, undercharted areas of military digital humanities and digital peacekeeping, digital diplomacy.

DHW 2021 is also a national breakthrough in the international publishing platform ACM. Many thanks to the team of the Program Committee, international experts and reviewers who guaranteed the level of quality and thematic scale of the event.



(a) Rusudan Makhachashvili



(b) Iryna Mintii

Figure 4: DHW 2021 session chairs.

This volume represents the proceedings of the Digital Humanities Workshop (DHW 2021), held in Kyiv, Ukraine, on the December 23, 2021. It comprises 21 contributed papers that were carefully peer-reviewed and selected from 39 submissions. Each submission was reviewed by at least 3, and on the average 3.03, program committee members (https://publons.com/journal/1055537/digital-humanities-workshop/). The accepted papers present the state-of-the-art overview of successful cases and provides guidelines for future research.

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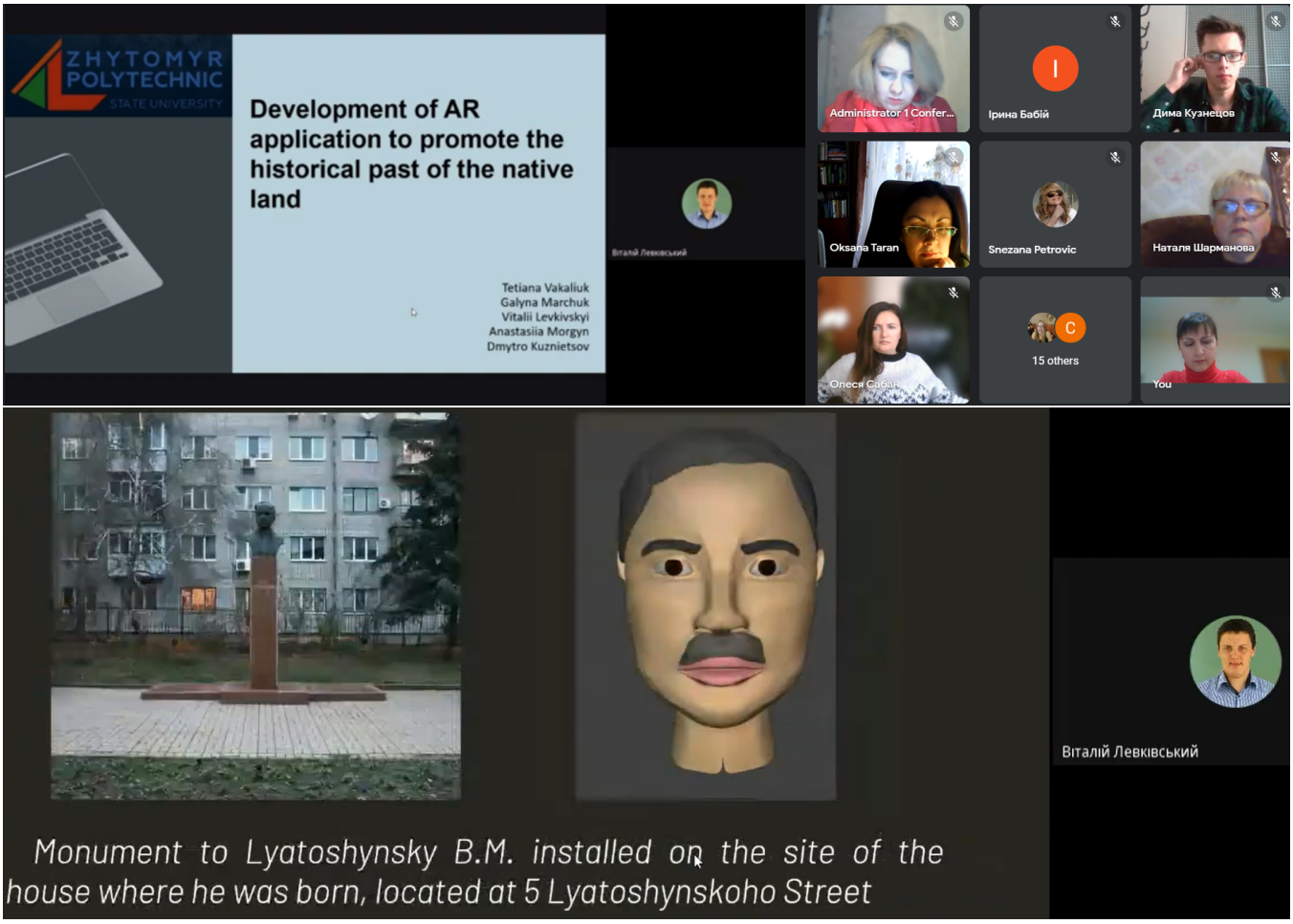


Figure 5: Presentation of paper [23].

3 DHW 2021 PAPERS OVERVIEW

The article "Development of AR Application to Promote the Historical Past of the Native Land" [23] by Tetiana A. Vakaliuk, Galyna V. Marchuk, Vitalii L. Levkivskyi, Anastasiia M. Morgun and Dmytro V. Kuznietsov (figure 5) demonstrates the possibilities of using augmented reality technology to create a software application in the field of local lore "Monuments of the city of Zhytomyr". The AR program "Monuments of the City of Zhytomyr" was implemented, the main task of which is to simplify the submission of information about people whose monuments are located in the city of Zhytomyr. To do this, nine 3D models were created, for each of which information was selected about the person to whom the monument is dedicated. Photographs of the sites were also taken for further use as triggers. Audio help is recorded for each model. The proposed development can be used to promote tourism and the history of the city. Augmented reality technology in the educational process has only just begun to develop and be increasingly used. We believe that this software application can be used in the educational process for such disciplines as "Local History", "Culturology", etc.

The aim of the study "Digital Drawing and Painting in the Training of Bachelors of Professional Education: Experience of Blended Learning" [17] by Kateryna P. Osadcha (figure 6), Viacheslav V. Osadchyi, Vladyslav S. Kruglyk and Oleg M. Spirin is to solve the problem of insufficient training of specialists who are able to meet the growing demand for projects in the digital design and computer games industry. Based on the analysis of the content of digital drawing and painting, two elective courses were implemented. They are: "Digital drawing with the basics of composition" and "Digital painting with the basics of color" for Bachelors of Professional Education majoring in digital technologies. In order to properly organize the process of blended learning, which was caused by quarantine restrictions due to the COVID-19 pandemic, appropriate tools to be used in the process of studying these courses, were selected. The Moodle distance learning platform and cloud technologies (Google Docs, Google Drive) were used to present theoretical material and set tasks for practical study. For operative communication with students VoIP program Discord was used. To develop students' skills of drawing from life and high-speed drawing we offered such Internet resources as Line of action, Character designs, Bodies in

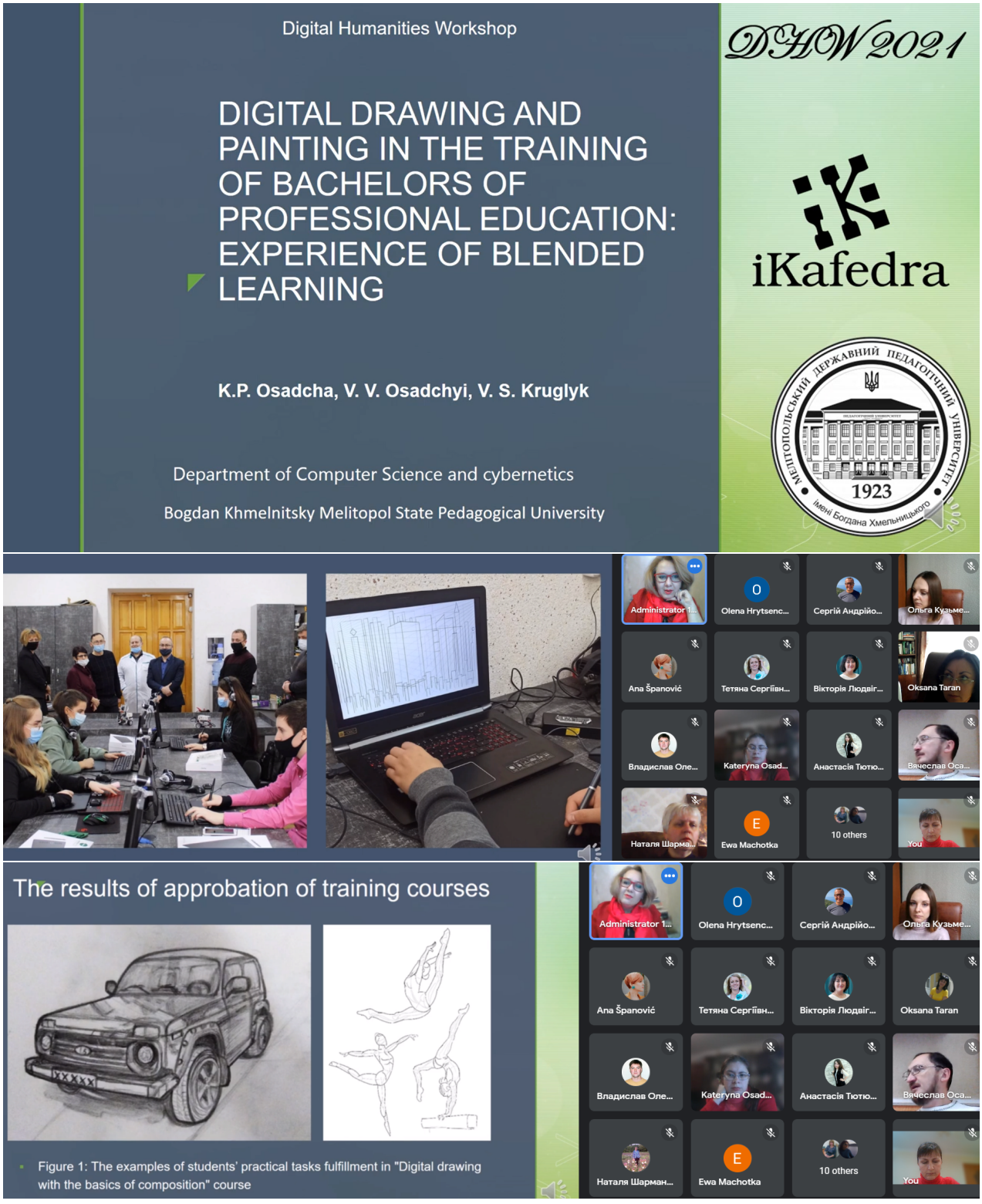


Figure 6: Presentation of paper [17].

Motion, Human anatomy for artist. Approbation of the developed courses in the institution of higher education in the conditions of blended learning and the results of the survey of students proved the effectiveness of the developed courses.

Modern academic librarians strive to qualitatively meet the information needs of their users. At the same time, librarians seek to take an active part in the organization and conduct of research. In the paper "Case Study: Citizen Science in Digital Humanities context" [16], Tetiana Opryshko and Serhii Nazarovets (figure 7) present the successful experience of Borys Grinchenko Kyiv University (Ukraine) in working on the wiki project "Dictionary of Borys Grinchenko" which uses elements of digital humanities, citizen science and gamification. The main aim of this project is to involve university students in getting acquainted with the Dictionary of the famous Ukrainian ethnographer and ethnographer Borys Grinchenko (1863–1910). During the project, students compete among themselves who will add the most quality explanations and visualizations of the Grinchenko's Dictionary words to the University wiki portal. The results show that this project not only promotes the development of university web resources but also promotes cultural heritage, develop successful team building, helps to the involvement of students in research activities. This experience will be useful for other academic libraries looking for ways to join the digital humanities and can be replicated in small, low-budget academic institutions.

E-terminography – one of the current areas of development of the digital humanism is in the limelight of the paper ""Lexical Minimum of Media Scientist": Reference Learning Edition as an Educational E-Resource" [10] by Victoria Ivashchenko, Vladyslav Yaskevych and Daria Ivashchenko (figure 8). It reveals the concept of terminological learning e-dictionary as an electronic reference edition and the typology of such dictionaries with examples. Special attention is given to the relevance of creating reference (namely dictionary) e-learning edition that contribute to a better study of terms and concepts of a particular subject area in professional learning, in particular educational e-resources of the combined type. It theoretically substantiates and describes stages of creating educational e-resource "Lexical Minimum of Media Scientist" focused on studying the cycle of media disciplines, which combines multimedia (audio, video, animation) fragments with visual and monomedia ones – in particular via text (in pdf) and hypertext fragments, using different semiotic codes – verbal and nonverbal with the possibility of interaction.

In the article "Software for Measuring Linguistic Literacy Rate of Students (Based on Comments Written in Ukrainian)" [7] by Ihor O. Drahushchak, Oksana S. Taran, Svitlana P. Bybyk, Olesya V. Saban and Natalia M. Sharmanova (figure 9), linguistic literacy rate is measured by the number of errors in students' comments on the web portal. The data comprising about 10,000 comments covering all regions of Ukraine over a period of 10 years has been analyzed. The stages of creating a software which interacts with the LanguageTool and enables generating the results of error analysis and classifying them by types and regions have been described. A map of linguistic literacy of Ukrainian students has been created. Also, the regions with the highest and lowest linguistic literacy and the main types of errors have been identified. The obtained data will make it possible to revise and adjust university language teaching programs in each region in the future.

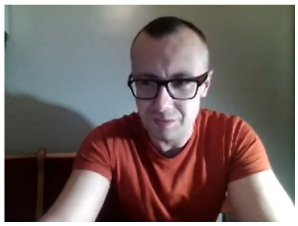
The paper "Stylometric Study of the Fiction Using Sketch Engine" [22] by Oksana S. Taran (figure 10), Oleksandra S. Palchevska, Alla A. Luchyk, Viktoriia V. Shabunina and Oksana V. Labenko deals with a stylometric study of I. Asimov's idiostyle considering a corpus-based approach. For the analysis of stylometric features the I. Asimov "Foundation" cycle text corpus was created. The quantitative and statistical processing of the text corpus is done via Sketch Engine tool that enables comparison of phrases and words in the following variants: lemma, token, subcorpus. The last parameter is important for distinguishing individual authorial features, comparing their combinability and identifying the dynamics of idiostyle. The following stylometric features of a text corpus by I. Asimov are described: quantitative morphological and lexical characteristics of the vocabulary, quantitative characteristics of occasionalisms' word formation and statistical estimation of occasionalisms' collocations. It is sated that the frequency of occasionalisms in the cycle of novels undergoes chronological change, as well as their combinability. In this paper, a method of occasionalisms' automated extraction due to keyness score was proposed, however, it requires the subsequent manual verification.

The article "Use of Digital Tools for Checking Uniqueness by Students and Academic Staff of the Borys Grinchenko Kyiv University: Problems and Solutions" [25] by Nataliia M. Vinnikova, Olena S. Aleksandrova, Olga M. Kuzmenko, Tetiana S. Opryshko and Anastasiia S. Karpenko (figure 11) examines the level of mastery by the Borys Grinchenko Kyiv University students, master's students, postgraduates, academic staff and researchers of the digital tools allowing to check the uniqueness of academic texts. The anti-plagiarism software most popular among the respondents was identified; its advantages and shortcomings, as well as the difficulties that arise when using it were analyzed. Proposals on how to increase the level of mastery of skills in self-regulation of educational and scientific activity, in particular writing own academic texts, for all participants in the Borys Grinchenko Kyiv University educational and scientific process were developed. Based on results of the survey, an algorithm for detecting the absence/presence of academic plagiarism in the student research papers submitted to the Ukrainian Competition of Student Research Papers in the Fields of Knowledge and Specialties was developed and launched, indicating the responsibility of all actors of the process for observance of the principles of academic integrity.

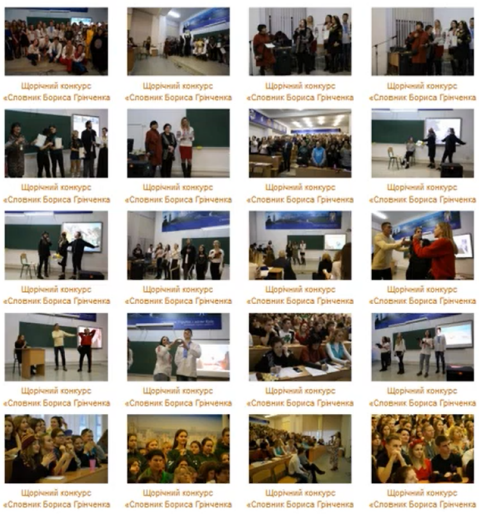
The study "Digital Interoperability of Foreign Languages Education" [13] by Rusudan Makhachashvili (figure 12), Ivan Semenist, Yurii Zatsnyi and Olga Klymenko is focused on the in-depth diagnostics of the development of digitally enhanced multipurpose orientation, universality and interdisciplinarity of skillsets for students of European (English, Spanish, French, Italian, German) and Oriental (Mandarin Chinese, Japanese) Languages major programs in Ukraine through the span of educational activities in the timeframe of COVID-19 quarantine measures of March 2020 to October 2021. The findings disclose a wide scope of generalized theoretical and applied issues, permeating the social and educational context worldwide: global event horizon and paradigm shifts in the interdisciplinary trends of digital education in the COVID-19 timeframe and beyond; transformative changes and avenues of development of the

Citizen Science in Digital Humanities Context

Tetiana Opryshko & Serhii Nazarovets



The annual competition "Dictionary of Grinchenko and modernity"



This competition is held in 2 stages:

1. The first stage involves the placement on the University wiki portal of links, images, videos, texts that complement the explanation and visualize the words from the Dictionary. The participant for the description of one word from the dictionary can gain a maximum of 20 points;

1. The second (final) stage of the competition takes place offline. A team of up to 5 people from each university's unit perform at the final stage of the competition. Each team presents the 3 best interpreted words of their choice. The performances of the teams are evaluated by a jury, and the winner is determined on the basis of the total nu points received by the teams for all stage competition.

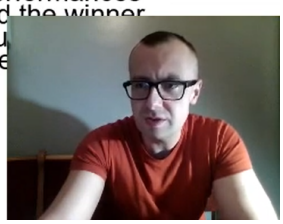


Figure 7: Presentation of paper [16].

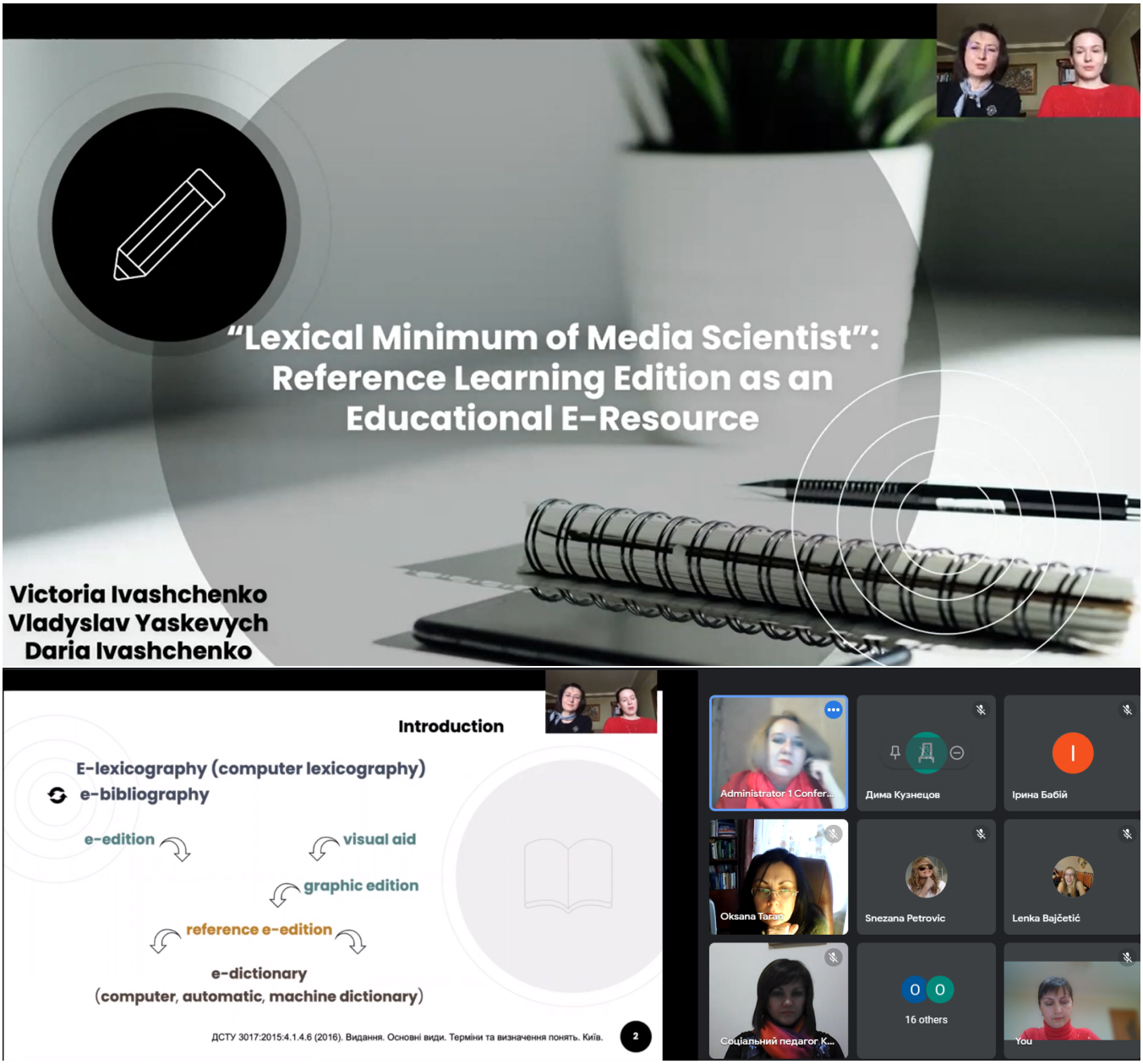
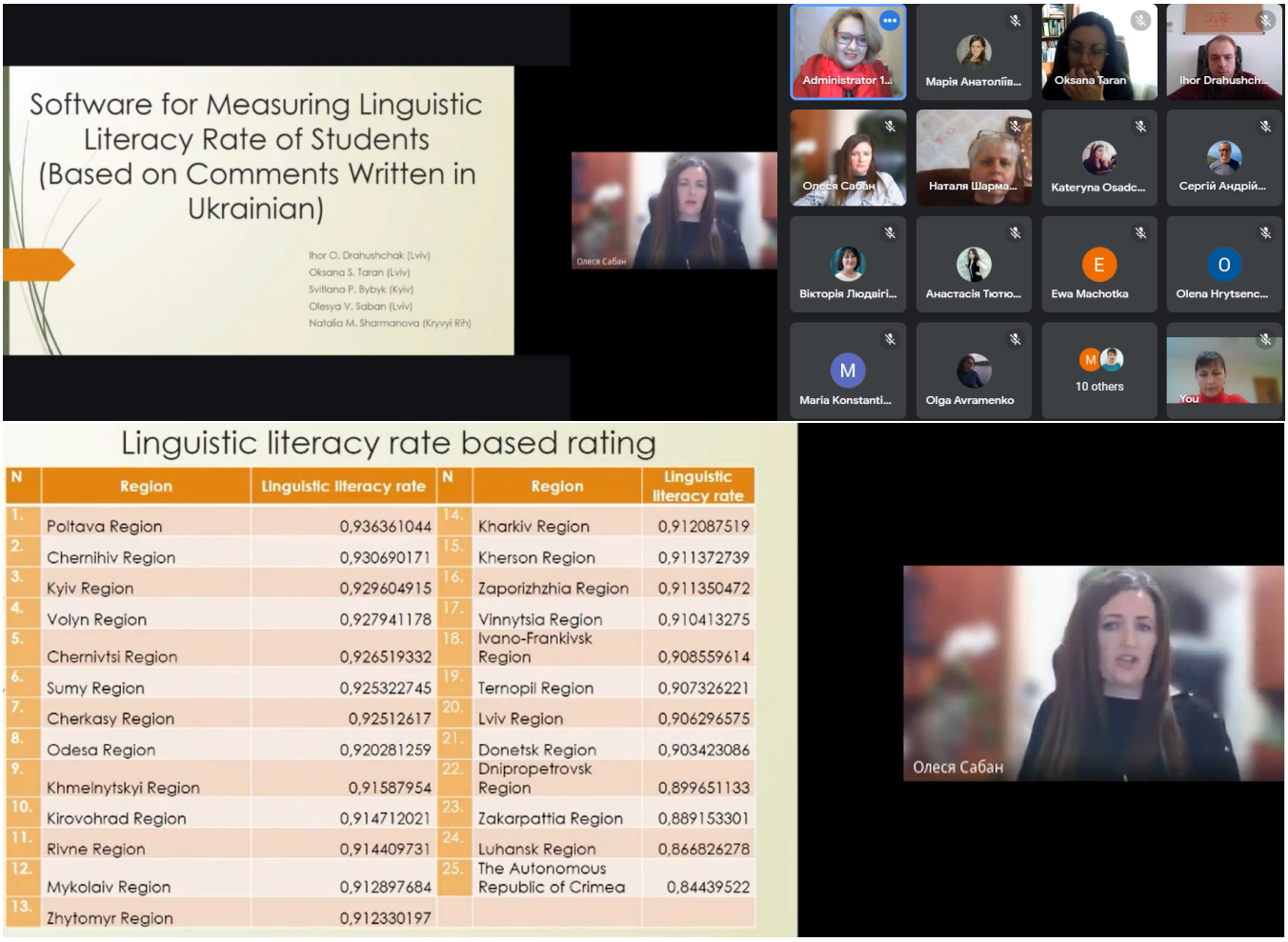


Figure 8: Presentation of paper [10].

network society and education as an interdisciplinary socio-cultural institution and industry in the digital age; global experiences, universal/generic challenges, technical advances and specific national gains in quality assurance of online and hybrid learning in the COVID-19 paradigm. A computational framework of digital interoperability and interdisciplinarity of foreign languages education is introduced in the study. The survey analysis is used to evaluate the digitally enhanced dimensions of interdisciplinarity, universality and transdiciplinarity, informed by the interoperability of soft skills and digital communication skills for foreign languages education across contrasting timeframes and stages of foreign languages acquisition and early career training.

The global pandemic and emergency digitization measures have introduced systemic challenges to the university summative and formative assessment workflow. Various modes of assessment for University-level programs are a strict regimen that consists of different elements and stages (oral, hybrid, and written exams, tests of different types, project presentations, internal and external review, expert evaluation, and peering). The study "Digital Formats



Linguistic literacy rate based rating

N	Region	Linguistic literacy rate	N	Region	Linguistic literacy rate
1.	Poltava Region	0,936361044	14.	Kharkiv Region	0,912087519
2.	Chernihiv Region	0,930690171	15.	Kherson Region	0,911372739
3.	Kyiv Region	0,929604915	16.	Zaporizhzhia Region	0,911350472
4.	Volyn Region	0,927941178	17.	Vinnytsia Region	0,910413275
5.	Chernivtsi Region	0,926519332	18.	Ivano-Frankivsk Region	0,908559614
6.	Sumy Region	0,925322745	19.	Ternopil Region	0,907326221
7.	Cherkasy Region	0,92512617	20.	Lviv Region	0,906296575
8.	Odesa Region	0,920281259	21.	Donetsk Region	0,903423086
9.	Khmelnytskyi Region	0,91587954	22.	Dnipropetrovsk Region	0,899651133
10.	Kirovohrad Region	0,914712021	23.	Zakarpattia Region	0,889153301
11.	Rivne Region	0,914409731	24.	Luhansk Region	0,866826278
12.	Mykolaiv Region	0,912897684	25.	The Autonomous Republic of Crimea	0,84439522
13.	Zhytomyr Region	0,912330197			

Figure 9: Presentation of paper [7].

of Learning Outcomes Assessment in the COVID-19 Paradigm: Survey Study" [15] by Nataliia Morze, Rusudan Makhachashvili, Liliia Varchenko-Trotsenko (figure 13) and Liliia Hrynevych aims to critically analyze the practices of Borys Grinchenko Kyiv University in various forms and modes of digital assessment for stakeholders of Liberal Arts, Education, and Computer Science major programs, implemented in the years 2020–2021 through quarantine induced digital learning. The survey analysis was conducted to evaluate ICT tools and digital competencies that are implemented to compare and contrast traditional and formative assessment practices, translated into the digital hybrid format. The investigation novelty is attained through systemic empirical findings on experiences and techniques of learning outcomes assessment in the emergency digitization measures, contrastive assessment of different modes in digital learning, evaluation of ICT tools and skills, implemented through different forms of assessment in the digital learning context.

The successful transformation of a country to an advanced digital state is substantially dependent on education and more specifically, the development of an e-Governance curriculum in higher institutions. Estonia as a role model has demonstrated that e-Governance implementation significantly stems from a strong collaboration between stakeholders such as the state, private sector, and academia. The study "Educating Future Digital Leaders: Developing e-Governance Curriculum in Estonia and Ukraine" [14] by Nataliia Morze, Rusudan Makhachashvili (figure 14), Gvantsa Mosiashvili and Ingrid Pappel aims to examine the risk factors of e-Governance curriculum development in an emergent e-democracy state – Ukraine, and how lessons learnt from Estonia's digital transformation can be used for coping with underlying risks. To conduct this research, a survey on Digital Competence in e-Governance Education in Ukraine was conducted along with analyzing secondary data related to Estonia's case. The results suggest that issues related to e-Governance curriculum implementation in Ukraine include comprehensive factors like low digital competence and low awareness in available trainings in e-Governance, as well as access to technology and respected e-learning sources. Thus, the recommendations which stem from Estonia's experience as an e-state are suggested for overcoming the risk factors that Ukraine faces in e-governance curriculum development.

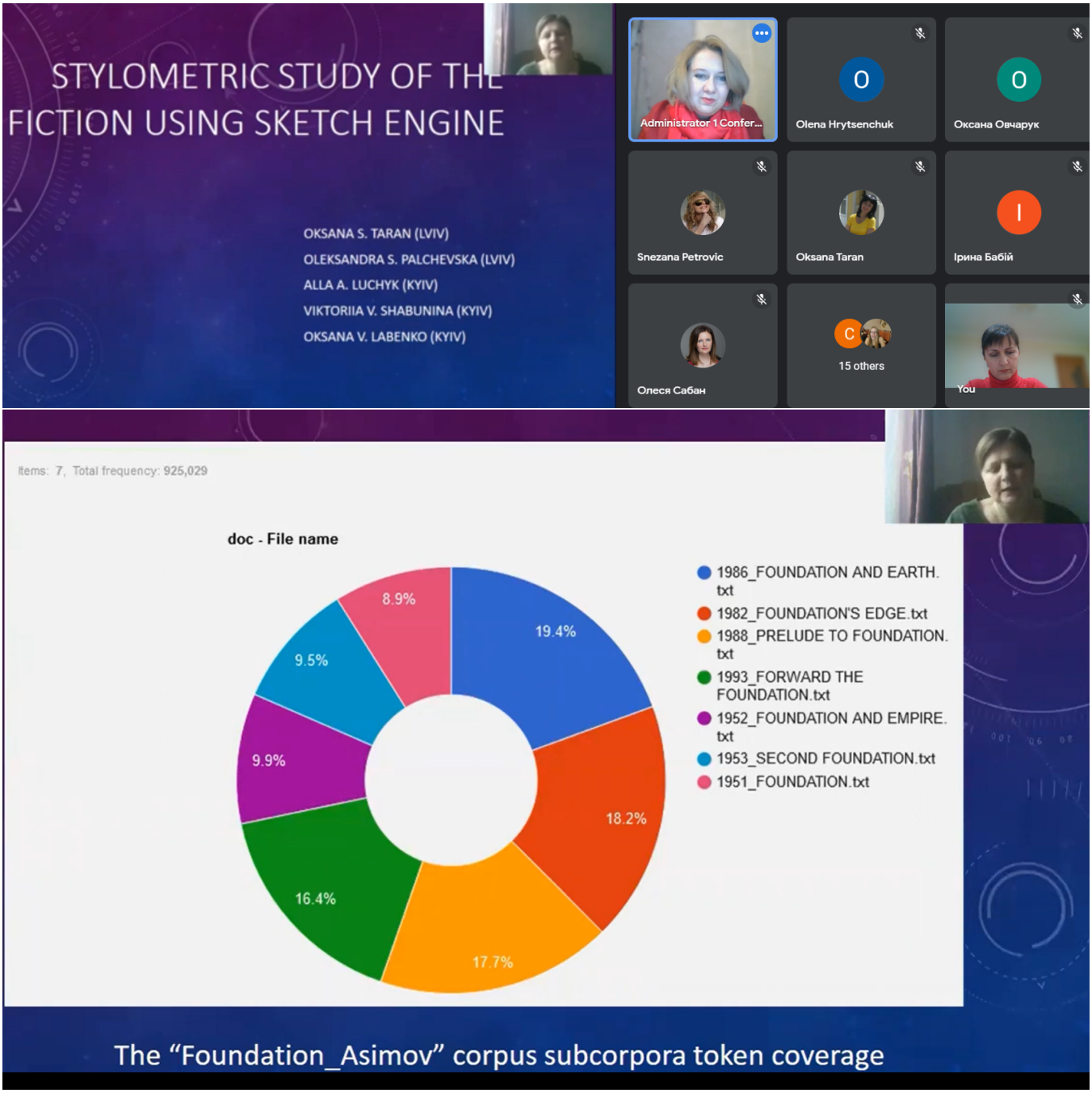


Figure 10: Presentation of paper [22].

The paper “Automated Recognition of Geographical Named Entities in Titles of Ukiyo-e Prints” [6] investigates the application of Natural Language Processing as a means to study the relationship between topography and its visual renderings in early modern Japanese ukiyo-e landscape prints. Marita Chatzipanagiotou, Ewa Machotka and John Pavlopoulos (figure 15) introduce a new dataset with titles of landscape prints that have been annotated by an art historian for any included place-names. The prints are hosted by the digital database of the Art Research Center at the Ritsumeikan University, Kyoto, one of the hubs of Digital Humanities in Japan. By applying, calibrating and assessing a Named Entity Recognition (NER) tool, Chatzipanagiotou et al. [6] argue that ‘distant viewing’ or macroanalysis of visual datasets can be facilitated, which is needed to assist art historical studies of this rich, complex and

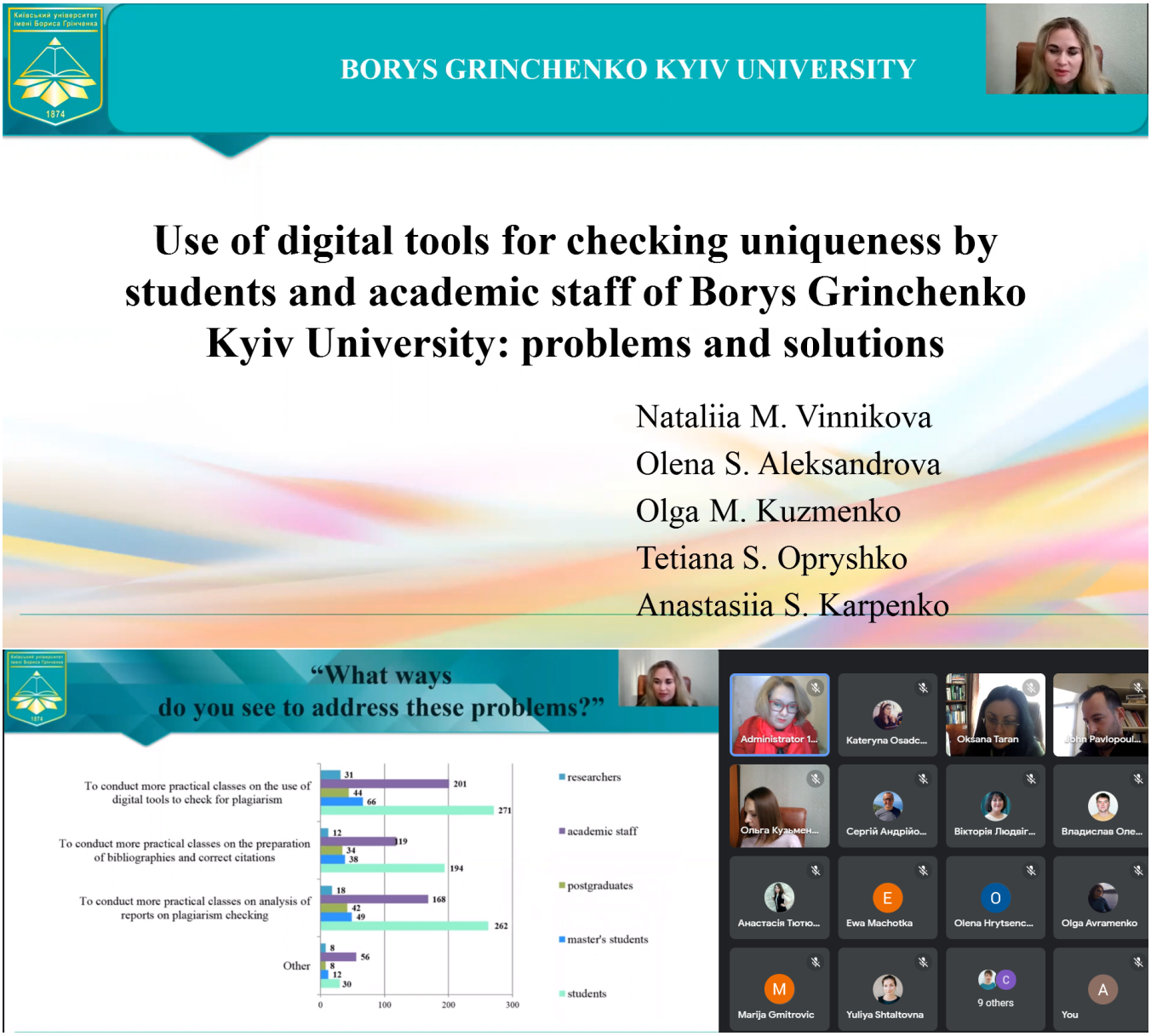


Figure 11: Presentation of paper [25].

diverse research material. Experimental results indicated that the performance of NER can be improved by 30% and reach 50% precision, by using part of the introduced dataset.

The paper "Digitization of the Serbian folk proverbs compiled by Vuk S. Karadžić" [4] by Lenka Bajčetić, Marija Gmitrović, Ana Španović and Snežana Petrović (figure 16) aims to present the digitization process of a very important piece of Serbian intangible cultural heritage, *Serbian folk proverbs and other common expressions and phrases*, compiled by Vuk Stefanović Karadžić during the first half of the 19th century. In the paper, we discuss the necessary steps in the digitization process, the challenges we had to deal with as well as the solutions we came up with. The goal of this process is to have a fully digitized, user-friendly version of *Serbian folk proverbs*, that will also easily integrate and be compatible with other digitized resources and/or multi-dictionary portals.

Iliad and Odyssey are products of a collective effort involving numerous authors, each contributing unknown portions of text, and it still cannot be determined whether a single individual (or distinct group of poets) contributed larger chunks of such additional verses, or even whole Books. In the paper "Computational Authorship Analysis of Homeric Language" [8], Maria Fasoi, John Pavlopoulos (figure 17) and Maria Konstantinidou employed character-level statistical language modeling to analyse the computational authorship of Homeric text and study the linguistic proximity and divergence

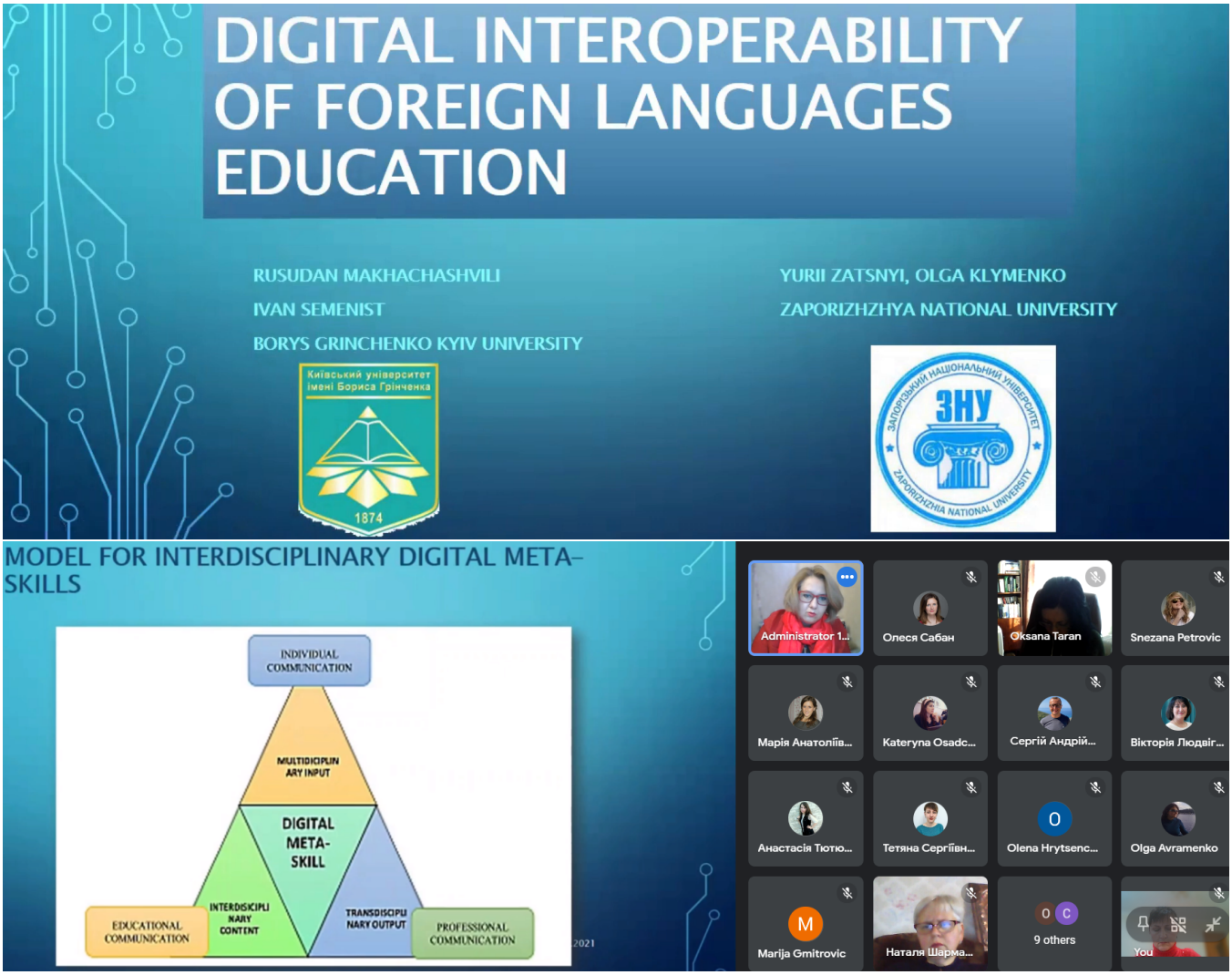


Figure 12: Presentation of paper [13].

between the books of Iliad and Odyssey. Fasoi et al. [8] show that some pairs of books are much closer than others and that some books are linguistically far from the rest. Furthermore, Fasoi et al. [8] investigated the linguistic association between the Homeric poems and four Homeric hymns, showing that *"To Aphrodite"* is linguistically close and that *"To Hermes"* is linguistically far from both, Iliad and Odyssey. In a final experiment, Fasoi et al. [8] show that statistical language models can be used to classify excerpts between Iliad and Odyssey similarly to the average human expert.

The design of learning environment is the central theme of paper "Creation and Development of the Digital Learning Environment in Educational Institutions" [9] by Olena O. Hrytsenchuk (figure 18) and Sergii I. Trubachev. The modern digital learning environment of educational institutions should be flexible and personalized, meet the needs, requirements and wishes of teachers, students and the educational institution. Education with the use of digital tools has become relevant today in the quarantine of COVID-19. The educational process takes place regardless of time and place. It requires quick and easy access to information and educational resources. The digital learning environment of the educational institutions provides these conditions. The components of the digital learning environment of the educational institutions should provide the main functions in the process of learning and education: learning, communication, cooperation, assessment and testing, planning and management, presentation and evaluation of tasks. The approach of creating and using the digital learning environment of the educational institutions involves the use of all its elements, namely: IT services, applications, systems, etc., which can be easily combined, updated, added, deleted, changed. This approach will create and develop the digital learning environment of the educational institutions that can be adapted to innovation in education and ICT.

The article "Digital Competence of Future Researchers: Empirical Research of PhD Students of Ukrainian University" [11] by Nataliia

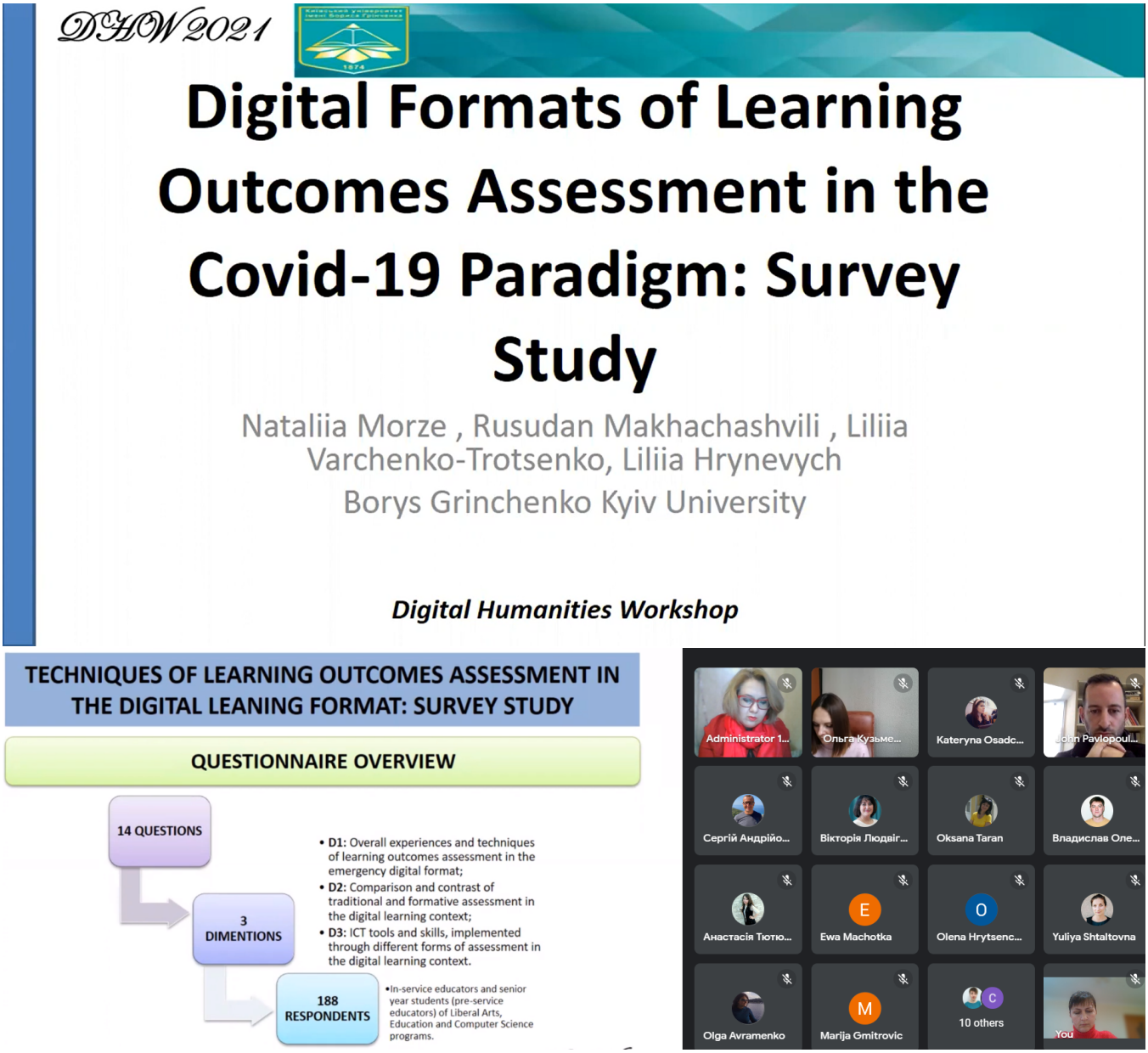


Figure 13: Presentation of paper [15].

Morze, Olena Kuzminska, Liliia Varchenko-Trotsenko, Maria Boiko (figure 19) and Mariia Prokopchuk analyzes the experience of Jisc, which provides digital solutions for education and research in the UK, which became the basis for additional research on scaling the Jisc Reseacher model for the formation of digital competence of graduate students in higher education in different countries. The digital competence of the PhD students researcher of a particular educational institution is considered as a factor influencing the quality of education and the readiness of PhD students for its development. The result of the study is to determine the readiness of PhD students of Borys Grinchenko Kyiv University to acquire and develop their own digital competence of the researcher. The readiness to acquire and develop digital competence of graduate students both at the level of resource provision and basic digital competence and motivation of future researchers was confirmed by conducting a survey of the experimental group of graduate students of the 1st year of study. To identify general or specific problems for graduate students based on the analysis of average group values for each group of Jisc Reseacher competencies, unformed digital competencies of researchers were identified and the author's interpretation of the causes and prospects of development was given

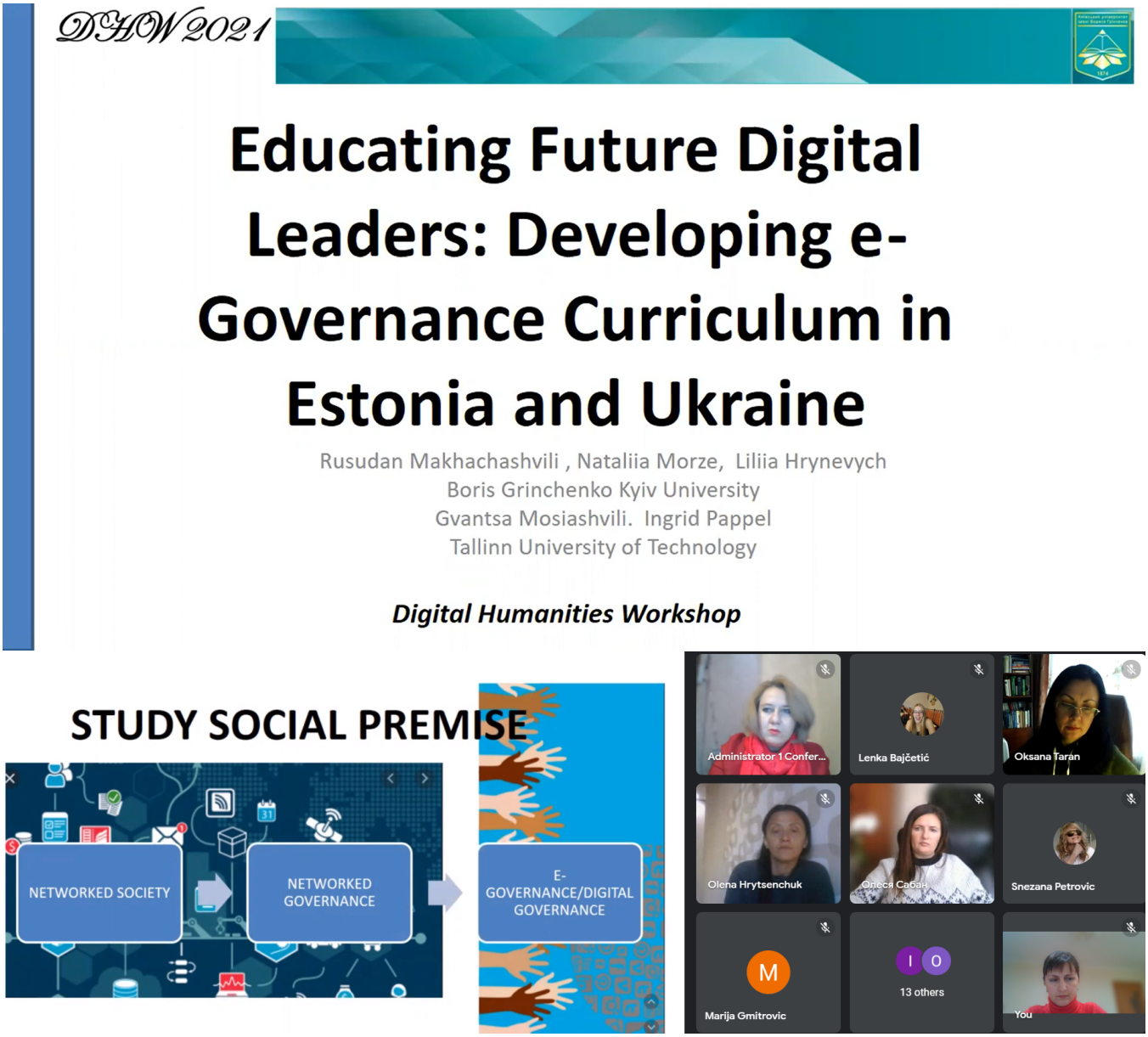


Figure 14: Presentation of paper [14].

The paper "Emoji Explication in Digital Communication: Logical-Phenomenological Experiment" [12] by Rusudan Makhachashvili (figure 20), Anna Bakhtina, Ivan Semenist, Ganna Prihodko and Olexandra Prykhodchenko examines the digital linguistic sign Emoji in digital communication through the logical-linguistic lens. It is concluded that the explication of the content plane and expression plane of an optical digital sign due to the bilaterality of its structure is inexhaustible, because emoji optics include psychophysiological factors that appeal to both linguistic and extralinguistic elements of sign formation. Consequently, the substrate for the study of the emoji sign is its polylaterality. The latter allows the synthesis of structural (logical) with the conceptual (phenomenological) level of explication of the sign, because the plane of content and the plane of expression of the optical sign in digital communication is both in its form and in the semantic load. The study focuses on an empirical experiment – an online survey called "Emoji-association", which contains 147 perceptions and interpretations of emoji signs from recipients. The experiment results are tested through G. Frege's semantic triangle, which schematically demonstrates a bilateral approach to the plane of content, depending on both the abstract denotation (word proper) and the specific meaning. With emphasis on polylaterality and its verification, hypothetical-deductive syllogisms are created, which includes interpretive tokens, which, according to digital analysis of answers using the web-application

ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

Automated recognition of geographical named entities in titles of *ukiyo-e* prints

MARITA CHATZIPANAGIOTOU, Athens University of Economics and Business
EWA MACHOTKA, Stockholm University
JOHN PAVLOPOULOS, Stockholm University

Kiev, 23.12.2021

Stockholm University

3. Dataset development

Ukiyo-e Portal Database, Art Research Center, Ritsumeikan University, Kyoto (screenshot)

3. Dataset development

- Sampled 200 prints, in two batches, out of the 20,408 available prints.
- Annotated by an art historian, expert in Japanese early modern history.
- Regarding place names in the titles and the inscriptions.
- GPE: place names that can be pinned on a map (city names, temples, etc.)
- LOC: place names less-easily pinned on a map (roads, etc.).

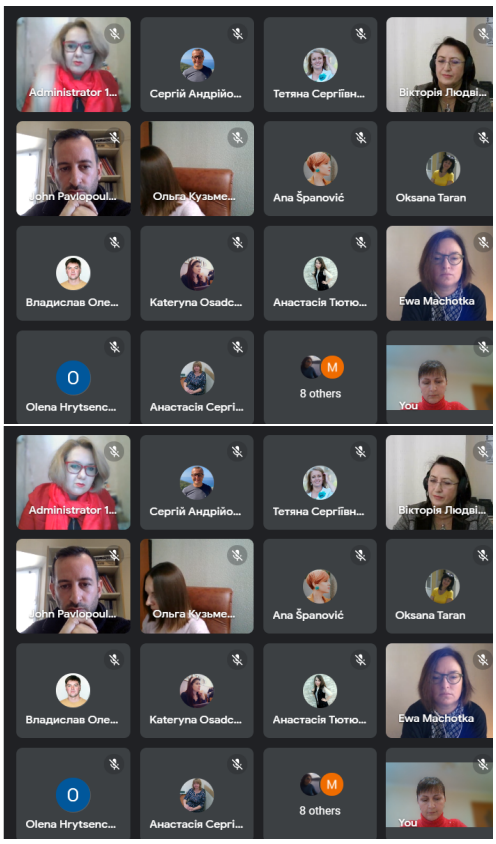


Figure 15: Presentation of paper [6].

Figure 16: Presentation of paper [4].

package Voyant Tools, are more common in frequency. According to the results of the experimental logical-linguistic approach to the study of the emoji sign in digital communication, it is concluded that the logical tools applied in the study, provide for the fractalization of agrammatical formants of the emoji sign with the verbal versions of its formants, with subsequent verification of both.

The article "Digital Educational Environment of a Modern University: Theory, Practice and Administration" [24] by Tamara G.

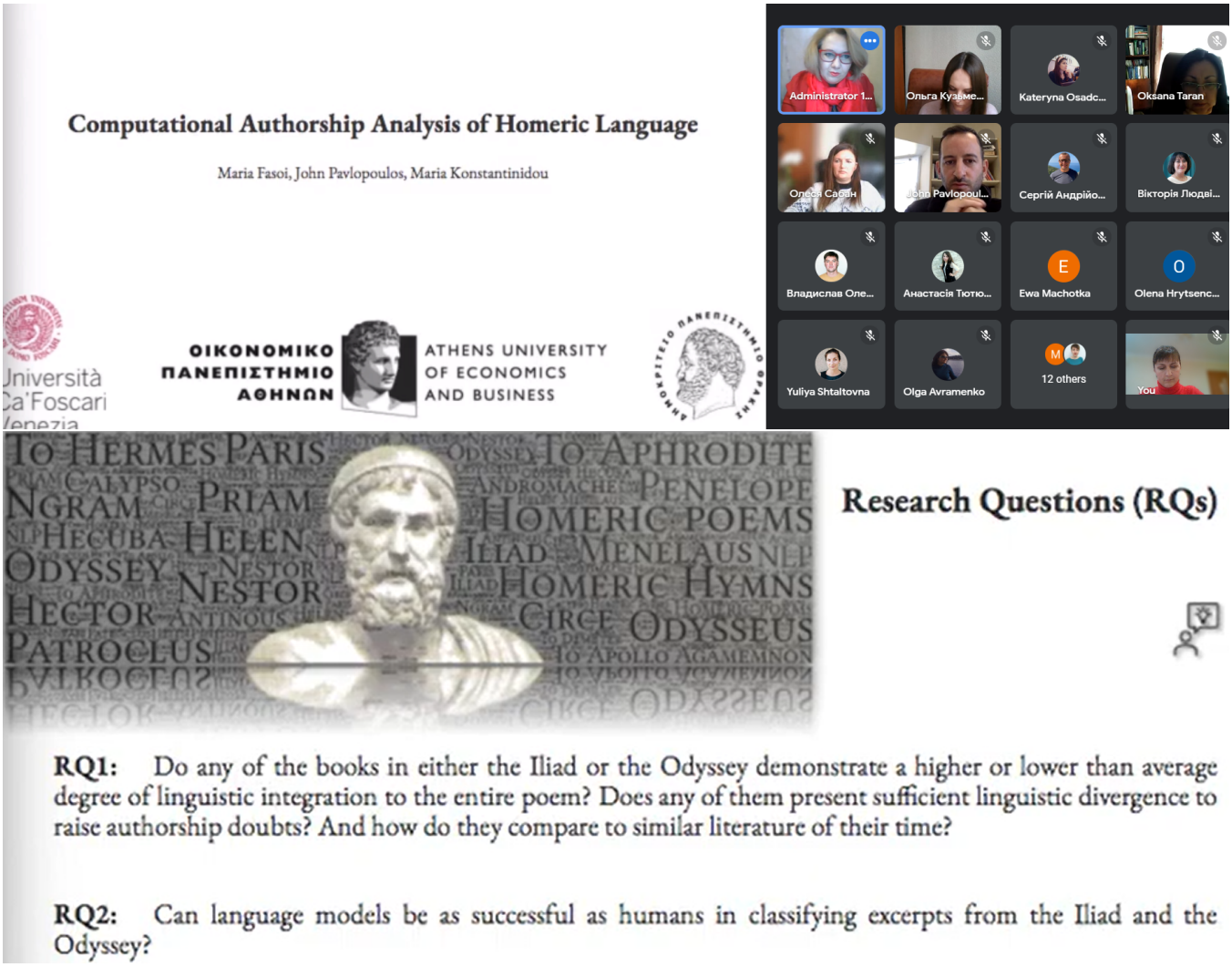


Figure 17: Presentation of paper [8].

Vasyliuk (figure 21), Ilia O. Lysokon and Iya M. Shimko reveals theoretical and practical aspects of the digital educational environment of a university. The main normative and legal documents of Ukraine regulating the informatization of the sphere of national education are determined. The experience of introduction of the system of electronic educational courses by the leading institutions of higher education of Ukraine is analysed; the concepts of "distance education", "digital educational environment", "educational management" are specified. It has been found that education is a social institution with its own laws, principles and regulations, so the ability to manage education is as important and difficult as finding the right vector for development of all mankind. The benefits of education transformation are listed: development of students' self-determination, ability to concentrate on the most valuable teaching material; increase of mobility of personality, ability to adapt to the dynamic environment; ensuring cooperation with diverse audiences; creating an individualized educational trajectory of the student; comfortable learning environment. An attempt is made to identify the definition of "digital educational environment" as a set of relevant resources that is able to ensure the implementation of educational, scientific, international and managerial activities of higher educational institutions. It was established that higher educational institutions of Ukraine in the conditions of distance learning increase the capacity of the digital educational environment. The conditions and modern vectors of information educational development are considered, and the basic problems, needed to be resolved at the state level, are defined. Strengths (flexible schedule of educational tasks, provision of inclusiveness, control and evaluation of the results of educational activities, individual consultations in remote mode, etc.) and weaknesses revealed of the development of the digital educational environment (the delay in the creation of digital training courses, lack of information literacy of teachers, low level of integration of digital learning environment and teaching disciplines, etc.). Presented the model of digital education

Figure 18: Presentation of paper [9].

environment of the university from the position of organizational and administrative activity. Described four operational modules of the specified model: scientific and technical module (repository, open publication system, digitalization of the library fund); educational module (electronic management system of educational courses, online learning, control of students' knowledge quality); administrative module (electronic document management, education environment management, digital archive, online questionnaires, operational process management, digital security systems, innovative activities in the education and information environment); informational module (official website of the institution of higher

Figure 19: Presentation of paper [11].

education, personal pages of teachers, 3D-courses, pages of the university in social networks). It is established that the level of compliance of all activities of the designated operational areas is an indicator of the successful functioning of the university under the conditions of digitalization of the educational environment.

The article "The Use of Open Electronic Scientific and Educational Systems to Support the Professional Activities of Research and Teaching Staff of Ukrainian Universities and Scientific Institutions" [21] by Oleg M. Spirin, Olga V. Matviienko, Svitlana M. Ivanova, Oksana V. Ovcharuk, Iryna S. Mintii (figure 22), Iryna V. Ivaniuk, Liliia A. Luparenko is devoted to the analysis and description of open electronic scientific and educational systems (OESES) and their use by scientific and pedagogical staff in Ukrainian universities and research institutions. The contribution of the use of open electronic systems by scientists and professors into the professional activity is considered. The results of experimental verification of the use of OESES and their impact on the research competence of teachers and researchers are presented. Based on the analysis of domestic and international research, the authors' own experience, the concept of open electronic educational systems designed to effectively organize and support research in education, pedagogy, social and behavioral sciences. The results of experimental research on the development of information and research competence of Ukrainian teachers and researchers during the use of open electronic systems

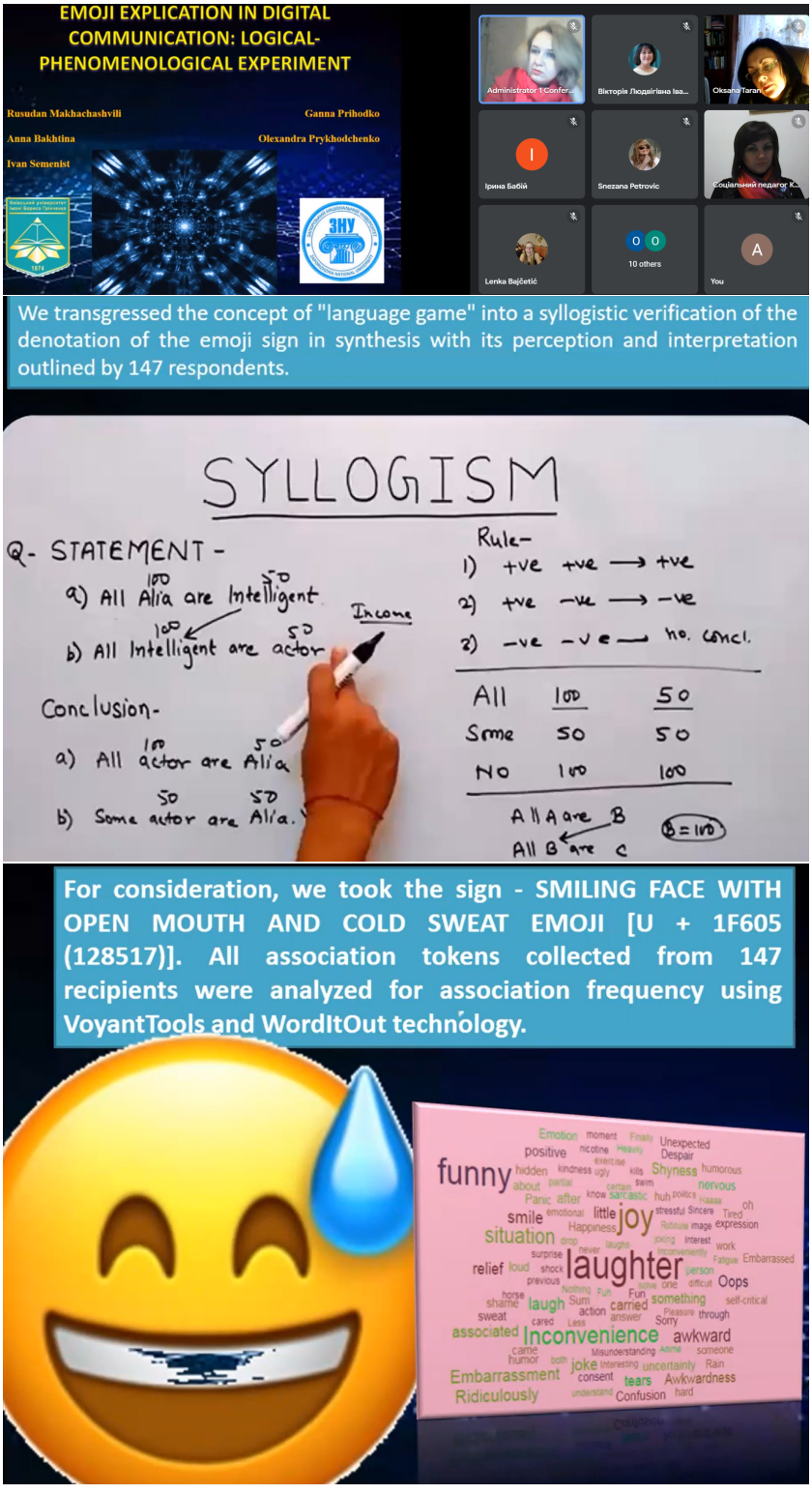


Figure 20: Presentation of paper [12].

Figure 21: Presentation of paper [24].

are presented. The necessity of creating an environment for the development of information and research competence of university teachers and scientists is substantiated. The scientific novelty is based on the obtained results and is that it is proposed to include in the structure of such environment the following elements: scientific electronic libraries, electronic open journal systems (EOJS), scientometric databases, electronic social networks, and quality assessment systems for pedagogical tests, digital identification systems for scientists and scientific publications, software verification uniqueness of texts. Today, these tools are in demand and widely used for the organization of scientific and educational activities in educational institutions and research institutions around the world.

The article "Utilization of E-Learning System for Innovative Methods Implementation in Humanities Pedagogy" [5] by Oksana

Figure 22: Presentation of paper [21].

Buinytska, Liliia Varchenko-Trotsenko, Tetiana Terletska and Anastasiia Tiutiunnyk (figure 23) presents the results of the research on e-learning system utilization at Borys Grinchenko Kyiv University by humanities students and teachers. Digitalization of humanities pedagogy is an integral part of the educational process today and e-learning systems belong to the most powerful digital instruments used at higher education institutions. Therefore, the topic of digital humanities implementation in existing at universities e-learning systems is high on the agenda. In particular, attention should be paid to the possibility of innovative teaching methods utilization with the help of the e-learning system resources. The authors focus on the capabilities of LMS Moodle for implementation of collaboration, flipped classroom technology, peer assessment and project-based learning. Utilization of such activities as Workshop, Wiki, Google Meet for Moodle as well as instruments and settings (embedded video, group submission) for implementation of innovative teaching methods are considered. The correlation between the request of humanities teachers and students and Moodle LMS options for its implementation is shown.Increased use of the e-learning system for innovative teaching methods provision is highlighted as a development area for humanities teachers.

In the paper “Mask and Emotion: Computer Vision in the Age of COVID-19” [18] by Serhiy O. Semerikov, Tetiana A. Vakaliuk, Iryna S. Mintii, Vita A. Hamaniuk, Vladimir N. Soloviev, Olga V.

Figure 23: Presentation of paper [5].

Bondarenko, Pavlo P. Nechypurenko, Svitlana V. Shokaliuk, Natalia V. Moiseienko and Vitalii R. Ruban (figure 24), educational applications of computer vision are considered. Computer vision systems since the early 1960s have undergone a long evolution and are widely used in various fields, in particular, in education for the implementation of immersive educational resources. When creating machine vision systems for educational purposes, it is advisable to use the computer vision libraries based on deep learning (in particular, implementations of convolutional neural networks). Computer vision systems can be used in education both under normal and pandemic conditions. The changes in the education industry caused by the COVID-19 pandemic have affected the classic educational applications of computer vision systems, modifying existing ones and giving rise to new ones, including social distancing, face mask recognition, intrusion detection in universities and schools, and vandalism prevention, recognition of emotions on faces with and without masks, attendance monitoring. Developed on the basis of Microsoft Cognitive Toolkit and deployed in the Microsoft Azure cloud, a prototype computer vision system integrates emotion recognition of students and detection of violations of the mask regime, additionally providing the ability to determine gender, smile intensity, average age, makeup, glasses, hair color, etc. with a high degree of reliability.

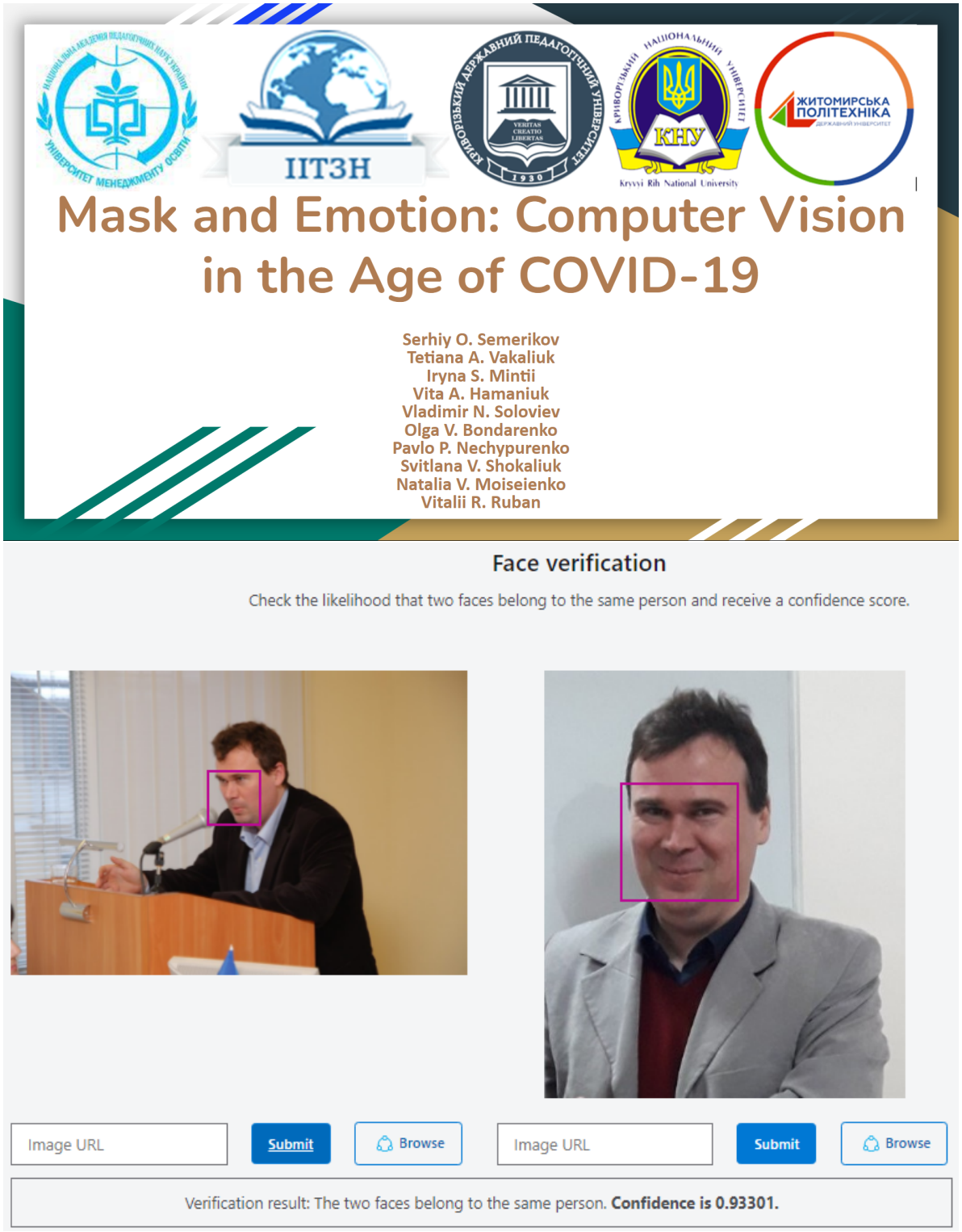


Figure 24: Presentation of paper [18].

Figure 25: Presentation of paper [19].

Proper design is the basis for the success of any application development, regardless of industry and field of application. This fully applies to both software design and learning design. Designing e-learning resources is a hybrid activity that significantly increases risks due to the speed of technological change. The risks are even greater when it comes to technologies of increased attention - immersive. In this regard, it is important to develop design methods of immersive e-learning resources – educational, scientific, informational, reference materials and tools used in an immersive environment, reproduced by immersive technical tools, and necessary for effective organization of the educational process. In the paper "Immersive E-Learning Resources: Design Methods" [19] by Serhiy O. Semerikov, Tetiana A. Vakaliuk, Iryna S. Mintii, Vita A. Hamaniuk, Vladimir N. Soloviev, Olga V. Bondarenko, Pavlo P.

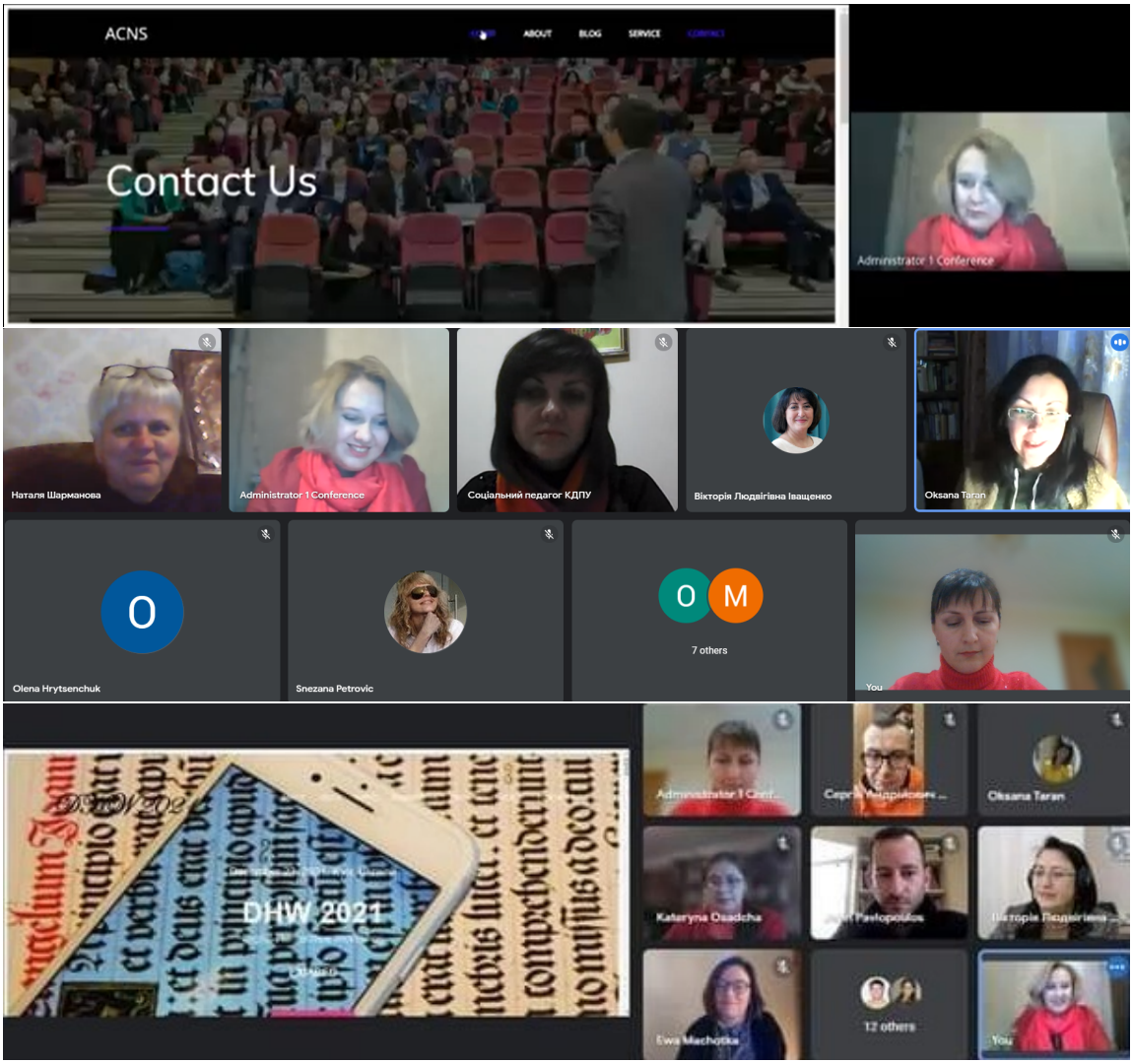


Figure 26: Blended workshop in uneven times.

Nechypurenko, Svitlana V. Shokaliuk, Natalia V. Moiseienko and Dmytro S. Shepiliev (figure 25), the classification of immersive educational resources is theoretically substantiated, and the generalized model of a technique of designing immersive educational resources is developed.

4 DHW 2021: CONCLUSION

DHW 2021 workshop would not have been possible without the support of many people. We would like to thank all the authors who submitted papers to our workshop and thus demonstrated their interest in the research problems within our scope. We are also very grateful to the members of our Program Committees for providing timely and thorough reviews and being cooperative in doing additional review work. We would like to thank the local organizers of the workshop, and the technical support team for their valuable service and help. Special thanks go to the Academy of Cognitive and Natural Sciences (ACNS, https://acnsci.org) whose financial and technical contributions enabled the materialization of this instance of the workshop. All these people, their devotion, energy, and efficiency, made our workshop a very interesting and effective scientific forum.

We are thankful to all the authors who submitted papers and the delegates for their participation and their interest in AREdu 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. Moreover, we would like to thank the developers of HotCRP, who made it possible for us to use the resources of this excellent and comprehensive conference management system, from the call of papers

and inviting reviewers, to handling paper submissions, communicating with the authors, and creating the volume of the workshop proceedings.

We are looking forward to excellent presentations and fruitful discussions, which will broaden the digital humanities event horizon. We hope all participants enjoy this workshop and meet again in more peaceful, friendly, hilarious, and happiness of further DHW 2022.

ACKNOWLEDGMENTS

The authors thank the Armed Forces of Ukraine for providing security for this work. This work was carried out despite the ongoing aggression of the Russian Federation, which poses a threat to global academic community.

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Use of Digital Tools for Checking Uniqueness by Students and Academic Staff of the Borys Grinchenko Kyiv University: Problems and Solutions

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ABSTRACT

The article examines the level of mastery by the Borys Grinchenko Kyiv University students, master's students, postgraduates, academic staff and researchers of the digital tools allowing to check the uniqueness of academic texts. The anti-plagiarism software most popular among the respondents was identified; its advantages and shortcomings, as well as the difficulties that arise when using it were analyzed. Proposals on how to increase the level of mastery of skills in self-regulation of educational and scientific activity, in particular writing own academic texts, for all participants in the Borys Grinchenko Kyiv University educational and scientific process were developed. Based on results of the survey, an algorithm for detecting the absence/presence of academic plagiarism in the student research papers submitted to the Ukrainian Competition of Student Research Papers in the Fields of Knowledge and Specialties was developed and launched, indicating the responsibility of all actors of the process for observance of the principles of academic integrity.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; • **Human computer interaction (HCI)** → *Empirical studies in HCI*.

KEYWORDS

digital tool, academic text, academic plagiarism, academic text uniqueness

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1 INTRODUCTION

Today, the possibilities for copying other people's texts have increased many times due to the digitalization of society and the rapid development of current methods of searching, collecting, storing and processing information. This phenomenon is academic plagiarism, which according to the Law of Ukraine on Education is interpreted as the "publication (partially or completely) of scientific (creative) findings obtained by others, as the findings of own research (creativity) and/or reproduction of published texts (published works of art) of other authors without attribution of authorship [17]". The opposite of it is the phenomenon of the uniqueness of the academic text.

According to the Law of Ukraine on Education, academic plagiarism and self-plagiarism are considered the types of breaching academic integrity [13] drawing special attention to this issue facing higher education institutions that recognize academic integrity as one of their core values.

Our study presents the experience of implementing the principles of academic integrity at Borys Grinchenko Kyiv University. Borys Grinchenko Kyiv University is located in Kyiv, Ukraine. The university consists of six institutes, four faculties and one university college with more than 9,000 students. Each year around 6000 teachers and school principals enhance their skills and gain qualifications at the university. Students study in more than 50 programs, mostly in the humanities.

Thus, one of the Borys Grinchenko Kyiv University operational and corporate culture principles is the observance of academic integrity. Accordingly, the Academic Council of the Borys Grinchenko Kyiv University developed and approved the documents aimed at forming a conscious attitude of the academic community to its own activities, in particular related to the preparation, publication of own academic texts, namely:

- Regulation on the Academic Integrity of academic staff, researchers, educators and higher education seekers of the University [5];

- Declaration on the Academic Integrity of academic staff, researchers, and educators of the Borys Grinchenko Kyiv University [2];
- Declaration on the Academic Integrity of students, postgraduates, and doctoral students of the Borys Grinchenko Kyiv University [3].

The Borys Grinchenko Kyiv University also has a School of Academic Integrity, whose representatives, in cooperation with the University Library and external experts, conduct systematic training of higher education seekers and staff in order to form the research culture and competencies necessary for the implementation of academic integrity principles, in particular on checking the texts for plagiarism, the use of digital tools to detect borrowings, the design of bibliographic references in scientific papers, etc., which aims to increase the percentage of uniqueness of academic texts.

However, according to a survey of 2,941 respondents conducted at the Borys Grinchenko Kyiv University at the end of 2020, plagiarism and self-plagiarism in the activity of students and postgraduates were indicated by 28% of academic staff and in the activity of academic staff by 18% of students and 28% of postgraduates.

In the contemporary scientific and educational space, this issue is being increasingly addressed through the use of various digital tools (Unicheck, Strikeplagiarism, Antiplagiat, eTXT Antiplagiarism, Content Watch, Advego Plagiatus, StrikePlagiarism, PlagiarismCheck), which help to check the academic texts for uniqueness and identify borrowings, similarities, matching with the texts of other authors placed on the Internet, in repositories and databases. The anti-plagiarism software is implemented in the training of future experts at the universities of the European Union [18].

The Ukrainian market is dominated by the services that are unknown to Western users, as the language of search must be Cyrillic. Antiplagiat is the leader among users of Borys Grinchenko Kyiv University, as it has a user-friendly interface, sufficient depth of archives and provides fast results. The only disadvantage is that there is the limit for free verification (not more than three documents per day of 15 MB and you can download the document only in txt and pdf format). Subscription services deal with this problem, where you can download about 40 MB of text and the number of checks is not limited. Sources for verification are publicly available, but subscription services also offer a separate search for Institutional and national repositories, databases of abstracts and dissertations, etc. In particular, the Strike Plagiarism system searches the RefBooks database, the home database, the database exchange program and the Internet.

2 LITERATURE REVIEW

The digital tools for plagiarism checking are currently actively studied by domestic and foreign authors. In particular, the main functions of digital tools, which check the texts for uniqueness are studied [4]; the areas of use of digital scientific and educational systems for the development of information and research competence of researchers and the academic staff are determined [21]; available tools to detect plagiarism are analyzed [10]; databases of text fragments are developed on the basis of the combined system of recognition of images [12]; the search for the algorithm of checking the texts for uniqueness is carried out [16]; the information technology that detects plagiarism is tested for effectiveness [9]; the application of anti-plagiarism software during the checking of student works as one of the main tools for the formation of academic integrity among the students of European universities is studied [18]. Also, international organizations, such as the American Councils in Ukraine [7], and individual authors [15] conduct awareness-raising activities and develop training courses on academic integrity for higher education seekers, academic staff and researchers in which separate sections are devoted to academic plagiarism and the checking of texts for uniqueness.

The topic of plagiarism check is not new for the co-authors of this article. Thus, in particular, Opryshko et al. [14] researched the use of text match scanners in the editorial process of Ukrainian scientific journals. The results showed that publishing houses that publish journals with international distribution and those indexed by the scientometric platforms Scopus and WoS (category “A” according to the national classification of Ukraine) mostly use similarity scanners. Publishing houses operating only within Ukraine, the journals of which are not represented in prestigious scientometric platforms, often ignore plagiarism detection software altogether and rely solely on the opinion of reviewers and edit ors. It is shown that the practice of using text similarity scanners, although entrenched in the Ukrainian scientific and publishing space, is still not widespread enough and does not cover the vast majority of scientific journals that rely only on traditi onal forms of reviewing scientific texts [14].

Borys Grinchenko Kyiv University’s experience in using digital tools to check the academic texts for plagiarism. Since 2015, the Borys Grinchenko Kyiv University has been one of the first in Ukraine to use digital tools in educational and research activities to check the academic texts for plagiarism. One of the most convenient services was the Unicheck [20], which allowed to identify similarities, matching and overlaps in the academic texts of higher education seekers and academic staff. Another digital tool that has been integrated into the Borys Grinchenko Kyiv University’s activity since 2020 is StrikePlagiarism [19].

By all the below indicators, as well as found text matches, Unicheck and StrikePlagiarism operate almost the same:

- speed
- usability
- check on remote server
- possibility to view borrowed text in the original document
- different file formats for download
- possibility to delete unnecessary references before checking
- counting the number of identical words (number of fragments)
- finding letters from other alphabets in the document, provision of relevant notification and replacement before checking
- quote detection
- program configuration options
- possibility to add a document to the University database
- batch check

They differ only in software interfaces, coefficients of check results and commercial offers of the developers.

Analysis and comparison of technical characteristics of individual services were not the subject of this study, but it is interesting

to evaluate various services, in particular the Unicheck system, which was made by Foltýnek et al. [9]. Regarding the list of other services, the Borys Grinchenko Kyiv University Library accumulates information about the various services available to check text matches for plagiarism on its website [11]. Students of the Institute of Philology are also offered 10 useful services for checking English-language sources for plagiarism [1]. However, it remains a problem to check the scientific works of students of Chinese philology, because the services available in Ukraine reveal matches only within European languages.

At the Borys Grinchenko Kyiv University, all scientific works recommended for publication by the Academic Council of the Borys Grinchenko Kyiv University; 16 scientific periodicals of the University; PhD and doctoral dissertations submitted for defense in specialized scientific councils of the University; scientific works submitted to competitions of scientific works; conference materials, etc are checked. The Borys Grinchenko Kyiv University also checks student qualification works with the help of digital tool Strike-Plagiarism, which provides an opportunity to check text matches using the internal databases of qualification works of other universities, with which the developer concluded cooperation agreements. Students of the Borys Grinchenko Kyiv University independently upload their works to the Database of Qualification Works, after which the responsible persons in the structural units check them.

In January-September 2021, 408 student works were checked (bachelor's, master's works, course works, diplomas, competition papers), 230 of them were checked using the Unicheck service and 178 using the Strike Plagiarism service. Other research papers were checked by the Library staff, namely: it is better to combine and write dissertations for the degree of Doctor of Philosophy and Doctor of Science – 36 works submitted for recommendation by the Academic Councils of institutes/departments and the university – 73 (66 – Unicheck, 7 – Strike Plagiarism). In total, as of September 29, 2021, 703 documents (in 2020 – 600) of 48,597 pages (in 2020 – 50,250 pages) were checked using the Unicheck service, 215 documents were checked using the Strike Plagiarism service.

It should be noted that although the Borys Grinchenko Kyiv University has all the necessary prerequisites (regulations, relevant training, system for plagiarism detection using digital tools), there are still cases of detection of plagiarism in the academic texts of higher education seekers and the academic staff, which necessitated a separate research.

3 METHODOLOGY

The research was conducted through a survey (G Suite service) with pre-defined questions (14) among the representatives of all institutes/departments (10) of the university. The respondents (a total of 1,171) were 529 students, 114 master's students, 84 postgraduates, 396 academic staff and 48 researchers of the university.

Ethics issues. The samples were formed randomly: students, master's students, postgraduates, academic staff and researchers of the university received e-mails via corporate mail (secure channel) which included a link to online questionnaires. The respondents voluntarily participated in the survey and had the opportunity not to take part in the survey. The questionnaires did not contain the data allowing to identify the respondent (the function of collecting e-mail addresses was turned off), and the information received from the respondents was not passed on to third parties. Respondents' answers were analyzed in aggregate according to the category of respondents (figure 1).

The students and lecturers of the Faculty of Law and International Relations and the Institute of Philology were the most active.

The questions of the questionnaire were aimed to meet the following research tasks:

- to determine the level of use of digital tools by students, master's students, postgraduates, academic staff and researchers of the university for checking the academic texts for uniqueness;
- to identify issues that arise in the course of using digital tools to check the academic texts for uniqueness;
- to outline ways to address the identified issues in order to reduce the number of cases of plagiarism/self-plagiarism.

4 RESEARCH FINDINGS

To the question "In your opinion, is it necessary to check academic texts for uniqueness using digital tools?" (figure 2): 50.8% of respondents answered – "Yes, always", 43.3% – answered "Sometimes", 5.9% – answered "No", which indicates the awareness of the majority of respondents of the need to check academic texts for uniqueness using digital tools.

However, it is worth considering some indicators among respondents: 19% of students answered "No". Analyzing the correlation of these results with a previous survey [8] and the results of checking student qualification works by institutes/departments, it can be argued that there is a problem associated with quite frequent detection of plagiarism in student academic texts, and the need to implement additional awareness-raising activities aimed at forming a responsible attitude toward their educational and scientific activity and principles of academic integrity.

At the same time, it should be taken into account that among the academic staff there were those who answered "No" to the above open-ended question of the questionnaire, stating that they did not see the need to check their works for uniqueness, as when writing them they did not use inaccurate text borrowings, and therefore the need to check the texts with additional means was irrelevant for them. We believe that such a conscious attitude toward the design of results of their intellectual activity can be considered a goal for all participants in the educational and scientific process, which is implemented at universities.

However, for most respondents the more urgent objective in the short term is to master the skills of using digital tools to increase the percentage of uniqueness of own texts, and therefore it logically necessitates the study of existing experience and issues that arose in the course of acquiring such experience. The analysis of answers to the question "Do you use digital tools to check your works for uniqueness?" (figure 3) generally showed the average level of use of digital tools to increase the level of uniqueness of academic texts: 60% of postgraduates, 52% of researchers, 43% of students, 41% of academic staff, 33% of master's students answered that they always use digital tools to check their academic texts for uniqueness.

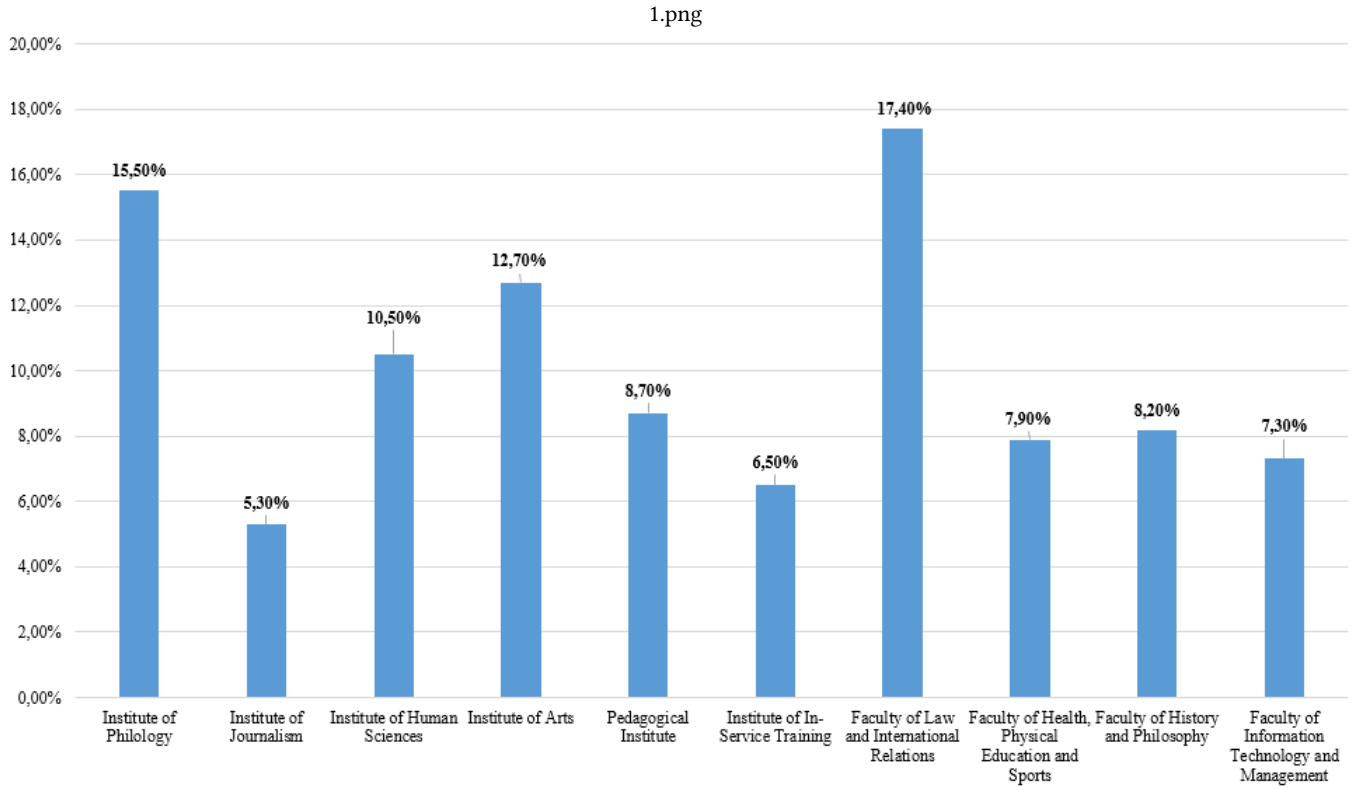

Figure 1: Diagram of the received answers in percentage terms.

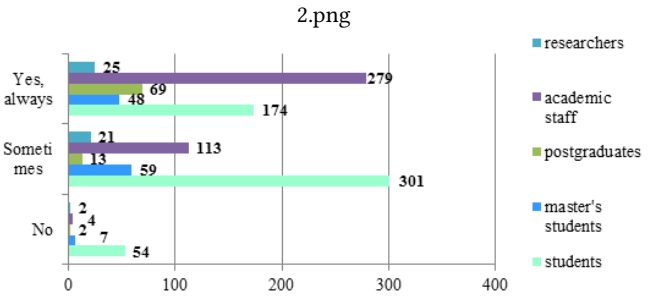

Figure 2: Respondents' answers to the question "In your opinion, is it necessary to check academic texts for uniqueness using digital tools?".

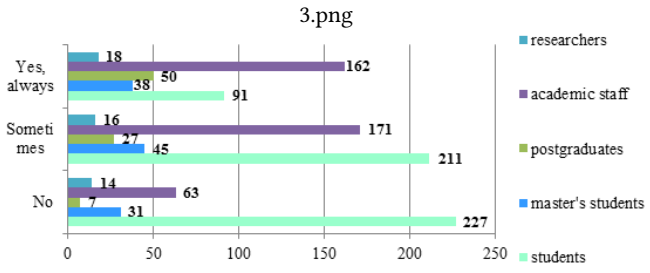

Figure 3: Respondents' answers to the question "Do you use digital tools to check your works for uniqueness?".

In general, we can see a positive trend of gradual formation of academic culture, which is based not only on understanding the basic principles, but also on specific skills.

The next step was to identify the digital tools that were most often used by the respondents and proved to be the most effective. Thus, according to the popularity of use of digital tools by the respondents to check academic texts for uniqueness, they were distributed as follows: 22% Antiplagiat; 16% Unicheck; 12% eTXT Antiplagiarism; 10% Advego Plagiatus; 5% each – Strike Plagiarism, Content Watch, PlagiarismCheck (23% of respondents answered that they did not use any, 2% answered "Other"). These services were presented by the Library staff at various trainings, so in general, respondents are familiar with various digital tools, including those that are charge-free, for checking academic texts for uniqueness.

The distribution among respondents of digital tools by efficiency of checking academic texts for uniqueness generally correlates with answers to the previous question (figure 4): 17% Antiplagiat, 16% Unicheck, 4% eTXT Antiplagiarism, 4% Advego Plagiatus, 3% Content Watch, 2% Strike Plagiarism, 1% PlagiarismCheck (14% answered "Did not use any).

The survey showed that the users are mostly familiar with the Antiplagiat and Unicheck anti-plagiarism systems. First of all, it is because the users of Borys Grinchenko Kyiv University are well acquainted with the work of free services and often use them. This

4.png

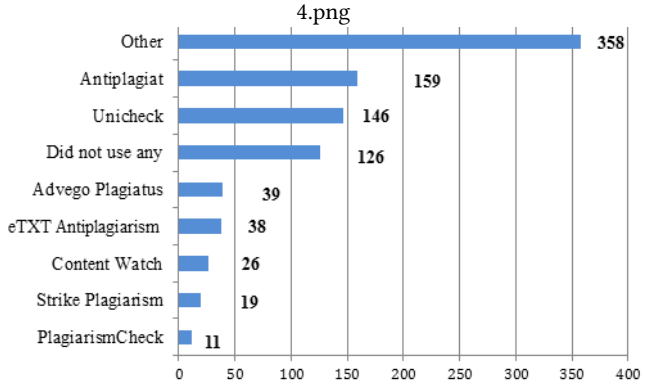

Figure 4: The distribution among respondents of digital tools by efficiency.

is the result of the work of the library staff within the School of Academic Integrity and carrying out various activities for students.

Quite a large percentage (39%) of respondents answered "Other", giving detailed answers, according to which:

- Some respondents found it difficult to compare different tools for effectiveness, because they used only one of those listed. This necessitates the implementation of activities aimed to demonstrate the advantages and shortcomings of different software, which will expand the pool of tools for all participants in the educational and scientific process.
- Some students noted that they used charge-free Russian software to check their texts. This necessitates the dissemination of information on charge-free Ukrainian and foreign software.
- Digital tools for checking academic texts for uniqueness, which were not on the list, were named, in particular: Grammarly Plagiarism Premium (works well with English-language content); Texty (is effective for data array analysis). This necessitates the analysis of the mentioned tools and making the decision to add them to the list of recommended ones.
- Also, some of the respondents stated that they submitted their works for checking to the Borys Grinchenko Kyiv University Library, and therefore did not see the need to master the skills of working with similar digital tools. And while the library does provide quality services of checking the academic texts for uniqueness, we still believe that the opportunities for higher education seekers, researchers and educators to use digital tools autonomously should be increased.

Responding to an open-ended question about the benefits of certain digital tools designed to check the academic texts for uniqueness, the respondents noted the following about the most popular tools:

- Antiplagiat: user-friendly interface; covers a large number of sources for thorough checking of texts for uniqueness; speed of data processing; detects grammatical errors. Shortcomings: recognizes fixed expressions and phrases as plagiarism.
- Unicheck: user-friendly interface; indicates in detail the possible variants of similar texts for each sentence; convenient and clear online report on the presence of text matches; support for different text formats. Shortcomings: recognizes citing legislation as plagiarism.
- Advego Plagiatus: user-friendly interface; detects not only the uniqueness of the work, but also spelling mistakes, repetitions, double space; does not have limitations as for the amount of text; separately identifies citations and plagiarism. Shortcomings: a limit of 3 checks per day.

Among the advantages of other digital tools (eTXT Antiplagiarism, Content Watch, PlagiarismCheck, StrikePlagiarism.com), the respondents mentioned ease of use, accessibility, lack of advertising. At the same time, it was noted that no software can provide a comprehensive report and requires expert analysis.

In the course of studying which academic texts are most often checked for uniqueness using digital tools, the following was found (figure 5).

5.png

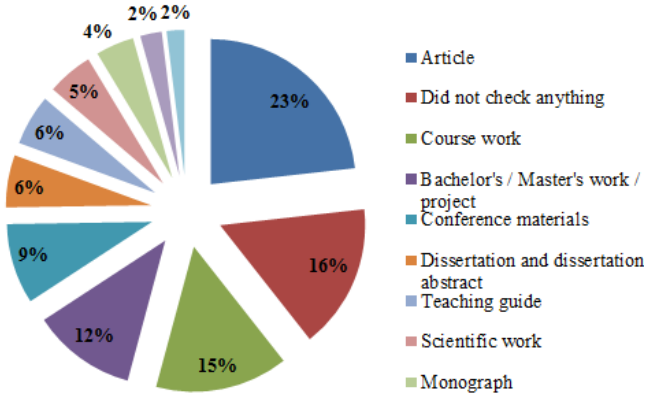

Figure 5: Academic texts which are most often checked for uniqueness using digital tools.

The answers of the respondents evidenced the fact that the Borys Grinchenko Kyiv University's requirements for texts submitted to the Scientific Councils and for defense promote the use of digital tools to increase the percentage of texts' uniqueness. It is important to note that answering the following question, 55% of respondents said that they checked their works for uniqueness on their own (including 65% of students, 59% of academic staff, 64% of master's students, 53% of postgraduates, 41% of researchers), that demonstrates the effectiveness of previously implemented activities (in particular, activities implemented by the Library and the School of Academic Integrity), aimed at forming the necessary competencies for self-checking of texts for uniqueness.

After checking their texts for uniqueness, in case of detection of inaccurate borrowings, 51% of respondents eliminate them completely, 32% – partially, 15% – do not change anything, 12% of respondents answered "Other" (of which 76% of researchers; 74% of postgraduates, 69% of academic staff, 57% of master's students, and 40% of students eliminate the inaccurate borrowings completely). It turned out that the check itself is often not enough to increase the percentage of uniqueness, which is explained by the answers to the following question: "Name the problems you encountered

when using digital tools (software) to check the uniqueness of your works" (figure 6).

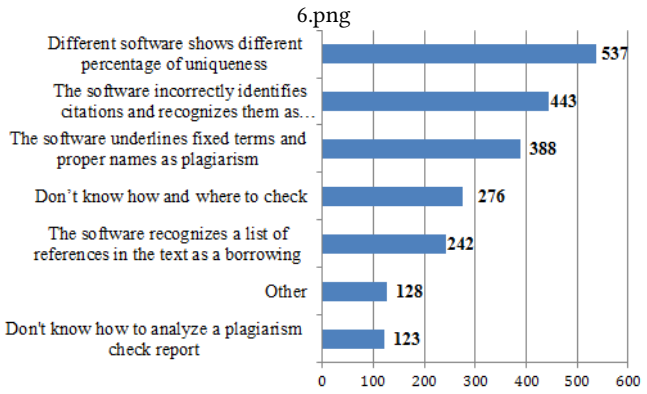

Figure 6: Respondents' answers to the question "Name the problems you encountered when using digital tools (software) to check the uniqueness of your works".

Given all the difficulties identified, it can be concluded that digital tools can only be used as an aid for detecting borrowings/similarities/matching, but the final decision on the presence or absence of plagiarism can be made by either the author or the review team.

To the question "What ways do you see to address these problems?" (figure 7) 37% of respondents answered: "To conduct more practical classes on the use of digital tools to check for plagiarism", 32% – "To conduct more practical classes on the preparation of bibliographies and correct citations", 24% – "To conduct more practical classes on analysis of reports on plagiarism checking".

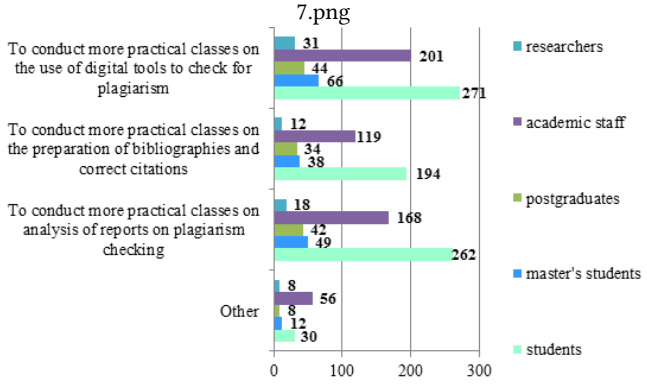

Figure 7: Respondents' answers to the question "What ways do you see to address these problems?".

7% of respondents answered "Other", stating their proposals, in particular to:

- Involve the staff in the research module in the framework of advanced training, which is designed to develop relevant skills, and to create separate training courses for higher education seekers.
- Develop relevant guidelines on the use of digital tools for checking academic texts for uniqueness and place them on the university website.
- Involve the responsible person in the analysis of check results before issuing the certificate.
- Create own anti-plagiarism software, which would take into account all the current shortcomings (in the future this could be done by master's students majoring in Information and Analytical Systems).

To the question "Did you participate in the activities implemented by the University Library and the School of Academic Integrity of the Scientific Society of the University dedicated to the use of digital tools to check the uniqueness of scientific works?" 30% of respondents answered "Yes" and 70% – "No". At the same time, those respondents that participated in the activities (97%) answered that they were satisfied with the learning outcomes, which indicates the quality of the activities.

These results highlight the need for further systemic work on forming the necessary skills that will facilitate the writing of unique academic texts by higher education seekers and staff. In particular, inquiries were collected from different categories of respondents, according to which all categories of respondents are interested in the topics "Preparation of bibliographies and rules of correct citation"; "How to properly check the work for plagiarism? What digital tools are better to use?"; "How to analyze the results of text checking by digital tools?". In addition:

- Master's students are interested in the topics: "How does professional dishonesty affect the individual?" and "Self-plagiarism and where is the boundary?".
- Postgraduates are interested in "Introducing academic integrity in the educational process (values, culture of citation), as well as how to avoid self-plagiarism"; "How to protect yourself from academic fraud: avoiding publication in pseudo-scientometric journals"; "Familiarization with European anti-plagiarism software".
- Academic staff is interested in "What to do when the system recognizes fixed terms: dynamometer, thermometer, etc. as plagiarism"; "Optimization of working with plagiarism checkers. Methodology (or procedure) of checking for uniqueness and elimination of shortcomings of the text".
- Researchers are interested in the "Experience of checking for plagiarism in Europe"; "How to correctly refer to previous own works and materials created in co-authorship".

Furthermore, according to statistics provided by the Borys Grinchenko Kyiv University Library, which checks scientific texts for plagiarism, the highest percentage of originality is found in technical and artistic sciences. First of all, this is because anti-plagiarism systems detect only text matches, but notes, charts, formulas, computer codes, etc. are not processed. As for the level of user satisfaction depending on the subject area and how technical tools identify direct citations and paraphrases allowed in different areas, they can be the part of a separate study. In the practice of the Borys Grinchenko Kyiv University Library there is an opportunity to adjust the settings of the anti-plagiarism system to increase / decrease the required number of words to identify text matches as plagiarism.

At present, automated plagiarism testing systems are used at Borys Grinchenko Kyiv University only as an auxiliary aid, and the final decision on the presence or absence of plagiarism is made by an expert commission. In the Strike Plagiarism and Unicheck systems, to which access is subscribed at the university, it is possible to make changes to the settings when determining the required number of words to detect text matches. As a rule, not less than 8 words are determined.

In general, at Borys Grinchenko Kyiv University the check of academic texts is applied in two stages: the first stage is the verification of scientific texts by automated systems, the second is the analysis of experts' verification reports on relevant topics. At the same time, we understand that in world practice the concept of plagiarism of the text is different from the plagiarism of a research result. However, this topic will be the subject of our further research.

The survey results showed a sufficient level of digital skills ensuring the detection of plagiarism in academic texts and allowing to implement measures aimed to improve the internal quality assurance system of educational and scientific work. Thus, during the first qualifying round of the prestigious Ukrainian Competition of Student Research Papers in the Fields of Knowledge and Specialties for the 2021/2022 academic year, held at the Borys Grinchenko Kyiv University (the winners of this competition are considered when determining the rating of Ukrainian universities), there was a launch of the algorithm for detecting the absence/presence of academic plagiarism in the student research papers, according to which all actors of the process became responsible for compliance with principles of academic integrity, in particular [6]:

Students preparing research papers for the competition:

- observe the principles of academic integrity at all stages of preparation of the research paper;
- check research papers using specialized software and analyze the results obtained for the absence/presence of academic plagiarism, given that all borrowings must be referenced.

Students' supervisors:

- monitor students' observance of academic integrity at all stages of preparation of research papers;
- before submitting student research papers for the review to the departments, ensure their checking with specialized software Unicheck/StrikePlagiarism and analyze the results obtained for the absence/presence of academic plagiarism, given that all borrowings must be referenced;
- bear the responsibility for observance of the principles of academic integrity by students supervised.

Department chairs:

- ensure the checking of student research papers at the level of university structural units using specialized software Unicheck / StrikePlagiarism and conduct expert evaluation of the check results for the absence/presence of academic plagiarism in research papers, given that all borrowings must be referenced;
- reject the works in which academic plagiarism is detected from the I (first) round of the Ukrainian Competition of Student Research Papers in the Fields of Knowledge and Specialties for the 2021/2022.

Heads of selection commissions:

- ensure quality selection of the best student research papers, including through analyzing the reports on automated checking of papers for the absence/presence of academic plagiarism, given that all borrowings must be referenced;
- withdraw student research papers from the competition in case of detection of academic plagiarism during the review.

It is envisaged that such systemic activity will ensure quality selection of the best papers and reduce the likelihood of detecting plagiarism.

5 CONCLUSIONS

According to the results of the survey, 522 students out of 529 surveyed and 356 academic staff and researchers out of 445 surveyed check their scientific works for the absence/presence of academic plagiarism using various specialized software.

It was determined that academic integrity is an integral part of the corporate culture of Borys Grinchenko Kyiv University, and therefore considerable attention is paid to the implementation of its principles. In particular, the internal system of quality assurance of educational and scientific work involves the checking of academic texts for uniqueness using digital tools, which necessitates the formation of appropriate skills among all participants in the educational and scientific process.

According to survey results, the average level of use of digital tools was determined among all categories of respondents (students, master's students, postgraduates, academic staff and researchers of the university): most of them have the relevant knowledge and experience in checking their texts. In order to increase the level of use, it is proposed to implement appropriate activities in all departments of the university, the content of which would be aimed to inform higher education seekers and staff about the opportunities for plagiarism detection in academic texts (most of them know only 1–2 digital tools); to describe the advantages and shortcomings of various software; and, most importantly, to develop research culture based on integrity and professional ethics according to which the best way to avoid plagiarism is to prevent it when writing a text.

The main problems that most often arise in the course of using a particular digital tool to check the academic texts for uniqueness were also identified. However, it is noted that even taking into account the existing shortcomings (which are gradually eliminated by developers), their use is an objective necessity, which is based on the need for self-regulation of educational and scientific activities by higher education seekers, academic staff and researchers. At the same time, an important conclusion is that even the best fee-based resources can be used only as an aid to identify borrowings, similarities, matching, etc. in academic texts. The final decision regarding the presence or absence of plagiarism can be made only based on the opinion of an expert or expert team (as is the case at the university, in particular when checking dissertations submitted for defense). In case of independent checking, the authors must take into account the features of digital tools they use, as well as know how to analyze the generated reports. This necessitates conducting training activities aimed to form the skills of independent use of digital tools to check the texts for uniqueness by higher education seekers, academic staff and researchers.

Also, a list of topics for trainings, which can be conducted by external and internal experts, taking into account the needs of different categories of respondents in order to form their ability to organize their educational and scientific activities in good faith was developed.

The study of user experience related to using digital technology for checking academic texts for plagiarism contributed to the improvement of the internal system of quality assurance of educational and scientific work. In particular, the algorithm for detecting the absence/presence of academic plagiarism in the research papers to be submitted to the Ukrainian Competition of Student Research Papers in the Fields of Knowledge and Specialties in 2021/2022 academic year, which is held in Ukraine in order to support the gifted students and create conditions for their creative growth, was developed and launched.

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Immersive E-Learning Resources: Design Methods

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ABSTRACT

Proper design is the basis for the success of any application development, regardless of industry and field of application. This fully applies to both software design and learning design. Designing e-learning resources is a hybrid activity that significantly increases risks due to the speed of technological change. The risks are even greater when it comes to technologies of increased attention - immersive. In this regard, it is important to develop design methods for immersive e-learning resources – educational, scientific, informational, reference materials and tools used in an immersive environment, reproduced by immersive technical tools, and necessary for effective organization of the educational process.

CCS CONCEPTS

• **Applied computing** → **E-learning**; • **Human-centered computing** → **Mixed / augmented reality**.

KEYWORDS

immersion, e-learning resources, design methods

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1 INTRODUCTION

Proper design is the basis for the success of any application development, regardless of industry and field of application. This fully applies to both software design and learning design.

Designing e-learning resources is a hybrid activity that significantly increases risks due to the speed of technological change. A vivid example is the work of 2017 by Rybalko [17], the technological component of which cannot be used in 2021 due to the completion of its support cycle by the manufacturer. The risks are even greater when it comes to technologies of increased attention – immersive.

In this regard, it is important to develop design methods for immersive e-learning resources – educational, scientific, informational, reference materials and tools used in an immersive environment, reproduced by immersive technical tools, and necessary for effective organization of the educational process.

2 THEORETICAL FUNDAMENTALS

2.1 Electronic Educational Resources: Interpretation, Types, Requirements

"Regulations on electronic educational resources" [15] defines an electronic educational resource (EER) as a learning tools on digital media of any type or placed in information and telecommunication systems that are reproduced with electronic technical means and used in the education process.

The purpose of EER is to ensure the modernization of the educational process, the content of the educational space, providing equal access to participants of the educational process regardless of their place of residence and form of education in accordance with quality educational and methodological materials based on information and communication technologies [15].

"Regulations on electronic educational resources" defines the following types of EER:

- electronic version of the printed edition;
- electronic chrestomathy;
- electronic edition;
- electronic reference book;
- electronic laboratory workshop;
- electronic tutorial;
- electronic educational game resource;
- electronic textbook;
- electronic workshop;
- electronic workbook;
- electronic dictionary;
- electronic didactic demonstration materials;
- electronic methodical recommendations.

General requirements for EER are defined in [15]:

- functionality;
- security;
- reliability of operation;
- ease of use for the user;
- cross-platform;
- conformity with the grounds of implementation of the principles of state policy of digital development;
- conformity with the legislation of Ukraine on copyright protection;
- conformity with international standards (Experience API [16], etc.).

Synonyms are used Electronic Educational Resource (EER) and E-Learning Resource (ELR) – educational resource, presented in digital form and includes structure, subject content and metadata about them. EER may include data, information and software necessary for its use in the learning process [12, 13].

A systematic study of scientific and methodological, organizational principles of assessing the quality of EER for general secondary education was conducted at the Institute for Digitalisation of Education of the NAES of Ukraine in 2009–2011. The final report on the implementation of this research work [27] identifies the main types of parameters that can be used to assess the quality of EER:

- psychological and pedagogical parameters (didactic and methodological; substantiation of the choice of the subject of the training course; check for pedagogical expediency of use and efficiency of application);
- technical parameters;
- ergonomic parameters (characteristics of EER compliance of methodological material, accompanying documentation; compliance with the sequence of actions required to configure EER; ease of starting EER; compliance with the main technical characteristics of EER documentation; stability of EER operation) [27, p. 25–26];
- aesthetic parameters;
- sanitary and hygienic parameters.

In the process of examination, experts must assess the degree of compliance with the EER such didactic and methodological requirements: scientific, accessible, problematic, visual, learning awareness, independence and activation of activities, systematic and consistent learning, the strength of knowledge acquisition, unity of educational, developmental and upbringing functions, adaptability, interactivity, the realization of possibilities of computer visualization of educational information, development of the intellectual potential of student, system and structural-functional coherence of presentation of educational material, completeness (integrity) and continuity of the didactic cycle of training, taking into account originality and features of concrete academic discipline, the reflection of the system of scientific concepts of the discipline, providing the possibility of controlled training activities [27, p. 28-29].

An integrated system of psychological and pedagogical requirements for EER was developed at the Institute for Digitalisation of Education of the NAES of Ukraine in 2012–2014. In particular, Bykov and Lapinskyi [8] provided a general classification of EER by direction of use, the form of existence, physical habitat and limited space (figure 1). The report on the implementation of the first stage of research work "System of psychological and pedagogical requirements of information and communication technologies for educational purposes" emphasizes that EER reflects the content and technological components of educational methodological systems, form subject-information components of the educational environment (closed and open), form the content of educational electronic information systems, designed for versatile purposeful use of participants in the educational process to provide informational and

procedural support for educational, scientific and managerial activities, information support for the functioning and development of educational systems [28, p. 16-17].

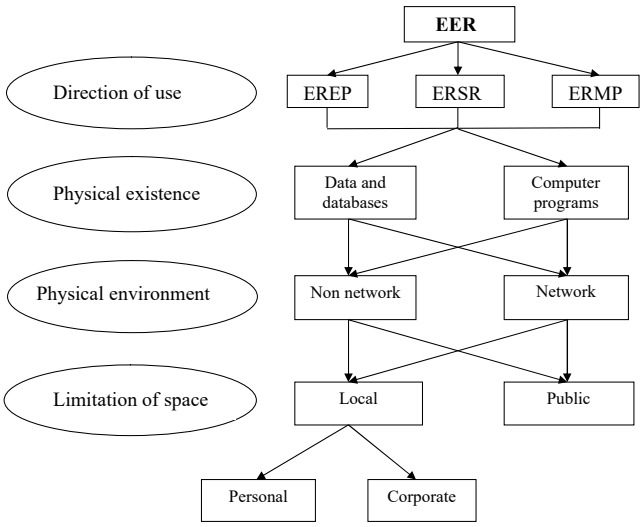

Figure 1: EER classification (according to [8]).

In [28, p. 32-37] the following system of EER requirements is proposed:

1) general didactic requirements:
   - *scientific teaching using EER* means sufficient depth, correctness and scientific reliability of the content of educational material in accordance with modern methods of scientific knowledge;
   - *accessibility of learning using EER* means the need to determine the degree of theoretical complexity and depth of learning material according to age and individual characteristics of students;
   - *problem-based learning using EER* means the need to stimulate educational and cognitive activities through specially created learning problem situations;
   - *clarity of learning using EER* means the need to take into account the sensory perception of the studied objects, their models and their personal observation by a student;
   - *awareness of learning using EER, independence and activation of the learner*, means the need to provide educational material for independent activities of students with the use of educational information, a clear understanding of the ultimate goals and objectives of the educational activities based on modelling their activities;
   - *systematic and consistent learning using EER* means the need to ensure consistent learning by students of a certain system of knowledge in the research subject area;
   - *unity of educational, developmental and upbringing functions of learning while using EER*;
2) specific didactic requirements:
   - *adaptability in the use of EER* means the need to ensure the adaptability of EER to the individual capabilities (level of knowledge and skills, psychological and other characteristics) of a learner;
   - *interactivity of learning while using EER* means that in the learning process there should be "interaction" of a student with EER: components and subsystems of EER should provide dialogue and feedback;
   - *the development of the intellectual potential of a learner using EER* is that there is a formation of thinking styles (algorithmic, visual, theoretical), the ability to make optimal decisions in difficult situations, the ability to process data;
   - *the systematic and structural-functional combination of the presentation of educational material in the components of EER*;
   - *completeness (integrity) and continuity of the didactic cycle of learning while using EER* means that EER should be able to perform all parts of the didactic cycle within one session with ICT tools;
3) psychological requirements:
   - compliance with verbal-logical and sensory-perceptual levels of the cognitive process;
   - focus on the peculiarities of perception (mainly visual, as well as auditory, tactile);
   - taking into account the features of attention (stability, concentration, ability to switch, distribution and amount);
   - development of thinking (visual and action, figurative, verbal and logical, concrete and conceptual, abstract and conceptual);
   - development of imagination (involuntary, voluntary, reproductive, creative);
   - development of memory (instant, long-term, short-term, operational);
   - vocabulary orientation, verbal and linguistic possibilities of a certain level of knowledge and training of children, availability of teaching according to age;
   - taking into account the "zone of proximal development";
4) ergonomic requirements:
   - requirements for the organization of dialogue;
   - suitability for communication purposes;
   - suitability for perception and understanding;
   - suitability for study;
   - attractiveness.

As a result of the second stage of research work "System of psychological and pedagogical requirements for information and communication technologies for educational purposes" the decomposition of the system "electronic educational resources" (figure 2) was performed and a typical structure of EER was identified, which provides effective learning educational purpose and depending on the functional purpose includes: content, program part, guidelines for teachers, guidelines for students, user manual for the administrator of the local network computer class or system administrator of the educational institution.

The EER content part includes: content, theoretical and practical parts, activity environment, including interactive models, drawings (diagrams, graphs, maps, tables), interactive diagrams, photographs, video clips, audio clips, 2D and 3D animations, dictionaries of terms

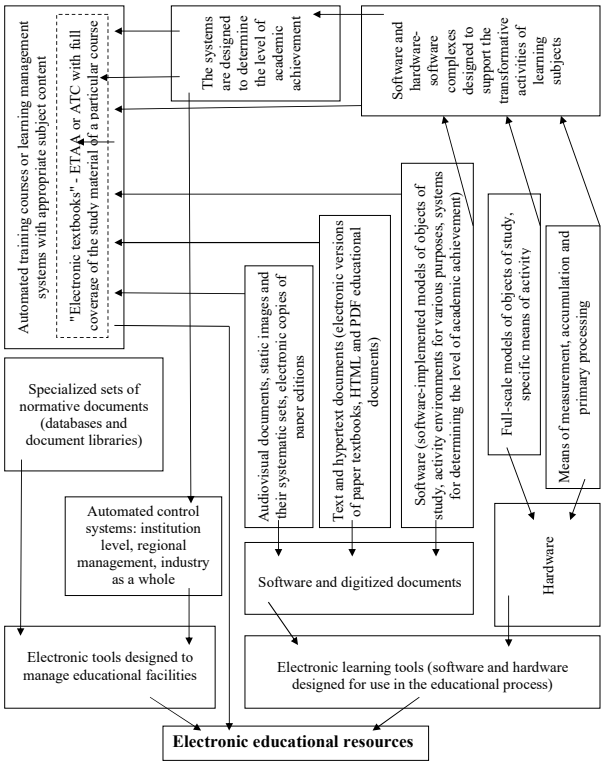

Figure 2: The result of the decomposition of the system "electronic educational resources" (according to [29, p. 29]).

and concepts (glossaries, thesaurus), historical references, list of sources of information, control questions and tasks, tests [29, p. 37].

The EER software part is a visualization of the content part by ICT tools which includes texts, media objects, tasks in text form, implementation of EER navigation, search of educational material, software for preparation, processing, transmission and visualization of statistical information on the level of academic achievement and student testing results [29, p. 38].

Guidelines for the teacher should contain a description of typical scenarios for different types of lessons and examples of their creation in the lesson designer, examples of using all modules and objects [29, p. 39].

Methodical recommendations for the student should contain a description of the basic methods of independent work [29, p. 39].

The user manual for the classroom LAN administrator or the school system administrator should contain a description of actions during installation, uninstallation, operation in various modes, EER settings for LAN operation, possible problems and ways to solve them, description of the collection (storing) methods and statistical processing of information on student performance [29, p. 40].

The final report on research work "System of psychological and pedagogical requirements for information and communication technologies for educational purposes" contains a table of evaluation of different types of EER [26, p. 26-27] – if it is sorted by weights (parameters that determine the significance, relative importance, advantages of this type of EER compared to other types), we obtain that among all EER distance learning course (e-learning course) has the highest weight.

2.2 Concept of Immersive E-Learning Resource

Immersion – "diving", deep involvement in certain activities. This concept is used in different contexts. Thus, Sokolyuk [30, p. 143-144] offers the following:

- a set of human sensations that is in an artificially created three-dimensional world, in which he/she can change the point of view, zoom in and out objects, etc.;
- creating the effect of "presence" due to a set of sensations of a person who is in an artificial environment;
- a group of teaching methods based on the unity of conscious and subconscious, two-way communication in the learning process, relaxation.

Under the immersiveness of the educational environment, Sokolyuk [30] understands such a property of the environment that reflects its ability to involve the subject in the system of relations, which is determined by its content: "immersion can be defined as a property of the technological part of the environment that provides the psychological state of a man, in which his/her own "I" perceives himself involved in the process and interacts with the environment that provides him/her with a continuous flow of stimuli and experience".

According to Sergeev [24], immersion of the subject in the learning environment (immersive environment) and navigation in it allow considering the processes of inclusion of the subject in the "world" of learning, which can live by their laws and not to correspond to the worlds of physical reality. The researcher distinguishes three types of immersion: immersion in the subjective world, immersion in the physical environment and immersion in the virtual environment [23, p. 96-98].

"The subject is immersed in learning environments that provide free forms of self-realization under the influence of environmental content, combined with didactic design and educational communication. Postclassical and post-nonclassical representations of learning environments provide more subtle and effective interpretations of learning and education processes, including synergetic and postclassical models of self-organization and evolution of artificial and natural systems of organized complexity. It is possible to include in the field of pedagogical knowledge technological advances in Internet communication, multimedia, virtual reality as a basis for creating integrated learning and education environments" [24, p. 38].

According to Sergeev [22], immersive educational environment is a dynamic systemic psychological construct that is self-organizing and has the properties of deep immersion, the presence of the subject, interactivity, extra subjective spatial localization, redundancy, observability, accessibility to cognitive experience, saturation, plasticity, integrity, motivation. The main types of immersive environments that arise in professional and educational activities are divided according to the types of immersion into psychological environments (complete immersion in the subjective world); physical environments (complete immersion in the real world); environments with variable realism.

Chupina [9, p. 492] identifies the following pedagogical aspects of learning in immersive environments:

- *the purpose of learning* in an immersive environment is to create conditions for practical experience and its transfer to professional activities, as "learning environment models specialized professional niches for the organization of learning with practice";
- *goals of activities* in the immersive environment are not strictly defined, but reflected in the form of a general strategy, mission, which determines the direction of the student's activities in the learning environment: "motivation is not generated by commitment but by understanding and division of mission";
- *pedagogical communication* is subject-subject in nature and is to coordinate the meanings of the participants in communication in the educational environment: "the learner is an active subject, and the teacher is an observer, organizer and active participant in communication, which changes the conditions and parameters of learning and uses his experience and authority for the semantic orientation of the learner";
- *the organization of the learning system* is not determined by strict rules, has a flexible structure that takes into account the individuality and variability of the subject, decision-making methods are not predetermined, but depend on the specific learning situation and experience;
- *learning assessment is multidimensional*, has a qualitative and integral nature and reflects the fixation of the trajectory of practical experience for the possibility of full reflection and improvement.

Azevich [6, p. 358] defines the immersive approach in education as "a strategy of cognition, a set of techniques and methods of interactive interaction of the subjects of the educational process to develop and self-develop the learner's personality in an artificial virtual environment capable of effectively influencing his/her mind and feelings". In his opinion, the main advantages of immersive educational environments are their clarity, dynamism and interactivity [6, p. 360], as well as the possibility of application in distance learning.

The latter establishes an interesting connection between such concepts as "Virtual Learning Environment" (VLE), a typical representative of which is the distance learning system Moodle, an "immersive environment" also known as a virtual/augmented/mixed reality (VR/AR/MR) – the corresponding technologies and tools will be called *immersive*.

This makes it possible to define *immersive e-learning resources* (IER) as educational, scientific, informational, reference materials and tools that are developed in electronic form, used in immersive environments, reproduced by immersive tools and necessary for effective organization of educational process in the part concerning its filling with qualitative educational and methodical materials. Then the IER includes both the relevant ICT tools (software component) and educational data (information component).

IERs are divided into:

- *immersive textbooks* – educational electronic publications that supplement the textbook and are intended for distribution in immersive environments;
- *immersive tools of assessment of educational achievements* – tools of an immersive environment, which provides the opportunity to automate the processes of determining the level of academic achievement of students, designed to support the processes of assessment and self-assessment in learning;
- *immersive training laboratories* – software IER that can be used in the laboratory and practical classes to conduct experimental research with computer models in immersive environments;
- *immersive electronic reference books* – electronic educational publications on immersive access models to short scientific and applied information of reference content;
- *immersive didactic demonstration materials* – IER, designed to visualize the objects and processes being studied;
- *immersive modelling environments* – immersive training laboratories designed to model objects, phenomena and processes that are the subject of study, or provide tools for building and researching models;
- *immersive simulators* – software and hardware IERs, designed for the formation and consolidation of skills and practical skills, mastering methods, procedures for certain types of educational or professional activities, as well as for self-training;
- *immersive workshops* – IER, designed to develop and consolidate skills and practical skills, use theoretical knowledge to solve practical problems and exercises;
- *immersive subject environments* – a set of interconnected IERs for solving problems of a certain class in the subject area under study, designed to automate actions that occur in this area;
- *immersive educational and methodical complexes* – a structured set of IERs containing educational materials intended for joint use in the learning process;
- *immersive program-methodical materials* – electronic educational publications in an immersive environment, which determine the content, scope, order of teaching a particular discipline, its section, topics (curricula, plans, lesson plans);
- *immersive educational and methodical materials* – immersive electronic educational publications that contain materials on teaching methods of a particular discipline (its section, part);
- *immersive additional scientific and educational materials* – information resources of the immersive environment, which contribute to the supplementation and expansion of ideas about objects and processes that are the subject of study;
- *immersive test systems* – tools of an immersive environment, which contain standardized test tasks and are designed to assess the level of academic achievement of students;
- *immersive learning management systems* – IER system to support all stages and components of the learning process, providing the ability to automate the organization of the learning process through the preservation and delivery of learning resources and organization of educational activities, learning management, accounting and control of various types of educational work, educational resources, administration of individual students and groups, organization of interaction with the teacher, reporting, etc.;

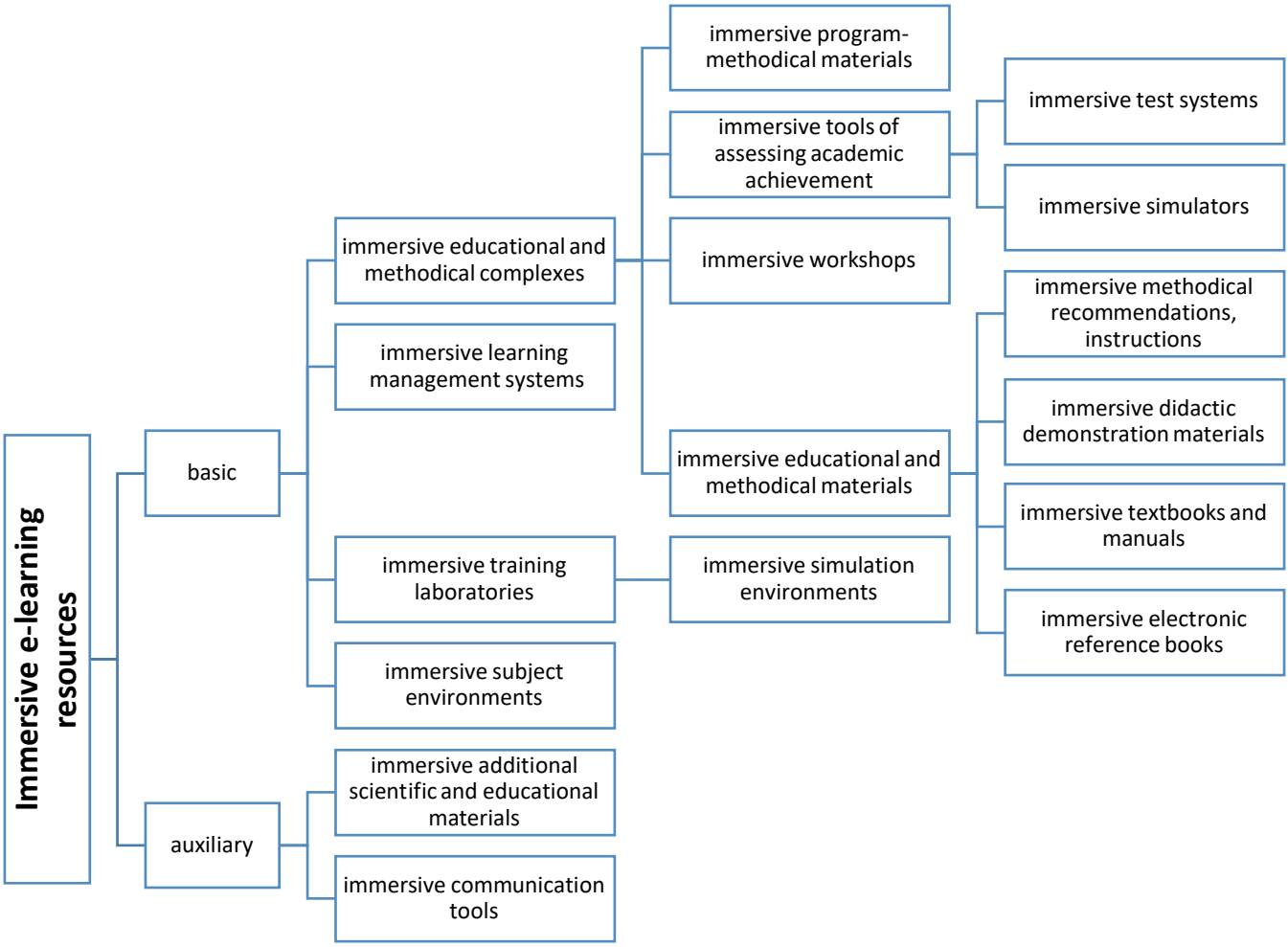

Figure 3: Classification of immersive e-learning resources.

- *immersive communication tools* – software for data exchange in an immersive environment.

To increase didactic efficiency, the tools of immersive learning technologies are used in the educational process together with other educational materials (for example, with traditional textbooks and manuals, guidelines for teachers and students, etc.), forming *immersive software and methodological complexes*.

Figure 3 presents the classification of immersive e-learning resources.

3 DESIGN METHODS

3.1 Model of Design Methods for Immersive E-Learning Resources

According to Boiko [7, p. 13], the process of development and implementation of EER (electronic educational resources) includes six interrelated components:

(1) analysis (the analysis of three aspects of learning using EER: the didactic component provides data on the content of educational material, didactic goals; the psychological and pedagogical component provides data on student's individual characteristics; the technical component consists of the analysis of information and learning environment);
(2) definition of requirements (the received data are specified);
(3) selection of software (market analysis and compliance);
(4) planning and development (the structure of the resource, stylistic design, methods of operation are determined, the preparation of the original multimedia components and their layout is carried out);
(5) deployment (practical usage of the developed software during the educational process);
(6) assessment (assessment of the EER functioning, students' learning activities and the user of the EER interface).

Boiko [7, p. 14] showed the need to update approaches (methods and forms) during the teachers' training for the EER designing, in particular, usage of problem-based, project-based and research

learning, gamification, use of e-learning environments, virtual and augmented reality.

Semerikov et al. [20] indicate that the essential characteristic of a methodic is the interrelation of means and methods, which should be defined in a specific order of their application to carry out the work – the algorithm for achieving the goal. For teaching methods, the activity content is the content reflecting the core activity – the learning content. "A methodic is by definition a system, so we can talk about methodical systems in general and methodical training systems in particular, about the methodical training systems of a particular academic course" [20, p. 2].

The essence of EER design by Rybalko [17, p. 6] may be defined as intentional activity on creation of electronic learning tools and their introduction into educational process: "creation of EER, on the one hand, is a creative process that requires logical and algorithmic thinking, on the other hand, is the pedagogical process, as they are designed to improve the productivity of the educational process" [18, p. 26].

By means of this approach, the *design methods for immersive e-learning resources* can be determined as a training system aimed at acquiring competencies in the formation and development of immersive e-learning environment (in its tool part).

As for the main *principles of the design methods for immersive e-learning resources* by Hrytsenko [10, p. 253-254] we define:

- *validity* – the choice of methods, techniques, forms, methods and tools provided by the design method must be scientifically and pedagogically balanced and justified;
- *intelligibility* – understanding and unambiguous awareness of the developed design methods by the subjects of the methodic: by lecturers (teachers) and students (pupils), who must design, implement and apply immersive e-learning resources;
- *availability* – tools, the use of which is provided by the design methods, must be available, and techniques, forms and methods can be implemented with the help of the proposed or alternative technologies;
- *reproducibility* – the possibility of implementing into the educational process the proposed design methods by relevant specialists who are not developers of this methodology;
- *effectiveness* – involves achieving a predetermined design result by applying the proposed methodology.

The general model of IER design methods is given in figure 4.

The purpose of the *IER design methods* is to form a specialist capable of designing and using the IER in his or her professional activity. Accordingly, the *main purpose of training* is formation of competence in the IER design.

Defining the goal in the target block of the model requires determining who it is aimed at – *the subjects of the design methods*: future teachers.

Training should be implemented in three stages: theoretical stage should be related to mastering the theory of IER design and design methods, practical stage consists of the formation of competence in IER design, stage of approbation is related with experience in preparing and conducting training sessions using developed IER, self-assessment and expert assessment of the experience of implementing the results of design in the educational process.

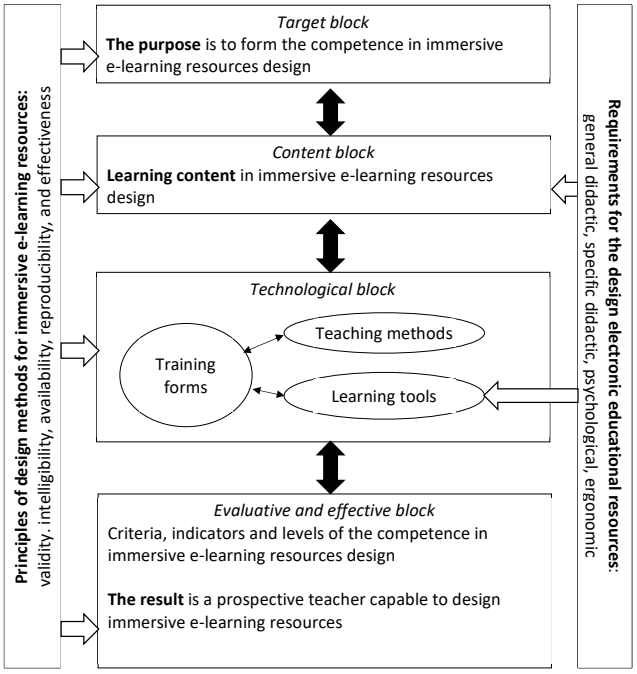

Figure 4: General model of design methods for immersive e-learning resources.

The selection of the *learning content* is important in the methodology. Therefor (immediately or after adaptation), previously developed author's training material on the design of autonomous [31] or web-based [19, 25] IER can be used. The content of training is reflected in the content block of the model, but it is not limited to it; it is also necessary to determine the content of *competence in immersive e-learning resources design.*

IER design training is carried out in the following basic *training forms*: training sessions (lectures, laboratory classes), independent work, control of learning outcomes. The main *teaching methods* for IER design are: explanatory-illustrative, reproductive and research learning method. Leading *learning tools*: traditional EOR and immersive electronic e-learning resources. The forms of organization, methods and teaching aids form together the basis of the technological block of the model.

The projected *result* of the application of the design methods is prospective teacher capable to design immersive e-learning resources. Diagnosis of the students' achievements is performed in the evaluation and performance block of the model, which requires the definition of criteria, indicators and levels of the competence in immersive e-learning resources design.

All the blocks of the model are influenced by certain principles of IER design, while the requirements are influenced by the content and technological block.

Each of the blocks of the model is interconnected with all the previous ones: it reflects the cyclical nature of the design process and the possibility of returning to any of its previous stages. The design and redesign of the methodology continues until the desired result is achieved.

This model does not reflect a number of important external factors that may initiate the redesign of the methodology namely regulatory changes due to changes in public procurement, and technological changes due to changes in immersive technologies.

Figure 5: Complex IER in the form of a distance course (extract).

3.2 Elements of the immersive e-learning resources design methods

Complex IER in the form of a distance course, the content of which is devoted to the IER design, is considered by Semerikov et al. [19]. Researchers emphasize that this course is designed for prospective STEM teachers, that provides a high level of variability in the definition of subjects of the methodology – future teachers of primary schools, gymnasiums and lyceums. The course is aimed at those specialists who have some experience in web-programming (figure 5).

For the design of *immersive textbooks* (figure 6) various tools, that provide the ability to programming and no-code design, can be used. The specific features of the design significantly depend on the hardware used. One example of prototyping an immersive textbook is given in [1].

Figure 6: Immersive textbook.

Immersive tools of assessing academic achievement are a relatively new IER class. In 2021, the EU launched the "Augmented Assessment" project [4] aims to address the gap that exists in assessing newly arrived migrant students' (age group of 9–15) prior knowledge in the fields of Science and Mathematics, by utilising augmented reality for assessment. This will be achieved by developing and piloting an innovative augmented toolkit in the form of an online library and a training course for teachers that will equip them with the necessary theoretical and practical knowledge for assessing newly arrived migrant students' prior knowledge. The authors of the project combine immersion in a language and virtual environment and point to the positive connection between augmented reality and the educational inclusion of special groups of students.

Immersive training laboratories (figure 7) are a classic type of IER, the design of which is widely represented in various sources (in particular, [11]).

Immersive electronic reference books can be designed using computer vision systems [21] and classical reference books (figure 8).

Immersive didactic demonstration materials design is the most common activity as they are visuals that can be combined in order to to create a lesson fragment.

The use of *immersive simulation environments* and *immersive simulators* requires specialized hardware to create an immersive

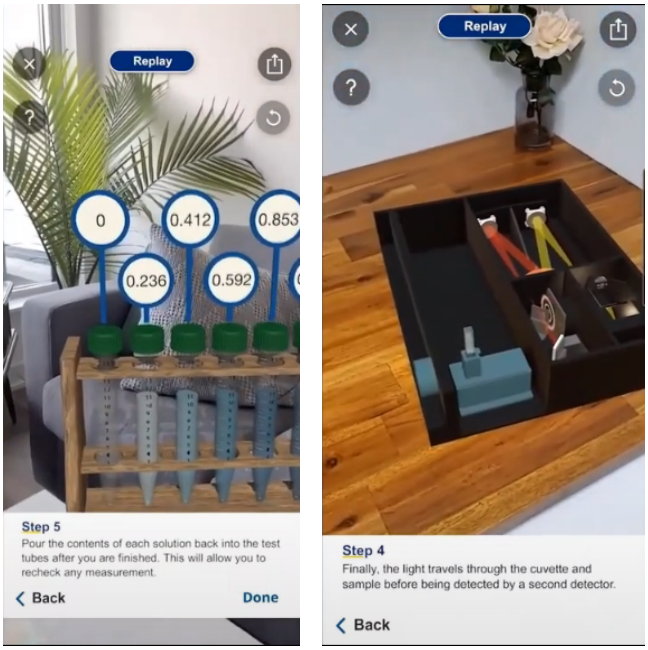

Figure 7: Immersive training laboratories.

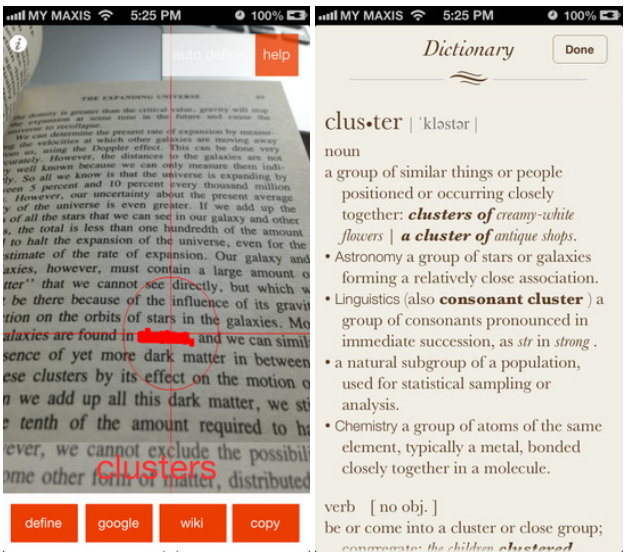

Figure 8: Meanings – immersive vocabulary.

environment with partial and complete immersion, in which a person moves with the required degree of freedom [32].

Immersive workshop can be developed, in particular, in the game form. In [5] there is an example of Qubit Arcade, a VR model of quantum computing. The arcade provides a hands-on sensory experience for students to manipulate qubits in a three-dimensional space, as well as see the qubit from the inside (figure 9). Such a workshop is a kind of *immersive subject environment.*

Figure 9: Immersive workshop Qubit Arcade.

Within the framework of ARETE project, a module and unit for the Moodle learning support system is developing, aimed at giving it a higher level of immersion [3] according to the IEEE 1589-2020 standard [2]. The ARETE ARLEM (Augmented Reality Learning Experience Models) combines Moodle with web-services and a user interface to create, store, retrieve, view and use of IER.

Immersive communication tools are standalone IERs or add-ons to existing ones, such as Skype. A promising direction for the development of this IER class is the metaverse – hypothetically next step in the Internet development, which provides the opportunity to present communicators as avatars that interact online in a 3D environment. As of 2021, the most famous project in the metaverse is Meta [14].

4 CONCLUSION

The following results were obtained in the process of solving the problem of preparing prospective teachers for the design of immersive e-learning resources:

1. The analysis of sources on the research problem provided an opportunity to summarize the definition of electronic educational resource as a structured educational resource, presented in digital form and includes structure, subject content and metadata about them. Requirements for the design of electronic educational resources are summarized in 4 categories: 1) general didactic requirements that correspond to the implementation of the principles of learning in electronic educational resources; 2) specific didactic requirements that reflect the peqularity of the learning process using electronic educational resources; 3) psychological requirements that must be taken into account in the process of electronic educational resources design; 4) ergonomic requirements that contribute to the full disclosure of the designed electronic educational resource potential.
2. Immersion is a "diving" (deep involvement) of the subject into the system of relations, which is determined by its content. Immersive educational environment is considered as a dynamic systemic psychological construct that is self-organizing and has the properties of deep immersion, the presence of the subject, interactivity, extra subjective spatial localization, redundancy, observability, accessibility to

cognitive experience, saturation, plasticity, integrity, motivation. Immersive educational environments are divided according to the types of immersion into psychological (complete immersion in the subjective world), physical (complete immersion in the real world) and environments with variable realism (partial and complete immersion in the virtual world). The study provided an opportunity to identify immersive e-learning resources as educational, scientific, informational, reference materials and tools that are developed in electronic form, used in immersive environments, reproduced by immersive tools and necessary for effective organization of educational process in the part concerning its filling with qualitative educational and methodical materials. Such types of immersive e-learning resources were identified and classified as immersive textbooks, immersive tools of assessment of educational achievements, immersive training laboratories, immersive electronic reference books, immersive didactic demonstration materials, immersive modelling environments, immersive simulators, immersive educational and methodical complexes, immersive program-methodical materials, immersive educational and methodical materials, immersive additional scientific and educational materials, immersive test systems, immersive learning management systems, immersive communication tools, and immersive software and methodical complexes.

3. Design methods for immersive e-learning resources is a training system aimed at acquiring competencies in the formation and development of immersive e-learning environment (in its tool part). The main principles of the immersive e-learning resources design method are validity, intelligibility, availability, reproducibility and effectiveness. The developed model of design methods for immersive e-learning resources consists of four interrelated blocks namely target block (learning purpose is is to form the competence in immersive e-learning resources design), content block (learning content in immersive e-learning resources design), technological block (training forms, teaching methods and learning tools), and evaluative and effective block (diagnostic tools and expected result).
4. The developed elements of the methodology include the learning, and examples of IER design: complex IER in the form of a distance course, immersive textbooks, immersive electronic reference books, etc. Among the undeveloped elements, the most important are the criteria, indicators and levels of the competence in immersive e-learning resources design – its theoretical justification is the direction of further research.

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"Lexical Minimum of Media Scientist": Reference Learning Edition as an Educational E-Resource

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ABSTRACT

E-terminography – one of the current areas of development of the digital humanism is in the limelight of the paper. It reveals the concept of terminological learning e-dictionary as an electronic reference edition and the typology of such dictionaries with examples. Special attention is given to the relevance of creating reference (namely dictionary) e-learning edition that contribute to a better study of terms and concepts of a particular subject area in professional learning, in particular educational e-resources of the combined type. It theoretically substantiates and describes stages of creating educational e-resource "Lexical Minimum of Media Scientist" focused on studying the cycle of media disciplines, which combines multimedia (audio, video, animation) fragments with visual and monomedia ones – in particular via text (in pdf) and hypertext fragments, using different semiotic codes – verbal and nonverbal with the possibility of interaction.

CCS CONCEPTS

• **Information systems → Multimedia information systems**.

KEYWORDS

E-terminography, Reference e-learning edition, Terminological learning e-dictionary, Educational e-resources

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1 INTRODUCTION

Today e-lexicography (computer lexicography) being closely interacted with e-bibliography is one of the powerful directions in the development of digital humanities, which using digital technologies, radically changes the humanities knowledge and practice of its application. Such changes have already affected e-terminology giving a powerful impetus to the creation of new types of industry dictionaries as terminological works of the new generation.

E-dictionary (or, in other terms, computer, automatic, machine dictionary) in contrast to the printed edition is one of the types of electronic edition by method of manufacture and purpose, in particular "electronic reference edition containing an ordered list of language units (words, phrases, terms, phrases, etc.) with information about their meaning, use, structure, origin, etc." [11]. According to DSTU 3017:2015 "Information and documentation. Editions. Basic types. Terms and definitions conceptions" reference edition falls under the category of visual aid as "a graphic edition by the symbolic nature of information indirectly, the content of which is mainly an image intended for use in the learning process, practical and industrial activities. Note 1. The visual aid according to the purpose can be a learning, production-practical, reference edition" [4]. Therefore, the e-dictionary can either provide access to the necessary information in digital format (or electronic data format) using computer technology, or visualize it through images – photos, charts, diagrams, drawings and more. The very possibility of pictorial representation of information mainstreams one of its main purposes – application in the learning process.

Active use in educational practice of such a kind of visual aid as a visual training aid (training appliance), "the main content of which is the image illustrating the subject of the discipline" [4], encourages the creation and implementation of learning e-dictionary into the learning process. In the scientific literature, this type of dictionaries is defined by researchers on the basis of the concept of electronic reference edition, envisaged in the "Regulations on electronic educational resources" [11], in particular in the following interpretation:

"learning e-dictionary is an electronic reference edition of an ordered list of language units (words, phrases, phrases, terms), designed to teach a certain aspect of language or type of speech activity and focused on a specific level of users' language competence" [8].

Our attention is drawn to learning e-dictionaries as an electronic reference edition that contribute to a better study of terms and concepts of a certain subject area in professionally oriented learning. These are terminological learning e-dictionaries.

The study uses the terminological and conceptual apparatus and definitions of basic concepts to denote different types of reference editions, which are developed in DSTU and other legal documents of Ukraine, as well as in the works of famous Ukrainian researchers given that the resource is intended for Ukrainian users. The purpose of the study is to show the place of the educational e-resource "Lexical Minimum of a Media Scientist" among the existing ones which

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correlate with reference e-publications, to describe its structure and specifics of creation.

The proposed study describes for the first time the creation of a unique multimedia educational e-resource (which has no analogue), on the platform of which students together with teachers will master various media practices – learn to repeat different types of media projects illustrating terms with media component.

2 TERMINOLOGICAL LEARNING E-DICTIONARIES: PROLEGOMENA TO TYPOLOGY

Terminological learning e-dictionaries contain terminology of a certain specialty or academic discipline and organically combine the functional purpose of different types of dictionaries:

(1) Electronic "having much greater opportunities for use in the definition of various types of illustrations (drawings, diagrams, animations, soundtracks) compared to paper" [18].
(2) Learning – short dictionaries/glossaries of narrow purpose, well-structured, simple, "to ensure the effectiveness of their use by pupils or students" [14].
(3) Terminological, "providing information on concepts or terms from one or more specific subject areas" [2].

The peculiarities in compiling and using such dictionaries in the learning process is the object of study of learning lexicography. This field is where many researchers work today, in particular Balalaeva [8], Perebeynoss [14], Poluektova [15]. However, most researchers are studying the creation of bilingual / multilingual learning dictionaries aimed at studying of a foreign language. As for the study and analysis of learning e-terminography, it is mainly works on the creation terminological databases, including learning materials as well (for example, Terminologue – web-based platform with open access as a tool for building, managing and publishing termbases) or e-dictionaries on the Moodle platform within various e-learning courses (recent research is lacking). Poluektova [15] believe that "terminological learning dictionaries should meet such characteristics as: conciseness, dedication to a particular topic of study, simplicity of structure and systematic presentation of material in order to ensure the effectiveness of their use not only by scientists and teachers, but also by students who have not yet gained experience of using dictionaries" [15].

Terminological learning e-dictionaries also fall under the category of reference e-learning edition, but intended "for use as an additional reference material when compiling abstracts, performing (…) learning tasks" [7]. Such an edition, according to Aleksieiev [7], "is not connected with a specific course, program, didactic scheme, and may contain information of educational, scientific and applied nature, in particular, that goes beyond the curriculum. (…) A prerequisite is the availability of tools for quick information search: from simple search by various characteristics or context to complex systems based on artificial intelligence" [7]. However, there are many editions that reflect the content of the course or discipline.

Terminological learning e-dictionaries are quite heterogeneous, first of all, given the typology of electronic publications, which is not only developed in DSTU 7157:2010 "Information and documentation. Editions electronic. Basic types and imprint" [1], but also found in the scientific works of a large amount of researchers, including Ohar [12], Pushkar et al. [16], Vul [21], Zhenchenko [24]. Extrapolating the developed typologies to our research object, it is worth noting that among all learning (by purpose) electronic (by information media) reference (including dictionary) editions, where terms are given in the required order for the user. We distinguish the following ones:

- On a functional basis – terminological dictionaries (by volume – short or minimum dictionaries), terminological encyclopedias.
- By subject area – multidisciplinary, branch and narrow-branch dictionaries / encyclopedias.
- By scope (Pushkar et al. [16]) – information retrieval systems, presentation publications.
- By the method of semantization of terms – explanatory, translational, explanatory-translational, thematic dictionary editions, encyclopaedic, illustrative editions.
- By the consumer audience (addressee) – editions intended for children of different ages, pupils, students of higher education institutions, foreign specialists who master the profession in another language and accordingly study terminology in this language for using it in professional practice, in production, etc.
- By informational nature – printed text (symbolic), graphic, sound (audio), combined editions.
- By format / structure of the publication (Pushkar et al. [16], Vul [21]) – homogeneous (e.g. in pdf), monomedia, multimedia / audiovisual (with audio clips, with animations, with digital video), hypertext, hypermedia (hypertext and multimedia).
- When printed equivalent is available (Zhenchenko [24]), or by a printing criterion (Pushkar et al. [16]) – original layouts (editorial electronic versions of editions), derived from printed editions, electronic analogues, electronic copies of printed editions, independent electronic editions as a type of multimedia projects (multimedia applications, presentations – linear, interactive), etc.
- By technology of use / distribution (Pushkar et al. [16], Zhenchenko [24]) – local (offline), network (online), combined use, or electronic resources of combined distribution.
- By the nature of interaction with the user (Pushkar et al. [16], Sinkevych and Pliushchai [18]) – determined, nondeterminined (interactive) editions (resources), which "differ in many aspects and parameters: quality, purpose, equipment, technological environment of operation, levels of structuring of input and output interfaces, types and preferences of end users, access inputs, illustrative environment", etc. [18].

Of course, the development of a thorough typology of terminological learning e-dictionaries as reference editions requires a separate study, which involves their detailed analysis. At present, we offer only one of the possible classification options and give only a few selective examples. For example:

- "50 termes del món digital" [3] – monomedia terminological learning e-dictionary as a visual aid in pdf format containing

static creolized text, short in volume, narrow-branch interpretive and translation type, is an independent electronic edition that have no printed analogue.
- "E-Learning Glossary" (compiled by Kaplan-Leiserson [9]) – text homogeneous monomedia terminological learning e-dictionary in PDF, short in volume, narrow-branch explanatory type, which is an independent electronic edition that has no printed analogue.
- "Medialinguistics. Dictionary of terms and concepts" (compiled by Shevchenko et al. [17]) – text homogeneous terminological e-dictionary as a textbook for university students in PDF, narrow explanatory type, which is an electronic analogue of the printed dictionary of terms and concepts.
- "Diccionaris en línia" on the web page of the e-resource TERMCAT – a collection of multidisciplinary learning terminological online dictionaries, short in volume, interpretive and translation, deterministic, hypertext [19].
- "Productes multimedia" on the on the web page of the e-resource TERMCAT – a collection of basic terms and concepts of various fields of knowledge in the format of learning terminological online dictionaries as multimedia products, deterministic, hypermedia [20].

3 "LEXICAL MINIMUM OF MEDIA SCIENTIST" AS AN EDUCATIONAL E-RESOURCE

3.1 Typological Status of the Resource

Many [terminological learning] e-dictionaries as reference editions of a combined type fall into the category of educational e-resources (EER), which are "important means of learning on digital media of any type or the ones placed in information and telecommunication systems reproduced by electronic means used in the educational process" [11]. They can be independent or part of the main EER. The "Regulations on electronic educational resources" [11] states that the e-dictionary being a kind of organizational and auxiliary EER shall either be published independently or be part of basic EER.

The proposed study provides a description of the structure and main stages of creation of one of these electronic educational resources – "Lexical Minimum of Media Scientist". One of its modules is a glossary-minimum of media studies terms with a media component. Depending on the volume in lexicography there are large, medium, small and very small dictionaries. The volume of terminological dictionaries depends on dictionary subject orientation, purpose and function. The purpose of learning dictionaries is to give a minimum or a limited number of the most common lexical items. The volume of such a dictionary, according to various lexicographers, can vary from 100 units to 30 thousand. The optimal number is considered to be 1 thousand lexical units.

The experience in compiling dictionaries in media studies has already existed in lexicographic practice, in particular "Keywords for Media Studies" [13]. This dictionary falls into the category of lexical minimum, "present sixty-five keywords, reflected upon by leading scholars tasked to show how their meanings, histories, and usage intersect with and inform problems and debates in media and society" [13]. This dictionary is created by analogy of the "Keywords: A Vocabulary of Culture and Society" by Williams [22]. It presents, in a broad context, discussions and a chronology of ideas about important, according to the authors, objects of media research, although there are almost no terms in the register with a media component (only one is New Media).

Unlike previous dictionaries, the "Lexical Minimum of Media Scientist" contains 100 terms with a media component (for example: media communication, media anthropology, media criticism, media art, media law, media comparative studies, etc.). On the e-resource, each term, in addition to its visualization (in different formats), will also represent a scientific article in which this term operates as a keyword.

English-language, Ukrainian-language, Russian-language, Polish-language sources – glossaries, dictionaries, journal articles, monographs, conference proceedings and other materials that define or interpret terms with a media component were the material for compiling the dictionary. This is a consolidated dictionary of definitions-quotations of the explanatory type. According to the typology of e-editions, in particular learning terminological e-dictionaries, which we proposed above, this dictionary can be characterized as follows:

- On a functional basis and practical purpose it is a dictionary-minimum learning type, the main task of which is to teach students in collaboration with teachers to create practically different media products: videos to illustrate deadlines, podcasts, create an e-library of media dictionaries and research papers media studies issues, etc.
- By subject area – branch dictionary (branch of knowledge "media studies").
- By scope – contains fragments of information search system and presentational publication.
- By the method of semantization of terms – dictionary edition of explanatory type with translation elements.
- By the consumer audience (addressee) – intended for students and teachers of higher education institutions, who study various media practices.
- By informational nature – combined (polycode, which uses different semiotic codes – verbal and nonverbal).
- By format / structure of the publication – hypermedia (combines hypertext and multimedia, represented by audio, video, animation fragments together with fragments of scientific publications). Such e-dictionaries can also be qualified as a kind of media texts, which, according to Yatsymirska and Dragan [23], "have universal features: word, sound, visuality (movies, photos, videos)", among which the actual internet-texts are distinguished thus giving grounds to "link the concepts of multimedia and hypertext", where "hypertext is a combination of language text with the computer's ability to interactively branch or dynamically reproduce nonlinear text that can not be printed on a sheet of paper in the usual way" [23].
- When printed equivalent is available / by a printing criterion – an independent electronic edition as one of the types of multimedia project with fragments of linear presentations and interactivity.
- By technology of use / distribution – combined use.
- By the nature of interaction with the user – determined with an element of interactivity.

3.2 Defining the Purpose and Objectives of Creating an E-Resource as a Research Project

"Lexical Minimum of Media Scientist" is an interdisciplinary research project (01.02.2021–01.12.2024). It involves the implementation of such objectives:

(1) To analyze and generalize the European experience of creating e-dictionaries, terminological and lexicographic databases, to compare it with the practice of compiling such e-resources in Ukraine.
(2) To formulate theoretical grounds and design the method of conclusion of hypermedia consolidated e-dictionaries of definitive type with a possibility of information search of terms.
(3) To form terminological, knowledge (format of scientific works) and lexicographic databases for e-resource for educational purposes.
(4) To choose a video series, photo illustrations for each of the register terms, thus creating video and / or animated videos and presentations for visualization of register units.
(5) To adapt the version of the e-resource for the visually impaired persons.
(6) To promote e-resource at the international and national levels in the format of presentation of scientific reports at conferences.

3.3 Designing an e-resource as an application

3.3.1 The general principle of construction. The educational e-resource "Lexical Minimum of Media Scientist" is based on the principle of Representative State Transfer (REST) – an approach to the architecture of network protocols providing access to information resources, including the Hyper Text Transfer Protocol (HTTP) in computer networks. Using this architecture has the following advantages: reliability, performance, scalability, transparency of the interaction system, portability of components, ease of change, the ability to evolve. According to the requirements of the REST architecture, the system must be divided into client and server parts, with each of them being able to be developed independently. The server part uses the Firebase Realtime Database [5], which is synchronized with the Google Sheets spreadsheet.

Using Google Sheets (figure 1) makes it easy for dictionary compilers to work. The row of the table corresponds to one term, the columns – to different fields of description of the corresponding term, in particular: "Term", "Etymology of term", "Equivalent in another language", "Synonym or reference to another term", "Dictionary meaning", "Contextual meaning", "Source".

If the same term has several definitions selected from different sources, all fields are filled in the first line (if relevant information is available), in the next line the field "Term" remains empty, and other fields are filled with other definitions.

All terms are grouped by the first letter and located on separate sheets of the table for convenience.

The advantage of Google Sheets is the connection to the cloud, which will not allow you to lose data. Cloud storage itself allows you to store any necessary files that require regular access from various locations and devices.

Another important feature is the ability to edit via co-authoring regime. For example, you can allow different users to make corrections to previously created text. This functionality is great for projects that involve a large number of participants, which has significant advantages over sending regular files by e-mail and transferring data from files to a spreadsheet.

3.3.2 Synchronizing the Firebase Realtime Database with the Google Sheets spreadsheet. The created table is automatically synchronized with the Firebase Realtime database in real time and serves as a service part giving API developers the ability to synchronize application data between clients and store it in the Firebase cloud. The principles of synchronization of the spreadsheet and Firebase Realtime database are described in detail in [10]. They are only adapted for the creation of the resource "Lexical Minimum of Media Scientist".

Step 1–2. Registration of a new project in the Firebase (figure 2, left) and creation of the Realtime Database, which provides for the definition of security rules for data (figure 2, right). The rules can be changed later e.g. adding access to record data for registered customers.

Step 3. Creating a Google Sheets to describe the terms. The first row of the table is the field name of the JSON object in the database. The second line is the full names of the fields in Ukrainian, convenient for the compilers of the dictionary. The "id" field is filled in automatically using the formula "=INDIRECT('R[-1]C';0)+1", which is applied to each line and allows you to insert or delete lines without violating the numbering of terms.

Step 4–5. Using the script editor (figure 3) add code that converts data from the table to JSON format according to the appropriate scheme and passes it to the database. Using the command "Launch – Launch function" (Initialize) synchronizes the table and database.

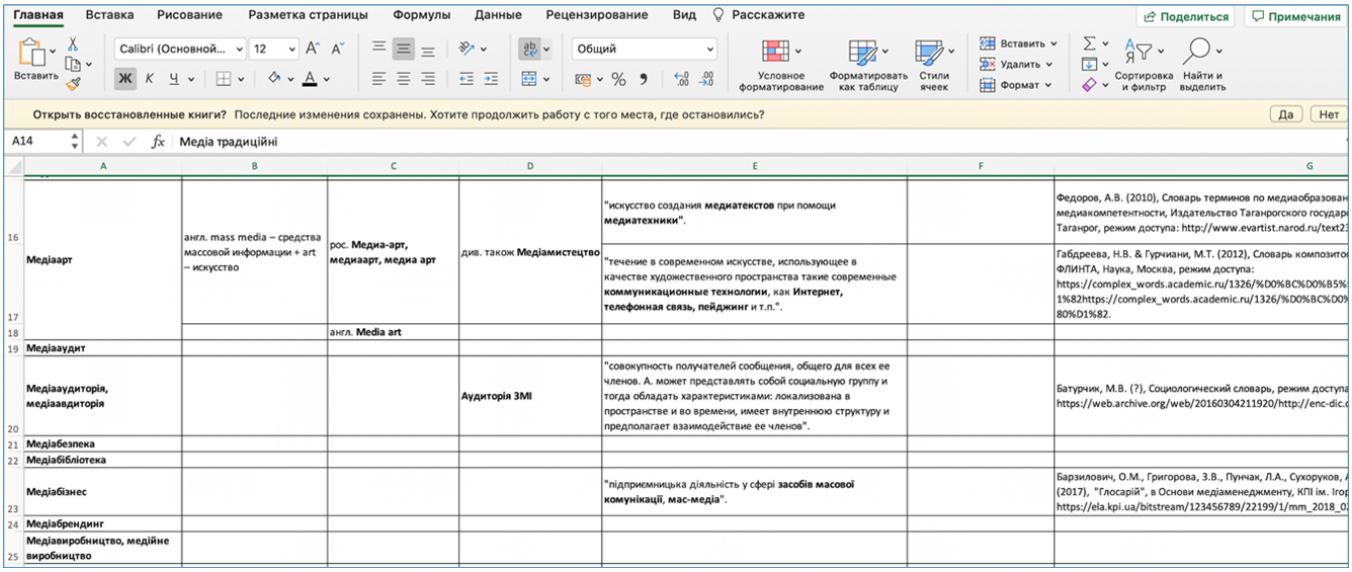
The terms from the table appear in the database (figure 4). The field names correspond to the names of the top row of the table.

Step 6. Firebase Realtime database provides an API for using applications developed on different platforms, including Android and iOS web applications. The REST API uses an event log with a server being an interface for creating HTTP connections to receive messages from the server. To do this, select the command "Project settings" and add a new project, select the type of project. Since in our case it is a web application, we get information about the configuration of the application.

4 CHOICE OF PROGRAMMING LANGUAGE

Such functions as communication with the database, search for terms and information blocks display are implemented in the Java Script programming language. To communicate with the database in real time, we use the configuration created by the Firebase Realtime Database (see the code for configuring the database in figure 5).

On loading the page structure appears the function (figure 6, top), which receives data directly from the database in JSON format. This function is signed for changes in the database e.g. changing any of the term fields, adding a new term, etc. are updated directly in the application. Data can be obtained both in the whole and under a certain condition, e.g. words for a certain letter or only one selected term. The resulting data must be converted to HTML and embedded in an existing page without completely overloading



	A	B	C	D	E	F	G
16	**Медіаарт**	англ. mass media – средства массовой информации + art – искусство	рос. **Медиа-арт, медиаарт, медиа арт**	див. також **Медіамистецтво**	"искусство создания **медиатекстов** при помощи **медиатехники**".		Федоров, А.В. (2010), Словарь терминов по медиаобразован медиакомпетентности, Издательство Таганрогского государ Таганрог, режим доступа: http://www.evartist.narod.ru/text2
17					"течение в современном искусстве, использующее в качестве художественного пространства такие современные **коммуникационные технологии**, как **Интернет, телефонная связь, пейджинг** и т.п.".		Габдреева, Н.В. & Гурчиани, М.Т. (2012), Словарь композито ФЛИНТА, Наука, Москва, режим доступа: https://complex_words.academic.ru/1326/%D0%BC%D0%B5% 1%82https://complex_words.academic.ru/1326/%D0%BC%D0 80%D1%82.
18			англ. **Media art**				
19	**Медіааудит**						
20	**Медіааудиторія, медіааудиторія**			**Аудиторія ЗМІ**	"совокупность получателей сообщения, общего для всех ее членов. А. может представлять собой социальную группу и тогда обладать характеристиками: локализована в пространстве и во времени, имеет внутреннюю структуру и предполагает взаимодействие ее членов".		Батурчик, М.В. (?), Социологический словарь, режим доступа https://web.archive.org/web/20160304211920/http://enc-dic.c
21	**Медіабезпека**						
22	**Медіабібліотека**						
23	**Медіабізнес**				"підприємницька діяльність у сфері **засобів масової комунікації, мас-медіа**".		Барзилович, О.М., Григорова, З.В., Пунчак, Л.А., Сухоруков, (2017), "Глосарій", в Основи медіаменеджменту, КПІ ім. Ігор https://ela.kpi.ua/bitstream/123456789/22199/1/mm_2018_0
24	**Медіабрендинг**						
25	**Медіавиробництво, медійне виробництво**						

Figure 1: Google Sheets.

Figure 2: Register a new project in Firebase (left) and define security rules for data (right).

Figure 3: Google Sheets Script Editor.

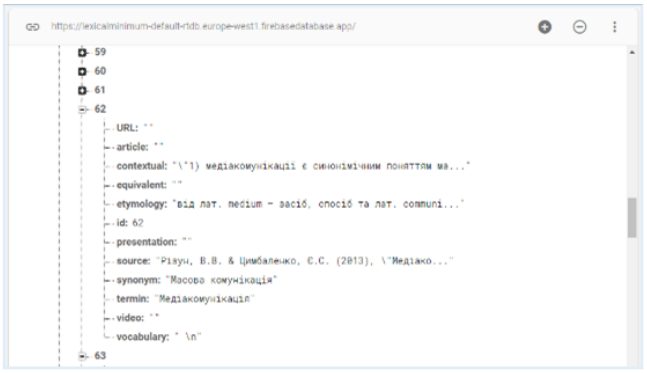


Figure 4: Fragment of the database structure.

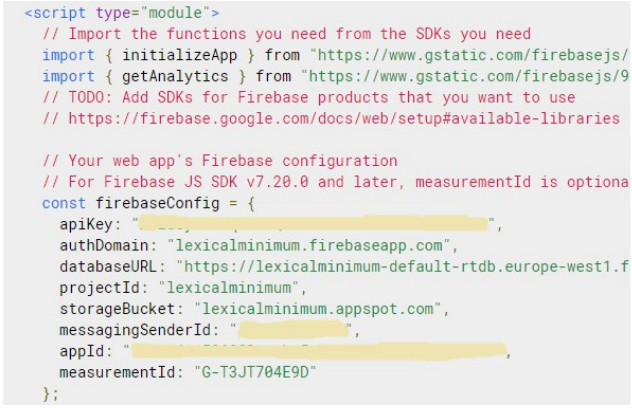


Figure 5: Database configuration code.

it, thus increasing the speed of the application. Given the same

structure of terms, it was decided to create our own rendering of the received data in JSON format in HTML format. The obtained data are delivered to the input of the function "render" building the display of terms in the window of registered terms. The display of each individual term is built using the "renderItem" function. Each term in this window is a link that, when clicked, displays detailed information about the term in the central window. It is implemented using the "renderTermin" function, which receives the "id" of the term. Then its HTML representation is created according to the developed template. Accordingly, the fields that are not in the description of the term are not displayed on the screen. In addition, during processing, the text is analyzed and the necessary links are added and abbreviations are highlighted. For an example of the implementation of these functions, see in figure 6, bottom.

```
function getData(event, type = 'LexicalMin') {
    var dbRef = firebase.database().ref(`1YQG7H2FTltWuQoEl_wXnhCHF0LCShGUrhpbtEtgF-qc/${type}`);
    dbRef.on('value', snap => { render(snap.val()); renderTermin(0) });
}
```

```
function addAbbr(description) {
    let abbrev = ['англ.', 'рос.', 'фр.', 'див. також', 'див.', 'лат.', 'син.'];
    for (var k = 0; k < abbrev.length; k++) {
        description = description.replaceAll(abbrev[k], `<span class="lightblue">${abbrev[k]}</span>`);
    }
    return description;
}

function addLink(text) {
    return text = text.replace(/(https?:\/\/[^ >]+[\w/])/gmi, '<a class="lightblue" href=$1>$1</a>');
}
```

Figure 6: Function that receives data from the database (top) and word processing functions (bottom).

In order to operate the search window and display the term, a "search" function has been created. It filters the list of terms displayed in the corresponding window by the entered text.

5 USER INTERFACE

The user part is implemented as a web application that receives data from the Firebase Realtime database in real time. It has (figure 7):

(1) A window for searching and choosing terms.
(2) A window of registered terms with a media component.
(3) Window with data on the term in which it is recorded (if any): etymology of the term, synonym or reference to another term, equivalent in another language, dictionary and / or contextual meaning of the registered terminological unit, source (if possible with a hyperlink to the e-dictionary or scientific work, from which the meaning of the term is selected).
(4) The top menu of icons, the choice of which allows to represent each term either in the format of a reference to scientific works, in which it is certified as a key one, or in the format of video illustration, animation, photo illustration, presentation, show or screen announcer (selectively for different terms).
(5) Side menu containing sections "About the project", "Version for the visually impaired persons", "Media Library", "Dictionaries of media terms", "Contacts", "Add term".

In comparison, e.g. the content of the concepts of "media education" and "media studies", which are denoted by the corresponding terms in the user window of register terms (figure 8).

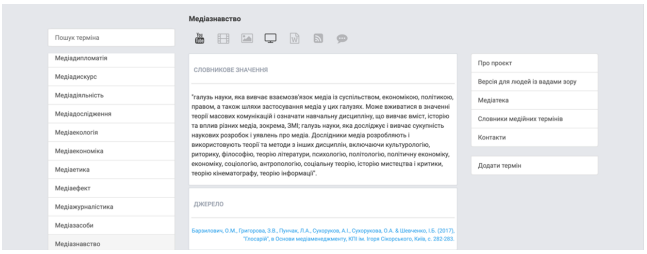


Figure 7: Custom windows, top and side menus of the web application.

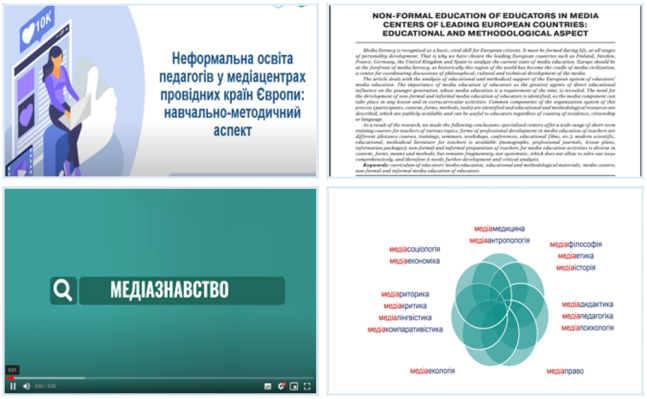


Figure 8: Fragments of video illustrations, scientific article and presentation of the terms media education and media studies.

Accessibility is a very important feature for a web application. To solve the problem of accessibility of the website for all people, a special plug-in "Button visually impaired" (BVI) [6] was added to the page. It automatically changes the version of the site for the visually impaired (figure 9).

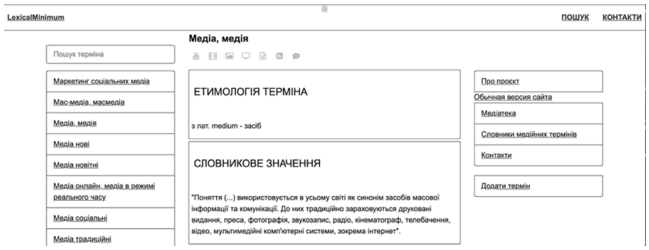


Figure 9: Version for the visually impaired using the plugin "Button visually impaired".

The panel on the site for the visually impaired allows you to change the color scheme of the site, size, type and line spacing of fonts, the speech synthesizer voices changes in settings. With the plugin one can change the functions of the site that meet the needs of people with disabilities [6]. Scalability requirements are also met – the font is increased to 200%, while there is no horizontal scroll bar. This effect is achieved with a scalable layout. The user has the

opportunity to choose the color of the font and background from 5 options: black on white; white on black; dark blue on blue; brown on beige; green on dark brown (figure 10).

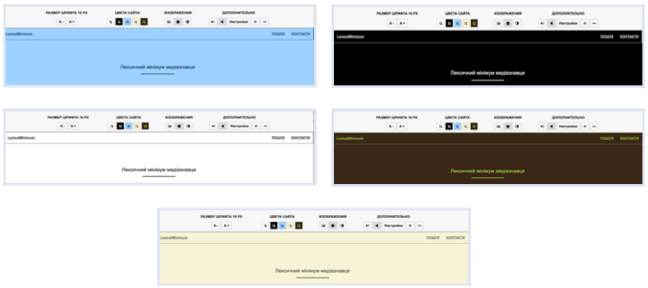


Figure 10: Option to select a color.

The developed web application has an adaptive design that allows to display pages and their contents according to the device on which the user opens them.

6 CONCLUSIONS

Thus, the electronic educational resource "Lexical Minimum of Media Scientist" as a reference educational publication provides applicants for education, graduate students, doctoral students and teachers of training courses in the media cycle with the following information:

- On the basic terminology with the media component of the subject area "media studies", giving grounds to form the lexical minimum of a media specialist and media researcher.
- On the meaning of basic terms, recorded in lexicographic sources and certified in scientific works, consequently forming their correct understanding and, accordingly, terminological competence not only of the future media specialist, but also the teacher who prepared information about a term.
- On the available equivalents in English, Polish, Russian and possible synonyms and related terms. It forms the knowledge about the specifics of systemic relations between terminological units that nominate the conceptual apparatus of the industry, and hence a holistic view of the industry, its structural sections and divisions, research objects, etc.
- On the current bibliography of dictionaries of media terms (traditional and electronic), as well as on the scientific works themselves where they function as keywords. This allows students and teachers not only to get acquainted with scientific achievements in the field of media studies, but also with teachers' works on a certain range of scientific interests using these materials to compile abstracts, write scientific papers and prepare reports for scientific conferences.

The proposed resource is, on the one hand, an experimental-educational virtual media laboratory, on the other – lexicographic and bibliographic laboratory which helps to form certain skills and abilities by students and teachers of, in particular:

(1) Forms knowledge about technologies of creation: the consolidated and systematized dictionary of definitions of terms with a media component, a definitive database of terminological units, e-library of dictionaries of media terms, media library (audio, video and photo libraries) collected on one platform (development of all these structural elements of the e-resource are discussed at regular scientific and practical seminars "Modern media studies: theory and practice").
(2) Forms and develops the ability to systematize and visualize the collected material, visualize and listen to information, interactively present abstract data to enhance the effect of cognition by teachers and students working on creating videos, photos, animations, podcasts, presentations about each term using the latest technologies – video cameras, cameras, appropriate software that allows you to shoot, edit, create animation, edit photos.

It is also a platform for the formation of interdisciplinary research teams, communicative interaction between teachers and students who work on its creation and simultaneously carry out scientific research in a particular research area of modern media studies.

In prospect, further development of the project provides:

(1) Creating a separate application, or adding functionality to the existing one, which will allow editing terms and adding new ones (it is possible due to the authentication system and security rules applied to Firebase [10]).
(2) Creation of a mobile application for the developed architecture.
(3) Making applications for the creation of a database of e-bibliography of media terms dictionaries and media library.

Today there is also a lack of research on the development of concepts of multimedia terminological e-learning dictionaries, which would involve lexicographers, IT specialists, specialists in certain subject areas who have the terminology of their field, as well as specialists in publishing. It is important to keep in mind that the dictionary is also one of the types of publishing products (paper or electronic), which has its own target audience, the queries of which need to be understood and studied. This aspect is often ignored in dictionary research projects. Therefore, one of the prospects of our further research will be a survey of the user audience in order to assess the effectiveness of the created experimental e-resource in the learning process, as well as improving its user capabilities.

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Software for Measuring Linguistic Literacy Rate of Students (Based on Comments Written in Ukrainian)

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ABSTRACT

In this article, linguistic literacy rate is measured by the number of errors in students' comments on the web portal. The data comprising about 10,000 comments covering all regions of Ukraine over a period of 10 years has been analyzed. The stages of creating a software which interacts with the LanguageTool and enables generating the results of error analysis and classifying them by types and regions have been described. A map of linguistic literacy of Ukrainian students has been created. Also, the regions with the highest and lowest linguistic literacy and the main types of errors have been identified. The obtained data will make it possible to revise and adjust university language teaching programs in each region in the future.

CCS CONCEPTS

• **Software and its engineering → Designing software**; • **Applied computing → Language translation**.

KEYWORDS

linguistic literacy rate, spelling error, grammatical error

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1 INTRODUCTION

According to the definition suggested by UNESCO, "the literacy rate is defined by the percentage of the population of a given age group that can read and write". Youth and adult literacy rates are the test of an educational system [22]. American Institutes for Research conducted the study which was aimed at analyzing literacy of college students in the USA along three dimensions, namely prose literacy, document literacy, and quantitative literacy. The question of correlation among academic experience, literacy, and readiness for the job market in the future was addressed. The study was conducted by surveying the English-language literacy abilities of students (U.S. adults aged 16 and older) in their final year of higher education institutions. Respondents were asked to provide answers to open-ended questions in their assessment booklets [6]. However, as Roser and Ortiz-Ospina [17] point out, "national definitions of literacy that are based on educational attainment vary substantially from country to country" [17]. Literacy rate is connected with Human Development Index (HDI). It is defined as "a composite index measuring average achievement in three basic dimensions of human development — a long and healthy life, knowledge and a decent standard of living" [2] in Human Development Report. Thus, Ukraine has HDI=0.779 compared to the world average HDI=0.737 in member states of the United Nations [2].

Ukraine is a country with 100% literate population in terms of basic literacy. The term 'linguistic literacy' / 'language literacy' is used to identify "the ability to write, pronounce and express thoughts both in written and oral manner correctly" [9]. Also, it is understood as "a constituent of language knowledge characterized by the availability of multiple linguistic resources and by the ability to consciously access one's own linguistic knowledge and to view language from various perspectives" [16]. The main components of linguistic literacy are the following: lexical, syntactic and discourse features of written language [7], grammar as the basis [9], rhetorical flexibility ("to be 'linguistically literate' means to possess a linguistic repertoire that encompasses a wide range of registers and genres" [16]) and orthography [10].

Linguistic literacy is the subject of research in psycholinguistics, social linguistics and language didactics. The problem of linguistic

literacy is related to the problem of teaching the mother tongue [9], teaching language to d/Deaf and hard-of-hearing students [11], as well as second language acquisition [12] (Knutsson et al. [13] used a term 'second language literacy'), bilingual education [8, 20], later language acquisition in children [16], etc. The international journal *Language Literacy: Journal of Linguistics, Literature, and Language Teaching* [3] is devoted to the study of these issues.

Linguistic literacy is diagnosed primarily empirically 1) by means of questionnaires, surveys or testing, 2) using the method of observation. In both cases, this is a manual analysis of quantitatively limited material, which is extremely time-consuming. This way, for instance, Trenkic and Warmington [20] tried to explain the interconnection between language and literacy indicators and academic results of home (British) and international (Chinese) students by analyzing the results of vocabulary, reading comprehension tests and comprehensive test of phonological processing. As a result of their study, students' cognitive, language and literacy skills were measured. The students were tested at the beginning of their studies and 7–8 months later [20].

In Ukraine, school graduates have a test in the form of External Independent Evaluation, the results of which are an indicator of the quality of secondary education, in particular those of Ukrainian Language and Literature. Statistical data on the results of External Independent Evaluation in 2008–2021 are presented on the official website [21]. Owing to that, it is possible to monitor the results of Ukrainian Language and Literature tests by region, year, and type of educational institution of graduates. One can also find the percentage of successfully completed test tasks of various types (spelling, morphology, vocabulary and phraseology, syntax and punctuation). This proves that the linguistic literacy rate varies. External Independent Evaluation in Ukrainian Language and Literature also contains an open-ended writing task in the form of an essay. Computer processing of the results of manually checked essays enables examiners to assess linguistic literacy skills of young Ukrainians. For example, the results of learner performance in essay-testing in 2021 showed a low level of mastery of spelling, punctuation, lexical, grammatical and stylistic norms of the Ukrainian language, as most works achieved 0 or 1 score point out of 4. However, these results show linguistic literacy of formal Ukrainian at an examination.

Formal communication and informal communication differ. Formal communication is a process controlled by teachers. Website and social media comment is a format of informal communication. Such spontaneous utterances show the level of linguistic literacy, i.e. mastering grammatical, spelling, punctuation, lexical and stylistic norms of a formal language. Nonetheless, researchers have not given attention to them and have most often studied genre, lexical, or syntactic features.

We understand the term 'linguistic literacy' as a set of language and speech competencies, i.e. the knowledge of the rules of the language and the ability to follow them when speaking. Our attention is focused on texts written primarily by students in an informal context as they are the country's intellectual elite for decades to come. It is possible to assess the level of mastering a formal language by a student based on written utterances made spontaneously, in particular in Ukrainian. Linguistic literacy of spontaneous utterances in Ukrainian has been studied for the first time. We suggested the method for measuring linguistic literacy rate automatically. In such a way, it is possible to process a vast array of written texts. This predetermines the overall topicality of this research.

The aim of the study is to design an algorithm for computational analysis of informal written texts, to create a database of typical errors made by Ukrainian students in the process of written spontaneous communication, to measure students' linguistic literacy rate and to create a map of linguistic literacy of Ukrainian students to update the way of mastering the norms of formal Ukrainian in each region in the future.

The research material is Ukrainian students' comments about 449 Ukrainian universities on the web portal https://www.education.ua. The portal section 'Comments' contains hundreds of web pages, which were used to conduct our analysis. All the comments made over the period of 2009–2018 were analyzed, i.e. since the creation of the portal till 2019 when the new Ukrainian spelling rules were introduced. During this period, the Ukrainian orthography of the 2007 edition [1] was in force. Thus, the research material is homogeneous in terms of spelling rules. However, 2/3 of these comments were made in Russian. Such comments were dismissed. Some universities have very few comments or comments are prohibited by the university management (81 universities). For instance, Taras Shevchenko National University of Kyiv currently has 405 comments in 12 years, i.e. an average of 33 comments per year, some of which were made in Russian. Universities from the East of Ukraine have comments which are written mainly in Russian. However, the number of comments per university neither influences the process of the identification of errors in general nor their frequency distribution among 10 000 comments. Therefore, the results are representative. The algorithm for identifying language of comments and creating the given database is explained in [19]. The database contains the following data: comments, date and time of their posting, author of the comment, language of the comment, name of the educational institution to which the comment was attached, city and region where the educational institution is located.

2 OVERVIEW OF RESOURCES AND TOOLS

The process of measuring the linguistic literacy rate involves two stages. The first stage is the qualitative and quantitative analysis of errors in the written text, and the second one is the computational analysis of the obtained results.

There are a number of services which are mostly aimed at spell checking Ukrainian language texts. They are available online: SpellStar (https://www.stars21.com/spelling/), ORFO Online (https://online.orfo.ru/). Some can also be downloaded and installed: GNU Aspell (http://aspell.net/), Yandex speller (https://speller.yandex.net).

The LanguageTool browser extension was chosen to complete the tasks of this study because it can test not only spelling but also grammar, as well as the style of the text. It is possible to trace the patterns according to which the program works due to the HTML markup [4]. Fragments of text containing an error are given the span tag, which contains classes that determine the type of error and its color (*hiddenGrammarError, hiddenSpellError, hiddenSuggestion*).

These classes are responsible for grammatical errors, spelling errors, and hidden suggestions about a possible error and its variations. The span tag also contains an onkeypress variable, which contains error data and hidden suggestions about how to correct it. Despite the obvious benefits of this program, it cannot analyze a big number of comments. At this stage, to automate the interaction with the site, we suggest creating a program that would input data into LanguageTool, encourage it to analyze errors, collect the analyzed data, and store it in a certain structure. We suggest creating such a program using the Python algorithmic programming language and Selenium library to simulate a browser. It will input data into LanguageTool, encourage it to analyze errors, collect the analyzed data, and store it in a certain structure.

3 ERROR ANALYSIS SOFTWARE

To form a table of initial Excel data, the above-mentioned database is used. It only requires the following data: names of regions, comments.

To write code in Python the following libraries and modules are used: a WebDriver and Selenium library for browser interaction, bs4 library for parsing HTML, time library for putting processes on hold, xlrd library for reading data from an Excel table, and os library for console screen clearing [5, 14, 15, 18]. It is important to create a save file of the last process as the program may crash due to different force majeure circumstances (interruption of the Internet signal, the Internet slowing down, etc.).

3.1 Algorithm Description

Step 1. Having received the initial data, the program launches the Firefox browser with the help of the Firefox webdriver and assigns its instance to the driver variable. The driver variable can be used to open a site using the get method, which takes the page URL (https://www.languagetool.org/). The operations that follow include: removing ads, opening the language selection menu, and language selection. They are performed using the repeat function, which enters the xpath of each of the objects responsible for these actions. In this function, certain actions are cyclically repeated using the while loop, which is set to True (always repeated). The loop uses the try statement, which puts the algorithm on hold for two seconds (the site takes time to load) using the sleep method of the time library by entering the number 2. The try statement then tries to simulate a mouse click on an object that has the corresponding xpath. To do this, the click method is used which is applied to the variable formed by the find_element_by_xpath method of the driver variable, into which xpath is entered. If no error occurs during this operation, the loop will be interrupted using the break statement. Otherwise, nothing is done, and the cycle is repeated.

Now that the language is set in the browser, it is necessary to put the algorithm on hold again. However, this time it is one second long. The next one is the switch_to_frame function. This feature enables switching to the text input frame. The text input frame is a separate HTML markup object that will not be displayed in the HTML markup, so xpath will not be found. The function assigns the xpath search value to the frame variable that matches the frame object. By using the frame method of the switch_to of the driver variable into which the frame variable is entered, the driver is switched to the frame.

Switching requires a minimum hold-on period, so a hold-on period of 0.1 seconds is applied. In this frame, the text of the frame is cleared using the clear method on the value of the find_element_by_xpath method of the driver variable into which the xpath of the frame body is entered.

Step 2. Initial data processing. The for loop iterates the list rates of the initial data, starting with the pos position and ending with the last position of this list, obtained using the len function. As the process of one comment verification will take from 1 to 2 seconds, and the total number of comments is about 10,000, the verification process can take several hours. To monitor the data processing procedure, the amount of processed data should be displayed as well as the percentage of work performed using the print function, where the following message should be inserted: “Processing: comment position / total length of the initial data list, rounded to two decimal places value of the comment position divided by the total length of the initial data list, and the ’%’ symbol”.

After that goes the check function, which takes the value of the region, the value of the comment and the position of the comment. This is the main function that checks and saves the data. In the process of its execution, a t variable is created, which takes the 0.1 value that corresponds to the time the algorithm is put on hold. Then operations similar to that of the repeat function are repeated, however, with a larger content of operations. So, the next one is a while loop with the True value. In this loop, the try statement is used, which will try to perform all subsequent operations. The operation of switching to the initial content of the HTML markup is performed using the default_content method of the already known module switch_to. Then it is necessary to switch to the frame again. The action seems illogical, however, it is necessary to make sure that switch to the frame does not occur in the frame itself in case of switching to the except operator in which a switch to the frame takes place. Doing so may cause the program to malfunction. Once in the input frame, it is necessary to insert the text of the comment into this frame. This can be done using the send_key method of the variable formed from the xpath search of the input window body, which accepts the comment text.

When the comment is input, it is required to switch to the original content of HTML markup. Next, it is necessary to check if the site has found an error. This can be done by checking if the message box is empty. If no errors are found, a corresponding message is displayed in the message window. This can be estimated with a conditional operator, which checks whether the value of the text variable attribute formed as a result of the search of this window by xpath is equal to an empty string. If so, then the errors are found and after that the body of the condition is executed.

The algorithm is put on hold for one second and switching to the input window takes place. Next, it is necessary to create an HTML markup tree for the input window to find the following: the error, the error class, the rule by which the error was made, and the hidden suggestions about the error. Using the BeautifulSoup method of the bs4 library, a tree is built from the HTML markup formed from the page_source attributes of the driver variable and is assigned to the soup variable. In this tree, it is necessary to iterate

through the span nodes using for loop and the list of nodes output using the page_source method of the soup variable.

Step 3. The data is saved in a text file encoded with UTF-8. It is necessary to tab it and add a paragraph symbol at the end. The comment position is also saved in a separate file.

If the condition is not met, the data and the position are saved, but all values will be the 'No Errors' string, except for the region and comment. Also, after that, the driver switches to the frame, and the algorithm is put on hold for one second. Whether the condition is executed or not, the t variable is assigned a value of 0.1 and the cycle is interrupted.

In case of a system error, the following actions are performed: the 0.1 value is added to the t variable, it switches to the frame, the algorithm is put on hold for t seconds and the frame is cleared. This ends the body of the check function. After that, the algorithm is put on hold again for 0.1 seconds, the frame is cleared and the os library with the 'cls' parameter is cleared using the system method. The loop of transition to the next comment rate is repeated.

As a result of the program execution, the .txt file is formed. In this file, each string is an error with its data, which is separated by tabs. This data was exported to an Excel spreadsheet, and a separate spreadsheet with data on regions, comments and errors was created for subsequent linguistic literacy rate measurement.

3.2 Error Database

Some absolute value is required to measure the linguistic literacy rate. As the data provided by the program for further error analysis contains pieces of text which are considered to be erroneous, it can be used to measure the linguistic literacy rate. The linguistic literacy rate will be based on the number of characters in a fragment of a comment containing an error and on the total number of characters in a comment. If there is an error in the word, then the number of error characters equals the number of letters in this word. If it is a punctuation error, i.e. one unnecessary punctuation mark or the one that is missing in a sentence, then the number of error characters equals 1.

To create a program that will output values for measuring the linguistic literacy rate, only xlrd library is needed. It is used for reading data from an Excel spreadsheet.

Step 1: reading data using the read_excel function and assigning data to the values variable. After that, these errors are summarized by regions and comments using the form_dict function and assigning the value of this function to the formed_dict variable (two-dimensional dictionary with region keys and comments).

Step 2: creating a list where processed data will be stored. As the generated data of the form_dict function is a two-dimensional dictionary, or a complete k tree, then it is possible to iterate through its nodes with the help of two loops. The first loop iterates through regions, and the second loop iterates through comments in these regions. In the loops, the number of comment characters is determined using the len function and this value is converted to a string. By using the list generator, a list of a number of characters in a fragment containing an error is created, the sum of the number of characters is determined, and it is converted to a string. A list from the region and two found values are added to the output list.

The result of this program is the data saved in a .txt file, where each data set is separated by paragraphs and each data element is separated by a tab.

The following data can be extracted from the consolidated exported table: the number of grammatical, spelling and other errors, quantitative parameters of error variations and hidden suggestions about the errors of these and other types. The latter shows the most frequent students' mistakes. Types of errors ranked by frequency ≥ 2 are provided in table 1.

In table 1, parameters are written in the form of a class naming standard in programming. Spelling errors are not further subdivided. LanguageTool errors of "hiddenSuggestion" type include technical errors (missing or extra spaces), stylistic errors (slang use), lexical, and punctuation errors.

In total, there have been detected 33 878 errors, 1 466 of which are grammatical errors, 14 255 are spelling errors, and 4 957 are hidden suggestions.

4 MEASURING LINGUISTIC LITERACY RATE AND DISCUSSION OF RESULTS

The obtained results show almost the same number of grammatical and spelling mistakes made by students in comments about Ukrainian universities. The number of errors per comment is 3.3.

Error analysis revealed neglect of rules of computer typing, in particular a space before or after certain characters, in spontaneous communication. Morphological, punctuation and euphonic errors were the most common ones. Morphological errors refer to a high level of language proficiency. The most frequent language errors were the following ones: the use of the Russian abbreviation 'ВУЗ' instead of 'ВНЗ' or 'виш'; incorrect formation of the superlative degree of comparison of adjectives / adverbs (use of the word 'самий'); grammatical errors such as 'по спеціальності'; lexical ones e.g. 'здавати', 'поступати'; writing words as one word, separately or hyphenated e.g. 'нажаль', 'будь-ласка', 'доречі', 'всетаки', etc.

The following formula is proposed for measuring the linguistic literacy rate:

$$i = 1 - \frac{e}{E}$$

where:

- i – the linguistic literacy rate.
- e – the total number of characters in a fragment of a comment containing an error.
- E – the total number of characters in a comment.

Using Excel tools, the linguistic literacy rate was measured for the data exported from the text file. The next step was to compile the regions and measure the average value of the linguistic literacy rate for each region. A fixed numeric format with five decimal places was chosen for the rate, and filtering by the linguistic literacy rate was conducted. As a result, the linguistic literacy rate based rating of regions was obtained (table 2).

The map of linguistic literacy of Ukrainian students was created in a similar way to the map of the language situation in Ukraine [19]. This map shows the linguistic literacy rate with the help of color saturation (figure 1). The more saturated the color, the higher the linguistic literacy rate.

Table 1: Types of rrrors

Type of errors	Frequency	Type of errors	Frequency
MORFOLOGIK_RULE_UK_UA	14256	MODAL_WORD	11
COMMA_PARENTHESIS_WHITESPACE	6922	PO_VS_OTHER	11
UK_SIMPLE_REPLACE	3326	VYD_VS_VYGLYAD	11
EUPHONY_CONJ_I_Y	2765	ZNUSCHATYSIA_NAD	11
slang_words	1279	KOROTSHE_KAZHUCHY	10
missing_space	823	PLEONAZM	10
COMMA_BEFORE_BUT	819	pryslivnykovi_spoluky_cherez_defis	10
EUPHONY_PREP_V_U	460	ZNIMATY_ZHYTLO	10
DIGITS_AND_LETTERS	366	LATIN_LETTERS_IN_SENTENCE	9
UK_PREP_NOUN_INFLECTION_AGREEMENT	233	MENSHE_WITH_TIME_NOUNS	9
UK_MIXED_ALPHABETS	200	UK_MISSING_HYPHEN	9
EUPHONY_PREP_Z_IZ_ZI	186	DO_CYH_PIR	8
UK_ADJ_NOUN_INFLECTION_AGREEMENT	158	NA_TAKIY_MOVI	8
TAK_YAK	147	OBYEM_VS_OBSYAG	8
SAMYI_WITH_ADJ	145	ZAVIDUVACH	8
PO_VS_ZA	112	ALT_SPELLING	7
INSERTED_WORDS_NO_COMMA	107	BILSHE_TOGO	7
ZDAVATY_EKZAMEN	95	SPRAVA_V_TOMU	7
POSTUPATY_V_INSTYTUT	84	COMMA_AFTER_OTZHE	6
PREP_BEFORE_VERB	76	DAY_BOG	6
ABBREVIATIONS_WRONG_DOT	72	DIAKUYUCHI_INANIM	6
UK_SIMPLE_REPLACE_SOFT	66	PO_PONEDILKAH	6
UKRAINIAN_WORD_REPEAT_RULE	54	PO_VS_NA	6
VELYKE_SPASYBI	53	SYOGODNYASHNIY_DEN	6
BY_B	47	zgidno_z	6
PORIVNYANO_Z	45	BILSH_WITH_ADJ	5
V_SHOCI	45	iz_za	5
ZA_RAHUNOK	43	OVKA_FOR_PROCESS	5
VERB_SUBSTANDARD_FORMS	41	VIDMINA_CHOLOVICHYH_PRIZVYSCH	5
WORDS_WITH_DASH	40	chut_ne	4
PLEASE_NO_COMMA	35	DAVAITE_VERB	4
BILSHE_WITH_TIME_NOUNS	34	JAK_PRYINIATO	4
CONSISTENCY_NOUN_NUMERIC_WHOLE	33	MATY_MISCE	4
UK_NOUN_VERB_INFLECTION_AGREEMENT	31	NOSYTY_NAZVU	4
HOTITY_VIDMITYTY	26	PO_VELYKOMU_RAHUNKU	4
nezvazhayuchi_na	24	RAHUVATYSIA_SCHO	4
UK_SIMPLE_REPLACE_RENAMED	23	stane_v_nahodi	4
vyrishuvaty_problemu	23	V_CHYSLI	4
LYUBYI_ADJ	20	V_TOY_ZHE_CHAS	4
PRYIMATY_VS_BRATY	20	VESTY_SEBE	4
NAVCHATY_CHOGO	19	ZHE_ZH	4
PRY_BAZHANNI	19	DASH	3
DASYSH	18	NANOSYTY_UDAR	3
SLOVA_BEZ_DEFISU	18	po_krainiy_miri	3
VIDMINYTY_VS_SKASUVATY	15	TOLK	3
povezlo_vs_poschastylo	14	DACHA_VS_DAVANNIA	2
PRYKLADATY_ZUSYLLYA	14	graty_vs_hraty	2
V_PODALSHOMU	14	KORYSTUVATYSIA_POPYTON	2
VSE_RIVNO	14	MISHATY_VS_ZAVAZHATY	2
PO_VS_Z	13	NEOBHIDNIST	2
ZADAVATY_PYTANNIA	13	PIVTORA_WITH_NOUNS	2
COMMA_AFTER_INSERT	12	u_diysnostim	2
PO_VS_NO_PREP	12	U_YEAR	2
ABBREVIATIONS_MISSING_DOT	11	vykliychennia_vs_vyniatok	2

Table 2: Linguistic literacy rate based rating

N	Region	Linguistic literacy rate	N	Region	Linguistic literacy rate
1.	Poltava Region	0.936361044	14.	Kharkiv Region	0.912087519
2.	Chernihiv Region	0.930690171	15.	Kherson Region	0.911372739
3.	Kyiv Region	0.929604915	16.	Zaporizhzhia Region	0.911350472
4.	Volyn Region	0.927941178	17.	Vinnytsia Region	0.910413275
5.	Chernivtsi Region	0.926519332	18.	Ivano-Frankivsk Region	0.908559614
6.	Sumy Region	0.925322745	19.	Ternopil Region	0.907326221
7.	Cherkasy Region	0.92512617	20.	Lviv Region	0.906296575
8.	Odesa Region	0.920281259	21.	Donetsk Region	0.903423086
9.	Khmelnytskyi Region	0.91587954	22.	Dnipropetrovsk Region	0.899651133
10.	Kirovohrad Region	0.914712021	23.	Zakarpattia Region	0.889153301
11.	Rivne Region	0.914409731	24.	Luhansk Region	0.866826278
12.	Mykolaiv Region	0.912897684	25.	The Autonomous Republic of Crimea	0.84439522
13.	Zhytomyr Region	0.912330197			

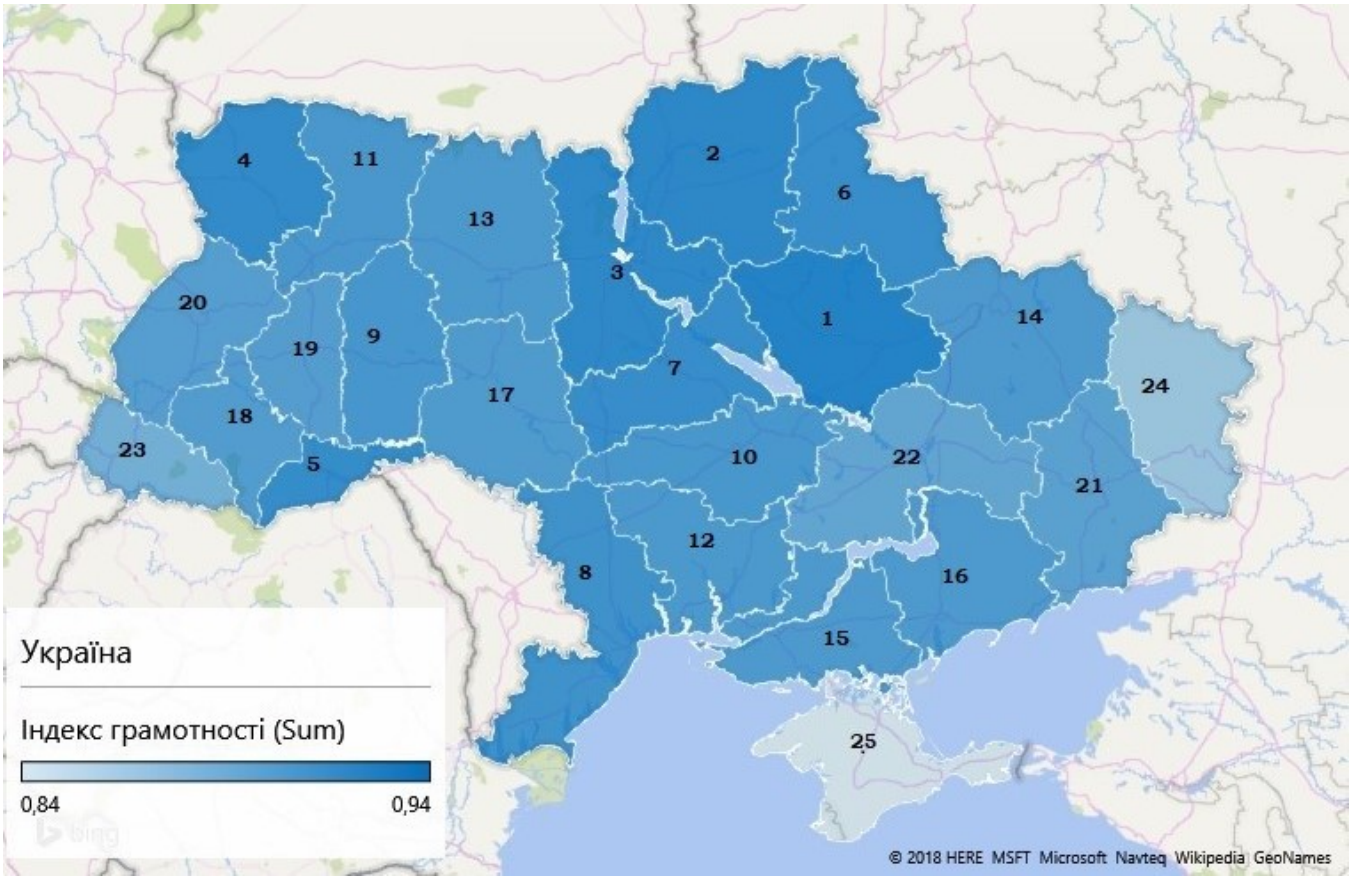

Figure 1: The map of linguistic literacy of Ukrainian students.

5 CONCLUSIONS

Analysis of the errors made by students in informal spontaneous monologue utterances has revealed the following: 1) the interfering influence of the Russian language; 2) high frequency of slang vocabulary; 3) lack of skills to leave a space where appropriate. The obtained results are of practical importance for language didactics, as they enable determining vectors of future work of philologists in both secondary and higher educational institutions, as well as adjusting programs in each region according to the most common errors made in a particular region.

The obtained linguistic literacy rating which is based on the student linguistic literacy rate shows that Kyiv, Poltava and Chernihiv regions have the highest figures. In general, the youth of central Ukraine has the highest linguistic literacy rate, which may be explained by the lack of strong interference influences of the neighboring countries' languages. The worst results are shown by South-Eastern Ukraine, where code-switching between Ukrainian and Russian occurs, and the Russian language predominates.

When comparing the results of External Independent Evaluation [21] and those obtained in our study, the 'region' parameter was used. The best results were shown in the city of Kyiv and Lviv region in 2009–2018, in Cherkasy region in 2010 and Chernihiv region in 2014. According to our results, the city of Kyiv and Kyiv region took 3rd place after Poltava and Chernihiv regions, and Lviv region took 20th place. There are several reasons for that. The speakers' intentions in the circumstances of External Independent Evaluation and in the process of commenting anonymously on the site are different. Students are aware of different communicative contexts and use different forms of language for them: formal or informal. The latter admits of the use of slang vocabulary, which ranks 5th by frequency of use in comments. What is more, students get prepared for External Independent Evaluation with a clear aim and actualize all their knowledge while doing a test, whereas, anonymous commenting removes any responsibility for the text and, therefore, represents the real linguistic literacy rate and level of general culture.

The comments depict spontaneous and informal written communication, the rate of linguistic literacy of which has been studied for the first time. The developed software can be used to measure the linguistic literacy rate of any social group by analyzing their texts written in Ukrainian.

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Stylometric Study of the Fiction Using Sketch Engine

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ABSTRACT

The paper deals with a stylometric study of I. Asimov's idiostyle considering a corpus-based approach. For the analysis of stylometric features the I. Asimov "Foundation" cycle text corpus was created. The quantitative and statistical processing of the text corpus is done via Sketch Engine tool that enables comparison of phrases and words in the following variants: lemma, token, subcorpus. The last parameter is important for distinguishing individual authorial features, comparing their combinability and identifying the dynamics of idiostyle. The following stylometric features of a text corpus by I. Asimov are described: quantitative morphological and lexical characteristics of the vocabulary, quantitative characteristics of occasionalisms' word formation and statistical estimation of occasionalisms' collocations. It is sated that the frequency of occasionalisms in the cycle of novels undergoes chronological change, as well as their combinability. In this paper, a method of occasionalisms' automated extraction due to keyness score was proposed, however, it requires the subsequent manual verification.

CCS CONCEPTS

• **Applied computing** → **Language translation**.

KEYWORDS

corpus-based approach, corpus, stylometry, Sketch Engine

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1 INTRODUCTION

With the development of corpus linguistics as well as the corpora and corpus managers emergence, quantitative-statistical, stylometric processing of texts acquired a new format, so as calculations and statistical evaluation became automated.

Stylometry can serve as a practical basis and a toolkit for further stylistic, lexicological, grammatical research allowing: to analyze the peculiarities of the author's language in terms of lexical composition, morphology and syntax (statistical and comparative analysis of lexical structures and syntactic structures in both texts of individual author's corpora as well as of the general language corpora) [12]; solve natural language processing tasks: authorship attribution, authorship verification, style change detection, authorship profiling, and text classification by genre [10]; search for words and collocations, examples of the lexical units use, author's occasionalisms and neologisms, depending on the context of use [14]; conduct research in the stylistics field (consideration of ways to convey stylistic features in texts, determination of techniques and stylistic means that a certain author uses in the text) [6]; develop software for text analysis, automatic search and extraction of equivalents for individual lexemes and collocations; explore phenomena in the language of a corpus [16].

The study of the systematic organization of individual-author lexical innovations (many of which not only became real linguistic findings of individual authors, but also entered the general language fund) is impossible without their statistical explication. However, works on stylometric research of the so-called neological vocabulary are represented only by single samples, despite the fact that recently the general tendency to language stylometric description has significantly increased. This task is still relevant, because modern studies of authorial neologisms are, in fact, a linguistic gap, the completion of which is extremely necessary and urgent.

The researchers agree that a feature of neologism-finding presents a technical challenge and their frequencies, even in very large corpora, will tend to be very low [8, 9]. So, the manuscript presents the new quantitative analysis of the author's style characteristics: for the first time the quantitative morphological and lexical features of I. Asimov's texts corpus are described, which gives the possibility to show the connection between the author's lexical diversity and background. The obtained stylometric parameters are important for further research of I. Asimov's texts and the genre of fiction in

general. Statistical estimation of occasionalisms' collocations based on LogDice score that is carried out gives the possibility to perform the automatic cross-check of the created innovations' list, and to supplement it.

The novels of I. Asimov's "Foundation" cycle were chosen as a material for our analysis. The aim is to carry out a corpus-based approach to stylometric study of I. Asimov's idiostyle on the novels of the "Foundation" cycle. The choice of the author working in the genre of science fiction was done due to the fact that the main characteristic feature of the last is the occasional lexical units use, which were mainly studied by manual sampling. In this paper, we propose a method of occasionalisms' automated extraction.

I. Asimov's works have been studied in the following aspects: 1) semantic, 2) cognitive, 3) translational (Allen [2], Bellefontaine [3], Hoppa [7], Nevala-Lee [13], Vainio [18], Westfahl [19]). However, all of these are examples of descriptive research, without taking into consideration quantitative and statistical indicators and the involvement of corpus data, which allow to determine the text stylometric features, to trace the author's style in the dynamics.

2 RESEARCH METHODOLOGY

2.1 Corpus-Based Approach

In modern linguistic studies, corpus-based and corpus-driven approaches are defined. Tognini-Bonelli [17] interprets the corpus-based approach as a method that involves the use of the language corpus to verify, confirm linguistic theory or as a source of illustrations to the formulated theoretical positions. The corpus-driven approach is a method that covers the interpretation of corpus data as a whole, i.e. the obtained results and formulated conclusions are based exclusively on corpus data [17]. Biber [4] proposes to use these two approaches comprehensively, as it will identify not only the phenomena of language but also speech, not yet fixed by grammatical theory [4]. Since our corpus is based on fiction of one cycle by one author, i.e. the corpus is static, it seems appropriate to determine a corpus-based approach with elements of corpus-driven, in particular in the analysis of collocations.

2.2 Creating of a Texts Corpus by I. Asimov in Sketch Engine

For this study, the commercial software Sketch Engine [1] was chosen because it gives the possibility to compare frequencies with the other 25 corpora of the English language and thus identify unique vocabulary, which is one of the indicators of the author's idiostyle.

Sketch Engine software helps to download the corpus, has a wide range of its statistical processing — both texts in general and individual lexical units, has options for creating frequency lists of words, concordances, N-grams, keywords, evaluation of collocations by statistical score, as well as allows to make morphological marking (PoS).

To avoid distorted search results, it is important to have a pre-grapheme analysis, i.e. prepare the corpus so that it does not contain special characters next to words, accidentally separated by a space words, coding errors, etc.

In order to be able to compare the quantitative parameters in different texts of the I. Asimov "Foundation" series we downloaded 7 books in plain text format as separate files. As a result, we have 7 subcorpora, which can be worked out separately and together. The statistics of the created corpus "Foundation_Asimov" is given in figure 1.

The size of the created corpus is 925,029 tokens. This corpus is written, monolingual (English), full-text, by one author (I. Asimov), static, marked (has morphological and syntactic markup), synchronous. It is structured into 7 subcorpora, which are named after the date of publication and the title of the novel. Thus, in each of the Sketch Engine options, queries are possible both for the entire "Foundation_Asimov" corpus as well as for a separate novel, which we select in the Text types section by title.

3 STYLOMETRIC FEATURES OF THE I. ASIMOV'S TEXTS CORPUS

Unlike the free version of NoSketch Engine, the commercial version has a broader functionality, where not only morphological markings are available for English, but also other tools important for stylistic features determination.

3.1 The Quantitative and Morphological Characteristics of Asimov's Texts Corpus

The *Wordlist* tool gives the possibility to sort the corpus lexicon according to the frequency of tokens, lemmas as well as the parts of speech. The last parameter is important for distinguishing individual authorial features. Quantitative ratio of speech parts according to relative frequency (RF[1]) in the I. Asimov's texts corpus are presented in the figure 2.

Despite the expected high frequency of stop words (primarily function words), the highest frequency was given to nouns and verbs: the first indicate the narrative type of texts, and the second describe human activities, some processes. The most frequent verbs in the corpus are: *be* (Fpm[2]=40827.91), *have* (Fpm=13654.71), *do* (Fpm=9173.77). Here, as expected, the most frequent were the verbs, which often act as auxiliary. It correlates with frequency per million of the most frequent verbs in The British National Corpus (v. 2.0) according to Leech et al. [11]: *be* (Fpm=42277), *have* (Fpm= 13655), *do* (Fpm= 5594). But the most frequent nouns in the "Foundation_Asimov" corpus reflect the Asimov's works vocabulary specifics (figure 3) and correlate with the highest score keywords.

Here it seems interesting to compare the results with the quantitative characteristics of both fiction and scientific style. Among the morpho-marking by Sketch Engine minuses the identification of the negative participle *not* as an adverb, the adverb *yet* – as a conjunction, *that* – as a preposition were noted.

Quantitative ratio of speech parts allows to define *epithetization index* and the *nominalization index*, which are represented by the novels in the table 1. Here and further for calculations of the idiostyle indexes we used the formulas resulted by Buk [5].

The highest is the nominalization index of the first three novels, then, after a 30-year break in the writer's work on the "Foundation" cycle, this index decreases. However, the epithetization index is the largest in the first and last novels of the cycle.

[1]RF – relative frequency, AF – absolute frequency.
[2]Fpm — frequency per million tokens, which is used to compare frequencies between corpora of different sizes.

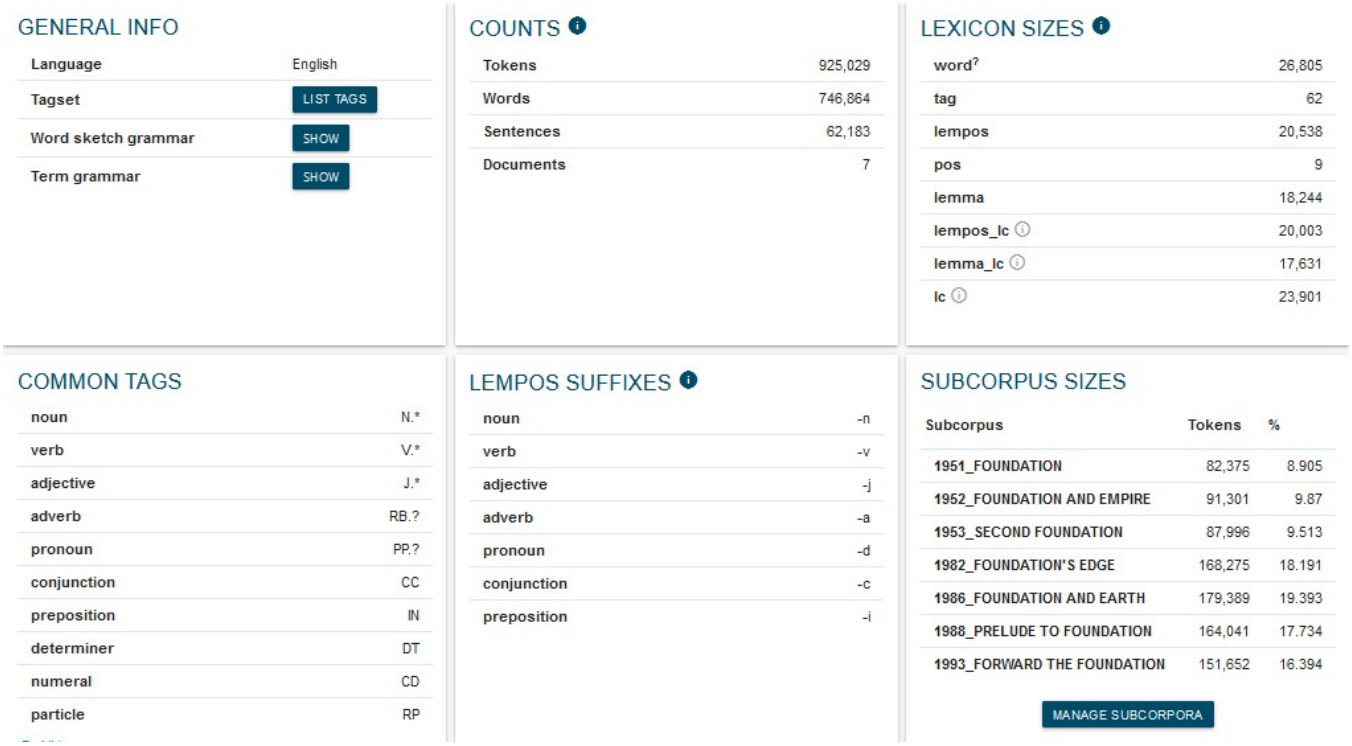

Figure 1: Statistics of the "Foundation" cycle text corpus by I. Asimov.

Table 1: The quantitative and morphological characteristics of Asimov's vocabulary by the novels

Subcorpus	Noun (AF)	Verb (AF)	Adjective (AF)	The epithetization index	The nominalization index
1951_FOUNDATION	15085	13056	4523	3.335176	1.155407
1952_FOUNDATION AND EMPIRE	16632	14205	5452	3.050624	1.170855
1953_SECOND FOUNDATION	15490	13969	5130	3.019493	1.108884
1982_FOUNDATION'S EDGE	27455	28839	8393	3.271178	0.952009
1986_FOUNDATION AND EARTH	28302	30553	9578	2.954897	0.926325
1988_PRELUDE TO FOUNDATION	25302	28810	8343	3.032722	0.878237
1993_FORWARD THE FOUNDATION	24737	26393	7351	3.36512	0.937256

3.2 The Quantitative and Lexical Characteristics of the Vocabulary

Also, the *Wordlist* tool gives the possibility to determine the author's vocabulary and, accordingly, calculate the *lexical diversity index* (L). It was calculated by the Equation 1:

$$L = \frac{V}{N} \tag{1}$$

where:

- L – the lexical diversity index.
- V – vocabulary volume (number of lemmas in a text).
- N – size of a text.

Since we have 7 subcorpora that reflect the period of Asimov's work during 1951–1993, it is possible to track the lexical diversity index dynamics table 2.

Table 2: The lexical diversity index in "Foundation_Asimov" subcorpora

Subcorpus	The lexical diversity index
1951_FOUNDATION	0.072
1952_FOUNDATION AND EMPIRE	0.071
1953_SECOND FOUNDATION	0.068
1982_FOUNDATION'S EDGE	0.040
1986_FOUNDATION AND EARTH	0.037
1988_PRELUDE TO FOUNDATION	0.040
1993_FORWARD THE FOUNDATION	0.043
In the entire corpus	0.019

As we can see, the lexical diversity index decreased in the novels, which were written after a break of almost 30 years at "Foundation" cycle work.

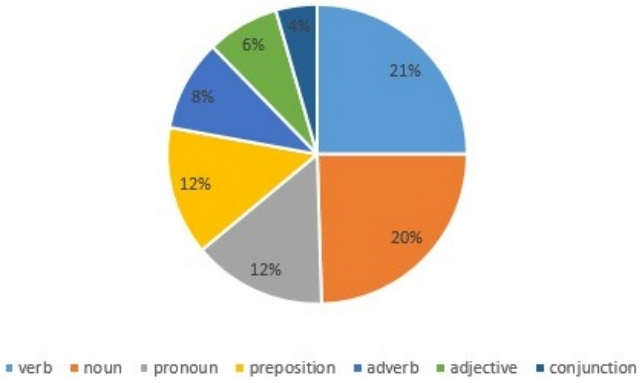

Figure 2: Quantitative ratio of speech parts in the "Foundation_Asimov" corpus.

	Lemma	Frequency ?	Frequency Per Million ?
1	seldon	3,003	3,246.38
2	trevize	2,125	2,297.23
3	time	1,604	1,734.00
4	foundation	1,532	1,656.16
5	man	1,429	1,544.82

Figure 3: The most frequent nouns in the "Foundation_Asimov" corpus.

Since the *Wordlist* tool shows lemmas with AF=1, we can define Hapax Legomena, which is necessary to calculate the exclusiveness index of the vocabulary (Ev) and the exclusiveness index of the text (Et), which are calculated by the equation 2, 3:

$$Ev = \frac{V_1}{V} \tag{2}$$

$$Et = \frac{V_1}{N} \tag{3}$$

where:

- Ev – the exclusiveness index of vocabulary.
- Et – the exclusiveness index of a text.
- V_1 – number of lemmas with AF=1.
- V – vocabulary volume (number of lemmas in a text).
- N – size of a text.

Thus, the exclusiveness index of vocabulary and the exclusiveness index of text also show a decline after a writer's break in the cycle of novels table 3. Here it would be interesting to compare the results with the frequency indicators of fiction style in general and the genre of science fiction in particular, but we will leave it for the future research. The exclusiveness index of vocabulary shows that almost half of the writer's vocabulary is the low-frequency vocabulary.

A significant number of single words prompted a check of their occasionality.

4 OCCASIONALISMS IN THE STYLOMETRIC STUDY

4.1 Automatic Extraction of Occasionalisms From the Corpus

Since the use of neologisms in general and author's neologisms (occasionalisms) in particular is a genre feature for science fiction, the most practical Sketch Engine tool for the occasionalisms search is Keywords, which compares the created I. Asimov's texts corpus (focus corpus) with that of the reference – any from the Sketch Engine database, after what keyword lists according to the specified parameters are displayed. For comparison, both synchronous corpora of Internet texts (*English Web Corpus 2018* or *enTenTen2020*) and diachronic corpora (*Transhistorical Corpus of Written English*) are available on the site, but in order to work properly with some corpora it is necessary to make tokenization or markup. Accordingly, keyword lists may differ after comparison with different reference corpora. Prior to the corpora comparing, there is the need to determine various parameters, which will, obviously, also affect the final results. One can select by lemmas, word forms, phrases, parts of speech, specify frequency ranges or focus on rarer or more general words, as well as the set rules for selecting words with or including words that begin with a capital letter or contain special characters, and so on.

In this study, the English corpus *enTenTen2020* was chosen as the largest one (38 149 437 411 tokens) to be the reference corpus. The obtained results partially coincided with the hypothesis of correlation between frequencies in the two corpora, where on the first positions of the list focused on rare words, there were occasionalisms observed during the pilot manual selection. These were mostly the names of science fiction inventions and phenomena or scientific terms, for example: *psychohistory*, *jet-down*, *electro-clarifier*, *visisonor*, etc., as well as the author's proper names — the names of fictional characters. Additionally, a list of verbose concepts was obtained, most of which are relevant to this study: *neuronic whip*, *psychic probe*, *meteorological vessel*. The list include not only nouns, but also other parts of speech that are also occasional: *trimensional*, *beblistered*, *offensify*.

The display of lists can be enriched by individual columns with numerical values of important characteristics, such as frequency in the focus or reference corpus, relative frequency, typicality score, which shows the difference between relative frequencies in the two corpora and, finally, the uniqueness of the word. Analysis of these characteristics allows one to select the occasionalisms themselves, and not rare words, as evidenced by the zero frequency in the reference corpus or a high keyness score.

Thus, the corpus-based approach using Sketch Engine tool made it possible to 1) automate extraction of occasionalisms, which, however, requires subsequent manual verification; 2) determine occasionalisms with the help of the keyness score. The obtained results were uploaded as a separate xml-file for further processing and sorting in MS Excel. The final occasionalisms' list consist of 1,115 units.

Table 3: Hapax Legomena and the exclusiveness index in subcorpora "Foundation_Asimov"

Subcorpus	Hapax Legomena	The exclusiveness index of vocabulary	The exclusiveness index of text
1951_FOUNDATION	2870	0.481	0.043
1952_FOUNDATION AND EMPIRE	3071	0.473	0.042
1953_SECOND FOUNDATION	2826	0.472	0.039
1982_FOUNDATION'S EDGE	3005	0.437	0.022
1986_FOUNDATION AND EARTH	2875	0.423	0.020
1988_PRELUDE TO FOUNDATION	2759	0.416	0.021
1993_FORWARD THE FOUNDATION	3062	0.463	0.025

4.2 The Quantitative Characteristics of Occasionalisms' Word Formation

The occasionalisms list was manually marked according to the word formation type. The seven creative types with uneven distribution were obtained:

- `One-component` (21.1%): *achaotic, achaotism, actionist, compor, comporellian, deducer, demoiry, demurity, desperance*
- `Compounds` (15.7%): *balancecard, baleyworld, cobwebbery, dethreading, earthlump, earthpeople.*
- `Jukstapositions` (43.8%): *after-blood, a-glimmer, air-car, air-jet, air-machine, air-taxi, air-vessel, all-but-complete, area-increasing, argyropol, arm-end, arm-stopping, auto-propel, auto-sweep, baby-smasher, baby-smashing, back-crawl, back-fringe, bad-expecting, blood-blind, blood-debt, blubber-head.*
- `Two-component` (17.8%): *arrogant metal, arrowed highway, cycloidic pathway, cylindered communication.*
- `Three-component` (1.3%): *emergency alarm box, expanding society set, galactic social pressure.*
- `Four-component` (0.3%): *mathematics of human behavior, course of future history.*
- `Five-component` (0.1%): *numerical probability of total destruction.*

The role of affixation is quite important in the production of new one-component authors units. At the level of word formation, affixation is realized as adding semantically significant prefixes and suffixes to the base of the word. Word formation (formation of compound and juxtaposition) is understood as the formation of a new word on the basis of two words. As a rule, compounds consist of two bases where the first basis specifies the meaning of the second (carrier of a generic sign). Two-component and multi-component occasionalisms are formed according to certain models by means of adjoining as well as the grammatical connection.

4.3 Statistical Estimation of Occasionalisms' Collocations

Word Sketch tool analyzes the search word's grammatical relationship with other parts of speech. This is interesting for studying of collocations and especially for occasional adjectives collocations determination. Firstly, this tool allows to perform the automatic cross-check of the created list of occasionalisms, and secondly, to supplement it. For example, one of the most productive concretizing elements of occasional compounds and jukstapositions is *hyper-* (30 units): *hyperatomic, hyper-engine, hypernuclear, hypernuclear motor, hyper-plan, hyper-raced, hyper-radiational, hyper-region, hyper-relay, hypershift, hypership, hyperspatial, hyperspatiality, hyperspatially, hyperthrust, hypertracer,hypertracking, hyper-video, hyperwarp, hyperwave. Word Sketch* tool gave the possibility to identify the following 21 collocations with the adjective *hyperspatial* with LogDice>5: *hyperspatialtravel* (12.4), *hyperspatial contact* (10.8), *hyperspatial distance* (10.3), *hyperspatial separation* (10.2), *hyperspatial pursuit* (10.2), *hyperspatial communication* (9.9), *hyperspatial tracking* (9.4), *hyperspatial missile* (9.4), *hyperspatial expedition* (9.2), *hyperspatial velocity* (9.2), *hyperspatial engine* (9.1), *hyperspatial flight* (8.9), *hyperspatial technology* (8.9), *hyperspatial image* (8.8), *Hyperspatial Theory* (8.8), *hyperspatial line* (8.7), *hyperspatial Galaxy* (8.1), *hyperspatial life* (7.1), *hyperspatial ship* (6.8), and also differently spelled: *hyperspatial jump* (10.3), *hyperspatial Jump* (9.2). Word sketch visualization can be seen in figure 4.

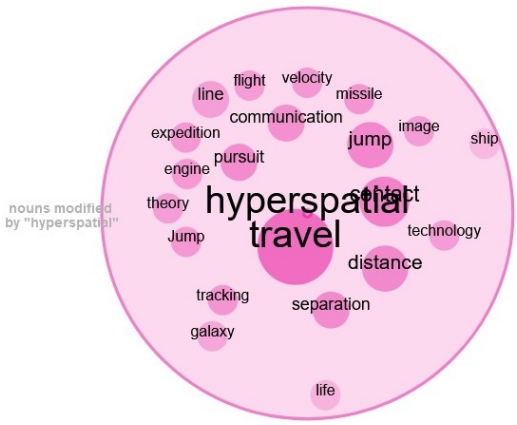

Figure 4: Word sketch for *hyperspatial.*

In all these cases, the AF is low: in the range 1–15, i.e. RF≤0.0000019, but also they have the high LogDice score, which indicates how strong the collocation is. These collocations are important for the conceptual analysis of the text, as well as for lexicographic practice. By the way, Asimov didn't use this adjective in his trilogy "Foundation" — only starting with his "Foundation's Edge" (1982). "Historical Dictionary of Science Fiction" dates back the use of occasionalism *hyperspatial* in the Asimov's work 1954 [15].

For nouns among the different grammatical relations *Word Sketch* tool shows the following construction "Noun is Noun", that has

the practical value for compiling a dictionary of the writer's language. For example, the word *psychohistory* which is one of the most frequent occasionalisms in the corpus "Foundation_Asimov" (AF=483), introduced by I. Asimov, has high LogDice score in the constraction "*psychohistory* is/is not …":

- `science`(12.3): *I quite understand that **psychohistory is a statistical science** and cannot predict the future of a single man with any accuracy* (1951). *Psychohistory **was not yet an experimental science*** (1993).
- `game`(12.0): *And, Seldon, do not tell me that **psychohistory is just a game**, that it does not exist* (1993).
- `study`(12.0): ***Psychohistory is just an abstract study*** (1988).
- `tool`(11.8): *...**psychohistory is a most valuable tool** to be used for the preservation of our culture* (1993).

Word Sketch Difference is a tool that is intended for comparison of phrases in the following variants: lemma (comparison of two lemmas due to the collocates), word form (comparison of two word forms of the same lemma due to the collocates), subcorpus (comparison one lemma usage in different subcorpora through the collocates). For example, let's compare the already mentioned I. Asimov's occasionalism *psychohistory* in novels by years of publication: the first "Foundation" (1951) and the last "Forward the Foundation" (1993). In the last novel of the cycle the frequency of lexical unit's usage by the author has increased 16 times: from AF=16 in "Foundation" to AF=260 in "Forward the Foundation".

Secondly, the last novel shows a compatibility that is missing in the first novel of the cycle:

- prepositional constructions ``psychohistory + in + NOUN'' (*way*, *place*, *time*, *detail*): *Foundation of psychohistorians only-mentalists, mind-touching psychohistorians-who will be able to work on **psychohistory in** a multiminded **way**, advancing it far more quickly than individual thinkers ever could.*
- prepositional constructions ``VERB + with + psychohistory'' (*do*, *interfere*, *satisfy*, *breakdown*, etc.): *Isn't that what you hope **to do with psychohistory**?*
- prepositional constructions ``at + psychohistory'': *… you must keep working **at psychohistory**.*
- constructions where the lexeme is used in the function of an object ``VERB + out + psychohistory (object)'': *...we're going **to work out psychohistory** in time to prevent the Fall of the Empire*e.
- constructions``VERB + without + psychohistory'': *In other words, psychohistory simply tells you what you **would know without psychohistory**.*
- constructions ``psychohistory + as + NOUN'': *It is possible to use **psychohistory as a tool** to manipulate the emotions of the people and achieve short-term effects.*

Totally 20 constructions which are not presented in the first novel were found. All this testifies to the development of the writer's idiostyle.

5 CONCLUSIONS

A corpus-based approach to stylometric study of I. Asimov's idiostyle on the novels of the "Foundation" cycle gave the possibility to make certain conclusions. For the analysis of stylometric features the I. Asimov "Foundation" cycle text corpus was created with the help of Sketch Engine. The "Foundation_Asimov" corpus is structured into 7 subcorpora according to 7 novels of the cycle. This enabled the quantitative parameters of each description, the idiostyle dynamics comparison and identification: the frequency of occasionalisms in the cycle of novels undergoes chronological change, as well as their collocational combinability, which was obviously influenced by extralinguistic factors. A comparison of the lexical diversity index, Hapax Legomena and the exclusiveness index of text in I. Asimov's 7 novels, i.e. for 40 years of his work, showed the decrease of the last after almost 30 years of work on the "Foundation" cycle. The exclusiveness index of vocabulary shows that almost half of the writer's vocabulary is the low-frequency vocabulary. The lower lexical diversity in the last I. Asimov's books may be connected with the fact that during this period he worked more in the genre of popular science literature. However, to test this hypothesis, it is necessary to conduct a stylometric study of the entire work of the author and rank the results over the years.

Analysis of the speech part frequency distribution revealed the highest frequency of nouns and verbs: the former indicate the narrative text type, and the latter the human activity description due to the theme and genre of novels.

This study considers the occasionalisms' extraction method using Sketch Engine tool based on the keyness score. In the created I. Asimov "Foundation" cycle text corpus 1115 occasional units were traced. The obtained base of occasionalisms can be analyzed by word-formation structure, semantics, etc., using the actual linguistic methods. Statistical estimation of occasionalisms' collocations based on LogDice score allowed to perform the automatic cross-check of the created list of occasionalisms, and to supplement it. Also, the found collocations are important for the conceptual analysis of the text, as well as for lexicographic practice.

Thus, the stylometry of I. Asimov "Foundation" cycle gives the possibility to identify certain patterns and features of the writer's idiostyle, which are especially valuable in the system of American literature, in comparison with other science fiction authors, to determine the influence of I. Asimov's work on his successors in the literature, as well as to identify the genre patterns.

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Automated recognition of geographical named entities in titles of Ukiyo-e prints

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ABSTRACT

This paper investigates the application of Natural Language Processing as a means to study the relationship between topography and its visual renderings in early modern Japanese ukiyo-e landscape prints. We introduce a new dataset with titles of landscape prints that have been annotated by an art historian for any included place-names. The prints are hosted by the digital database of the Art Research Center at the Ritsumeikan University, Kyoto, one of the hubs of Digital Humanities in Japan. By applying, calibrating and assessing a Named Entity Recognition (NER) tool, we argue that 'distant viewing' or macroanalysis of visual datasets can be facilitated, which is needed to assist art historical studies of this rich, complex and diverse research material. Experimental results indicated that the performance of NER can be improved by 30% and reach 50% precision, by using part of the introduced dataset.

CCS CONCEPTS

• **Applied computing → Digital libraries and archives**; • **Computing methodologies → Information extraction**.

KEYWORDS

Ukiyo-e prints, named entity recognition, natural language processing, art history

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1 INTRODUCTION

Japanese early modern woodblock prints, so-called ukiyo-e or 'pictures of the floating world' produced between the seventeenth and mid-nineteenth century, are one of the most widely recognizable visual images today. Collections of prints are kept in almost all major museums across the world and exhibitions of prints attract large audiences. Among diverse topics depicted in these images, landscape prints remain the most popular as evidenced by the iconic "The Great Wave" (Kanagawa-oki nami-ura) designed by Katsushika Hokusai (1760-1849) in the 1830s and its global career. However, the understanding of these highly popular materials is still shaped by Western modern epistemologies that may not be well fitted for the analysis of pre-modern non-Western artefacts. Therefore, there is a need to approach Japanese early-modern prints from new perspectives that take as an analytical point of departure the objects themselves.

The recent development of diverse computational technologies, especially Machine Learning (ML) and Natural Language Processing (NLP), combined with the advancing digitization of prints and growing digital databases worldwide as well as the emergence of *open access* principles create an exceptional opportunity to engage with this type of inquiry. Particularly promising in this context is the analysis of large datasets of digitized objects that can facilitate discovery of visual patterns that are not possible to identify through a study of individual objects. These patterns interpreted through the lens of Art History can create the ground for a new historically contextualized classification of objects, based not on the existing epistemologies, but on newly discovered content-based characteristics of the objects. The combination of 'distant viewing' or macroanalysis of visual materials, and 'close reading' of the artefacts has a potential to develop a more nuanced understanding of Japanese early modern prints, expand and diversify functionalities of digital databases, and stimulate scholarly and public interests in the non-Western cultural heritage.

In this work we approached distant viewing by employing Named Entity Recognition (NER), an NLP technique used to detect named entities in texts. In principle, NER can be used to extract named locations from any text, including ones mentioned in the titles of Japanese early modern ukiyo-e landscape prints. Any extracted locations, then, may allow for a digital geospatial exploration of the studied prints, which is currently impossible. This spatiotemporal analysis can shed light regarding the geographical distribution of the sites depicted within the prints as well as regarding the frequency of the depiction of certain sites in relation to their production context (e.g., time, location and designer) contributing to a better understanding of Japanese landscape prints in general. In this context Named Entity Recognition (NER) has a potential to play an important role especially that the recognition of titles of artefacts as named entities is crucial for the study of cultural heritage. However, the scarcity of training data remains a challenge in the analysis of artworks [11]. This is especially relevant for the analysis of non-Western pre-modern artefacts such as Japanese early modern prints. The titles are rendered in pre-modern Japanese language

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used before the standardization of the language and script in the late nineteenth and twentieth century Japan. Another problem is ambiguity inherent to the artwork titles or lack of data. This all makes identification of titles, and in extension also place names featured in them, a challenging task. Therefore, before engaging in an advanced context-based analysis rooted in art-historical inquiry, this study focused on the assessment and customization of a NER system. In order to realize this goal we annotated the titles of a random sample of 100 records and we applied on them a well-known and well-performing, off-the-shelf NER system. We observed a surprisingly low performance, so we annotated another set of 100 records and we used them to fine-tune the system. Fine-tuning increased the results by 30%. These research results will function as a foundation for our subsequent work, in which we plan to use the suggested NER model in a semi-supervised setting, in order to annotate more data and improve further NER on titles of Japanese ukiyo-e prints.

2 THE CORPUS

2.1 Digital Art History

Data mining and knowledge discovery from large and complex data sets, including visual images, have advanced significantly in the past several years. Although Digital Art History emerged in the late 1990s and access to large digital image collections is steadily growing, the study of art images in the context of big data and application of predictive analytics has been advancing slowly [5], [28], [16]. This is especially the case for non-Western art, which has received relatively little attention to date, especially in the Anglophone world. Different factors are responsible for this situation, ranging from material and financial conditions for research to geopolitics of national identification and international relations. In this situation, computational technologies and analytics of large cultural data sets across different geo-political, cultural and chronological boundaries offer methodological solutions and intellectual incentives to respond to the call for pluralistic art studies ([19]). On the other hand, the development of Digital Art History, which reveals a profound change in the character of knowledge, raises questions about the relationship between human activities and metric evaluation [2]. Scholars emphasize that the digital research of cultural heritage needs to be informed by a professional art historical knowledge and rigorous scholarly methodology that acknowledges the mediation and situatedness of knowledge production, or it risks producing findings of uncertain cognitive value [1]. The main focus of the debate, and a question which still remains open, is not what art history can do with the digital, but what "important art historical questions can be addressed with the help of digital tools" [15]. However, although there is little doubt that the intellectual problem rather than methodology ought to be at the center of the discussion, it is also necessary to acknowledge that digital methods used in Digital Art History have not yet been customized to investigate non-Western cultural data, and that the first step in this process should be devoted to the development, customization and testing of methodological instruments capable of developing of the new knowledge. Therefore this project conducted by our interdisciplinary team consisting of data scientists and art historian specialized in Japanese art has two main goals: customization of computational research tools and addressing pertinent art historical research questions.

2.2 Ukiyo-e landscape prints

Early modern visual culture in Japan spanning between the seventeenth and mid-nineteenth century saw the emergence of a rich printed culture, which encompassed both printed books and single prints executed in a woodblock printed technology. This phenomenon was facilitated by a vibrant commoner urban culture developing in the largest Japanese cities: Edo (today' s Tokyo), Kyoto and Osaka. So-called ukiyo-e or 'images of the floating world' executed mainly in prints but also in painting mediums and visualized popular entertainment of the era such as kabuki theatre and red-light-districts (including pictures of actors and beauties), scenes from history and folk tales, erotica, fauna and flora etc. The nineteenth century saw the raise in popularity of landscape images created by some of the most famous designers such as Katsushika Hokusai and Utagawa Hiroshige (1797-1858) [10]. These images produced in thousands presented scenic visions of rural Japan, the hilly countryside populated by people occupied with daily work, harvest, fishing and traveling.

These prints played a key role not only in the history of Japanese art but also the emergence of Western modern art in the second-half of the nineteenth century, when they inspired artists such as Vincent van Gogh (1853-1890) or Claude Monet (1840-1926) in France and across Europe and North America [26]. However, despite their global historical and artistic significance as well as their seemingly straightforward subject i.e. landscape, the social functions of these images are little understood. The problem is that Japanese pre-modern visual culture is rooted in an entirely different episteme. Although today images featuring different scenic views of natural environment are called 'landscapes' (fūkei), the concept of landscape is a modern invention in Japan. In fact, the notion of 'landscape' appeared in Japan only in the late nineteenth century. [14] identified the 'discovery of landscape' (fūkei no hakken) as the apex of the cultural appropriation of Western modernity, as fūkei transformed the way of viewing and understanding the world. Cartesian mind-body dualism shaped modern understanding of landscape as ontologically separate from the human perceiver, a neutral external background. Modern artistic conventions such as linear perspective and realism gave the subjective viewer the power to control the landscape and identified looking with scientific objectivity [21].

In contrast to this, the pre-modern period (namely, before 1868) images of the natural environment often took the form of meisho-e (pictures of famous places) [13]. The topography or even locality of particular views was not necessarily relevant, as the concept of meisho derives from utamakura (lit. poem pillow), rhetorical figures that tie seasonal images with particular places [12]. This phenomenon has been explained in relation to the culturality of pre-modern notions of nature in Japan ([22]). However, this does not explain the sudden popularity of meisho prints in the first half of the nineteenth century, which saw one of the most disastrous environmental and social catastrophes in Japanese history, the Tenpō Famine (1833-37). Interestingly, this sudden flourishing of landscape in single prints and printed illustrated books especially in the

Figure 1: Utagawa Hiroshige (1797-1858), Seta sekishō (Sunset Glow at Seta), from the print series Ōmi hakkei no uchi (The Eight Views of Ōmi, 1834-35), 23.3 cm x 35.5 cm, multicolour woodblock print, the Metropolitan Museum of Art, New York (OA). A poem is written inside the box in the upper left corner and the title is written on its right, inside the red rectangle. The artist's signature and seal are in the bottom right corner.

1830s coincides with some of the worst environmental and social disaster of the time, namely the crop failure that led to a colossal social disturbance. This popularity is commonly explained in the context of the representational paradigm, and points to a boom in travel [25]. But it is doubtful that people would have travelled during these crises. Hence, the social function of the images, and their role in defining contemporary spatialities, remains unknown. Paradoxically, the natural and social catastrophe is not visible in them. The print shown in Fig. 1, designed by Utagawa Hiroshige, is a good example of the genre. The print was deigned ca. 1834-35 and appeared within the woodblock print series "Ōmi hakkei no uchi" (The Eight Views of Ōmi). The inscription in the square cartouche in the upper left corner features the poem: "Tsuyu shigure/ moru yama tōku/ sugikitsutsu/ yūhi no wataru/ Seta no nagahashi", which has be translated as "The long bridge at Seta, over which crosses the setting sun, passing far beyond the mountains, dripping with autumn dew" [4]. The image presents a view of the famous Seta Bridge, which connects the two banks of the Seta River in the southeast part of Lake Biwa. A tranquil landscape view features the lake with a few sailing boats and Mt. Mikami in the background. Although Mt. Mikami is not very high at only 432 m., it has served as a prominent literary topos. Its cultural significance is demonstrated by its imposing presence in the view, which challenges the representational quality of the image [6]. Its form and proportions have been modified to liken it to the venerated Mt. Fuji, which is some 350 km away. These conceptual connections resulted in Mt. Mikami's alternative name Ōmi Fuji or "Fuji of Ōmi Province". The image curates reality on at least one more level. Despite being produced at the peak of the Tenpō Crisis, which heavily affected the province, it shows an idyllic view of the countryside with no sign of natural, social or political disturbance. This situation raises the question of the function of pastoral landscape images at the time of the unprecedented socio-ecological crises, the relationship between landscape imagery and the world and their role as representations of particular topography and places. Understanding of these issues necessitates identification of the nature and extent to which they refer, depict and distort topography. As this is a complex issue the research needs to be divided into several analytical steps.

First of all, it is necessary to establish: what places are depicted and what places are not featured in the images; how are these places distributed across Japanese topography and in relation to changing socio-cultural, political and economic contexts;and how their distribution change in time and depending on the designer, publisher, format etc. Answering these questions require analysis of a very rich and diverse research materials including thousands of objects in different formats and styles (e.g. single prints and printed book illustration). Therefore, considering the scope of the data and the nature of the inquiry computational methods offer a potential to assist art historical inquiry.

2.3 Computational methods for image analysis

Diverse methodologies have already been used in the study of visual images. Several Machine Learning techniques have been employed to investigate the problem of style recognition in historical images, including both feature extraction and engineering [18], such as histograms of gradients, spatial envelopes, discriminative colour names, and predictive modelling [3, 24], e.g. SVMs, random forests, and neural networks. More importantly, existing literature demonstrates and argues that due to the curse of dimensionality and the inherent complexity of the problem, adding more features typically does not improve predictive performance. Towards this end, variants of convolutional neural networks have been used for automatic style and feature recognition, and have so far been achieving competitive performance against other state-of-the-art Machine Learning models [8, 23]. The main advantage of deep neural network models is that they can facilitate rich representations without compromising predictive performance, as they are capable of learning such representations at difference feature levels. More importantly, they have recently shown the ability to additionally extract features corresponding to semantic concepts, such as object categories, which can in turn improve the interpretability and understandability of the predictions [18]. There is little doubt that these innovative technological solutions can enrich art studies [20]. In this context Named entity recognition (NER) has a potential to play an important role especially that the recognition of titles of artefacts as named entities is crucial for the study cultural heritage. However, as argued by Nitisha Jain and Ralf Krestel current state of the art NER tools are not successful in identification of artwork titles. They point to the scarcity of training data as the state of the art NER systems are trained on a few well-known corpora such as CoNNL datasets and OntoNOtes. This hindrance is especially relevant for the analysis of non-Western pre-modern artefacts such as Japanese early modern prints produced before mid-nineteenth century. The titles are rendered in pre-modern Japanese language used before the standardization of the language and script in the late nineteenth and twentieth century. In premodern Japanese the Sino-Japanese characters could be used alternately depending on their phonetic value so the same word could be written in different characters. What is more, titles are usually written with characters only (without the use of phonetic alphabet intercepting the words), which makes divisions between words difficult to recognize by the computational analytical tools. Another problem is ambiguity inherent to the artwork titles or lack of data. Print titles are not always standardized across different collections and metadata feature different titles, either based on the titles inscribed in the prints or descriptive assigned by collectors, museum curators etc. This all makes identification of titles, and in extension also place names featured in them, a challenging task and necessitates dividing the study into several analytical steps. In this paper we are presenting the result of the first step of this inquiry in which we applied Named Entity Recognition for the automated extraction of place-names that are mentioned within the titles of the prints.

2.4 The ukiyo-e collection

The access to data was facilitated by the database hosted at the Art Research Centre at Ritsumeikan University, one of the leading Digital Humanities hubs in Japan and a collaborative partner of this project (http://www.arc.ritsumei.ac.jp/en/index.html). The Art Research Center was established in 1998. Its mission has been to conduct historical and social research and analyses of both tangible and intangible cultural heritage, namely visual and performing arts and crafts, as well as to record, preserve, digitalize, curate, analyze, and disseminate the research outcomes. Since the 2000s the Ministry of Education, Culture, Sports, Science and Technology (MEXT) recognized the Digital Humanities Center for Japanese Arts and Cultures (FY 2007-2011) as the Global Center for Excellence (COE). In 2014 the Center was designated a Digital Archive Research Center for Japanese Cultural Resources (FY 2014-2019) and recently it has assumed the role of the International Joint Digital Archiving Center for Japanese Art & Culture (ARC-iJAC) upon the MEXT accreditation. Importantly, the Art Research Center keeps rich digitalized collections of Japanese cultural heritage including 12,287 single ukiyo-e prints, Early Japanese Cooks Collections (218,088 items) including Hayashi Yoshikazu Collection, Fujii Eikan Bunko Collection, Sakurai Bunko Collection. The Center has also played a key role in the digitalization of Japanese artefacts worldwide and has collaborated in this respect with the leading research institutions and museums across the world as well as private collections. The ARC digital databases of Japanese printed culture hosts early Japanese books (299,983 titles)and woodblock prints (678,429 prints). The Ukiyo-e Portal Database itself comprises of collections of 28 institutions in Japan and abroad including 45,631 items from the Museum of fine Arts in Boston and 20,315 items from the British Museum, London. In total, 72 institutions share their collections via ARC. The ARC databases are open to the research community and the wider public. The Center provides access to the archive and database management technologies, shares expertise and methods as well as fosters global research community engaging with Japanese cultural heritage and computational methodologies relevant for the Digital Humanities.

2.5 Dataset development

Our study investigated 20,408 digitized prints featuring natural environments, issued ca.1800-1850s, such as the ones designed by Katsushika Hokusai and Utagawa Hiroshige. We focused on single woodblock prints (not printed book illustrations), produced mainly in the nineteenth century following the guiding research questions pertinent to art history and relevant for the historical contextualization of the prints. As the prints produced at the time were

often serialized the dataset features several large sub-sets of prints belonging to the same series. Some sets include as many as circa 30 or 60 prints. These series share the same title but depict different places scattered across Japanese islands and celebrated for their cultural, political, economic importance, therefore functioning as meisho (famous places). The corpus has been identified through textual metadata (inscriptions on prints). The search was facilitated by the use of the keyword 'meisho' (famous place) and 'meisho-e' (image of a famous place). Both the print series titles and the names of the specific places are inscribed within the pictures often in rectangular cartouches in the upper corners of the prints. Besides this the inscriptions refer to names of designers, publishers, censor seals and other information relevant to the prints production process. Often the images also include short poems (either 31- or 17-syllable-long) related to the depicted places. In some cases, the images also featured smaller inscriptions scattered across the picture plane that identify diverse topographical features located in the proximity to the main meisho such as mountains, rivers, villages, temples and shrines. Similarly to the visual depictions, all inscriptions are printed and executed in a cursive script characteristic for the early-modern Japanese textual culture. Therefore, the data set includes a large number of place names, which makes them highly relevant for our analysis. These inscriptions have been deciphered by experts (specialists in Japanese art history and textual culture) and included as metadata in the database. At the time of our exploratory analysis we only had access to Japanese-language metadata although some (especially foreign) collections hosted in the database have bilingual metadata. As English-language metadata was not accessible for us during this phase of the project it will be analyzed in the next phase and the findings will be crosschecked with the results of the Japanese-language analysis.

2.6 Benchmark data set

From the 20,408 digitized prints which arose from our search based on the keyword 'meisho' (famous place) and 'meisho-e' (image of a famous place), we randomly selected 200 samples to annotate and use them as our training and testing benchmark data. We re-trained Spacy's NER Japanese model [9] using the first 100 annotated Titles and evaluated, whether we improved, by assessing on the testing set. Tables 1, 2 and 3 present statistics of the dataset and the most frequent genre types.

2.7 The annotation process

An art historian, an expert in Japanese early modern history annotated two sets of images (100 images each) identified through random sampling. The annotation process targeted textual metadata provided by the database and included place names featured in the titles of the series and individual prints as well as place names that appeared in the inscriptions and used to identify diverse topographical features and structures (e.g. temples, bridges etc.) The annotation process was guided by two major principles. First, all places that were possible to be pinned on a map (e.g. names of cities, temples, shrines, bridges) were annotated as geopolitical entities (GPE). Second, places that were less-easily pinned on a map (e.g. roads, mountain ranges) were annotated as non-GPE locations (LOC).

3 EMPIRICAL EVALUATION

3.1 Theoretical Framework

Information Extraction (IE) concerns the process of extracting useful structured information from entities, relationships, events and other types of unstructured data. The extracted information can then serve as data for analysis. In this study, we used a subfield of IE called Named Entity Recognition. ***Named Entity Recognition*** (NER) is an important and challenging task, used in many fields of Artificial Intelligent (AI) including Natural Language Processing (NLP) and Machine Learning (ML). NER concerns the extraction of information by processing structured and unstructured data and identifying Named Entities (NE), such as locations, people, events, organizations or companies [17]. ***The types of NER algorithms*** can be grouped into three categories: rule-based, ML-based and hybrid [27]. A rule-based NER algorithm detects the name entity by using a set of rules and a list of dictionaries that are manually predefined by human, e.g., patterns for location names, organization names, etc., which are mostly made up by a combination of grammatical, syntactic and spelling charasteristics [17]. ML-based NER algorithms most often solve the task by casting it as a classification or a sequence labeling task, and their training process requires (often, a large amount of) annotated data. Hybrid NER algorithms combine rules and ML methods. In this study, we employ ML-based NER, by using SpaCy [9]. ***SpaCy*** is an open-source Natural Language Processing library that is based on a Convolutional Neural Network (CNN) [7], which is pre-trained for POS tagging, dependency parsing, and Named Entity Recognition.[1] The focus of the library is production usage and the default model can recognize a wide range of named entities, including place, person, and organization in multiple languages, including Japanese. The Japanese model was trained on written texts from media and news, and the performance reported is 75% Precision, 69% Recall and 72% F1.[2]

3.2 Experimental Analysis

A human expert annotated 100 randomly sampled prints, which were used to evaluate SpaCy's NER model, by comparing the system-predicted named entities against the ones provided by the annotator (gold standard). We measured Precision, Recall and F1 at the named entity level (Table 4). We also calculated and compared the frequencies of the human-annotated named entities and those generated by SpaCy's NER model. It should be noted, that in the present study the named entities that we are interested in are places, which are mainly labeled by SpaCy either as GPE or as LOC.

As can be seen in Table 4, SpaCy's NER (shown in the *default* column) is relatively precise for LOC (53%)) and very precise for GPE (84%). However, it achieves a very low Recall in both LOC (14%) and GPE (8%), which means that SpaCy can not detect most of the named locations that exist within the titles of Japanese Ukiyo-e prints. Hence, it can not be used, as is, to assist with automated annotation. However, when we calibrated SpaCy, using only 100 other annotated prints, Recall improved significantly (50% and 44%

[1] https://spacy.io/
[2] https://spacy.io/models/ja

Table 1: Overview of the training and testing datasets.

	Training Set	Testing Set
ANNOTATED SENTENCES (#)	100	100
LOC NAMED ENTITIES (#)	43	52
GPE NAMED ENTITIES (#)	85	157

Table 2: Most frequent genre types in the training dataset.

Japanese	English	Occurrences
名所絵京都関連	Meisho-e Kyoto related	36
江戸名所案内記図絵	Edo Famous Place Guide Illustration	15
京都関連	Kyoto related	15
京都関連名所絵	Kyoto-related Meisho-e	9
名所絵	Meisho-e	5

Table 3: Most frequent genre types in the test data.

Japanese	English	Occurrences
名所絵東京名所	Meisho-e Tokyo	23
名所絵東海道	Meisho-e Tokaido	18
名所絵江戸名所	Famous place picture Edo	9

Table 4: Evaluation of SpaCy's Japanese NER with Precision, Recall and F1 at the named entity level, without (default) and with fine-tuning (calibrated) on 100 instances. In bold is the best score.

	Precision		Recall		F1-score	
	default	*calibrated*	*default*	*calibrated*	*default*	*calibrated*
LOC	0.53	**0.59**	0.14	**0.5**	0.23	**0.54**
GPE	**0.84**	0.39	0.08	**0.44**	0.15	**0.41**

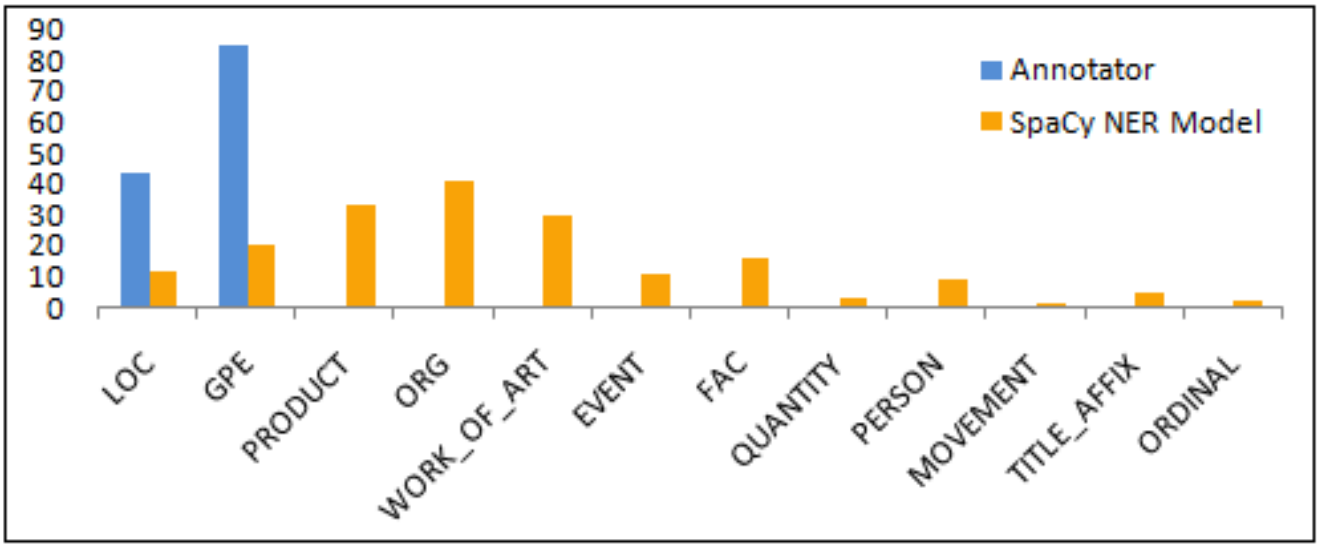

Figure 2: Frequencies of named location entities, extracted by the human annotator (blue) and by SpaCy's default NER model (orange).

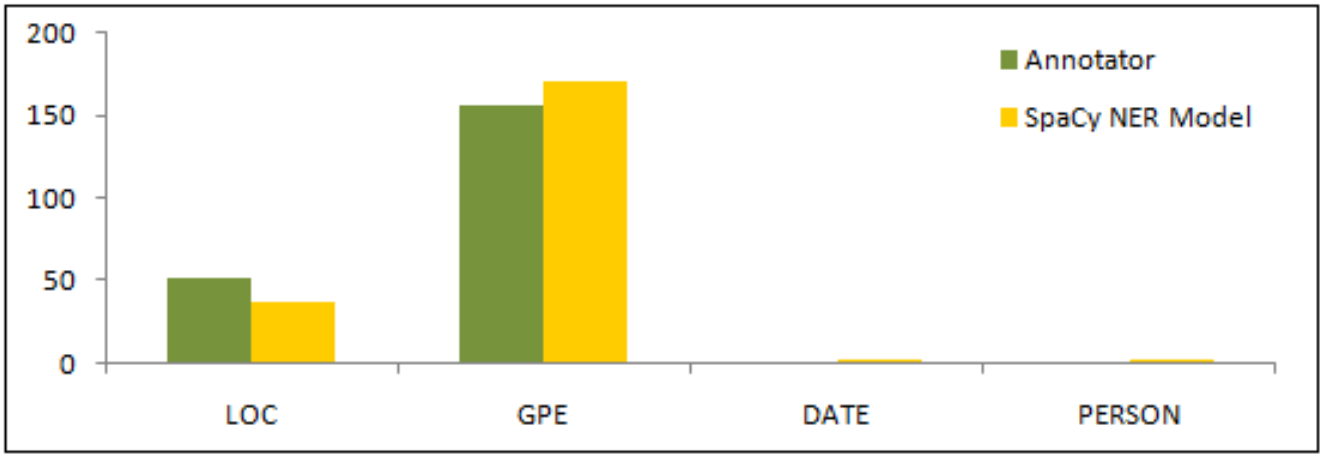

Figure 3: Frequencies of named location entities, extracted by the human annotator (in blue) and by the calibrated SpaCy NER Model (orange).

Figure 4: Comparison between the annotations of the human expert and the default SpaCy Japanese NER model for a title.

respectively for LOC and GPE), pulling up also F1. Although Precision appears to drop for GPE (39%), Recall improves more than five times (44%), leading to an F1 score that is significantly higher.

By performing error analysis, we found out that the low performance of *default* SpaCy's model is explained in part by its inability to assign the correct labels to the named entities that it correctly identifies. In other words, the *default* model is able to identify correctly many named entities, but the labels it assigns to them do not seem to match those of the annotator. This is also reflected in Fig. 2, where the frequencies of several other classes are above zero. For example, the assignments of LOC and GPE tags are relatively low compared to those of the annotator, while for instance ORG tag has been assigned (incorrectly) to a large number of entities. The calibrated SpaCy model, on the other hand, is much more aligned with the gold standard, in terms of the predicted-class frequency (see Fig. 3).

4 DISCUSSION

Our experimental results showed that the performance of the default (pre-trained) NER model that SpaCy library offers for Japanese is low. In terms of scores, for the LOC and GPE labels that we are interested in, given that these are the corresponding named entity tags for places, SpacY's default model achieves relatively high precision scores (53% and 84% respectively), but significantly low recall (14% and 8%) and F1 (23% and 15%) scores. Also, although it is able to detect correctly various named entities, it seems to assign incorrectly the named entity tags to most of them (e.g. assigning to place entities labels such us ORG [-Companies, agencies, institutions-] or PRODUCT). Such an example is shown in Figure 4, where SpaCy's default NER model classifies a correctly recognised GPE as a 'work of art'.

Concerning our attempt to retrain and update SpaCy's default NER model, with our own custom entities presented in our data set, the experimental results prove that is was a successful one. Specifically, despited the fact that for the LOC and GPE labels precision scores may decrease, recall scores improved by 40% and F1 scores by 30%. These fluctuations prove that our re-trained model has an adequately better overall performance. Performance can be improved further by adding more annotated data, a task that we plan to undertake in future work.

5 CONCLUSION

In this paper we presented results of the first-step of an analytical process aimed at the investigation of the relationship between topography and its visual renderings in early modern Japanese ukiyo-e landscape prints. Due to the complexity of the question and research material at hand we applied Named Entity Recognition (NER), an NLP technique, to detect place-names featured in the titles of landscape prints hosted by the digital database of the Art Research Center at the Ritsumeikan University, Kyoto, one of the hubs of Digital Humanities in Japan. We proposed an approach to generate labeled data to facilitate 'distant viewing' or macro-analysis of visual datasets needed to assist art historical studies of this rich, complex and diverse research material. Experimental evaluations indicated that NER performance can be improved by 30% and reach 50% precision by using part of a new dataset, introduced with this study, to retrain the model. By adding more data, as we plan to do in future work, we can develop an automated annotator of satisfying performance, which will be applied to assist realization of the overarching goals of our study presented above.

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Digitization of the Serbian folk proverbs compiled by Vuk S. Karadžić

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ABSTRACT

This paper aims to present the digitization process of a very important piece of Serbian intangible cultural heritage, *Српске народне пословице и друге различне као оне у обичај узете ријечи* (Engl. Serbian folk proverbs and other common expressions and phrases), compiled by Vuk Stefanović Karadžić during the first half of the 19th century. In the paper, we discuss the necessary steps in the digitization process, the challenges we had to deal with as well as the solutions we came up with. The goal of this process is to have a fully digitized, user-friendly version of *Serbian folk proverbs*, that will also easily integrate and be compatible with other digitized resources and/or multi-dictionary portals.

CCS CONCEPTS

• **Applied computing** → *Extensible Markup Language (XML)*; *Arts and humanities*; **Digital libraries and archives**; **Annotation**.

KEYWORDS

Annotation, TEI, Electronic Editions, Cultural Heritage, Serbian Language

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1 INTRODUCTION

Српске народне пословице и друге различне као оне у обичај узете ријечи (Engl. Serbian folk proverbs and other common expressions and phrases) [5] is a vast collection of Serbian folk proverbs, compiled by Serbian linguist and philologist Vuk Stefanović Karadžić (1787–1864) during the first half of the 19th century, starting as early as 1814 [4]. Vuk Stefanović Karadžić was one of the most important reformers of modern Serbian language and he played a major role in the process of modernization of the Serbian language in the 19th century. His work went beyond the language reform, as he was a meticulous collector of Serbian folklore, including oral epic and lyric songs, folk tales, proverbs, etc. He is considered, by many, to be the first Serbian folklorist, ethnographer, and literary critic [1]. He drew the attention of European scholars and readers to Serbian folk poetry and Serbian culture as a whole, due to his acquaintances with the times' leading scholars, such as Wolfgang von Goethe, Jacob Grimm, and many others. Proverbs were seen by Vuk as an important component of the Serbian folk tradition and, in addition, as a perfect representation of the language he advocated for to later become the new standard [8]. He dedicated a considerable amount of time during his travels to collect as many proverbs as he could. The result was two editions of *Serbian folk proverbs* – the first one was published in Cetinje (Montenegro) in 1836, containing more than 4,000 proverbs, and the second, the extended one, in Vienna in 1849, with over 6,000 proverbs.

Proverbs collected by Vuk in *Serbian folk proverbs* are very diverse, and they cover a vast number of topics, providing insight not just into everyday life, but into the core of what Serbian folklore is. Furthermore, *Serbian folk proverbs* contain more than just proverbs – Vuk also included curses, oaths, and frozen expressions. Since they were perceived by Vuk as the most authentic expression of the language of its speakers, most of them were kept in their original form, often with more than one variant of a single proverb. Therefore, it is obvious why *Serbian folk proverbs* hold such importance in the realm of Serbian intangible cultural heritage, and why the decision to digitize them was a logical next step.

There were some previous attempts to digitize *Serbian folk proverbs* [2]. However, the results obtained from this project are not visible to the general public, so we have no knowledge of the outcome and whether the digitization included the complete work of *Serbian folk proverbs* and to what extent they were digitized.[1]

The need for the digitization of *Serbian folk proverbs* is obvious, given the significance it has for Serbian culture, especially in this age where the preservation of intangible cultural heritage is a given. When deciding to embark on the path to digitize Serbian folk proverbs, our primary goal was to end up with a fully digitized, user-friendly version of *Serbian folk proverbs*, that would also easily integrate and be compatible with other digitized resources and/or multi-dictionary portals. Apart from this general objective, we focused on a few specific, narrow objectives, one being searching

[1] See also: http://alas.matf.bg.ac.rs/~cvetana/proverb/#deo1.

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and tagging all geo-locations found in the proverbs. The idea behind it was not just to get a list of all locations mentioned in *Serbian folk proverbs*, but to have a geographical differentiation of all proverbs as well as to classify them by specific location (for a detailed description of the process see chapters 2.3 and 2.4). The intent was to have the proverbs presented in a way that is comprehensible and to ease the process of filtering the results and searching for a specific proverb from a particular location.

As far as the authors of this article know, *Serbian folk proverbs* are currently available for the general (and scientific) public as a printed edition and as an e-book (PDF file) on Google Books. When deciding to digitize *Serbian folk proverbs*, the first step was to see into detail what the faults of its printed edition are, and how to resolve them in the digital one.

First and foremost, printed editions are final. Once out of the print, there are no more opportunities to add, fix, or replace anything. On the other hand, digitization is an ongoing process that leaves us with more options to upgrade and change any inconsistencies or errors we may encounter, especially with older editions, such as *Serbian folk proverbs*. Another factor that makes it much more difficult to navigate through the material is the material itself – a strict lexicographic approach (including alphabetical order) may not be the best solution when dealing with proverbs. Digitizing the material from *Serbian folk proverbs* would make it easier to connect the variants, and to connect the proverbs on several other criteria – meaning, usage, semantic field, etc.

Bearing all the pros and cons of the printed edition in mind, as well as characteristics of the digital edition we would like to obtain, we set up the following steps for the digitization process of the *Serbian folk proverbs*.

2 THE DIGITIZATION PROCESS

In the process of digitization, we relied on the experience of previous projects performed within our institution and followed their workflow. Along with "four types of methods and activities for creating digital representations of lexical resources: 1) image capture; 2) text capture; 3) (lexicographic) data modeling and 4) (lexicographic) data enrichment" [6], which we would refer to here as phases of digitization, we added one more, 5) data presentation.

According to Tasovac and Petrović [6], the phrase image capture pertains to "the process of recording the visual representation of the text by means of digital cameras and scanners and its subsequent delivery to the user as a digital image". In our case, this activity has already been done by the Serbian National Library, so we used the digital object they had created.[2]

The next step was to obtain the textual content of the proverbs in digital form. Following Tasovac and Petrović [6], we have also named this phase text capture, when referring to the "transposition of textual content into a sequence of alphanumeric characters". This task was also executed by the Serbian National Library, automatically, by means of Optical Character Recognition (OCR) software, which converts images into searchable strings. More about this phase will be presented in chapter 2.1.

[2] Accessible at: https://digitalna.nb.rs/attach/NBS/Tematske_kolekcije/procvat_pismenosti/sabrana_dela_vuka_karadzica/II_146423_09/output.pdf

Data modeling refers to "the process of explicitly encoding the structural hierarchies and the scope of particular textual components" [6]. This implies marking up both the macrostructure and the microstructure of the text. Marking up the macrostructure pertains to the demarcation of the smallest independent units of the texts (such as entries of the dictionaries) while marking up the microstructure involves further segmentation of each unit (in the case of the lexicographic data, differentiation of lemmas, grammatical information, senses, etc. inside each entry). This kind of text annotation dramatically increases the use-value of the lexical resource, enabling retrieval of more reliable and faster search results, for instance, in the case of proverbs collection, retrieving all instances of a particular lexeme when it appears only in the text of the proverbs and not in the text of the explanation. For further information on the data modeling phase see chapter 2.2.

The next phase, data enrichment, involves "the process of encoding additional information that specifies, extends or improves upon the information already present in the lexicographic resource" [6]. This kind of text annotation can also increase the use-value of the lexical resource, enabling, inter alia, multiple access paths to the information from the resource. For instance, if each proverb was annotated with the semantic field that would mark its domains of language use, the user could see a list of proverbs only from one domain, from which point he could easily access and further explore individual proverbs from the list. Such access to the information could facilitate research on certain historical or ethnolinguistic topics as well as enable the user to retrieve a specific proverb, overcoming the obstacle of not knowing the exact form of the proverb. For more information on the data enrichment phase in our project see chapter 2.3.

The final phase, data presentation, concerns the mode of publishing data and results of the digitization process. The first concern is to deliver an easily accessible and user-friendly final product. In this respect, digitization of lexical resources creates amazing possibilities for visualization of this kind of data, thus enabling greater comprehension and acquisition of information from a digital object in comparison to the printed one. Given the huge number of possibilities, there can be as many different approaches at this stage as there are authors. For the approach that we chose see chapter 2.4.

2.1 Text Capture

As previously mentioned, we worked on the text already extracted by the Serbian National Library using Optical Character Recognition (OCR) software. Although OCR output of Cyrillic texts, especially with older versions of characters, usually contains more errors than texts in Latin, this one was very accurate.

The correction of the OCR output was done manually by a group of fifteen high school students as a part of the seminar on digital humanities during the 2021 summer school of the Serbian language in Tršić. In addition to correcting errors made by the program, typographical errors found in the printed edition were also corrected. Since the editorial policy was aimed to preserve the original characteristics of the printed edition, the editors agreed not to make any corrections in these particular cases:

- Preservation of the old orthography: in the printed edition we used as a model, the text was presented in the original orthography from the 19th century, which is outdated today. Here are some examples of orthographical disparities: не ћу 'I will not', now нећу; Црна гора 'Montenegro', now Црна Гора; the appearance of the semivowel ъ (see figure 1), which does not exist anymore in the Serbian alphabet, etc.

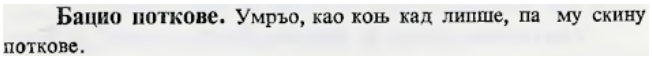
Бацио поткове. Умръо, као коњ кад липше, па му скину поткове.

Figure 1: Semivowel ъ.

- Retention of the author's abbreviations: in the text, there are also some common abbreviations, which are still in use, for instance, н. п., standing for на пример, meaning 'exempli gratia'; т. ј. standing for то јест, meaning 'id est', but in some cases, the orthography has changed, such as in и т. д., now итд., standing for и тако даље, meaning 'et cetera';
- Preservation of the author's self-censorship: in the text, there is an intentional omission of the letters in the middle of obscene words marked with the ellipsis, where each dot represents one omitted letter (see figures 2 and 3 below). This was an editorial decision of the original author due to puristic tendencies of the public and critique of that time.

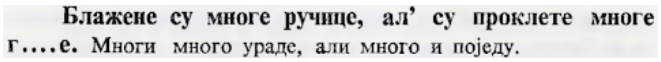
Блажене су многе ручице, ал' су проклете многе г....е. Многи много ураде, али много и поједу.

Figure 2: Censored word *гузице* (Engl. asses).


Ђе се п..и, не да се клањати.

Figure 3: Censored word *прди* (Engl. farts).

The first concern of the editors of this digital edition was the preservation of the authenticity of the text, therefore in the succeeding stages of the project we intend to include now missing information about the new orthography, the meaning of abbreviations, and the full form of censored words, while retaining the original text.

There have also been minor interventions, which were similarly motivated by preserving the original characteristics of the printed edition. For example, some parts of text are in verse (see figure 4), and in order to preserve this information, the editors of the digital edition decided to add a vertical line with spaces before and after it at the end of each verse (figure 5).


Вук не вије што је меса гладан,
Него вије да дружину свије.

Figure 4: A rhyme.

```
<entryFree xml:id="630">
 Вук не вије што је меса гладан, | Него вије да дружину свије.
</entryFree>
```

Figure 5: A rhyme with a vertical line.

2.2 Data Modeling

The collection of proverbs is organized by the same principle as a dictionary: the items are arranged by the alphabetic order (in this case by the Serbian Cyrillic alphabet, since the text was written in Cyrillic script). The peculiarity of this kind of lexicographic resource lies in the fact that the proverbs are treated as independent dictionary units, i.e. the whole proverb is a headword of the entry, which means that each entry has a multi-word lemma since the proverbs are not simple lexical units consisting of one word only (as the usual dictionary items are), but multi-word (complex) lexical units. In short, a proverb collection is in fact a multi-word expression lexicon. It can be seen in the paper edition that the form of the proverb is highlighted by the different typographic style, as it is the lemma in the dictionary. Commonly, every new entry is separated by a new paragraph.

The text in the bold typeface is the form of the proverb – the multi-word lemma, separated from the rest of the text with a full stop. The rest of the text is a note which contains different information. The majority of those notes contain the explanation of the meaning or the usage of a proverb, but, occasionally, they include information about the provenance of the proverb. Most frequently, the information about provenance constitutes a separate sentence (figure 6), but there are plenty of cases where it is integrated in the note (figure 7).


Али си ми прасицу шишао? Кад који кога зовне: *куме*, а није му кум. У Боци.

Figure 6: Information about provenance is in a separate sentence.

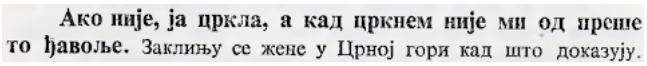
Ако није, ја цркла, а кад цркнем није ми од прсше то ђавоље. Заклињу се жене у Црној гори кад што доказују.

Figure 7: Information about provenance is integrated in the note.

The references to other entries in the same collection are also included in the note, mainly introduced by the formula 'Гледај:', meaning 'See:' (figure 8).

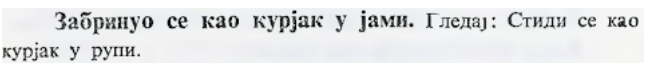
Забринуо се као курјак у јами. Гледај: Стиди се као курјак у рупи.

Figure 8: Reference introduced by the formula 'Гледај:'.

Since all this information is optional, the minimal structure of an entry consists only of the multi-word lemma (figure 9).

The majority of the proverbs consist of only lemma without the note (figure 10). Diversely, in figure 11 we can see the maximal

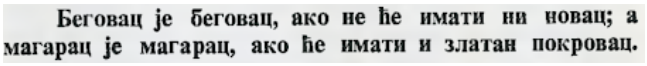
Беговац је беговац, ако не ће имати ни новац; а магарац је магарац, ако ће имати и златан покровац.

Figure 9: One of the longest proverbs.

structure of an entry, containing all elements of the schema, and in figure 12 there is a representation of the same entry in XML.

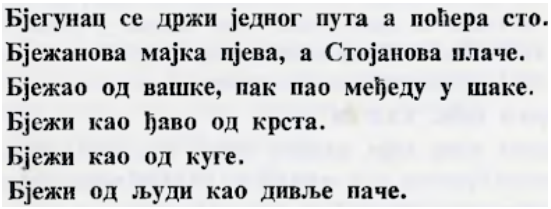
Бјегунац се држи једног пута а пођера сто.
Бјежанова мајка пјева, а Стојанова плаче.
Бјежао од вашке, пак пао међеду у шаке.
Бјежи као ђаво од крста.
Бјежи као од куге.
Бјежи од људи као дивље паче.

Figure 10: A series of proverbs without additional information.

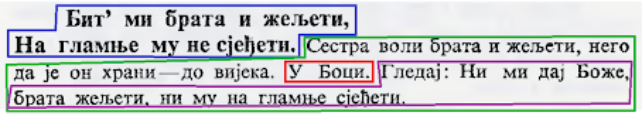
Бит' ми брата и жељети,
На гламње му не сједети. Сестра воли брата и жељети, него да је он храни — до вијека. У Боци. Гледај: Ни ми дај Боже, брата жељети, ни му на гламње сједети.

Figure 11: Example of a fully segmented entry.

Following the original structure, we have used the TEI P5 standard for dictionaries [7] to annotate data from the collection of proverbs. We decided not to annotate non-linguistic features (levels) of the text, such as division of the proverbs by starting letters, or the end of the page. For linguistic annotation, we used the following labels. We have chosen the EntryFree element to be the main unit of the macrostructure of the text, containing all the information related to one proverb. Speaking in hierarchical terms, the microstructure of the entry has two top-level constituents: the text of a proverb, contained by the element Form, and the text of a note, contained by the element Note. We have chosen this label because it broadly covers the content and can contain other lower-level constituents we needed: PlaceName and Cross-reference. We decided not to annotate the meaning of the proverb with a separate label such as Sense, because the remaining text in the notes is not always an explanation of meaning, but sometimes an explanation of the usage of the proverb (which would have to be annotated with a different label Usage), or even an anecdote. Distinguishing these cases could not be done differently than by a human decision, which would require additional time and resources, therefore we decided to skip this step for the time being.[3]

The first step we took in the annotation was the automatic parsing of the macrostructure. This entailed separating the individual proverbs, marking them with EntryFree labels, and giving each of them a unique ID. This was done using a python script, and the separation was made using a set of heuristic rules that covered most cases. We considered one proverb to start with a capital letter and end with a punctuation mark followed by a newline character.

After this step, we had the complete text of the collection structured with the EntryFree label, but with some errors - still quite a few examples remained to be corrected. There were mistakes in some entries consisting of more than one sentence. In certain cases, the explanation of the proverb was written in a new line and, since it started with a capital letter, the proverb and its explanation would end up separated. Those cases were incorrectly recognized as two separate entries (figures 13 and 14).

Another typical example of an error is an entry consisting of two very similar proverbs, which were listed one by one, and connected with the linker Или:, meaning 'Or:'. Those two separate entries were often automatically recognized as one (figures 15 and 16). In this other case it was not really a mistake of the algorithm, but an oversight of the author of the collection, for he inconsistently used the linkers followed by the colon sometimes as shown, connecting two entries, but prevalently connecting two units inside one entry (as it is in the cross-references above: see figure 8). The correction of these cases was done manually by the annotators.

Annotation was done by high school students, participants of the Tršić summer school. The students had no previous experience, neither with digital humanities nor annotation of XML files, but they picked up the task quite quickly and they had no problems using the Oxygen XML editor.[4] They were given XML files with proverbs marked as EntryFree elements, and they first had to correct the issues from OCR (see chapter 2.1 above) and the proverb separation.

After the proverbs were all correctly separated and listed as EntryFree elements, the next task for annotators consisted of several steps:

- annotating locations with PlaceName label;
- adding location attributes: mention or location;
- annotating notes with Note label.

It was a priority to annotate these entry constituents first since we assumed that other constituents could be annotated automatically without a high mistake rate once these labels were fixed.

Once the annotations were complete, the XML files were shuffled for cross-validation. The annotators were given work from their peers to fix any remaining mistakes and proofread the newly added annotations. This had highly reduced the number of errors in the data. It is, of course, recommendable to have the annotations checked one more time by an expert.

Even after double-checking, we discovered a few mistakes in annotation, two of them were false positive locations. Word челебија, an obsolete Turcism meaning 'young gentleman', was recognized as a location name, probably due to its resemblance to a real location name Келебија. The other case includes a rare word трипуњица meaning 'the day of Saint Tryphon', found in a compound Котoрска трипуњица, which contains a place name Kotor (Котор). However, this extended named entity does not denote a place name but a holiday name, meaning 'the day of Saint Tryphon of Kotor', which

[3] Compare also the Excerpt of the Encoded Text of the Collection of Proverbs, from the already mentioned electronic edition (see Introduction), given by the author team on the link https://alas.matf.bg.ac.rs/~cvetana/proverb/append/e-tei.html.

[4] https://www.oxygenxml.com/

```
<entryFree xml:id="191">
 <form type="proverb">Бит' ми брата и жељети, | На гламње му не сједјети.</form>
 <note>
  Сестра воли брата и жељети, него да је он храни–до вијека. У <placeName type="location">Боци</placeName>.
  <xr><lbl>Гледај:</lbl><ref><rs type="proverb">Ни ми дај Боже, брата жељети, ни му на гламње сједјети.</rs></ref></xr>
 </note>
</entryFree>
```

Figure 12: Example of a fully annotated entry.

```
<entryFree xml:id="138">
 Што виде четири ока, вићеће и двадесет и четири.
</entryFree>
<entryFree xml:id="139">
 Што знаду двојица, то већ није тајна.
</entryFree>
```

Figure 13: Example of XML of a wrongly separated proverb from its explanation.

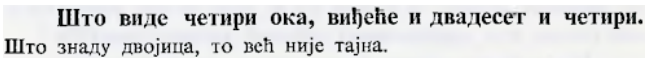
Што виде четири ока, вићеће и двадесет и четири.
Што знаду двојица, то већ није тајна.

Figure 14: The same entry in the printed edition.

```
<entryFree xml:id="124">
 Шта је тражио, мало је нашао. Или: Шта је тражио то је и нашао.
</entryFree>
```

Figure 15: Example of XML of two wrongly connected proverbs.

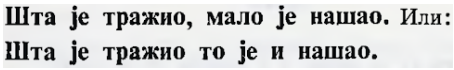
Шта је тражио, мало је нашао. Или:
Шта је тражио то је и нашао.

Figure 16: The same entry in the printed edition.

is a spot in time, not in space, and consequently should not be annotated as a place name. This shows us that the location identification task can be challenging even for humans.[5]

2.3 Data Storage and Enrichment

In the initial phase of digitization, our focus was on correctly extracting the proverbs from the OCR text, processing them, and storing them in a database. Processing the proverbs entailed separating the proverb from its explanation and annotating locations. In terms of data enrichment, the information added by the annotators was regarding the type of location, more precisely by adding location type which denotes whether a place name is a mention, or a source, i. e. location where a certain proverb was recorded. This information is stored in the first database, which consists of:

- unique proverb ID
- proverb text
- explanation
- locations (type irrelevant)

After the initial processing, done in the annotation phase, was complete, we have added a new layer of information to our proverb location database. This was done by determining the geo-coordinates of the toponyms, both mentioned and cited as a source. For this task, we have initially used a database of geolocations which was previously compiled for the dictionary platform Raskovnik.[6] As expected, not all toponyms from the proverbs were present in this database, so we needed to determine the coordinates for the remaining locations.

In order to connect the locations from the proverbs to their respective coordinates, we needed to create a mapping between the locations as recorded in the text and their normalized versions. One aspect of this problem was to lemmatize the inflected location names, while the other involved disambiguating ambiguous locations.

We have first considered creating a lemmatizer for the inflected forms of toponyms, but we soon realized it would be less complicated to manually create a lexicon which contains all the inflected forms and to connect them to their normalized versions, as they can be found in the database with coordinates or the Google API.

Another issue we encountered in this phase was the identification of obsolete forms of toponyms (for instance, Lipisca is the old name for Leipzig). In some cases, the author used elliptical names of location (Novi for Herceg Novi or Karlovci for Sremski Karlovci). We can assume in the time when the proverbs were written, it was implicitly clear what locations were referred to, but we needed to disambiguate them correctly in order to make sure the appropriate coordinates were shown on the map. Additionally, there were some locations which have completely changed, or even disappeared over the course of almost two centuries (for example "The Turkish empire").

After using our lexicon to disambiguate and normalize the toponyms, it was straightforward to connect them to their respective coordinates. We have stored this information in our second database. The locations database consists of:

- location text (verbatim)
- location name (normalized)
- type
- coordinates
- ID of the proverb where toponym is found

2.4 Data Presentation

The final result of our work is stored in two SQL databases. Out of 5684 annotated proverbs, only 587 (about 10%) contain toponyms. In total, there are 708 annotated instances of locations: 76 mentions

[5] For a detailed discussion on automatic location identification and its challenges see [3]

[6] See: http://raskovnik.org/

Figure 17: Map of locations from the proverbs.

and 632 sources cited. When normalized, we are left with 99 specific locations, out of which 50 are sources and 49 are mentions. The most common location cited as a source is Montenegro, as we can see in table 1 below.

Table 1: Five most common locations with toponyms as sources.

Location	Number of instances
Montenegro	219
Vojvodina	67
Risan	63
Dubrovnik	58
Boka Kotorska	44

In order to present our data in an explicit and comprehensible way, we made a Django web application which shows our data tabularly and allows search and sort. In this way, users can easily filter proverbs and look for particular locations.

In addition, we have also used the Google Maps API to create a visual representation of the locations on a map that differentiate place names only mentioned in proverbs from ones designating a location where a certain proverb was recorded, while locations

Table 2: Five most common toponyms mentioned.

Location	Number of instances
Kosovo	6
Budapest	5
Bačka	5
Morača	4
Rome	4

which were both mentions and sources are also distinguished. In figure 17 you can see the source locations marked with red and location mentions marked with blue, while purple markers distinguish locations which are both mentioned and cited as a source.

When a marked location is clicked, you can see the normalized name of the location. For future work, we intend to make the map more interactive and make it possible to get a list of proverbs collected in one location with a click.

3 CONCLUSION AND FUTURE WORK

In conclusion, while the digitization process of *Serbian folk proverbs* is still ongoing, we believe the approach we have chosen has allowed

us to continuously work on having a fully digitized and user-friendly edition once the full annotation of the entire collection is completed. By providing new access paths for search and navigation, we are increasing the use-value of the collection, especially in regards to search abilities and accessibility.

It is important to mention that this approach to digitization has some limitations, the main one being that the annotation process was done either automatically or by high school students. This means we had to predict a certain error percentage and invest some more time and human resources in checking the material, looking for errors, and correcting them. We still find that the high school students were a great addition to the process and that the correction period will decrease over time.

Since the digitization process is still in progress, there are further possibilities to supplement the digital edition, such as adding new labels in terms of data modeling, like ethnonyms and references, as well as in terms of data enrichment, such as semantic field, marking of omitted and censored proverbs or those that occur with other authors. In accordance with open science requirements, we plan to make this electronic edition of *Serbian folk proverbs* available to the public as soon as possible.

We believe that the main benefit of having a digitized edition of *Serbian folk proverbs* is the possibility to obtain a multi-level insight into the collection, which is not possible with printed editions only. In addition, a digitized edition will give us a broader perspective in terms of any future research of proverbs, and it can serve as a model for similar digitization projects in the future. By doing so, the digitized edition will also easily integrate and be compatible with other digitized resources and/or multi-dictionary portals, which would enable its better visibility to scientific researchers and the broader public.

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Digital Formats of Learning Outcomes Assessment in the COVID-19 Paradigm: Survey Study

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ABSTRACT

The global pandemic and emergency digitization measures have introduced systemic challenges to the university summative and formative assessment workflow. Various modes of assessment for University-level programs are a strict regimen that consists of different elements and stages (oral, hybrid, and written exams, tests of different types, project presentations, internal and external review, expert evaluation, and peering). This study aims to critically analyze the practices of Borys Grinchenko Kyiv University in various forms and modes of digital assessment for stakeholders of Liberal Arts, Education, and Computer Science major programs, implemented in the years 2020–2021 through quarantine induced digital learning. The survey analysis was conducted to evaluate ICT tools and digital competencies that are implemented to compare and contrast traditional and formative assessment practices, translated into the digital hybrid format. The investigation novelty is attained through systemic empirical findings on experiences and techniques of learning outcomes assessment in the emergency digitization measures, contrastive assessment of different modes in digital learning, evaluation of ICT tools and skills, implemented through different forms of assessment in the digital learning context.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in collaborative and social computing**;

KEYWORDS

ICT Tools, Summative Assessment, Formative Assessment, Digital learning, Digital literacy

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1 INTRODUCTION

Comprehensive factors of social transformation (globalization, digitization, development of a new media ecology [6]) highlight the development of various types of meaningful networking structures in the knowledge economy: knowledge networks, professional networks and networked society overall [19]. Subsequently, networked society as a global institution in the knowledge economy context calls for the implementation of networked education.

The topical need to revisit and reexamine the established models of education and, subsequently, assessment, arises from the changes that networked societies experienced due to the global pandemic COVID-19.

The global pandemic and emergency digitization of all socio-economic spheres presented a rage of challenges to the structure, procedure and efficiency of learning institutional operations and assessment procedures, subsequently [15, 17]. In the educational sphere, the result of the COVID-19 pandemic digitization measures and protocols resulted in the transformative shift along the following functional avenues:

- adaptation of the educational formats to digital, blended or hybrid modes;
- activation of hard and soft skills, latent or underdeveloped in digital learning in the timespan preceding the quarantine measures;
- breakthrough in improvement of digital competence for different educational activities, procedures and scenarios, involving all groups of stakeholders of the higher education.

In view of the combination of the delineated factors of educational practice digital adaptation, the inquiry overarching **objective** *is to profile and evaluate the practices of two contrastive modes of learning outcomes assessment in higher education (traditional and formative) as implemented in the timeframe of emergency digital learning measures of 2020–2021* at Borys Grinchenko Kyiv University.

2 STATE-OF-THE-ART OVERVIEW

In the current pedagogical paradigm, there are distinguished three core functional assessment modes in education [5, 10]:

- **Assessment for the purpose of learning** is a practice of application of students' progress report to inform a teaching strategy and workflow.
- **Assessment as a form of learning** is a practice of reflection and monitoring of progress by students proper to shape learning goals.
- **Assessment of learning as an object** is an evidence-based practice of application of learning efficiency data to measure achievement against learning goals and institutional standards.

Assessment for the purpose of learning is formative in nature and is instrumental to integrate assessment into the educational process by establishing the teacher's leading role in assessment [22]. Assessment for learning is unidirectional and hierarchal. Assessment as a form of learning is formative in nature as well and facilitates establishement of the students' roles and responsibilities in the educational progress benchmarking. Assessment as learning is collaborative, multidirectional and equipollent.

Assessment of learning as an object is summative in nature and facilitates the measurements of learning goals feasibility and learning outcomes efficiency [5].

Assessment of learning is institutional and standardized.

The COVID-19 crisis brought the new Digital Education Action Plan into focus, where issues like the digital readiness of education and training institutions, teachers' digital competences and the design and implementation of online learning, the creation of a digital education ecosystem were increasingly identified as pressing to be tackled at European level [4]. The results of the OPC contributed to contextualising the extent of digital technologies use for education and training during the crisis. The majority (66.6%) of consulted groups reported that the use of distance and online learning had increased during the crisis [14, 18].

Digital learning implementation challenges in universities in the time of COVID-19, as estimated by the authorial group through continuous observation [14, 16] and benchmarking include the following:

- lack of a single distance learning platform – LMS
- unpreparedness of teaching staff for distance learning
- unpreparedness of teaching staff for distance learning
- lack of understanding of the purpose of digital tools for the effective implementation of educational activities
- academic integrity (of teachers and students)
- misunderstanding of changes in educational activities in distance learning
- there is no support for teachers and students
- insufficient communication, collaboration and cooperation between students and teachers
- lack of time

As one of the key institutional elements of the educational workflow, the assessment of learning outcomes and measurable learning goals in all its forms is subject to transformative shifts and challenges in skills (soft and digital) [16], ICT tools and implementation practices, due to the emergency digital learning measures in higher educational institutions (figure 1, 2).

As is evident (figure 2), the typology of assessment activities undergoes qualitative transformation, enhanced by the emergency digital learning measures, in terms of techniques, that serve as digital equivalents to real-time educational practices, for measurable evaluation of performance results and competence formation on each tier of learning goals achievement.

3 METHODOLOGY AND DESIGN

The design of the inquiry methodology is based on the mixed method approach (correlation of qualitative profiling and quantitative evaluation of a phenomenon) and comprises of a combination of consecutive steps:

(1) Assessment of learning outcomes (summative and formative) activity, experience and application profiling in the digital learning context;
(2) The online survey method, that combines mixed media surveys [7], was implemented to evaluate and compare experiences and practical application of digital assessment by different groups of educational process participants;
(3) ICT tools and relevant types of skills for different modes of assessment evaluation, tailored to the overall context of education modernization via digitization and stakeholders' target group needs.

Based on the activity profile (assessment of learning outcomes) a survey was conducted among the stakeholders of higher education process – in-service educators and senior year students (pre-service educators) of Liberal Arts, Education and Computer Science programs.

The survey consists of 14 questions of multiple choice and Likert-scale scoring types, that were aggregated into 3 groups, corresponding to the following dimensions of inquiry:

(1) Overall experiences and techniques of learning outcomes assessment in the emergency digital format;
(2) Comparison and contrast of traditional and formative assessment in the digital learning context;
(3) ICT tools and skills, implemented through different forms of assessment in the digital learning context.

A sizable sample of 188 respondents total took part in the survey.

The study qualitative profiling of assessment activities is based to the generic structure of Higher education technology landscape 2020 [1], that features such elements as: institutional IT infrastructure; admissions and enrollment management; ICT tools for performance assessment; ICT tools for student distinction. The inquiry qualitative premise furthermore incorporated various approaches to digital literacy structuring, based on the actual frameworks of 21st century skills [8, 9, 20, 21] for educational purposes and profiled digital literacy requirements in the educational and civil service spheres:

(1) UNESCO Framework [2] is based on the core ICT competence principle: the ability to help the students to apply soft (communicative) skills through the use of information and communication technology so they will be effective as future educators.
(2) Liberal Arts ICT competence profile, generated through the toolkit of the European e-competence framework guideline [3] includes the following key components:

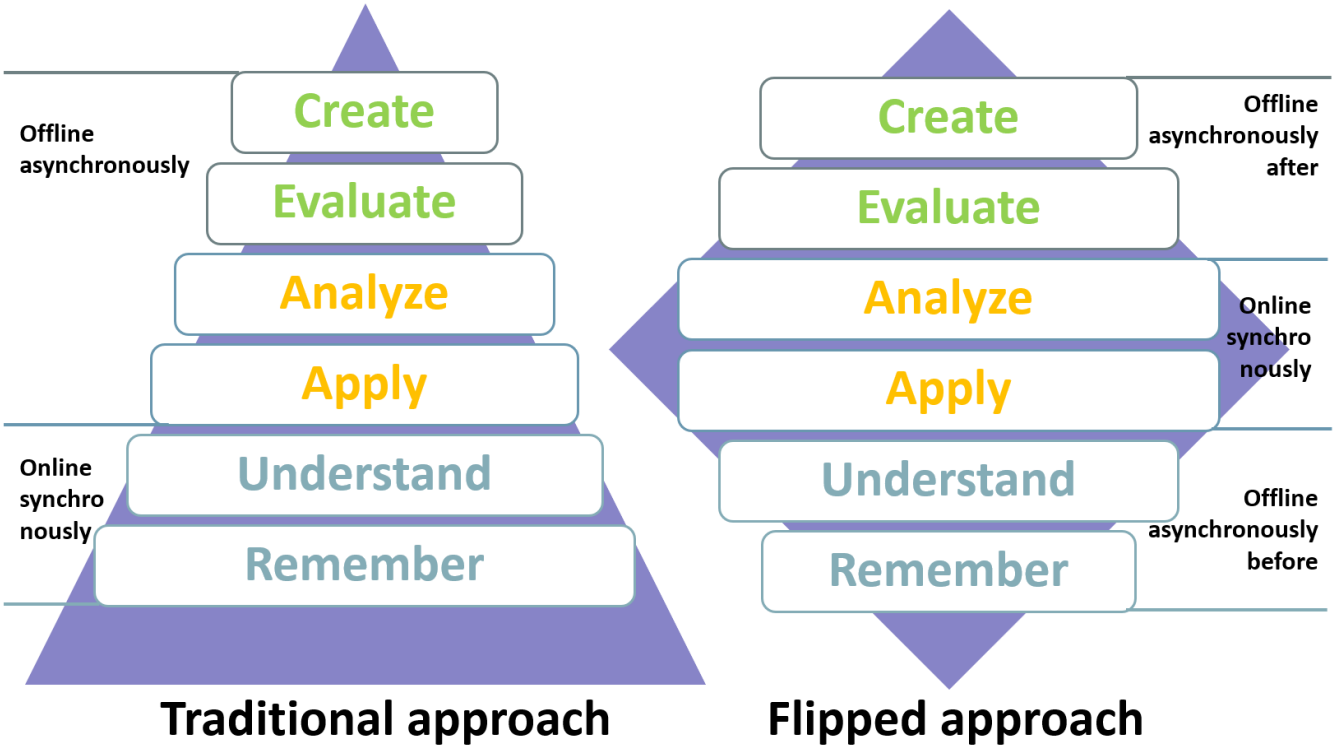

Figure 1: Revised Bloom's Taxonomy of Educational Objectives in the online format [12].

- training to attain institutional and vocational standards of ICT competence in technical sphere or in business;
- analyzing skills gaps;
- defining and implementing an institutional training policy in ICT to bridge the existent gaps in skills.

(3) Digital Competence 2020 framework consists of 5 core parameters assessed according to proficiency [11]:
   (a) Information and data literacy;
   (b) Communication and collaboration;
   (c) Digital content creation;
   (d) Safety;
   (e) Problem-solving.

4 TECHNIQUES OF LEARNING OUTCOMES ASSESSMENT IN THE DIGITAL LEANING FORMAT: SURVEY STUDY

Dimension 1 of inquiry (disclosed through Group 1 of questions) – overall experiences and techniques of learning outcomes assessment in the emergency digital format- provided the following scope of qualitative and quantitative results.

The proportional number of respondents predominantly implemented both formats of assessment in the emergency digital learning context (regular assessment – 78.7% of respondents, formative assessment – 57.4% of respondents). In the COVID-19 emergency digital learning format, the following way of assessment have been implemented by the sampled respondents (figure 3):

- Blended assessment format (synchronous and asynchronous) – 85.1% of respondents;
- Asynchronous electronic format of assessment (preparation of tasks in the LMS Moodle and their grading later) – 12.8% of respondents.

The changes in the workflow and procedures of assessment have ben dynamically evaluated by the stakeholders in the following way (figure 4):

- 56,4% of respondents (overwhelming majority) testify that there was a transition to the use of alternative tools for assessing students (for example, the use of open-end tests, instead the use of testing with closed-ended questions or an oral interview, etc.)
- 28.7% of respondent believe that assessment technologies have changed (educators use more formative assessment techniques or, conversely, more regular techniques, but in the electronic form)
- 9.6% of respondents see no changes in the assessment strategies and techniques.

89% of respondents estimate, that the time spent of assessment procedures of any form in the emergency digital learning format has been overall increase, thus postulating the digital environment and enhanced digital literacy requirements to be the core challenges to implement both regular and formative assessment types.

Dimension 2 of inquiry (disclosed through Group 2 of questions) – comparison and contrast of traditional and formative assessment

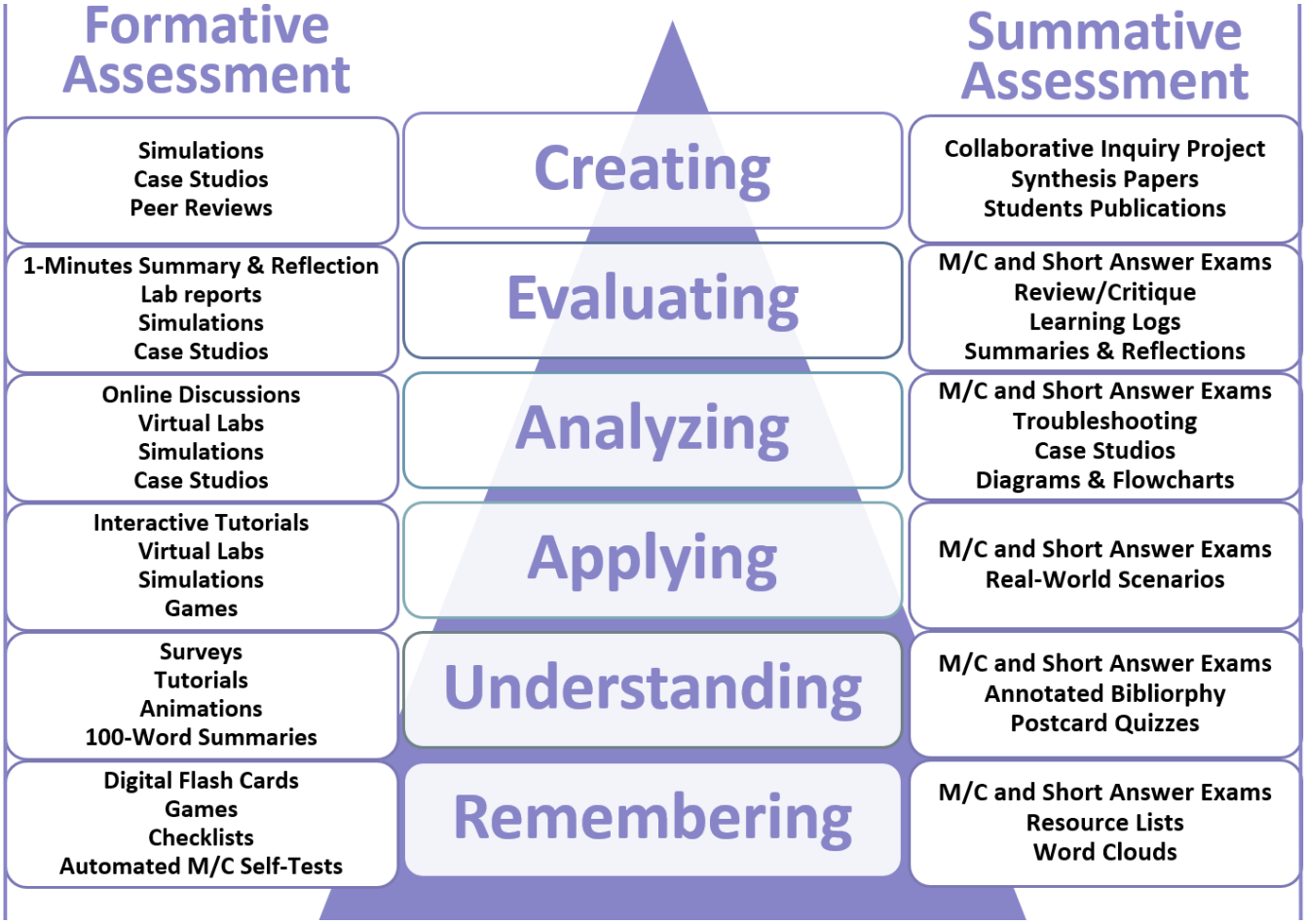

Figure 2: Assessment Activities in the Online Format According to Revised Bloom's Taxonomy of Educational Objectives [13].

in the digital learning context – provided the following scope of results.

Qualitatively, regular and formative assessment are compared through the following key dimensions:

(1) Subject matter or learning content;
(2) Type of activity or technique;
(3) Subject, who performs the assessment

Subsequently, regular assessment incorporates the following core parameters:

- subject mastery assessment
- assessment by a teacher/professor

Whereas, formative assessment incorporates such core parameters:

- peer assessment, self-assessment
- project assessment
- individuality and collaboration assessment
- full mapping of learning
- learning trajectory identification
- reflection

Subsequently, the following dominant techniques of regular assessment in the digital format are estimated by the stakeholders:

- Tests (87.2% of respondents);
- Practical task (83.5% of respondents);
- Oral answer/interview (80.3% of respondents);
- Written answer/essay (74.5% of respondents)

The priority techniques of assessment, customized for formative type, in the digital format are estimated by the stakeholders as follows:

- Educational workflow assessment by the professor with the help of special tools (checklists and assessment criteria dimensions) – 68.1% of respondents
- Peer-to-peer assessment by students (49.5% of respondents);
- Self-assessment by students (48.4% of respondents)

Quantitatively, the major advantages of regular assessment techniques, implemented in the digital distant format are estimated by the survey respondents to be:

- Evaluation tasks by a professional expert – 6% of respondents;
- Verification of the learning proficieny – 58% of respondents;

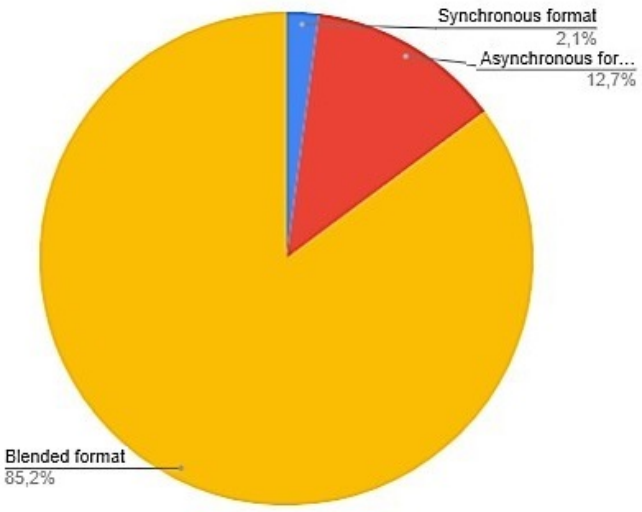

Figure 3: Formats of assessment implemented in digital learning.

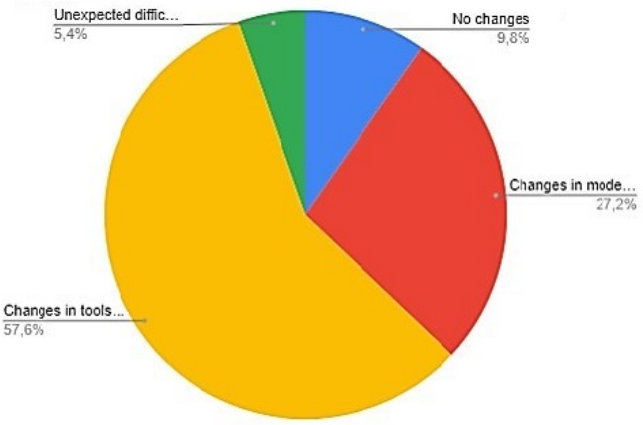

Figure 4: Changes in the assessment workflow in the COVID-19 context.

- Precise identification of errors that provides for learning from one's own mistakes – 57% of respondents.

In comparison, the major advantages of formative assessment techniques in the digital distant format are estimated by the survey respondents to be:

- Possibility to detect generic mistakes through peer-to-peer analysis – 71% of respondents;
- Amplified transparency of assessment – 60% of respondents;
- Inspiration, derived from the peer-to-peer assessment to improve one's own workflow and progress – 6% of respondents;
- Increased motivation for collaborative efforts in learning – 58% of respondents.

Dimension 3 of inquiry (disclosed through Group 3 of questions) – questions on ICT tools and skills, implemented through different forms of assessment in the digital learning context – yielded the following results across the board.

The respondents assessed a wide array of ICT tools, implemented in digital learning workflow for the purposes of regular and blended assessment (figure 5).

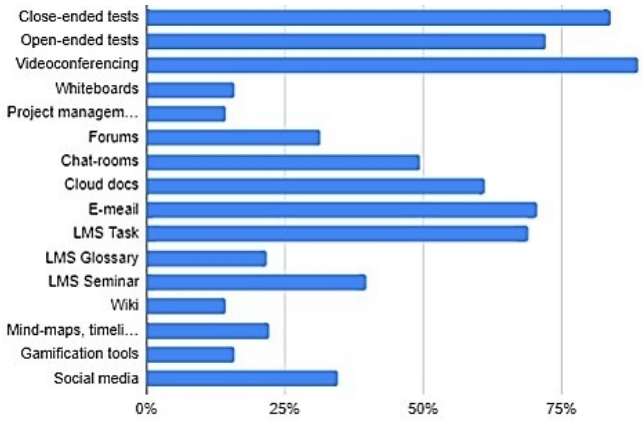

Figure 5: Digital tools for assessment.

The priority ranking digital tools for assessment, implemented across different educational programs in the COVID-19 measures and incorporating both regular and formative assessment modes was estimated to be as follows:

- Videoconference meetings (895 of respondents);
- Close-ended online test questions (84% of respondents);
- Open-ended online test questions (72.3% of respondents);
- E-mail (70.7% of respondents);
- Google documents (71% of respondents);
- LMS Moodle 'Task' (69.1% of respondents)

In contrast, the dominant ICT tools and services, customized for formative assessment in digital format were estimated as follows (figure 6):

- Questions, that guide the learning workflow (outline questions) – 66% of respondents;
- Criteria checklists and tables (64% of respondents);
- Reflection (via online synchronous and asynchronous means) – 60.1% of respondents;
- Online project assessment and online feedback surveys (43.6% of respondents).

As the survey data results have indicated (Group 1 of questions) – the digital format proper and the necessary use of online and hybrid tools for assessment purposes inevitably pose a challenge of activation of an array of soft skills, necessary to carry out the required assessment techniques successfully.

Qualitatively, the following soft skills, across different relevant frameworks, necessary for efficient assessment were estimated: communication, collaboration, team-work, time-management, research, digital literacy, project management, learning and innovation. Quantitatively, the following soft skills are assessed as dominant for regular assessment in the digital format:

- Communication (83% of respondents);

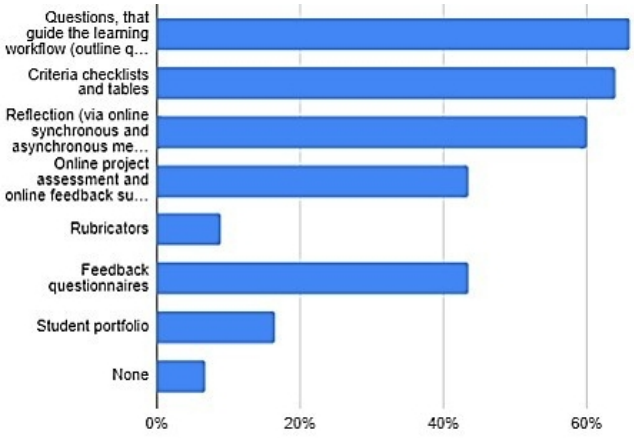

Figure 6: Digital tools for formative assessment.

- Learning (73% of respondents);
- Time-management (66% of respondents);
- Research (65% of respondents).

In comparison, the dominant soft skills, customized for efficient formative assessment in the digital format are estimated as follows:

- Innovation (84% of respondents);
- Digital literacy (80.1% of respondents);
- Collaboration (80% of respondents);
- Project management (79.2% of respondents).

Overall the survey data testifies, that the implementation of formative assessment in the digital learning format activated a set of soft skills, distinctly different from the one needed for efficient regular assessment techniques and procedures in the digital format.

The soft skills, that are estimated as equipollent and proportionally relevant both for regular and formative types of assessment in the digital format are as follows: capacity for learning (average of 73.4% of respondents); communication (74.7%); research (68.3% of respondents).

It bears notice, that soft skills, required for formative assessment are process oriented, whereas soft skills, required for regular assessment are result and subject oriented.

5 CONCLUSION

Assessment procedures (regular/summative and formative), implemented through different types of educational activities for different types of educational programs at Borys Grinchenko Kyiv university have been efficiently adapted to digital and hybrid learning through the implementation various ICT tools and techniques in the timespan of the COVID-19 emergency measures. The consistent benchmarking of summative and formative assessment techniques in the digital learning environment can provide a best practice model for other universities of Ukraine and countries of the world. Digital assessment format is a measure to increase learning efficiency in the context of a prolonged lockdown. It serves as an efficient vehicle of democratization of education in the digital age.

The survey results conducted among stakeholders of the learning outcomes assessment for Liberal Arts, Education and Computer Science programs have yielded conclusive data as to the comparative efficiency of different types of assessment in the digital format, as well as the adaptability of various digital tools for assessment scenarios. The qualitative evaluation of assessment experiences in the digital format confirmed that across different study programs, implementation of assessment activities and practices with the help of ICT tools demands intermediate digital literacy of educational stakeholders. Application of learning management systems for different facets of assessment procedures calls for advance to intermediate digital literacy and points to the existent gap in technical skills of educators in high-stress, emergency digitized environment.

The following recommendations can be derived for the successful implementation of the formative assessment techniques and tools in the digital learning format:

- Assessment through discussion requires implementation of such ICT tools and services as online learning materials / manuals, email discussions and messengers, discussion groups, discussion forums, whiteboards, web conferencing tools – synchronous and asynchronous;
- Assessment through inquiry requires implementation of such ICT tools and services and practices as use of online information and recommendations, analysis of ideas and information in various digital resources, use of digital tools for data collection and analysis, comparison of digital texts, use of digital tools for search and evaluation of information and ideas;
- Task-based assessment requires implementation of such ICT tools and services and practices as use of modeling, micro worlds, online simulators, virtual laboratories and excursions, role-playing games online;
- Assessment through product development requires implementation of such ICT tools and services and practices as creation and storage of digital documents, presentation of projects, performances, artifacts, cartoons, models, resources, slide shows, photos, videos, blogs; e-portfolio;

The results of this inquiry can be further elaborated in evaluation of digital tools efficiency and applicability of digital skills for different groups of assessment activities participants (educators, students and administrative staff). The combinatory modes of assessment in digital learning environments of different degrees of complexity has the potential to be further investigated for separate types of university programs (Liberal Arts and STEM).

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Mask and Emotion: Computer Vision in the Age of COVID-19

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ABSTRACT

Computer vision systems since the early 1960s have undergone a long evolution and are widely used in various fields, in particular, in education for the implementation of immersive educational resources. When developing computer vision systems for educational purposes, it is advisable to use the computer vision libraries based on deep learning (in particular, implementations of convolutional neural networks). Computer vision systems can be used in education both under normal and pandemic conditions. The changes in the education industry caused by the COVID-19 pandemic have affected the classic educational applications of computer vision systems, modifying existing ones and giving rise to new ones, including social distancing, face mask recognition, intrusion detection in universities and schools, and vandalism prevention, recognition of emotions on faces with and without masks, attendance monitoring. Developed on the basis of Microsoft Cognitive Toolkit and deployed in the Microsoft Azure cloud, a prototype computer vision system integrates emotion recognition of students and detection of violations of the mask regime, additionally providing the ability to determine gender, smile intensity, average age, makeup, glasses, hair color, etc. with a high degree of reliability.

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CCS CONCEPTS

• **Human-centered computing**; • **Social and professional topics** → **User characteristics**; • **Computing methodologies** → **Computer vision tasks**;

KEYWORDS

computer vision, COVID-19, education, mask detection

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1 EDUCATIONAL APPLICATIONS OF COMPUTER VISION SYSTEMS

1.1 The Origins and Current State of Computer Vision Systems

The first mentions of machine vision or computer vision appeared in the late 1950s, and today the "computer vision" term is much more frequently mentioned (figure 1).

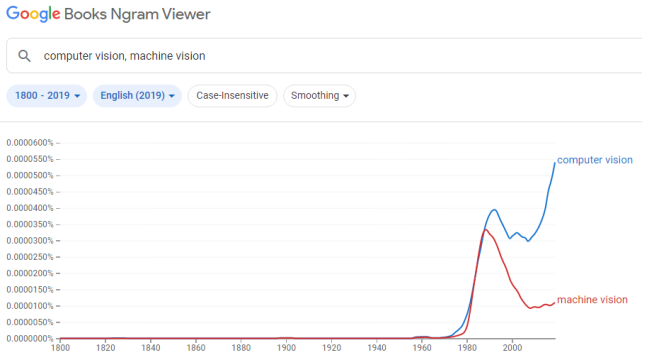

Figure 1: Mentions of computer / machine vision [1].

Gunnar Rutger Grape in his report [8] mentions the pioneering dissertation "Machine perception of three-dimensional solids" [14] by Lawrence Gilman Roberts. Completed with the assistance of Claude Elwood Shannon at MIT Lincoln Laboratory, this dissertation, like that of Ivan Edward Sutherland [17], laid the foundations for computer graphics.

Roberts [14] points out that the basis of machine recognition of simple images in the 1960s was based on the traditional use of artificial neural networks, such as perceptrons, which divide the set of input images (patterns) into classes by choosing link coefficients (weights) [17, p. 11]. However, the existing developments in letter recognition were not suitable for recognizing images constructed using straight lines: the problem concerned both flat (two-dimensional) and spatial (three-dimensional) images – the latter was the focus of the dissertation [17].

Roberts [14] relied on psychological researches on human perception of depth and recognition of figures, especially those of James Jerome Gibson [6]. The result of this work was a system for converting photographic images into three-dimensional models (figure 2).

10 years after the work of [14], the state of art in the field of computer vision has changed significantly. Grape [8] presents a system for computer vision, which is based on two-dimensional prototypes, and which uses a hierarchy of features for mapping purposes. The visual input is provided by a TV-camera, and the

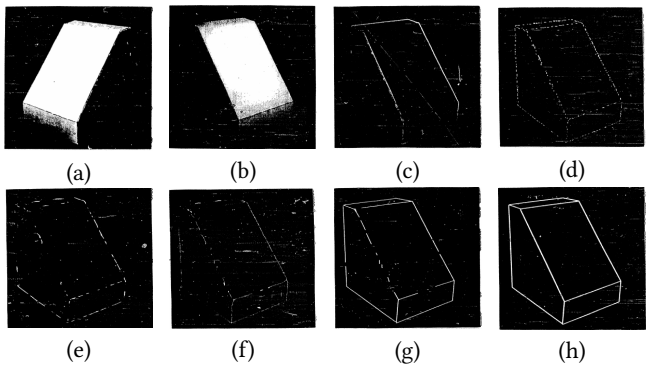

Figure 2: Transformation of the picture to line drawings: (a) original picture; (b) computer display of picture; (c-g) picture transformation; (h) final line drawing [14, p. 35-36].

problem is to interpret that input by computer, as a projection of a three-dimensional scene. The system proposed and demonstrated in the [8] uses perspectively consistent two-dimensional models prototypes of views of three-dimensional objects, and interpretations of scene-representations are based on the establishment of mapping relationships from conglomerates of scene-elements line-constellations to prototypes templates. The prototypes are learned by the program through analysis of – and generalization on – ideal instances (figure 3).

Determining the future directions of the development of computer vision systems, Grape [8] proposed a conceptual model for processing of information flow in a three-dimensional system (figure 4).

Ten years after Grape's report, the first generalization of the current state of the art in the field of computer vision was made. The authors of the first textbook on computer vision [4] Dana Harry Ballard and Christopher M. Brown considered methods of image formation, pre-processing (recovering intrinsic structure, filtering the image, finding local edges, surface orientation from reflectance models, optical flow and resolution pyramids), boundary detection, region growing, texture, motion, representation of two-dimensional geometric structures (boundaries, regions), representation of three-dimensional structures (solids, surfaces, cylindrical), knowledge representation and use (knowledge bases, semantic networks), matching, inference, goal achievement [4].

Ballard and Brown [4] proposed 4 categories of image representation in computer vision systems (figure 5). In the table 1 shown the main areas of application of computer vision systems as seen by the authors in 1982.

"Computer vision and machine learning have gotten married and this book is their child" is an Amazon review given by William T. Freeman to Simon J. D. Prince's "Computer Vision: Models, Learning, and Inference" [10]. This book outlines the fundamentals of machine learning needed to support current applications and research in computer vision.

Thus, over 60 years of development, computer vision systems have spread to a significant number of industries, including education, where they are used to implement immersive e-learning resources. However, changes in the educational industry caused

Table 1: Examples of image analysis tasks [4, p. 11]

Domain	Objects	Modality	Tasks	Knowledge sources
Robotics	3D outdoor and indoor scenes Mechanical parts	Light X-rays	Identify or describe objects in scene Industrial tasks	Models of objects Models of the reflection of light from objects
Aerial images	Terrain Buildings, etc	Light Infrared Radar	Improved images Resource analyses Weather prediction Spying Missile guidance Tactical analyses	Maps Geometrical models of shapes Models of image formation
Astronomy	Stars Planets	Light	Chemical composition Improved images	Geometrical models of shapes
Medical (macro)	Body organs	X-rays Ultrasound Isotopes Heat	Diagnosis of abnormalities Operative and treatment planning	Anatomical models Models of image formation
Medical (micro)	Cells Protein chains Chromosomes	Electronmicroscopy Light	Pathology, cytology Karyotyping	Models of shape
Chemistry	Molecules	Electron densities	Analyses of molecular compositions	Chemical models Structured models
Neuroanatomy	Neurons	Light Electronmicroscopy	Determination of spatial orientation	Neural connectivity
Physics	Particle tracks	Light	Find new particles Identify tracks	Atomic physics

by the COVID-19 pandemic [18] could not but affect the classical educational applications of computer vision systems, modifying existing ones and giving rise to new directions.

1.2 Changes in Educational Applications of Computer Vision Systems Caused by the Spread of COVID-19

Nico Klingler, the developer of Viso Suite, the no-code computer vision platform for teams to build, deploy and operate real-world applications, gives an overview of computer vision in education [9]. Let's focus on the applications of computer vision in education relevant to the current COVID-19 pandemic.

Enforcing social distancing is a key strategy to combat the spread of COVID-19 at public facilities such as schools and universities. Deep learning systems can be used for crowd monitoring to analyze social distancing, identify bottlenecks, and trigger alerts in case of persistent violations (figure 6).

The tools needed for social monitoring are inexpensive surveillance cameras that some schools already have. The main advantage of controlling social distance using computer vision systems is non-contact and automation.

In [25] a key features of social distancing recognition using computer vision are defined:

- automated detection and tracking of multiple people in real time using surveillance cameras;
- analyzing the people's moving trajectories and rate of social distancing violations;
- identification of high-risk areas with the greatest danger of possible virus spread.

The latter takes on additional significance in the context of the spread of highly contagious strains of COVID-19, such as Omicron [11].

Masked face detection is a way to monitor compliance and adherence to wearing masks in crowded public places such as universities or schools. Deep learning algorithms automatically detect people without mask and track mask mandate violations. The masked face detection model based on computer vision is non-invasive, scalable, and comparably easy to implement because any camera feed can be used (figure 7).

In [23] a key features of masked face detection using computer vision are defined:

- automated mask adherence monitoring is more consistent and accurate than human inspection;
- detecting unmasked people increases safety by reducing the risk of transmission of COVID-19 and other infectious diseases;
- masks or face coverings in the workplace can prevent outbreaks in schools and universities, especially during the spread of highly contagious strains.

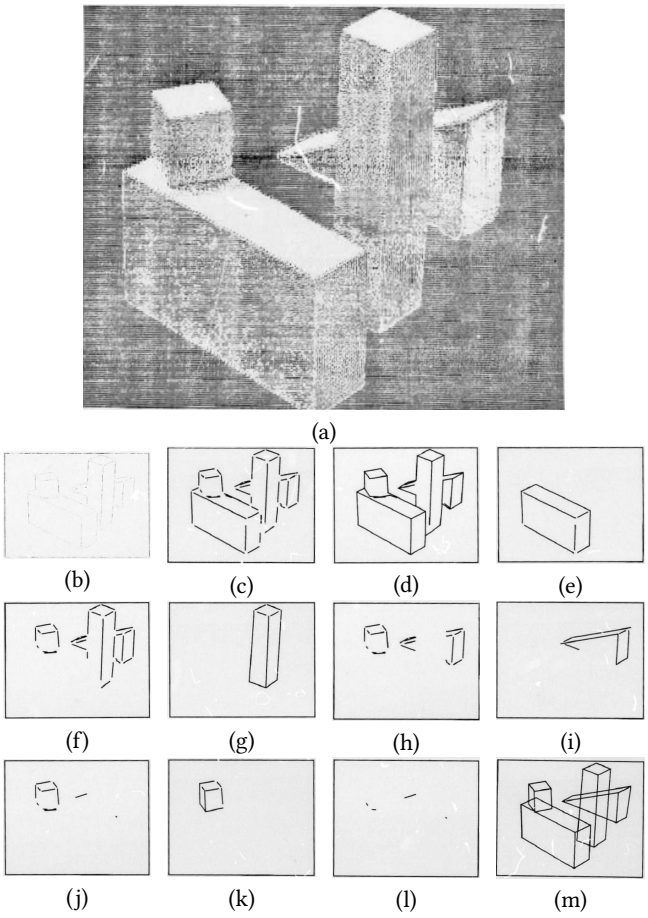

Figure 3: Image transformation: (a) TV-image; (b, c) edge-data – initial lines; (d, e) tentative vertices – first isolation; (f, g) amended scene – second object; (h, i) amended scene – third object; (j, k) amended scene – fourth object; (l, m) amended scene – final interpretation [8, p. 174-181].

Mahdi Rezaei and Mohsen Azarmi develop DeepSOCIAL [13], a hybrid computer vision and deep neural network model for automated detecting people in the crowds indoors and outdoors using closed-circuit television cameras (figure 8). The proposed deep neural network model in combination with an adapted inverse perspective mapping technique and SORT tracking algorithm leads to a robust people detection and social distancing monitoring. The model has been trained against two datasets – the Microsoft Common Objects in Context and Google Open Image datasets. The system has been evaluated against the Oxford Town Centre dataset (including 150,000 instances of people detection) with superior performance compared to three state-of-the-art methods. The evaluation has been conducted in challenging conditions, including occlusion, partial visibility, and under lighting variations with the mean average precision of 99.8% and the real-time speed of 24.1 fps. DeepSOCIAL also provide an online infection risk assessment scheme by statistical analysis of the spatio-temporal data from people's moving trajectories and the rate of social distancing violations,

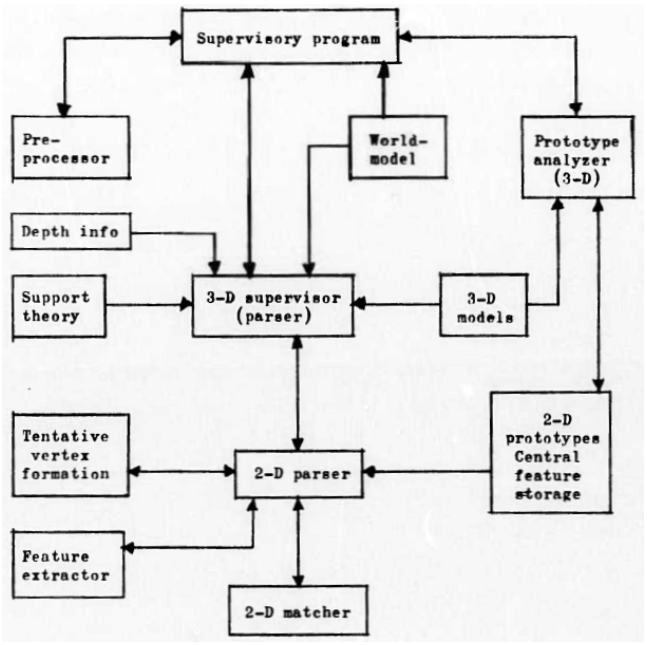

Figure 4: Possible information flow in a 3D system [8, p. 242].

and identify high-risk zones with the highest possibility of virus spread and infection. This may help authorities to redesign the layout of a public place or to take precaution actions to mitigate high-risk zones. The developed model is a generic and accurate people detection and tracking solution that can be applied in many other fields such as autonomous vehicles, human action recognition, anomaly detection.

Connor Shorten, Taghi M. Khoshgoftaar and Borko Furht in [15] presents a knowledge graph of deep learning and computer vision applications to fight COVID-19 (figure 9).

Parking management system for detecting the occupancy of parking lots in schools or universities is another classic computer vision application useful during a pandemic. Cameras that are also used for security surveillance provide a video feed that can be used to automatically determine and track the occupancy of multiple parking slots. Available parking information can be visualized in dashboards and sent to third-party systems to provide real-time data to students and teachers.

In [24] a key features of parking management systems for detecting the occupancy of parking lots in schools or universities are defined:

- parking occupancy detection based on deep learning computer vision saves money compared to costly sensor-based methods;
- parking optimization helps reduce traffic congestion during peak hours and traffic flows in cities caused by people cruising for a parking place (about 30%);
- no additional infrastructure is required for camera-based solutions, provided that the facility is equipped with closed-circuit television surveillance cameras covering the parking spaces;

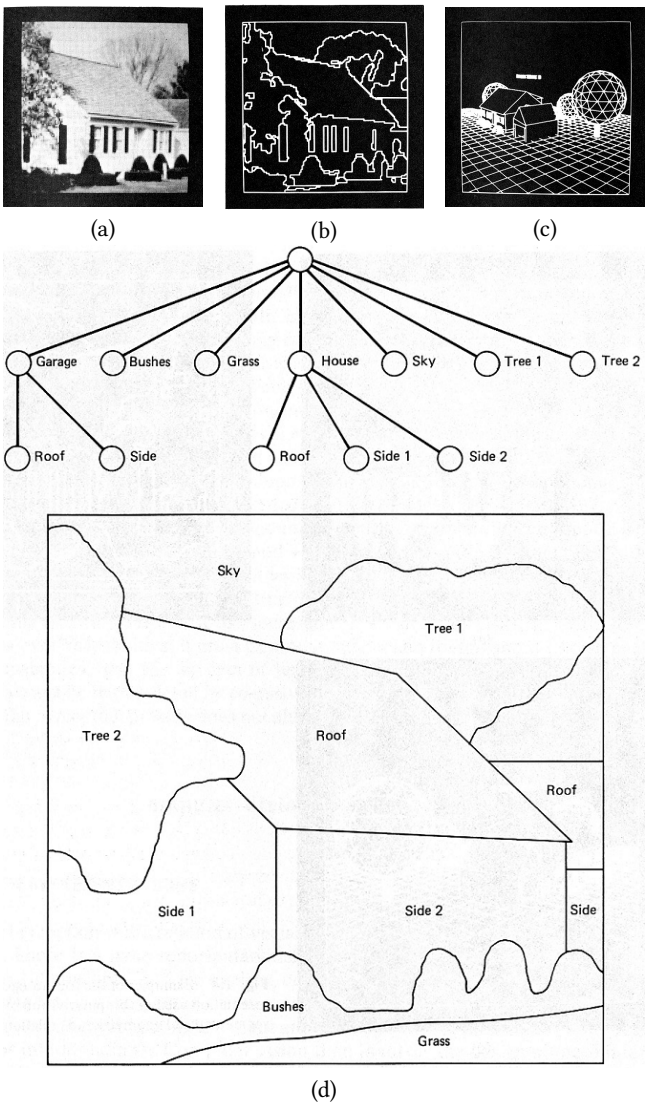

Figure 5: Categories of representation used in computer vision: (a) iconic, (b) segmented, (c) geometric, (d) relational [4, p. 7-8].

- computer vision-based solutions provide accurate location of a free parking space, which is a requirement for navigation of vehicles to free parking spaces.

Intrusion detection systems are an integral part of most physical security systems, critical infrastructure protection, and safety applications in transportation and manufacturing. *Intrusion detection in universities and schools* is the application of deep learning with surveillance cameras to monitor for perimeter and automatically detect intruders (figure 10).

In [22] a key features of intrusion detection systems are defined:

- real-time object detection algorithms to detect people and objects in the video of multiple cameras (high scalability);

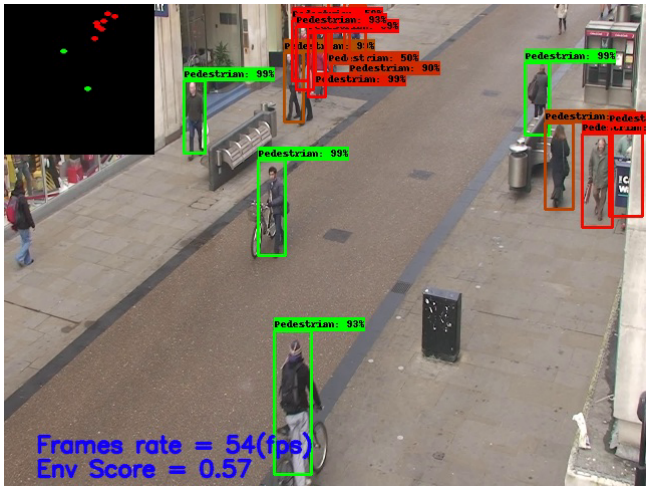

Figure 6: Social distance monitoring with https://viso.ai/application/social-distancing-monitoring/.

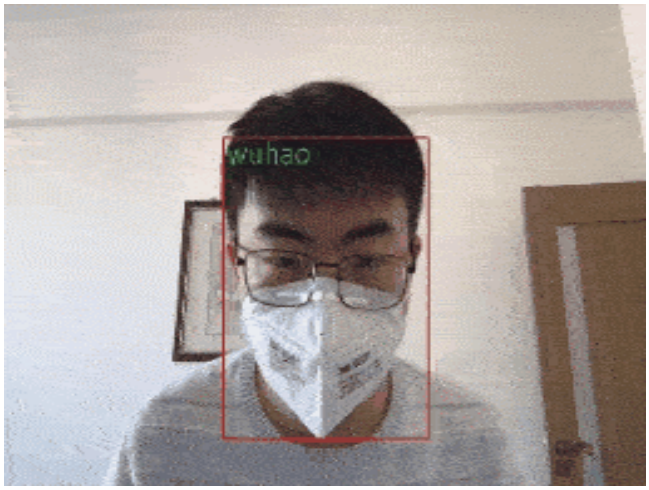

Figure 7: Masked face detection with https://viso.ai/application/mask-detection/.

- regions of interest can be visually determined by drawing and naming specific areas within camera frames;
- the ability to trigger alerts based on how objects are detected in those areas (for example, after a person enters the area for more than 5 seconds);
- edge AI with on-device machine learning allows privacy-preserving, high performance, and robust (offline capabilities) perimeter detection systems.

Vandalism prevention systems and systems for the detection of suspicious abandoned objects are used to detect suspicious behavior leading to vandalism and identify potentially dangerous items (suitcases or bags that may contain explosives or biological weapons) placed in public places (figure 11).

In [19] a key features of Vandalism prevention systems and systems for the detection of suspicious abandoned objects are defined:

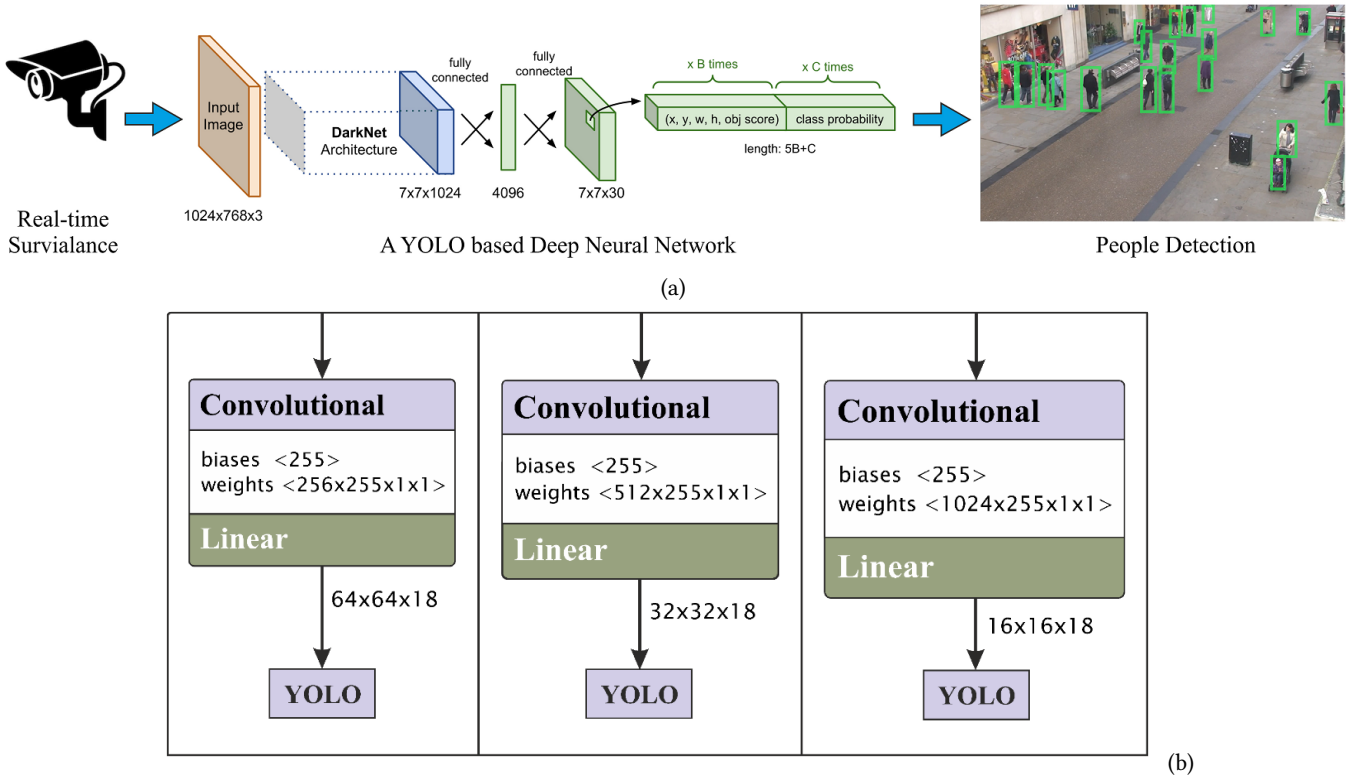

Figure 8: The general structure of the DeepSOCIAL people detection module (a) and the architecture of the neural network (b) [13, p. 7, 10].

- classification of objects to determine the type of item (suitcase, bag, etc.);
- focus detection on specific areas within camera streams (regions of interest such as platforms, surfaces, elevators, etc.);
- scalable and objective monitoring of public areas, public transport, schools, and hospitals;
- real-time early detection to assist humans in detecting suspicious items and initiating an evacuation.

The video stream from the cameras can be used to recognize the emotional states of one or more people, including the *recognition of the emotions of masked and unmasked faces* (figure 12).

Emotion recognition systems based on facial expressions allow [21]:

- detection of emotional states: sadness, anger, happiness, fear, surprise, and neutral state;
- identification of changes in emotional states based on specific conditions and events;
- measure the confidence score for the recognized emotions.

Attendance monitoring systems perform face recognition and find faces in an image database to identify students and register their attendance (figure 13).

Key benefits of attendance monitoring systems [20]:

- automated and non-invasive identification of one or multiple people;
- smart video surveillance for infrastructure protection in real-world settings;
- accurate deep learning models developed by Microsoft, Google, Meta, and others that are robust to occlusion, expression, lighting, and pose.

Attendance monitoring systems can be implemented at the hardware level based on Raspberry-pi [16] using convolutional neural networks – a class of deep neural networks most commonly used for visual images analysis [3, 12, 16] and implemented in software libraries such as Caffe, Deeplearning4j, Dlib, Microsoft Cognitive Toolkit, TensorFlow, Theano, Torch.

2 DEVELOPMENT OF A PROTOTYPE COMPUTER VISION SYSTEM FOR EDUCATIONAL PURPOSES

2.1 Computer Vision Libraries for Identification of Dynamic Objects

The most commonly used computer vision libraries for dynamic object identification are:

- *fastai* is a deep learning library that provides GPU-optimized computer vision features (Python);
- *IPSDK* is an image processing library optimized for 2D and 3D image processing (C++, Python);

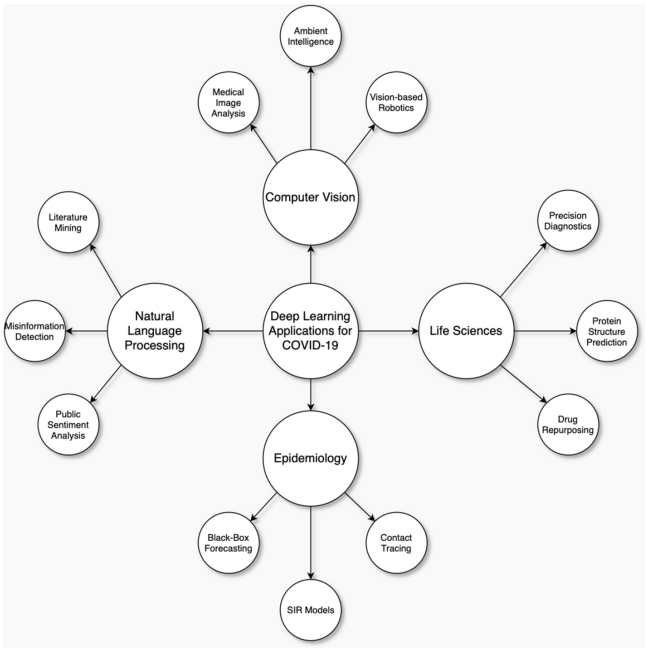

Figure 9: Application of deep learning to overcome the consequences of COVID-19 [15, p. 18].

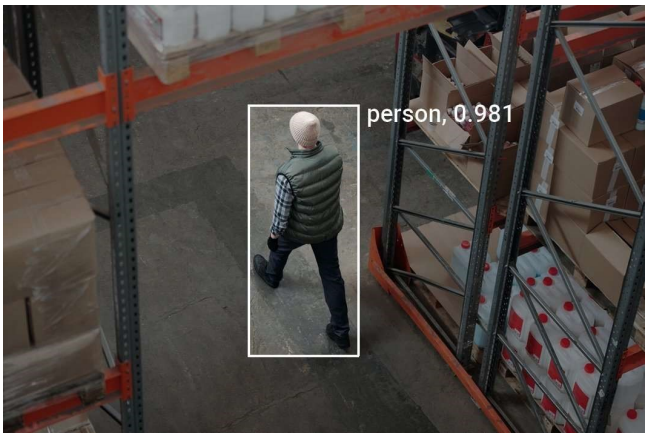

Figure 10: Intrusion detection using https://viso.ai/application/intrusion-detection/.

- *Imutils* is an OpenCV-based computer vision package (C++, Python);
- *Keras* is a high-level neural networks library that is capable of running on top of either TensorFlow or Theano and includes support for image recognition using both convolutional networks and recurrent networks (Python);
- *OpenCV* is a computer vision library that is focused on real-time applications and includes a number of modules for image processing, video analysis, object detection, etc (C++ and other languages);

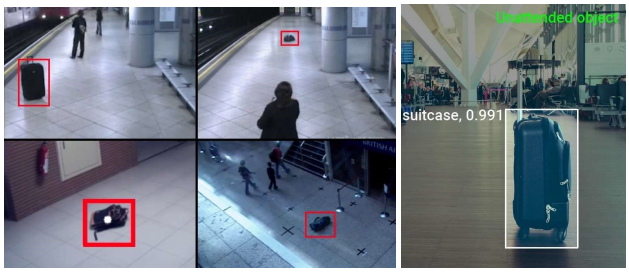

Figure 11: Detection of suspicious abandoned objects using https://viso.ai/application/abandoned-luggage-detection/.

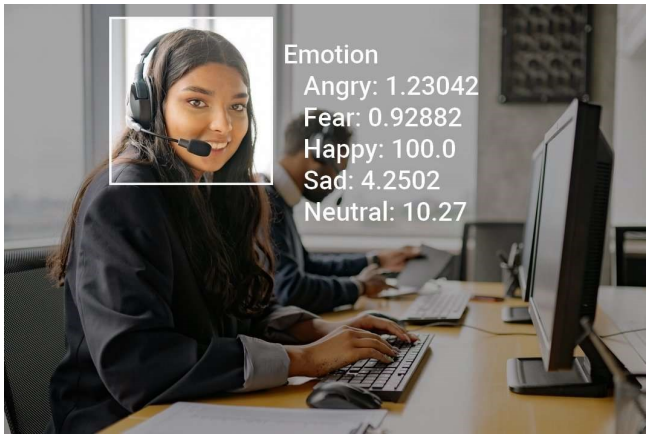

Figure 12: Facial emotion analysis using https://viso.ai/application/emotion-analysis/.

Figure 13: Face recognition using https://viso.ai/application/face-recognition.

- *PyTorchCV* is a PyTorch-based framework for computer vision tasks: image classification, segmentation, detection, and pose estimation models. There are a number of implemented models in this framework, including AlexNet, ResNet, ResNeXt, PyramidNet, SparseNet, DRN-C/DRN-D and more (Python);
- *Scikit-Image* is an image processing toolbox for SciPy (Python);

- *SimpleCV* is a collection of libraries and software that provides a concise, readable interface for cameras, image and video streams manipulation (Python).

Common features of these libraries are free licenses, rapid prototyping with Python, image recognition using deep neural networks, and the ability to use web platforms to deploy computer vision applications. The latter is often a paid option, as is data processing in the developer's cloud.

Viso.ai is an all-in-one platform to build computer vision applications without code (e.g., [19, 21]). Despite a lot of features and high attractiveness, this platform has a high cost, which makes it unsuitable for the domestic education system. A similar situation is observed with other commercial solutions: for example, Adaptive Vision experts, comparing the functionality of OpenCV, MVTec HALCON and Adaptive Vision Library (AVL) [2], draw conclusions not in favor of the free OpenCV – especially significant differences in functionality in favor of commercial products HALCON and AVL in such components, important for the efficiency of recognition, as the region analysis, two-dimensional graphics, machine learning, and hardware support.

When using cloud-based recognition frameworks such as Google Cloud [7], the charges are incurred per unit (single image or page of a multi-page image). So, with a limit of up to 1000 units per month Cloud Vision provides the following features:

- CROP_HINTS – determine suggested vertices for a crop region on an image;
- DOCUMENT_TEXT_DETECTION – perform OCR on dense text images, such as documents (PDF/TIFF), and images with handwriting;
- FACE_DETECTION – detect faces within the image;
- IMAGE_PROPERTIES – compute a set of image properties, such as the image's dominant colors;
- LABEL_DETECTION – add labels based on image content;
- LANDMARK_DETECTION – detect geographic landmarks within the image;
- LOGO_DETECTION – detect company logos within the image;
- OBJECT_LOCALIZATION – detect and extract multiple objects in an image;
- TEXT_DETECTION – perform OCR for areas of sparse text within a larger image;
- WEB_DETECTION – detect topical entities such as news, events, or celebrities within the image, and find similar images on the web using the power of Google Image Search.

Any non-standard actions, in particular, using Vertex AI Training to build custom machine learning models, require additional payments, but for beginners often provided some credit – such policies are currently followed by Google Cloud, AWS, Microsoft Azure, which allows them to be considered as the technological basis for building computer vision systems for educational purposes.

2.2 Stages of Development of a Prototype Computer Vision System for Educational Purposes

2.2.1 Static Face Recognition with Microsoft Face API. Jim Bennett's "Happy, Sad, Angry Workshop" [5] provides an opportunity to develop a prototype of a computer vision system using the Azure Face API, a software interface that allows you to determine the position of a face on an image and collect 27-point face landmarks pointing to the important positions of face components, including the eyes position and mask detection.

To access the Azure Face API, you need a subscription key, which can be obtained through free registration at https://azure.microsoft.com/en-us/free/students (Azure for Students Starter) – it does not require the use of a credit card, although service credit is provided. Unfortunately, e-mail address in the second-level domain (in particular, the domain of Kryvyi Rih State Pedagogical University is kdpu.**edu**.ua) are not recognized as belonging to academic institutions – in this case, regular registration is recommended (figure 14).

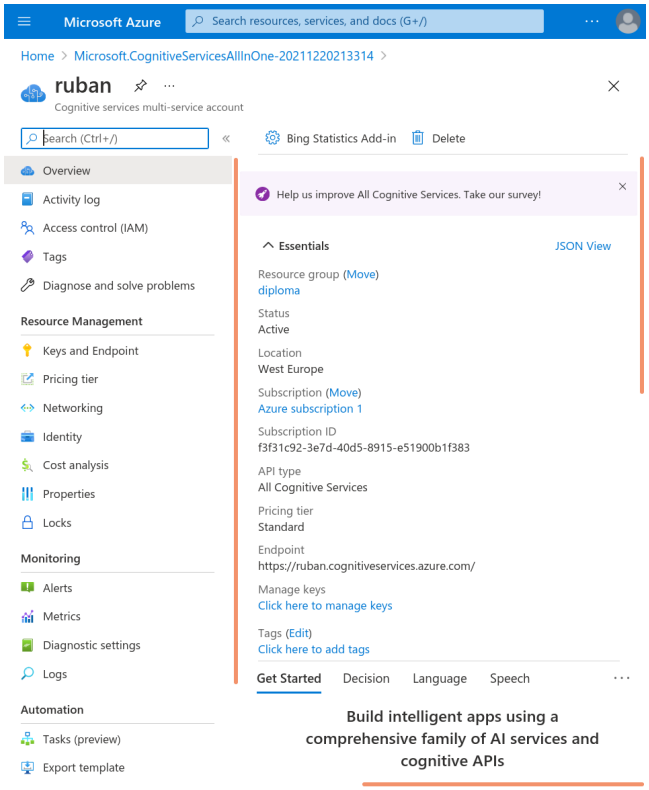

Figure 14: Regular registration in Cognitive Services.

After receiving the key, it must be verified using a test code (figure 15) or a web form (figure 16). If the key is invalid, the result will be a 400, 401, 403, 408, 415, or 429 error message:

```
b'{"error":{"code":"401","message":"Access denied due to invalid subscription key or wrong API endpoint. Make sure to provide a valid key for an active subscription and use a correct regional API endpoint for your resource."}}'
```

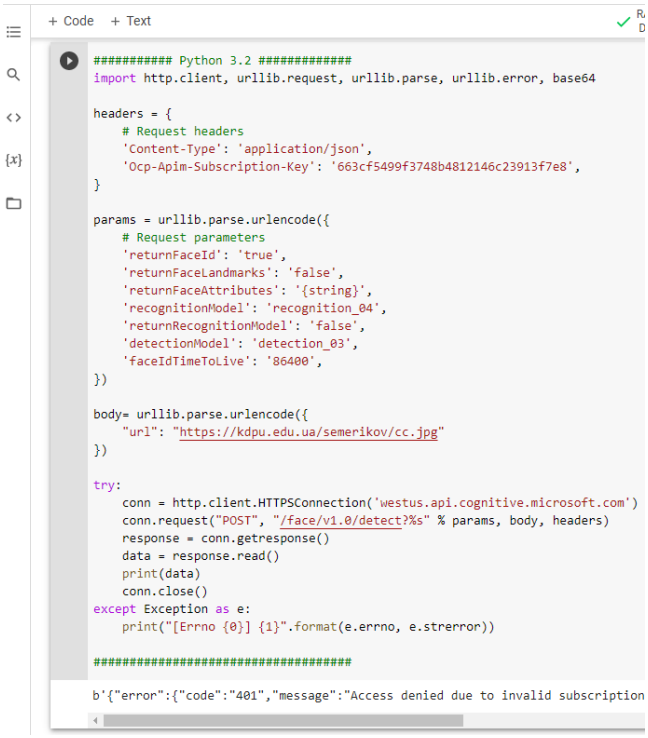

Figure 15: Key verification with a test code.

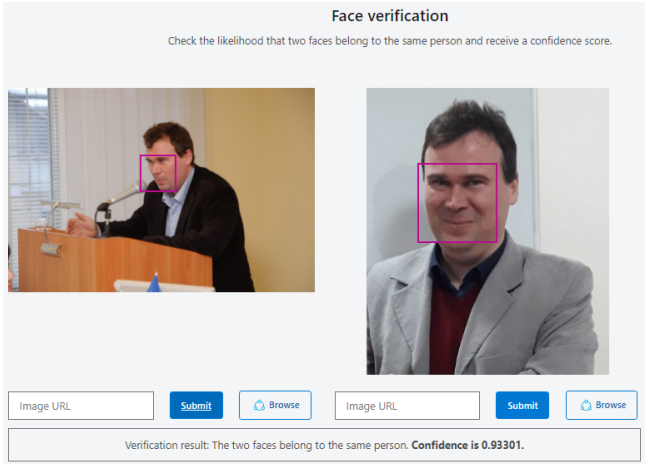

Figure 16: Static image identification results.

The result returned in JSON format allows you to get a large number of attributes associated with a face.

It should be noted that different face attributes are available for different face detection models (detectionModel): for detection_03 – headpose, mask, qualityforrecognition, for detection_01 – accessories, age, blur, emotion, exposure, facialhair, gender, glasses, hair, headpose, makeup, noise, occlusion, qualityforrecognition, smile.

We recommend the recognition_04 recognition model (recognitionModel), introduced in February 2021. At the moment, this is the only model that can be used to detect masks.

Azure also provides the ability to access the endpoint directly – in our case, it is https://ruban.cognitiveservices.azure.com.

Below is the code to get the properties of the right image from figure 16:

```
import os, json, requests
face_api_url =
"https://ruban.cognitiveservices.azure.com" +
 '/face/v1.0/detect'
image_url =
'https://kdpu.edu.ua/images/ipm/%D0%90%D1%81%D0'+
'%BF%D1%96%D1%80%D0%B0%D0%BD%D1%82%D1'+
'%83%D1%80%D0%B0/%D0%B3%D0%B0%D1%80%D0'+
'%B0%D0%BD%D1%82/%D1%81%D1%81_2.jpg'
headers={'Ocp-Apim-Subscription-Key':
         "secret subscription key"}
params = {
'detectionModel': 'detection_03',
'returnFaceId': 'true',
'returnFaceLandmarks': 'true',
'returnFaceAttributes':
'headpose,mask,qualityforrecognition', # detection_03
# 'returnFaceAttributes':
# 'accessories,age,blur,emotion,exposure,facialhair,'+
# 'gender,glasses,hair,headpose,makeup,noise,occlusion,'+
# 'qualityforrecognition,smile', # detection_01
'recognitionModel': 'recognition_04',
'returnRecognitionModel': 'false',
#'detectionModel': 'detection_01',
'faceIdTimeToLive': '86400',
}
response = requests.post(face_api_url, params=params,
headers=headers, json={"url":image_url})
print(json.dumps(response.json()))
```

To determine the presence of a mask on the face, we will use this code below. The result of the query for the second person from figure 16 is presented in table 2.

When we set returnFaceAttributes to 'accessories, age, blur, emotion, exposure, facialhair, gender, glasses, hair, headpose, makeup, noise, occlusion, qualityforrecognition, smile' and detectionModel to 'detection_01', we get the following attribute for the same face (table 3).

Setting detectionModel to 'detection_01' resulted in a high value of qualityForRecognition – for the same image, this corresponds to different algorithms used for image analysis.

2.2.2 Dynamic Face Recognition with Microsoft Face API. Adaptation of example [5] will begin with the change of the operating system from Windows / macOS to Linux – the latter is widespread in a higher education institutions. Any development environment can be used to work with Azure tools, including a specialized text editor Visual Studio Code, in which you need to install the Python Extension for Visual Studio Code and Azure App Service Extension for Visual Studio Code (figure 17).

Table 2: Face API request result for the detection model detection_03

attribute	value	comment
"faceId"	"1b98e2a9-0c6c-4864-91d7-b8281e9377cc"	an unique identifier of the detected face, created using the Face API, which can be used within 24 hours of receipt
"faceRectangle"	"top": 77, "left": 92, "width": 144, "height": 191	a rectangle within which a face can be found
"faceLandmarks"	"pupilLeft": "x": 122.8, "y": 156.0, "pupilRight": "x": 180.7, "y": 157.2, "noseTip": "x": 143.7, "y": 196.2, "mouthLeft": "x": 123.8, "y": 219.1, "mouthRight": "x": 179.4, "y": 220.6, "eyebrowLeftOuter": "x": 102.5, "y": 147.1, "eyebrowLeftInner": "x": 136.1, "y": 147.3, "eyeLeftOuter": "x": 113.8, "y": 156.1, "eyeLeftTop": "x": 123.1, "y": 152.9, "eyeLeftBottom": "x": 122.4, "y": 158.6, "eyeLeftInner": "x": 131.9, "y": 156.4, "eyebrowRightInner": "x": 161.3, "y": 147.0, "eyebrowRightOuter": "x": 202.7, "y": 150.0, "eyeRightInner": "x": 171.4, "y": 157.4, "eyeRightTop": "x": 180.3, "y": 153.9, "eyeRightBottom": "x": 180.5, "y": 159.8, "eyeRightOuter": "x": 190.6, "y": 157.6, "noseRootLeft": "x": 141.0, "y": 159.6, "noseRootRight": "x": 157.1, "y": 160.2, "noseLeftAlarTop": "x": 134.5, "y": 182.5, "noseRightAlarTop": "x": 161.7, "y": 183.0, "noseLeftAlarOutTip": "x": 128.6, "y": 194.4, "noseRightAlarOutTip":30 "x": 167.7, "y": 196.1, "upperLipTop": "x": 148.5, "y": 218.2, "upperLipBottom": "x": 147.8, "y": 222.1, "underLipTop": "x": 147.7, "y": 226.0, "underLipBottom": "x": 147.5, "y": 233.0	a collection of 27-point face landmarks pointing to the important positions of face components
"faceAttributes"		face attributes
"headPose"	"pitch": -14.2, "roll": 1.3, "yaw": -9.3	properties indicating head pose of the face: 3D angles of face pitch, roll and yaw
"mask"	"type": "noMask", "noseAndMouthCovered": false	the presence of a mask on a given face. Mask type if any of the face: 'noMask', 'faceMask', 'otherMaskOrOcclusion' or 'uncertain'. 'noseAndMouthCovered' is a boolean value indicating whether nose and mouth are covered
"qualityForRecognition"	"medium"	value indicating quality of image for recognition: low, medium, or high. Only high-quality images are recommended for identity registration, and medium or high-quality is for personal identification. This attribute is only available when using a combination of detection models detection_01 or detection_03 and recognition models recognition_03 or recognition_04.

The Flask microframework for creating web applications is installed with the command

```
pip3 install flask
```

If pip3 is not installed, it can be added by calling the package manager:

```
sudo apt install python3-pip
```

Using Python 2.7 is possible but not recommended, although Azure provides options for using different versions of Python (currently up to 3.9). Let's configure Visual Studio Code to use Flask according to the procedure described by Bennett [5] (figure 18) – this makes it possible to debug the server part of the system. During the configuration process, it turned out that for Flask to work correctly in the terminal, it is necessary to set the FLASK_APP environment variable to the full path to the server part of the system – the app.py file (figure 19), and make changes to the Flask configuration file in Visual Studio Code (figure 20).

In the process of debugging the server part of the system, its code can be changed – this will automatically restart Flask.

The client part of the system is represented by a single home.html file located in the templates directory.

To ensure the availability of the developed system, it is advisable to deploy it in the Azure cloud using such an Azure App Service component as Deploy to Web App (figure 21). This requires setting up an ability to login Azure directly from Visual Studio Code,

Table 3: Face API request result for the detection model detection_01

attribute	value	comment
"smile"	0.999	smile intensity, a number between [0,1]
"gender"	"male"	possible gender of the face: male or female
"age"	44.0	approximate value of "visual age" in years (how old a person looks, not actual biological age)
"facialHair"	"moustache": 0.1, "beard": 0.1, "sideburns": 0.1	properties describing facial hair attributes – moustache, beard, and sideburns, a number between [0,1]: 0 for the absence of facial hair, 1 for long or very thick facial hair
"glasses"	"NoGlasses"	glasses type if any of the face: 'NoGlasses', 'ReadingGlasses', 'Sunglasses', 'SwimmingGoggles'
"emotion"	"anger": 0.0, "contempt": 0.001, "disgust": 0.0, "fear": 0.0, "happiness": 0.999, "neutral": 0.0, "sadness": 0.0, "surprise": 0.0	facial emotion (anger, contempt, disgust, fear, happiness, neutral, sadness, surprise) in form of confidence ranging from 0 to 1
"blur"	"blurLevel": "medium", "value": 0.48	presence of blur within the image: blurLevel indicate a level of blurriness (low, medium, and high), value is a number indicating level of blurriness ranging from 0 to 1
"exposure"	"exposureLevel": "goodExposure", "value": 0.69	exposure level of the image: exposureLevel can be 'GoodExposure', 'OverExposure', or 'UnderExposure', value is a number indicating level of exposure level ranging from 0 to 1: [0, 0.25) is under exposure, [0.25, 0.75) is good exposure, [0.75, 1] is over exposure
"noise"	"noiseLevel": "low", "value": 0.0	noise level of the image; noiseLevel can be low, medium, or high, value is number indicating level of noise level ranging from 0 to 1: the larger it is, the noisier the image
"makeup"	"eyeMakeup": false, "lipMakeup": false	presence of makeup on a given face: eye makeup and lip makeup
"accessories"	[]	any accessories on a given face: headwear, glasses, and mask; the empty array means the absence of accessories
"occlusion"	"foreheadOccluded": false, "eyeOccluded": false, "mouthOccluded": false	a boolean values indicating whether eyes, forehead, and mouth are occluded
"hair"		hair attributes
"bald"	0.22	A number describing confidence level of whether the person is bald
"invisible"	false	a boolean value describing whether the hair is visible in the image
"hairColor"	["color": "black", "confidence": 0.98, "color": "brown", "confidence": 0.97, "color": "gray", "confidence": 0.41, "color": "other", "confidence": 0.16, "color": "blond", "confidence": 0.08, "color": "red", "confidence": 0.04, "color": "white", "confidence": 0.0]	confidence levels for the different hair colors

determining the system name (the first part of the domain name), choosing the Python version, and pricing plan (figure 22).

Figure 23 shows the protocol for deploying a system to the cloud.

Machine learning models can be created as completely independently ("from scratch"), and on the basis of models created by others. Microsoft proposes a range of pre-trained models, called Cognitive Services. These models include recognizing images, recognizing speech, or translating between different languages. Face API implements machine learning models for detect faces in the image. To access it, you need a subscription key, which can be obtained from the Azure portal (figure 24).

The name of the generated resource must be *globally unique* because it will become part of the URL that must be accessed to identify the face in the image. The place to run this code (Azure region – datacenter group) is best to choose the nearest one.

The price level is essential for educational software. If your software will make fewer than 2,037 API calls per minute and fewer than 30,000 calls per month, you can choose the free F0 tier – only one per Azure service.

Upon successful setup, you can get secret keys and an endpoint for accessing the Face API (figure 26).

Both secret keys are equal – you can use any of them. The obtained endpoint can be used to access the Face API from multiple

Figure 17: Visual Studio Code extension required for development.

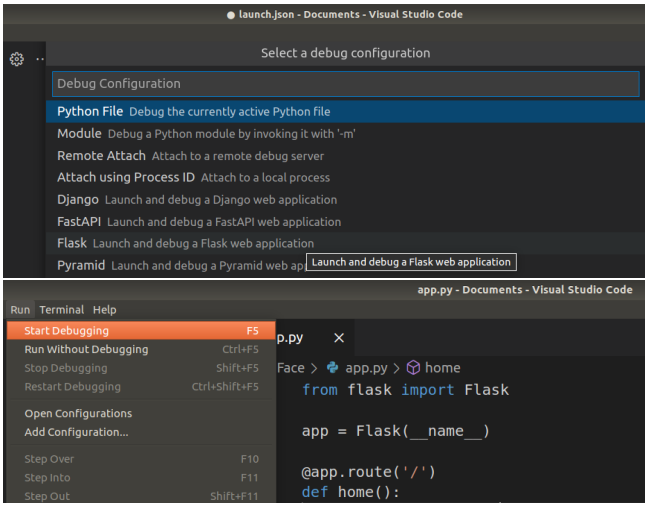

Figure 18: Configuring Visual Studio Code to run the server part using Flask.

applications, including the method described in subsection 2.2.1.

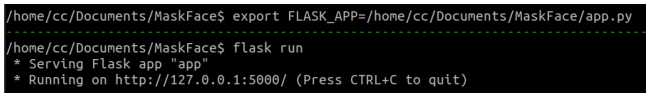

Figure 19: Running Flask in the standalone Linux terminal.

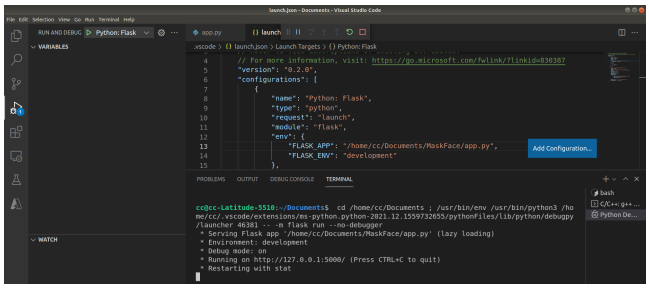

Figure 20: Running Flask in the Visual Studio Code built-in terminal.

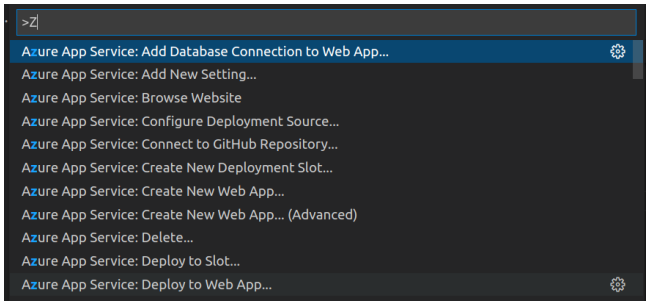

Figure 21: Setting up software in the Azure cloud.

Bennett [5] notes the inexpediency of storing secret data in the program code, seeing an alternative to storing them in third-party files such as .env.

In the process of finalizing the [5] code, the following main changes were made in the client side:

(1) increased resolution to 1024x768 for better face recognition – Face API defines a minimum face size of 36x36;
(2) due to the fact that the details associated with the mask are not compatible with other attributes, the two different handlers associated with buttons "Am I wearing a mask?" (figure 27) and "Analyze the face".

The creation of buttons for capturing a dynamic image is related to the selected tariff plan: automatic calls to the Face API even 15 times per second exhaust the monthly limit in half an hour.

The server part has undergone the biggest changes

(1) along with the best_emotion function, the best_color function was developed to determine hair color;
(2) the check_results function, which handles the click on the "Am I wearing a mask?" button, uses the recognition_04 and detection_03 recognition/detection models to extract the mask attributes and return the corresponding response ('Your face is not masked', 'Your face is masked', 'Your face is covered by something', 'Impossible to determine if your face

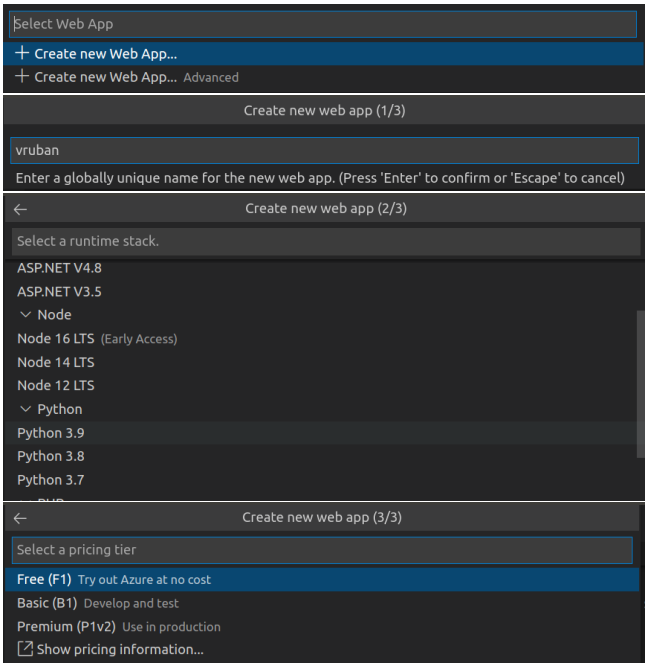

Figure 22: Cloud deployment steps.

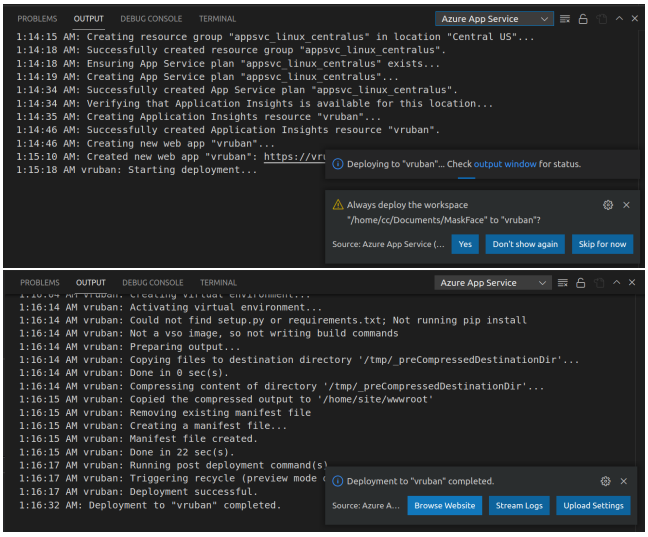

Figure 23: Protocol for deploying a system to the cloud.

is masked', 'Your mouth and nose are closed', 'Your mouth and nose not closed');

(3) "Analyze the face" button returns such facial attributes as 'emotion', 'accessories', 'age', 'facialhair', 'gender', 'glasses', 'hair', 'makeup', and 'smile'.

2.2.3 Testing the developed prototype. Figure 27 shows the results of testing the system in the mask detection mode: out of 4 tests, 3 were performed correctly, and one (figure 27d) was partially correct (it was determined that the mouth was not covered by the mask).

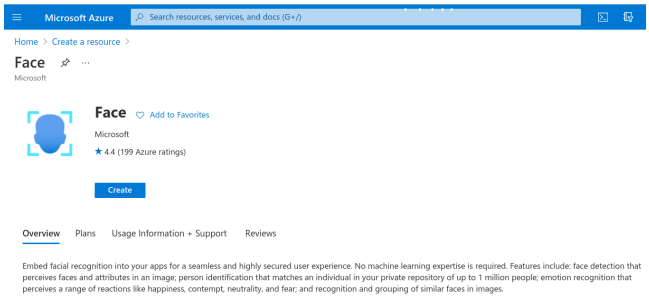

Figure 24: Create a Face API resource.

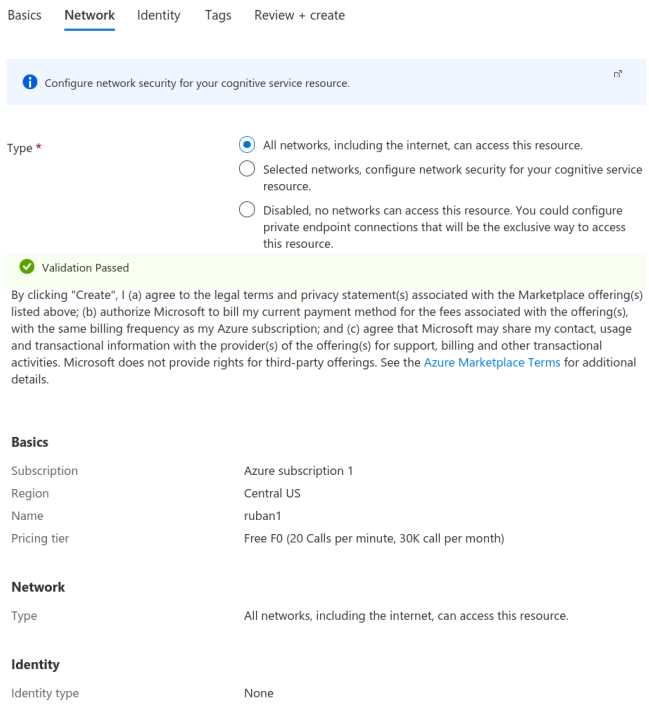

Figure 25: Setting up a resource to use the Face API.

Appendix A presents the results of testing the system on mobile and stationary devices. Summarizing the test results allowed us to draw the following conclusions on face identification using pre-trained Face API models:

(1) the "visial age" of faces significantly depends on the mood of their owners – the better, the closer to the biological age: this is due to the fact that learning took place on a set of predominantly smiling faces;
(2) blond hair is the worst identified – depending on the lighting, it can be "any color" (falsely identified as gray, blond, black);
(3) uneven lighting and shadows give rise to false effects of forehead occlusion and putting on headwear;
(4) reading glasses and sunglasses with extra decorative elements can be identified as swimming goggles;
(5) misidentification of the facial eye makeup of a face wearing sunglasses is common.

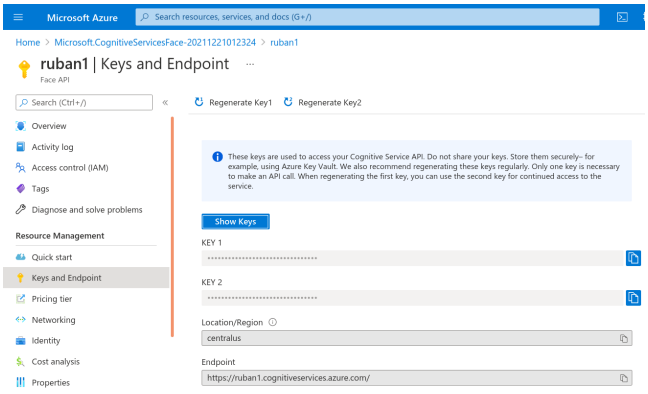

Figure 26: Obtaining secret keys and an endpoint to access the Face API.

Figure 27: Testing the system in mask detection mode.

3 CONCLUSION

During the study of the problem of new educational applications of computer vision systems in the context of the COVID-19 pandemic, the following results were obtained:

1. Computer vision systems since the early 1960s have undergone a long evolution and are widely used in various fields, in particular, in education for the implementation of immersive e-learning resources. At the present stage of their development, the identification of dynamic objects in computer vision systems is performed primarily by machine learning tools. When creating computer vision systems for educational purposes, it is advisable to rely on computer vision libraries based on deep learning (in particular, various implementations of convolutional neural networks).
2. Computer vision systems for identifying dynamic objects can be used in education both under normal and pandemic conditions. The changes in the education industry caused by the COVID-19 pandemic have affected the classic educational applications of computer vision systems, modifying existing ones and giving rise to new ones, including social distancing, masked face recognition, intrusion detection in universities and schools, vandalism prevention, recognition of the emotions of masked and unmasked faces, attendance monitoring.
3. Among the large number of general-purpose computer vision libraries, the most appropriate in the educational process is the use of stand-alone libraries (in particular, OpenCV), whose common features are free licenses and the abilities to use Python for rapid prototyping, and neural networks for recognition. Commercial tools like MVTec HALCON and the Adaptive Vision Library provide much more functionality, and the use of viso.ai provides users with the ability to non-code development. Software deployment for computer vision systems is possible on various web platforms, the most suitable of which are Amazon Web Services, Google Cloud, and Microsoft Azure. The latter is a paid option, as is data processing in the developer's cloud, but it is offset by access to a set of pre-trained machine learning models, such as Cognitive Services.
4. Developed with the help of Microsoft Cognitive Toolkit and deployed in the Microsoft Azure cloud, a prototype of a computer vision system combines the recognition of emotions of participants in the educational process and the detection of violations of the mask regime, additionally providing the ability to determine gender, smile intensity, and the presence of glasses and age, color – with a high degree of certainty, and hairstyles, the presence of a headdress, makeup, etc. – with an average degree of certainty.

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A PROTOTYPE TESTING RESULTS

Ваш настрій - щастя, Ви посміхаєтесь на 86.8%, Ви виглядаєте на 21.0 років, Ви вусаті на 10.0%, бородаті - на 10.0% та "бакенбардаті" на 10.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі не нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб чимось закритий, на Вас головний убор, Ваше волосся для камери невидиме.

Ваш настрій - нейтральний, Ви посміхаєтесь на 0.0%, Ви виглядаєте на 23.0 років, Ви вусаті на 10.0%, бородаті - на 10.0% та "бакенбардаті" на 10.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі не нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 86.0%, колір Вашого волосся - сірий.

Ваш настрій - нейтральний, Ви посміхаєтесь на 12.1%, Ви виглядаєте на 22.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 79.0%, колір Вашого волосся - блондинистий.

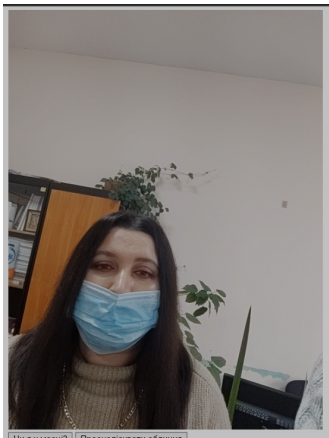
Ваш настрій - нейтральний, Ви посміхаєтесь на 8.7%, Ви виглядаєте на 26.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи не нафарбовані, Ваш рот чимось закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, на Вас маска, Ваше волосся для камери видиме, густина Вашого волосся - 77.0%, колір Вашого волосся - чорний.

Ваш настрій - нейтральний, Ви посміхаєтесь на 29.299999999999997%, Ви виглядаєте на 23.0 років, Ви вусаті на 10.0%, бородаті - на 10.0% та "бакенбардаті" на 10.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі не нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб чимось закритий, на Вас головний убор, Ваше волосся для камери невидиме.

Ваш настрій - смуток, Ви посміхаєтесь на 0.0%, Ви виглядаєте на 27.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи не нафарбовані, Ваш рот чимось закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, на Вас маска, Ваше волосся для камери видиме, густина Вашого волосся - 89.0%, колір Вашого волосся - блондинистий.

Ваш настрій - щастя, Ви посміхаєтесь на 60.099999999999994%, Ви виглядаєте на 34.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 99.0%, колір Вашого волосся - рудий.

Ваш настрій - нейтральний, Ви посміхаєтесь на 12.6%, Ви виглядаєте на 37.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 98.0%, колір Вашого волосся - чорний.

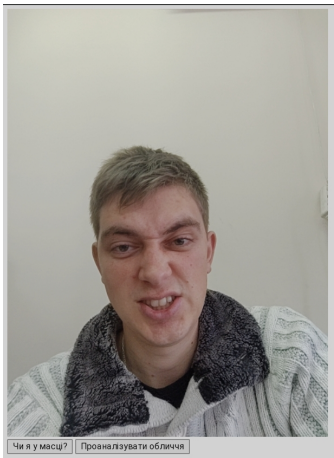


Ваш настрій - нейтральний, Ви посміхаєтесь на 0.6%, Ви виглядаєте на 30.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи не нафарбовані, Ваш рот чимось закритий, Ваші очі нічим не закриті, Ваш лоб чимось закритий, на Вас головний убор, маска, Ваше волосся для камери невидиме.

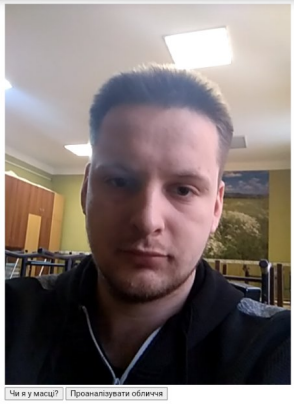
Ваш настрій - нейтральний, Ви посміхаєтесь на 0.3%, Ви виглядаєте на 28.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи не нафарбовані, Ваш рот чимось закритий, Ваші очі нічим не закриті, Ваш лоб чимось закритий, на Вас головний убор, маска, Ваше волосся для камери невидиме.

Ваш настрій - нейтральний, Ви посміхаєтесь на 6.6000000000000005%, Ви виглядаєте на 30.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі не нафарбовані, Ваші губи не нафарбовані, Ваш рот чимось закритий, Ваші очі нічим не закриті, Ваш лоб чимось закритий, на Вас головний убор, маска, Ваше волосся для камери невидиме.

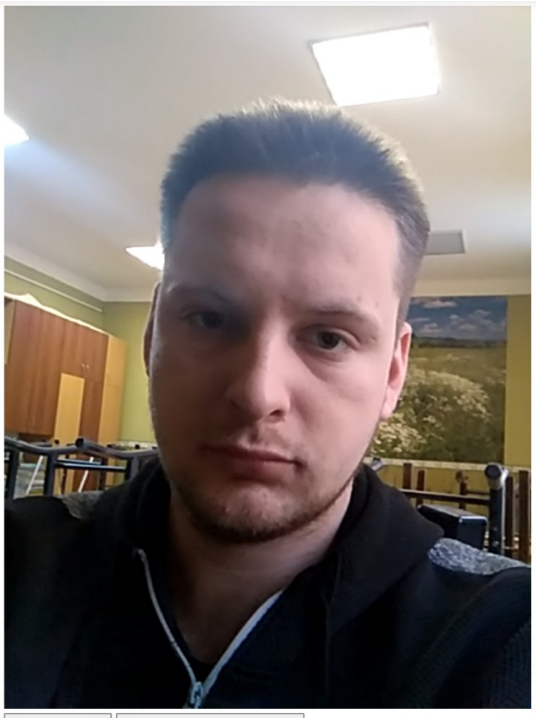
Ваш настрій - смуток, Ви
0.0%, Ви виглядаєте на 3
на 10.0%, бородаті - на 1
"бакенбардаті" на 10.0%,
чоловіча, на Вас немає о
не нафарбовані, Ваші гу
Ваш рот нічим не закри
нічим не закриті, Ваш л
закритий, Ваше волосся
видиме, густина Вашого



Ваш настрій - гнів, Ви посміхаєтесь на 38.1%, Ви виглядаєте на 27.0 років, Ви вусаті на 10.0%, бородаті - на 10.0% та "бакенбардаті" на 10.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші
не нафарбовані, Ваші губи не нафарбов
Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 40.0%
колір Вашого волосся - сірий.

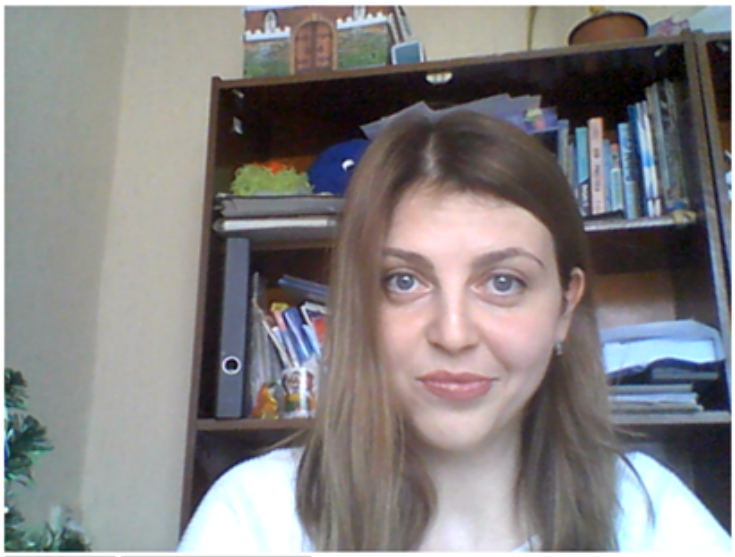


Ваш настрій - нейтральний, Ви посміхаєтесь на 0.3%, Ви виглядаєте на 24.0 років, Ви вусаті на 10.0%, бородаті - на 10.0% та "бакенбардаті" на 10.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі не нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 49.0%, колір Вашого волосся - сірий.



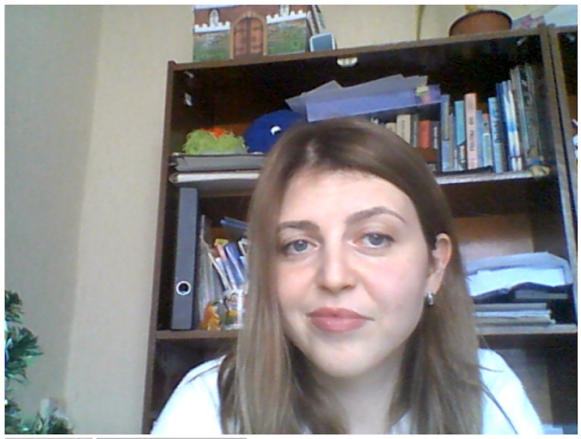
Чи я у масці? Проаналізувати обличчя

На Вашому обличчі немає маски, Ваші ріт та ніс не закриті



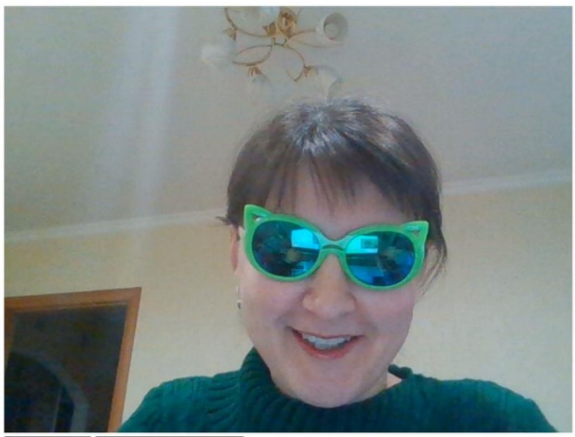
Чи я у масці? Проаналізувати обличчя

На Вашому обличчі немає маски, Ваші ріт та ніс не закриті



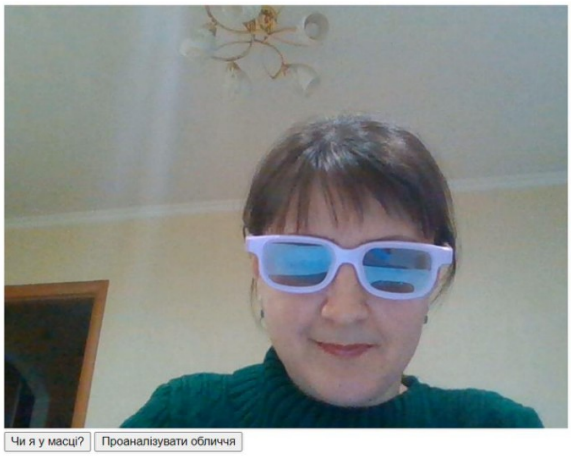
Чи я у масці? Проаналізувати обличчя

Ваш настрій - презирство, Ви посміхаєтесь на 5.4%, Ви виглядаєте на 32.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 91.0%, колір Вашого волосся - коричневий.



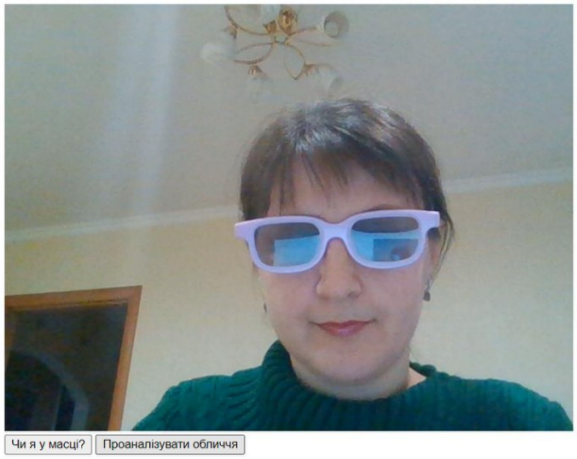
Чи я у масці? Проаналізувати обличчя

Ваш настрій - щастя, Ви посміхаєтесь на 100.0%, Ви виглядаєте на 41.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас окуляри для плавання, Ваші очі не нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб чимось закритий, на Вас окуляри, головний убор, Ваше волосся для камери невидиме.



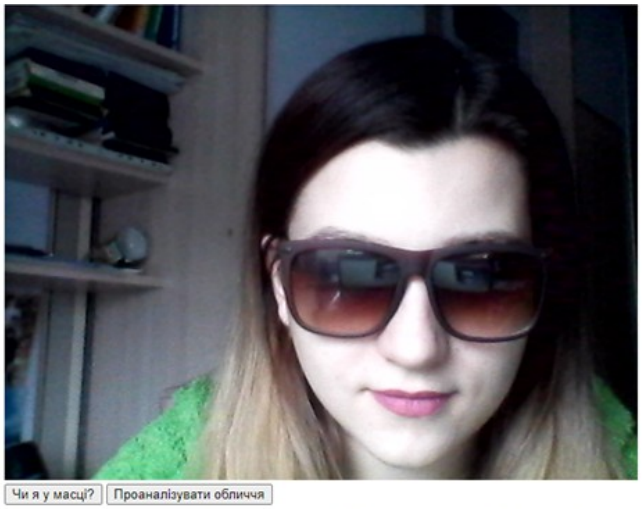
Чи я у масці? Проаналізувати обличчя

Ваш настрій - щастя, Ви посміхаєтесь на 100.0%, Ви виглядаєте на 35.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас сонцезхисні окуляри, Ваші очі нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, на Вас окуляри, Ваше волосся для камери видиме, густина Вашого волосся - 84.0%, колір Вашого волосся - чорний.



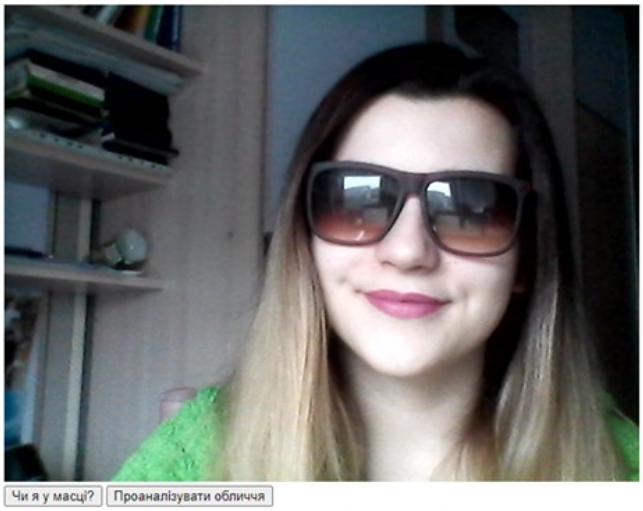
Чи я у масці? Проаналізувати обличчя

Ваш настрій - нейтральний, Ви посміхаєтесь на 5.3%, Ви виглядаєте на 37.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас сонцезхисні окуляри, Ваші очі нафарбовані, Ваші губи нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, на Вас окуляри, Ваше волосся для камери видиме, густина Вашого волосся - 84.0%, колір Вашого волосся - коричневий.



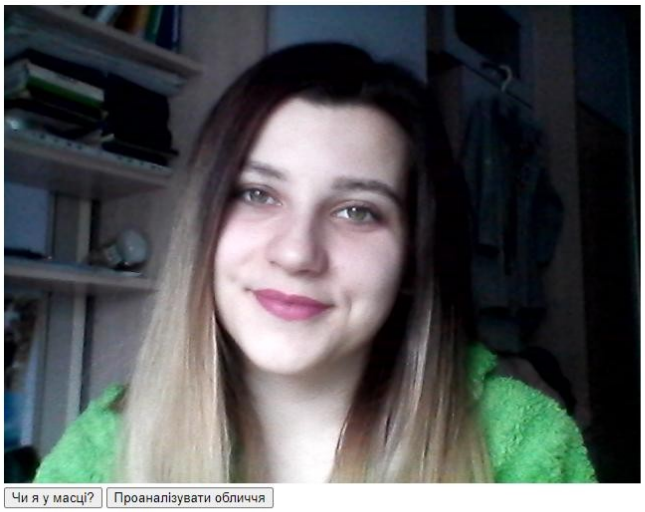
Чи я у масці? Проаналізувати обличчя

Ваш настрій - нейтральний, Ви посміхаєтесь на 0.0%, Ви виглядаєте на 25.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас сонцезхисні окуляри, Ваші очі нафарбовані, Ваші губи нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, на Вас окуляри, Ваше волосся для камери видиме, густина Вашого волосся - 96.0%, колір Вашого волосся - чорний.



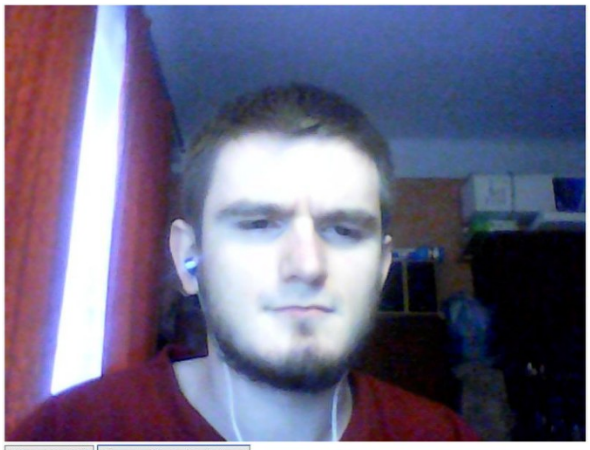
Чи я у масці? Проаналізувати обличчя

Ваш настрій - щастя, Ви посміхаєтесь на 99.5%, Ви виглядаєте на 22.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас сонцезхисні окуляри, Ваші очі нафарбовані, Ваші губи нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, на Вас окуляри, Ваше волосся для камери видиме, густина Вашого волосся - 96.0%, колір Вашого волосся - чорний.



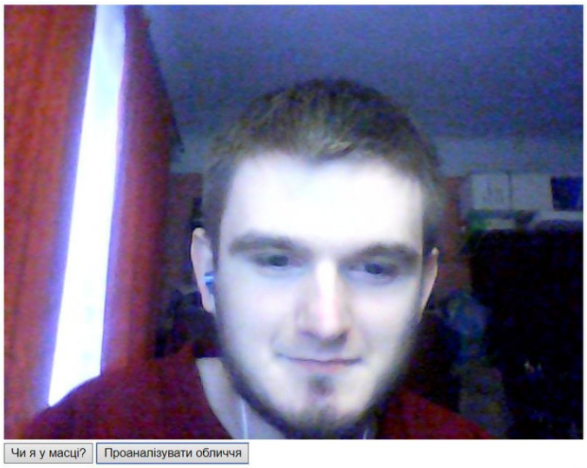
Чи я у масці? Проаналізувати обличчя

Ваш настрій - щастя, Ви посміхаєтесь на 99.8%, Ви виглядаєте на 21.0 років, Ви вусаті на 0.0%, бородаті - на 0.0% та "бакенбардаті" на 0.0%, Ваша стать - жіноча, на Вас немає окулярів, Ваші очі нафарбовані, Ваші губи нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 100.0%, колір Вашого волосся - чорний.



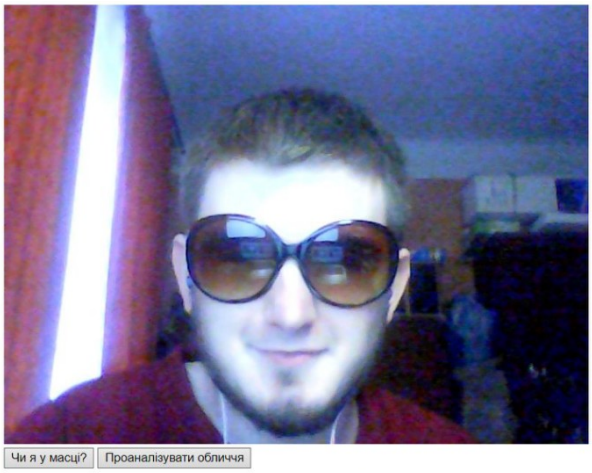
Чи я у масці? Проаналізувати обличчя

Ваш настрій - щастя, Ви посміхаєтесь на 78.60000000000001%, Ви виглядаєте на 30.0 років, Ви вусаті на 10.0%, бородаті - на 10.0% та "бакенбардаті" на 40.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі не нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 98.0%, колір Вашого волосся - рудий.



Чи я у масці? Проаналізувати обличчя

Ваш настрій - щастя, Ви посміхаєтесь на 78.60000000000001%, Ви виглядаєте на 30.0 років, Ви вусаті на 10.0%, бородаті - на 10.0% та "бакенбардаті" на 40.0%, Ваша стать - чоловіча, на Вас немає окулярів, Ваші очі не нафарбовані, Ваші губи не нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, Ваше волосся для камери видиме, густина Вашого волосся - 98.0%, колір Вашого волосся - рудий.



Чи я у масці? Проаналізувати обличчя

Ваш настрій - нейтральний, Ви посміхаєтесь на 32.0%, Ви виглядаєте на 28.0 років, Ви вусаті на 10.0%, бородаті - на 10.0% та "бакенбардаті" на 10.0%, Ваша стать - чоловіча, на Вас сонцезхисні окуляри, Ваші очі нафарбовані, Ваші губи нафарбовані, Ваш рот нічим не закритий, Ваші очі нічим не закриті, Ваш лоб нічим не закритий, на Вас окуляри, Ваше волосся для камери видиме, густина Вашого волосся - 74.0%, колір Вашого волосся - коричневий.

Development of AR Application to Promote the Historical Past of the Native Land

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ABSTRACT

The article demonstrates the possibilities of using augmented reality technology to create a software application in the field of local lore "Monuments of the city of Zhytomyr". The AR program "Monuments of the City of Zhytomyr" was implemented, the main task of which is to simplify the submission of information about people whose monuments are located in the city of Zhytomyr. To do this, nine 3D models were created, for each of which information was selected about the person to whom the monument is dedicated. Photographs of the sites were also taken for further use as triggers. Audio help is recorded for each model. The proposed development can be used to promote tourism and the history of the city. Augmented reality technology in the educational process has only just begun to develop and be increasingly used. We believe that this software application can be used in the educational process for such disciplines as "Local History", "Culturology", etc.

CCS CONCEPTS

• **Applied computing** → **Education**; **E-learning**; **Arts and humanities**; • **Human-centered computing** → **Mixed / augmented reality**; **Mixed / augmented reality**.

KEYWORDS

Augmented reality, Vuforia, 3D models

DHW 2021, December 23, 2021, Kyiv, Ukraine

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1 INTRODUCTION

At the present stage of spiritual revival of independent Ukraine, an integral part of the social movement and research is historical local lore, aimed at reviving spirituality, historical memory, the formation of citizens and especially young people interest in their homeland, national patriotism, respect for people, responsibility for the preservation of historical and cultural heritage. Local lore remains an underdeveloped branch of science, as evidenced by the lack of general theoretical developments and terminology in this area.

The use of augmented reality technology in the educational process will undoubtedly increase the motivation of pupils and students, as well as increase the level of assimilation of information due to the diversity and interactivity of its visual presentation. In addition, the use of 3D models will be more interesting for primary school students.

The application of augmented reality is not only a new way to improve the local history of the city. The use of augmented reality technology in the tourism industry will increase the influx of tourists and interest the local population in the study of their city and awareness of the famous places of Zhytomyr and the people of the Zhytomyr region. Local lore is a social movement, the main tasks of which are practical actions to preserve the historical and cultural heritage of the region, the revival of spirituality, historical memory. Zhytomyr Scientific and Local History Society attaches

great importance to work with students and pupils and their involvement in local history activities to promote knowledge about the region.

The purpose of this study is to use augmented reality technology to create a software application that can be used in the educational process and popularization of the historical past of the native land. And also to increase the flow of tourists to the city of Zhytomyr, increase the interest of the authorities and the active population in the development of the city and support the modern vector of development of local lore of the city and region.

2 THEORETICAL BACKGROUND

2.1 Related Work

Morkun et al. [8] consider the possibilities of using virtual reality as a visualization tool that facilitates the wider adoption of ultrasound technologies and visualizes the propagation of ultrasound in heterogeneous environments.

According to Shyshkina and Marienko [12], the open science cloud structure has been shown to include augmented reality as an open science platform. Kramarenko et al. [6] researched to improve the methods of teaching mathematics using cloud technologies and augmented reality.

Nechypurenko et al. [9] analyzed the possibilities and described the experience in the development and implementation of augmented reality technologies to support the teaching of chemistry in higher educational institutions of Ukraine. As a result of the study, it was found that augmented reality technologies have tremendous potential for increasing the effectiveness of independent work of students in the study of chemistry, providing distance and continuing education.

Oleksiuk and Oleksiuk [11] described that the use of augmented reality makes it possible to increase the realism of the study; provides an emotional and educational experience. All this contributes to the involvement of students in systematic learning and creates new opportunities for joint learning, develops new representations of real objects.

Nezhyva et al. [10] substantiated the prospect of augmented reality technology for mastering the artistic image of the world of literary work, the relevance of use of AR to modern educational challenges, and also demonstrated the possibility of immersion into the space of artistic creation and activation of students' imagination with the help of AR applications.

The current state and relevance of the use of augmented reality technology as an appropriate means of improving the educational process are considered by Midak et al. [7]. Hordiienko et al. [3] consider the possibilities of using augmented reality technology are analyzed and the software model of the solar system model is created. The developed software application demonstrates the behavior of solar system objects in detail with augmented reality technology [3].

Krainyk et al. [5] describes the developed application-guide "Historical Reference" based on the technology of augmented reality.

Because of the research described in the article [4], the growth of the professional level of students with augmented reality technologies has been proved. The use of augmented reality technologies increases motivation for learning increases the level of assimilation of information due to the diversity and interactivity of its visual presentation [4].

Denysenko et al. [2] have considered the peculiarities of training future teachers to organize virtual tours of augmented reality in the educational process of educational institutions. Emphasis is placed on the importance of media education training for future teachers.

2.2 Augmented Reality Technology

Today it is important to use AR technology in various fields of education. The potential of AR for education is just beginning to unfold, as the ability to interact with virtual and real objects makes the learning process more exciting, visual, and dynamic.

The specificity of augmented reality technology is the visual combination of the world of real objects around us with the world of virtual objects created by man. This is created by overlaying the created 3D objects on top of the video signal from the camera.

The basis of augmented reality technology is an optical tracking system. This means that the "eyes" of the system become the camera, and the "hands" – the markers. The camera recognizes markers in the real world, "transfers" them to the virtual environment, imposes one layer of reality on another, and thus creates a world of augmented reality. There are three directions in the development of AR technology: markerless; spatial; marker-based.

Markerless technology works according to special recognition algorithms: a virtual "grid" is superimposed on the landscape fixed by the camera. On this grid, software algorithms find reference points that determine the exact location to which the virtual model will be "tied". The advantage of this technology is that real-world objects serve as markers in themselves and do not require special visual identifiers.

Spatial technology uses GPS, gyroscope, and compass data built into a mobile phone, and the location of a virtual object is determined by coordinates in space. Activation of the augmented reality program occurs when the coordinates that are in the program with the coordinates of the user. Marker-based technology is convenient in that it is easier to recognize by the camera and gives a tighter binding to the location for the virtual model. This technology is much more reliable than markerless and works almost without fail.

Today, the following SDKs are relevant for the development of applications in the field of augmented reality: ARKit, ARCore, AR Foundation, Vuforia. ARCore is a popular SDK for creating applications for smartphones and tablets. It allows you to develop cross-platform AR applications for both Android and iOS. ARCore is based on two elements: position tracking and object recognition. AR Foundation includes basic ARKit, ARCore, Magic Leap, and HoloLens functions, as well as unique Unity functions, allowing you to create full-fledged AR applications. Vuforia is one of the most popular SDKs for developing augmented reality applications. Thanks to the availability of the API through Unity, Vuforia can be used to develop your applications for iOS and Android. It is also considered a complete SDK with a large set of features for AR applications. The most important feature of Vuforia is that it uses ARCore / ARKit technology if the equipment it runs on supports it, otherwise Vuforia uses its AR technology and a propulsion system known as a software solution without dependent hardware.

2.3 Vuforia Marker Technology

Marker technology uses static markers to activate a 3D object. Through the camera, the program recognizes the marker or object in front of it and then displays the created 3D model on top of the marker or object. Markers can be: QR codes, generated points on the image, images, brand logos, etc. Currently, technology allows you to recognize 2D or 3D markers.

To use marker technology, you can use photos, pictures of good quality. To use photos, you need to create a database on the Vuforia website. Photos or pictures must be less than 2 megabytes in size. When uploading photos, each received a rating, the value of which shows how easily and quickly the photos will be recognized when using them. It is better not to use a rating of 1–2 stars because the speed and quality of recognition are very low and incorrect reviews of the program are possible, so it is better to change photos with such a rating. As you can see in figure 1, the photos have been rated 4–5 stars, which means that their recognition in the future software application will not take much time and will show the correct 3D model and play the correct audio file with information about the monument.

Target Name	Type	Rating	Status	Date Modified
Taras	Single Image	★★★★★	Active	Jan 08, 2020 14:13
Franko	Single Image	★★★★☆	Active	Jan 08, 2020 14:11
Pshkin	Single Image	★★★★★	Active	Jan 08, 2020 14:11
Sergey	Single Image	★★★★★	Active	Jan 08, 2020 14:08
Olhech	Single Image	★★★★★	Active	Jan 08, 2020 14:07

Figure 1: Photobank.

An example of a photograph with markers applied to it is shown in figure 2. Yellow crosses are markers that the program will look for when scanning an image to search its database for the corresponding pattern and then display a 3D model on top of the image. Vuforia Engine is a suite of software development tools (SDKs) for creating augmented reality applications.

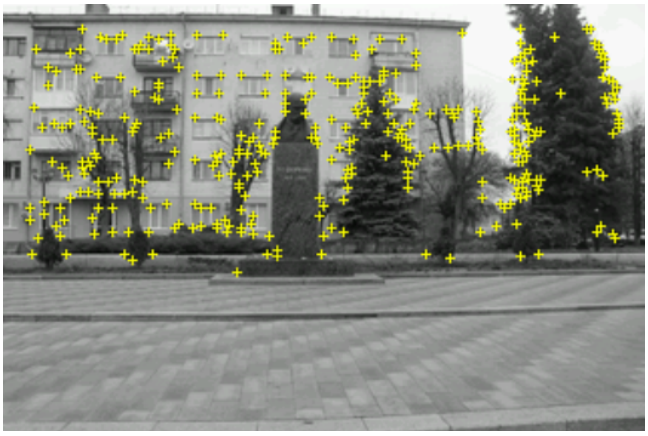

Figure 2: Recognized markers.

All plugins and functionality of the platform are free but include Vuforia watermarks. The restrictions only apply to VuMark and the number of interactions with the cloud database. A paid plan without watermarks and with a certain amount of cloud recognition costs $ 99 per month.

Vuforia provides application programming interfaces in C++, Java, Objective-C, and .NET through integration with Unity gaming. Thus, the SDK supports the development of native AR applications for iOS and Android, while assuming development in Unity, the results of which can be easily transferred to both platforms. The augmented reality applications created on the Vuforia platform are compatible with a wide range of devices, including iPhone, iPad, Android-based smartphones and tablets.

2.4 3D Modeling

Blender includes a large arsenal of tools for creating 3D graphics. So, in Blender it is possible to operate systems of particles, to control weights of separate particles at texturing, to apply guides at animation, and to use external forces, for example, wind. In addition, the program has a fluid simulator, which opens up huge opportunities for the user to create the effects of fluids, such as smoke or liquids. In real-time, the user can calculate physical tasks, such as simulating the behavior of soft bodies. The program allows you to edit NURBS surfaces, use metabolites and adjust the equipment of the characters.

All 3D models are developed in Blender. A model of the face was built in detail, on which textures were superimposed close to the real ones, hair was created due to the function of particles. The whole model consists of separately made parts: eyes, hair (mustache), and the face itself. Creating a 3D model consists of several stages. The first stage is the creation of a grid of faces (figure 3), a set of vertices, edges, and polygons that make up one 3D object with the addition of symmetry specifiers and units. The second stage is to create a 3D model of the hair. The third stage includes the overlay of textures and materials on the 3D model (figure 4). After making some settings, for the created model to be displayed correctly in Unity, we get the finished model, and export the model to FBX format.

A total of nine models were created: monuments to the Holodomor Victims and Heroes of the Heavenly Hundred, Taras Shevchenko, Ivan Franko, Alexander Pushkin, Sergei Korolyov, Oleg Olzhich, Lariosik, and B. M. Lyatoshynsky.

3 RESULTS

3.1 Design and Implementation of Individual Modules of the System

Figure 5 presents the Use Case Diagram which shows the relationship between actors and precedents and is an integral part of the precedent model.

Figure 6 shows a diagram of the project elements.

The diagram (figure 6) shows that the project created an AR Camera that will display images. When you get to Camera Image Target, the desired model will be displayed, which is a child element of Camera Image Target. Vuforia methods were used to implement the software application. The application uses standard Vuforia techniques, which use computer vision and flat image tracking technology. The Vuforia Engine platform provides the ability to

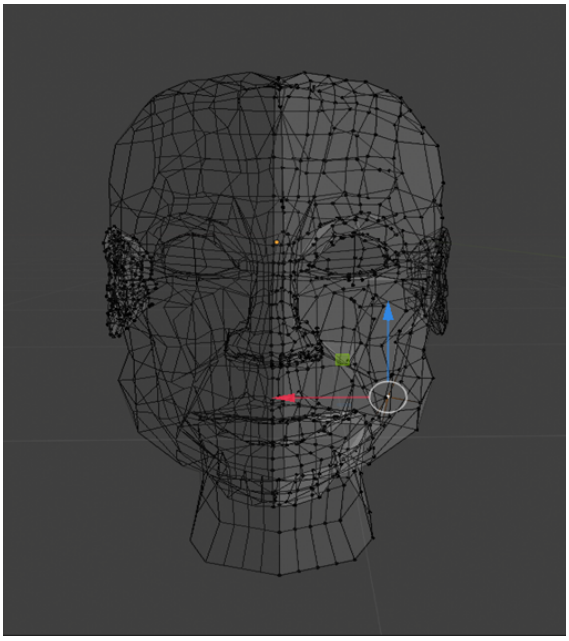

Figure 3: Face grid.

Figure 4: A ready-made version of hair and texture.

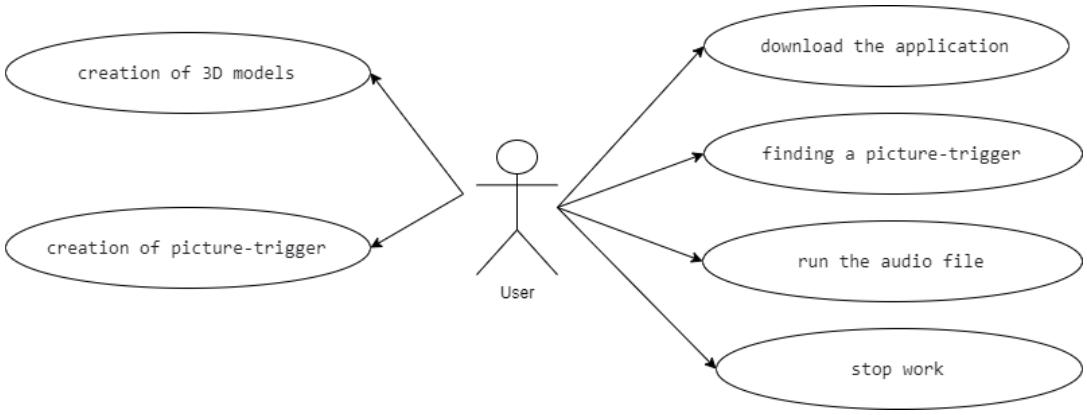

Figure 5: Use Case Diagram.

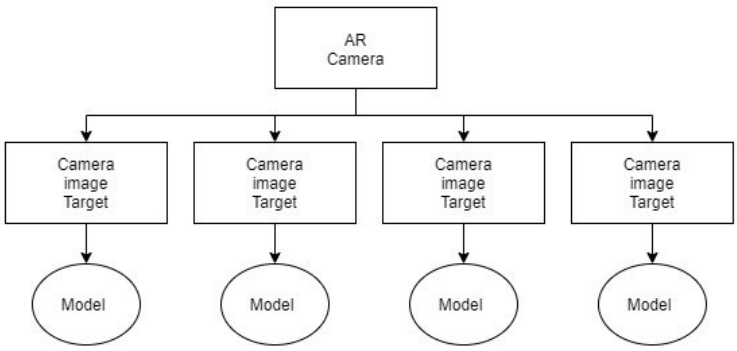

Figure 6: Scheme of project elements.

Figure 7: Display when hovering over the desired photo.

Figure 8: Taras Shevchenko.

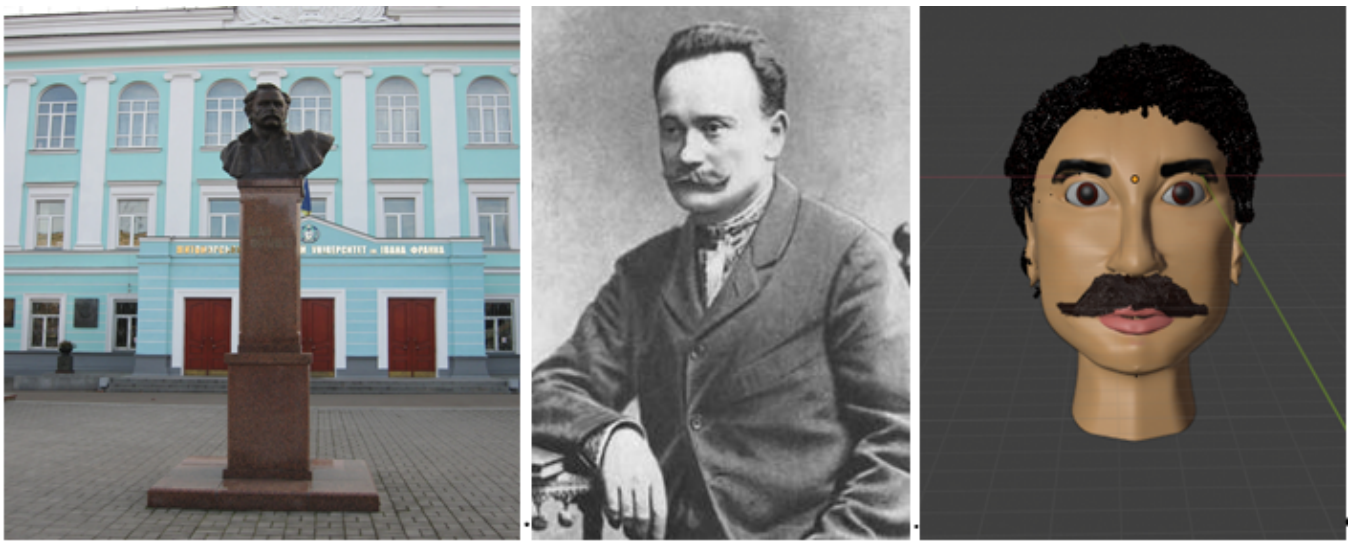

Figure 9: Ivan Franko.

Figure 10: Alexander Pushkin.

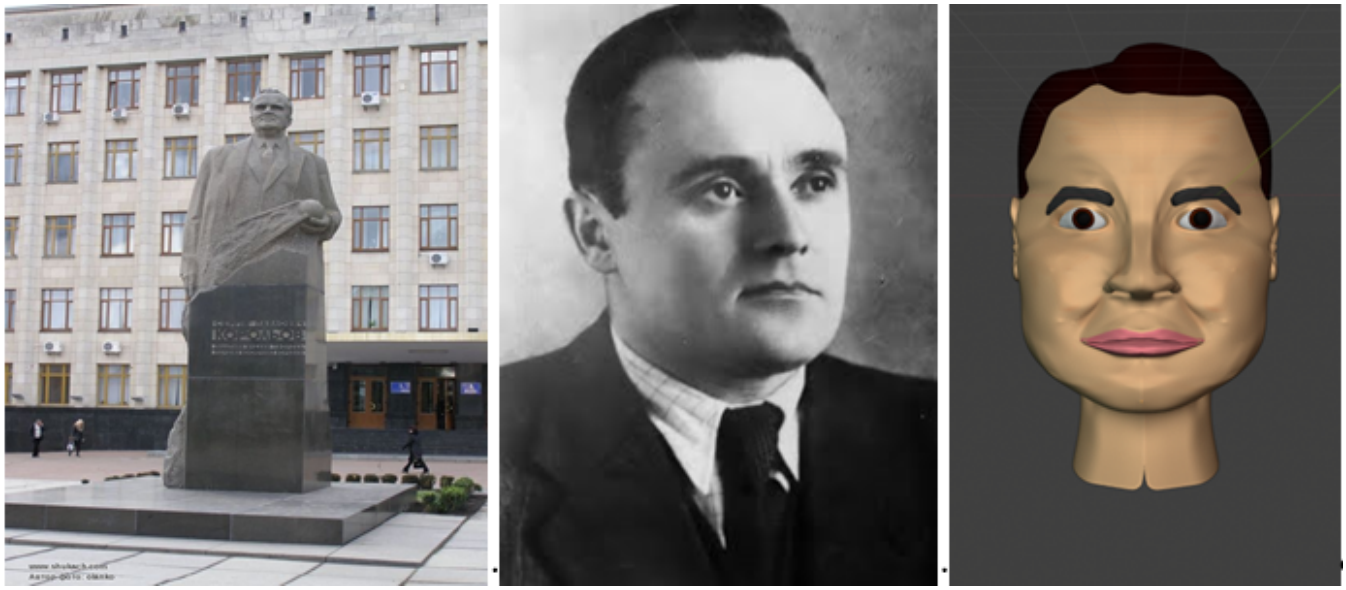

Figure 11: Sergei Korolev.

freely use the created methods depending on the needs of developers [1].

Vuforia first detects "feature points" in the target image and then uses that data to compare the target image with the model. The OnTrackableStatusChanged method is used to work with the image, namely to find markers on the image. It records the state of the marker change. The HandleTrackableStatusChanged method performs actions depending on the change in the status of the token, if the corresponding tokens are found then the OnTrackingFound method is called, if not the OnTrackingLost method. The OnTrackingFound method is responsible for playing the video stream, and OnTrackingLost is responsible for pausing the video stream. The ShouldBeRendered method is used to obtain a model image, which determines whether the object needs to be rendered.

3.2 The Overview of Application

The application is implemented using the Unity engine using AR technology from Vuforia SDK. The software application has a fairly simple interface. Control is carried out using the camera of the smartphone on which the application is installed, and pictures of the triggers on which the user must point the camera. After

hovering over the image, a model of a specific sight appears on the screen and an audio file with information is launched.

Nine 3D models were created for the application, and photos of the places were taken for further use as triggers. For each model, a text about the person to whom the monument is dedicated was selected. The Zhytomyr monument to Taras Shevchenko (figure 8) is located near the city center in a small park on the corner of Velyka Berdychivska and Shevchenko streets.

Audio text: Taras Shevchenko (also known as Kobzar; February 25 (March 9) 1814, Moryntsi village, Kyiv province, Russian Empire (now Zvenigorod district, Cherkasy region, Ukraine) – February 26 (March 10) 1861, St. Petersburg, Russian Empire) is Ukrainian poet, writer (playwright, novelist), artist (painter, engraver), public and political figure. National hero and symbol of Ukraine.

3D models were also created for the monument to Ivan Franko (figure 9) located on Velyka Berdychivska Street, near the Ivan Franko State University, the monument to Alexander Pushkin (figure 10) located on the Old Boulevard, the monument to Sergei Korolev (figure 11), located on Dmitrovskaya Street, near the National Museum of Cosmonautics named after S. P. Korolev.

Audio references to historical sites were recorded using Audacity. The recording is reproduced when the model is turned off on the screen to provide information to the user conveniently and simply for its assimilation and for clarity to whom the monument is dedicated. The main task of the application is to simplify the presentation of initial information about people whose monuments are located in our city.

4 CONCLUSIONS

Augmented reality opens new perspectives for work, study, games, and interaction with the outside world. It is interesting for each person to know where we live and what is the history of our region. Not the last place in the comprehensive knowledge of the region is played by tourism. The problem of methodological support of local lore has been relevant since the independence of Ukraine. Thanks to the proposed software product, you can learn about outstanding people or update your knowledge about them.

Thus, AR Monuments of the City of Zhytomyr is a complete software product that can be used by people from all walks of life and at any level of knowledge. Today, this software product is a tool for teachers, for the greater interest of students. He successfully passed the approbation in the secondary school No. 21 of Zhytomyr. The concept of augmented reality opportunities opens wide prospects for the introduction of educational innovations in all forms of organization of the educational process.

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Utilization of E-Learning System for Innovative Methods Implementation in Humanities Pedagogy

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ABSTRACT

The article presents the results of the research on e-learning system utilization at Borys Grinchenko Kyiv University by humanities students and teachers. Digitalization of humanities pedagogy is an integral part of the educational process today and e-learning systems belong to the most powerful digital instruments used at higher education institutions. Therefore, the topic of digital humanities implementation in existing at universities e-learning systems is high on the agenda. In particular, attention should be paid to the possibility of innovative teaching methods utilization with the help of the e-learning system resources. The authors focus on the capabilities of LMS Moodle for implementation of collaboration, flipped classroom technology, peer assessment and project-based learning. Utilization of such activities as Workshop, Wiki, Google Meet for Moodle as well as instruments and settings (embedded video, group submission) for implementation of innovative teaching methods are considered. The correlation between the request of humanities teachers and students and Moodle LMS options for its implementation is shown.Increased use of the e-learning system for innovative teaching methods provision is highlighted as a development area for humanities teachers.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in collaborative and social computing**;

KEYWORDS

E-learning system, Moodle, Digital humanities, Innovative methods of teaching, Collaboration, Fipped classroom, Project based learning

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DHW 2021, December 23, 2021, Kyiv, Ukraine

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https://doi.org/10.1145/3526242.3526262

1 INTRODUCTION

Digital humanities are one of the cutting edge knowledge spheres that combine digital science and humanities. Having started their history around 40 years ago from creating digital archives and databases for texts, art pieces and other materials, they developed into wider and more integrated usage including communication and collaboration, computer-based statistical analysis, search and retrieval, topic modelling, and data visualization [2].

Thanks to the design and utilization of new software and teaching techniques, digital humanities allow the implementation of new teaching methods that combine digitalization and cultural heritage study [13]. At the same time, the proportion of distant learning in higher education grows, which brings up the issue of digital humanities and e-learning combination [4].

Taking into consideration the importance of e-learning for higher education institutions and e-learning systems for arrangement and maintenance of educational process in particular, scientists started to pay attention to the above-mentioned issue. For example, Teixeira et al. [12] with co-authors analyse capabilities of Blackboard for digital humanities implementation, Shakil et al. [11] address the problems of e-learning in digital humanities pedagogy. However, digital education environment often borrows the teacher-centred model typical for traditional classroom learning where little attention is paid to students' collaboration, peer review and opportunities for students to build their own educational trajectory [10].

We focus our attention on the capabilities of the e-learning system for innovative teaching methods based on the case of Borys Grinchenko Kyiv University (BGKU). The novelty is represented by the analysis of less commonly used Moodle activities for implementation of digital humanities pedagogy methods. In particular, the e-learning system activities are being considered in the context of blended learning (flipped classroom), formative assessment, project-based learning implementation.

The survey taken as a background for the research has shown that humanities teachers use the e-learning system to provide innovative teaching methods. However, the activities used for that are very limited. Thus, the question of increased use of the system is of high interest.

2 E-LEARNING SYSTEM DESCRIPTION

The e-learning system plays an important role in the educational process at Borys Grinchenko Kyiv University. Based on the students survey results, where 168 respondents from five different institutes/faculties took part, 78% of the surveyed students noted that they constantly use the e-learning system and 15,5% of the students gave the answer "often" to the question (figure 1).

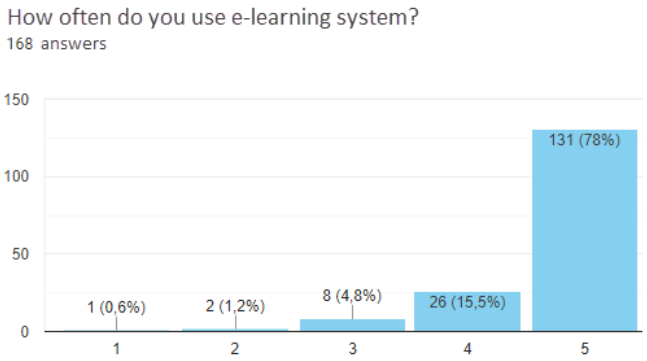

Figure 1: Frequency of the e-learning system usage by students.

Similar results were shown in the survey of the university teachers, where 126 respondents from seven structural institutions of the university with humanities specialities took part – Institute of Human Sciences, Institute of Journalism, Institute of Philology, Pedagogical institute, Institute of Arts, Faculty of History and Philosophy and Faculty of Law and International Relations. 80,2% of the respondents answered that they constantly use the e-learning system and 12,7% of surveyed teachers noted that they often work in the e-learning system (figure 2).

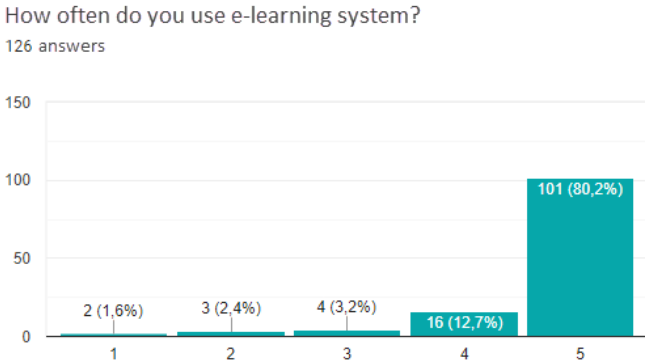

Figure 2: Frequency of the e-learning system usage by teachers.

Similar to many other higher education institutions, at Borys Grinchenko Kyiv University LMS Moodle is used for e-learning arrangement as it is an open source system and has many capabilities to be adopted to the needs of the higher education institution [8]. With the beginning of the COVID-19 pandemic when education had to move online mostly, the e-learning system of the university has been modernized in the way so that it could provide for the needs of all educational process participants at its best [3, 7]. In particular, the arrangement of electronic learning courses (ELC) according to the educational programs was introduced, which organises access of students to the information important for them according to the results of the survey including arrangement of academic disciplines by semesters, forms of control in each semester, links to ILCs that support each discipline and progress information on all subjects (figure 3).

Besides, in Dashboard the following blocks are added: Schedule, Tools for communications, Tools for collaboration, E-portfolio, University library, Scientific publications search, etc. Both students and teachers mark them useful for educational process organization (figure 4, 5).

Among the main advantages of e-learning system utilization there is access at any time and at any location, possibility to gather all learning materials at one place, statistical data on progress and results of the educational process. We widened them with possibilities to arrange communication and collaboration from Dashboard thanks to the blocks of the same name as well as with additional resource Google Meet for Moodle in ELC. Communication and collaboration are important parts of the educational process for humanities in particular. Teaching with the accent on collaboration allows a teacher to shift the focus from teacher-centred work model to student-centred where a teacher acts more like a facilitator than as a lecturer. At the same time, such approach allows gaining knowledge not only from the lecturer but also from the process of work with peers [6].

The resource Google Meet for Moodle makes it possible to arrange one time sessions as well as regular online meetings (figure 6, 7) with the help of corresponding settings. Links to the recordings of the conferences are saved in the resource added to the ELC that provides students and teachers with the possibility to return to it when needed.

The e-learning system of the university is not only a storage for learning materials. It is an important element of educational process arrangement, in particular, in teacher-student interaction and communication in assignments, collection and demonstration of statistical data including students' progress in ELC. The survey shows that the e-learning system is not very frequently used as a source of links to online lessons, but more than a half of the surveyed students interact with ELCs materials and 84,5% of respondents constantly submit assignments in ELCs (figure 8, 9).

At the same time, the data of the surveys of both teachers and students show that the e-learning system is not frequently used for communication. It is confirmed by the choice of activities and resources for work in ELC, where teachers prefer Assignments, Lessons, Quizzes, Pages, Files and URLs (figure 10).

That is why the authors see mastering tools that allow increasing the level of communication and collaboration in ELCs as a perspective and important direction of university teachers' digital competence development. This coincides with the teachers' need in training as 63,5% of teachers marked the activity Workshop as the one which requires additional training (figure 11).

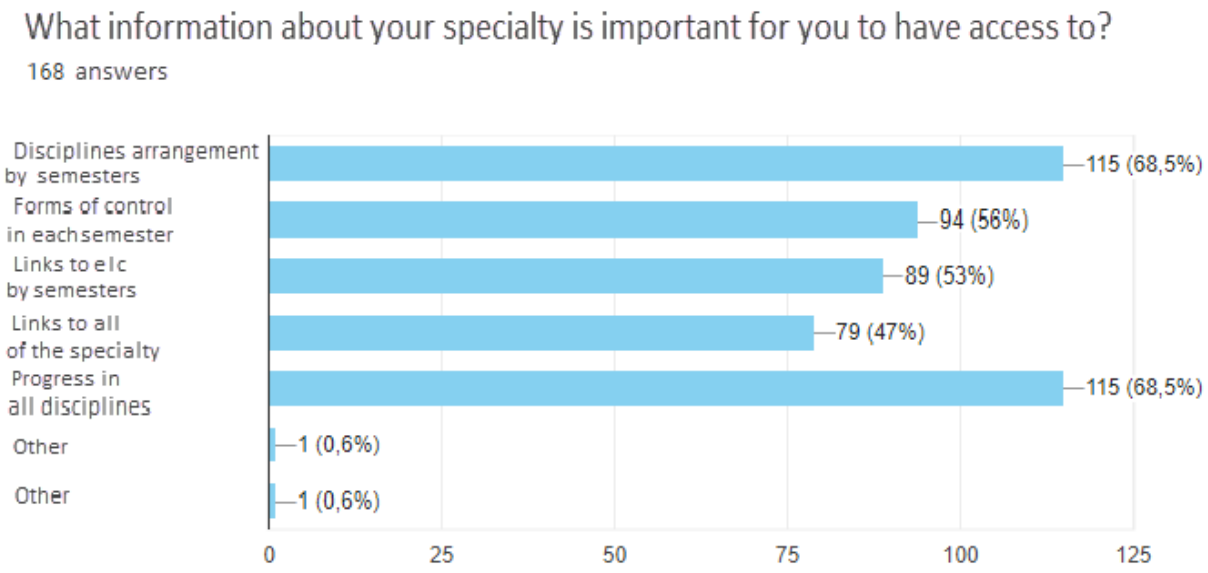

Figure 3: Important information in the e-learning system for students.

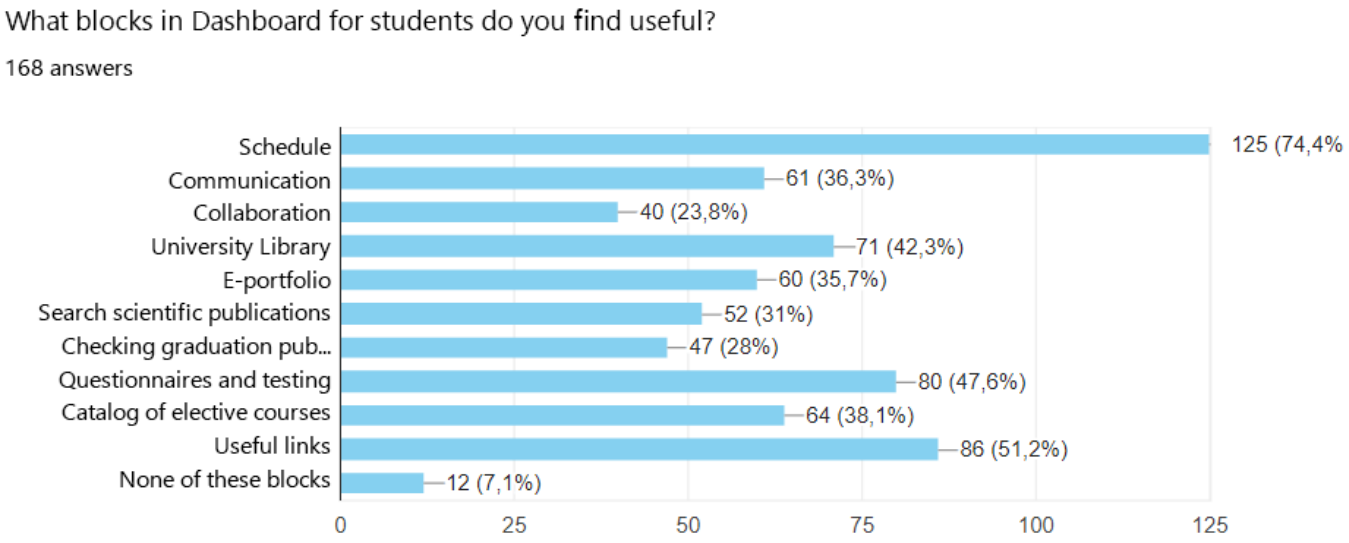

Figure 4: Useful blocks in Dashboard for students.

3 EXAMPLES OF INNOVATIVE TEACHING METHODS IMPLEMENTATION

Activities and resources of LMS Moodle applied at BGKU e-learning system allow implementation of such innovative teaching methods as blended learning, problem-based learning, project-based learning, formative assessment, gamification, case method, etc.

Formally, a humanities workshop is already “flipped”. The way used for arrangement of an interactive “flipping” for technical disciplines is a usual lesson for humanities [1]. That is why implementation of such learning activities in the e-learning system is an important part of humanities pedagogy digitalization.

Most activities and resources of LMS Moodle allow implementation of flipped classroom pre-phase with the help of embedded video (figure 12).

According to the teachers survey more than a half of respondents use blended learning in their pedagogical practice (figure 13). However, the activities they use for this purpose are mostly limited to Assignments and Lessons (figure 14).

Utilization of other activities could expand teachers’ possibilities in the educational process arrangement. Thus, the activity Workshop allows teachers to implement both “flipped” classroom method and peer-to-peer assessment. Work with the activity Workshop has several phases: the setup phase, the submission phase, the

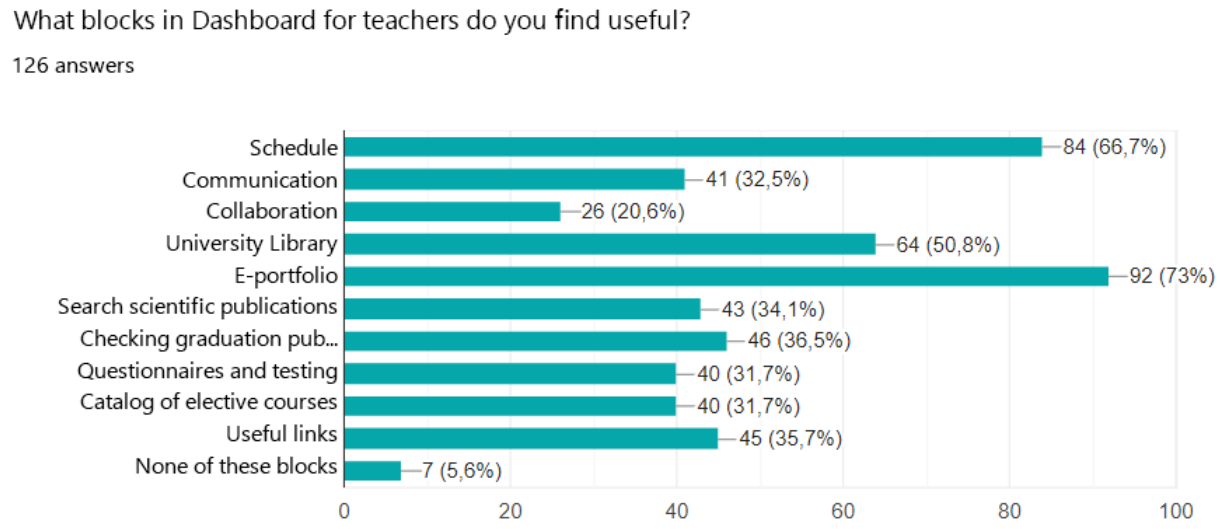

Figure 5: Useful blocks in Dashboard for teachers.

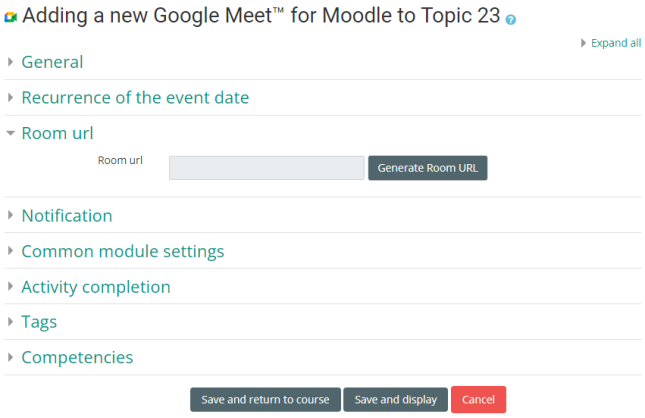

Figure 6: Google Meet for Moodle settings.

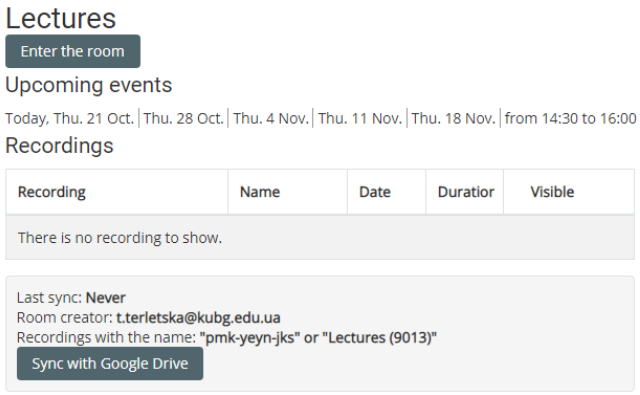

Figure 7: Google Meet for Moodle multiple times meeting added to ELC.

assessment phase, the grading evaluation phase and the closure (figure 15). While arranging blended learning, a teacher can give materials for self-study (including video, texts, graphic materials, links, etc.) at the first phase and the other phases can be fulfilled during the lesson (in the classroom or remotely) under the teacher's supervision. In this case it is very important to provide students with clear and detailed instructions for the tasks and criteria for peers' work assessment.

According to the settings chosen by a teacher each student receives a set amount of assignments for assessment as well as similar amount of reviews for their own work. The activity allows setting anonymity of assessment which together with above-mentioned settings contributes to the objectivity of the assessment (figure 16).

At the phase of grading evaluation the system compares the mark given by one student with those given by the other peers and considering the result it evaluates objectivity of the assessment (figure 17).

It is important to take into consideration formative and summative assessment differences while using Workshop activity to ensure corresponding assessment criteria settings. To the peculiarities of formative assessment [9] belong assessment of the learning process itself not limited to the products of educational activities; assessment criteria design based on set learning goals; students' participation in the assessment process; process character of assessment; utilization of digital instruments for assessment; absence of open comparison of different students' results.

The Workshop activity can be used for implementation of summative assessment in the form of peer assessment. The peculiarities of peer assessment include strictly defined assessment criteria; assessing each other by students; receiving a note not only for performed work but also for objectiveness of assessment; high efficiency of activities.

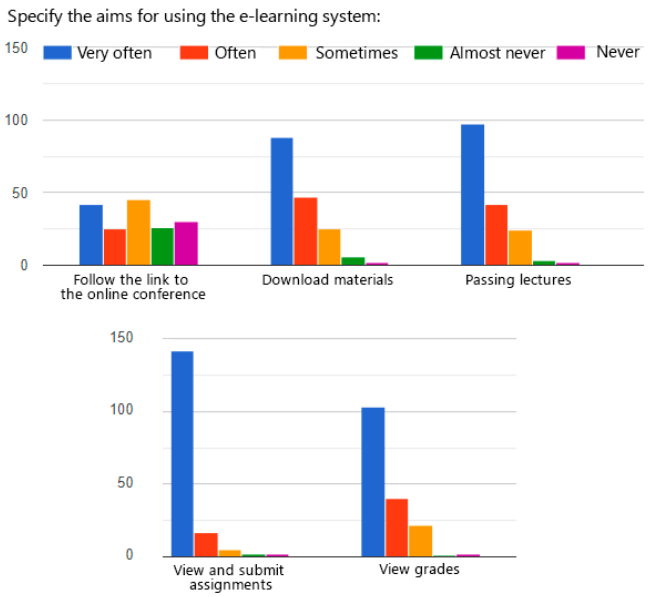

Figure 8: Aims of e-learning system usage (students).

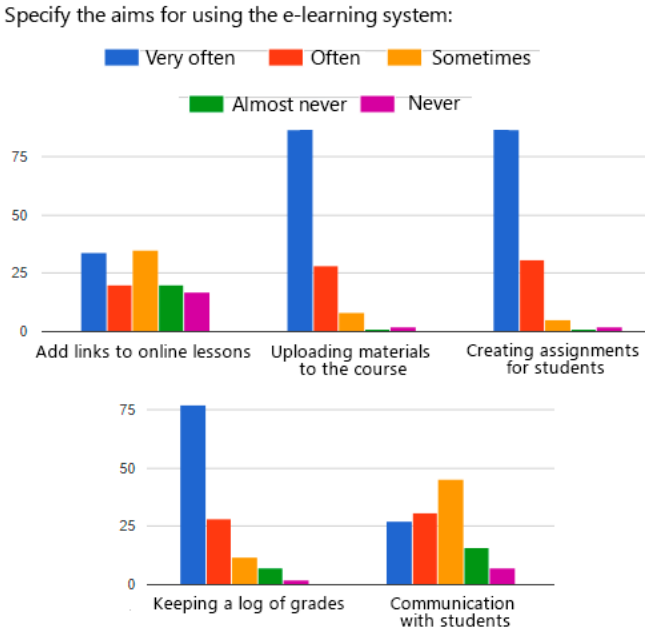

Figure 9: Aims of e-learning system usage (teachers).

The following methods of formative assessment can be implemented with the help of Moodle activities and resources: social recommendation and community participation (peer assessment, learning groups, network social mechanisms, peer review, peer reflection, peer assistance, peer learning, benchlearning), self-assessment according to the set criteria (responsive evaluation, formative evaluation, stakeholder participation).

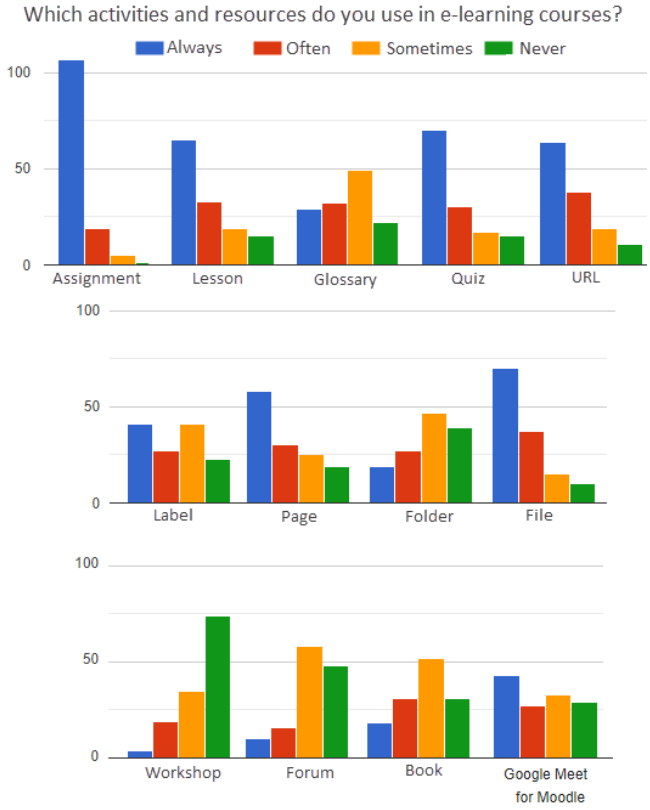

Figure 10: Activities and resources used by teachers.

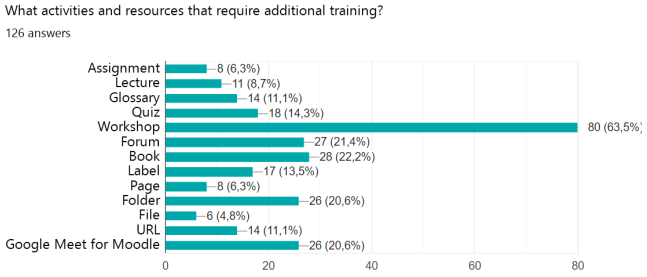

Figure 11: Activities and resources that require additional training.

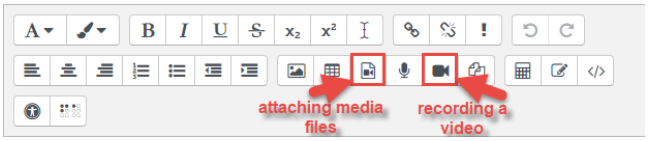

Figure 12: Attaching video in LMS Moodle.

Another innovative method widely used by teachers is project-based learning. Implementation of project-based learning in teaching humanities contributes to cultural and global competencies

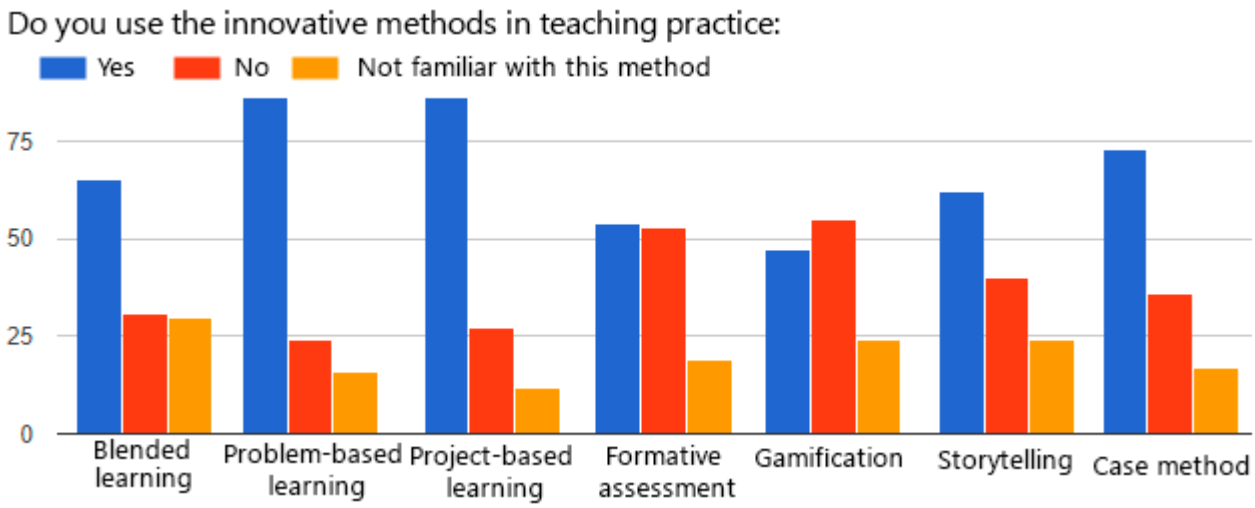

Figure 13: Innovative methods used by teachers.

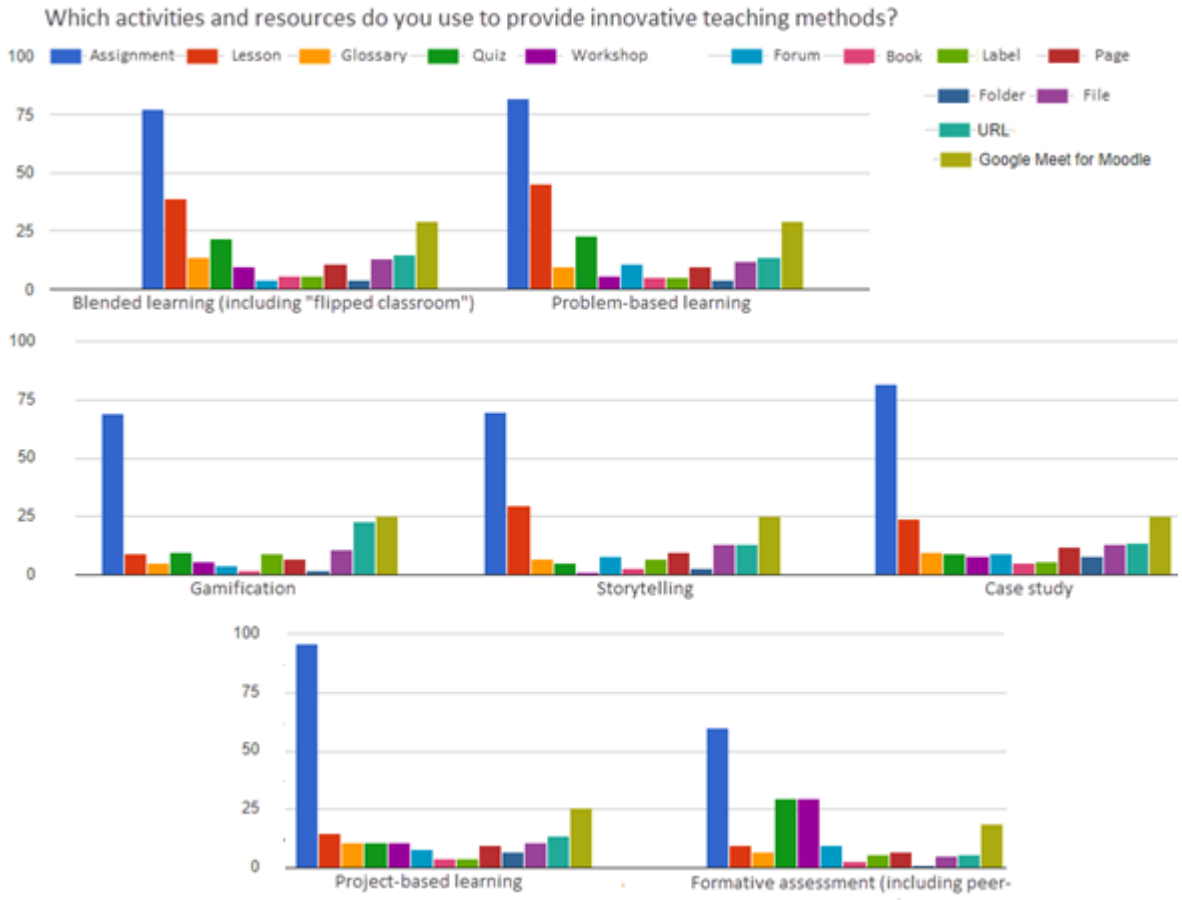

Figure 14: Activities and resources used for innovative.

development and also plays an important role in forming student-centred educational space [5]. The e-learning system at BGKU has various options for arrangement of project-based learning, for example, activities Wiki, Forum, Assignment, etc.

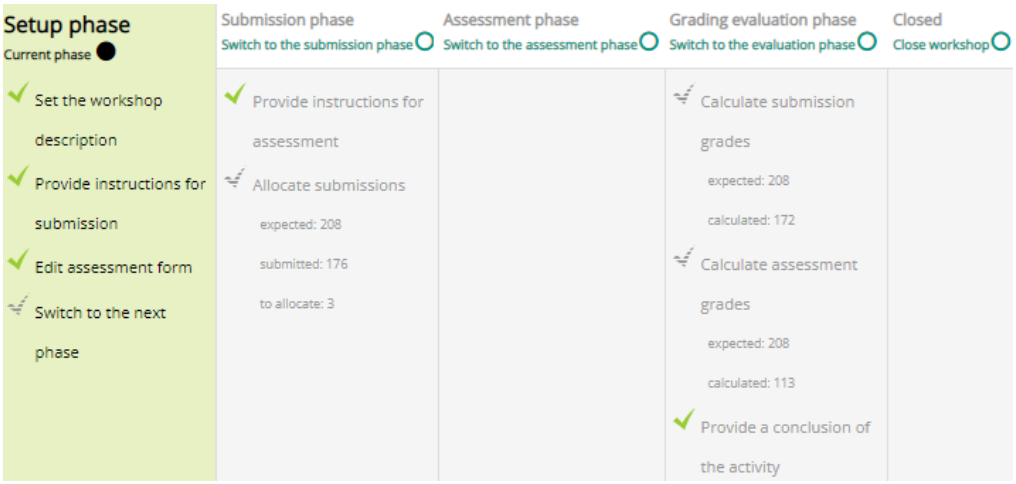

Figure 15: Phases of work.

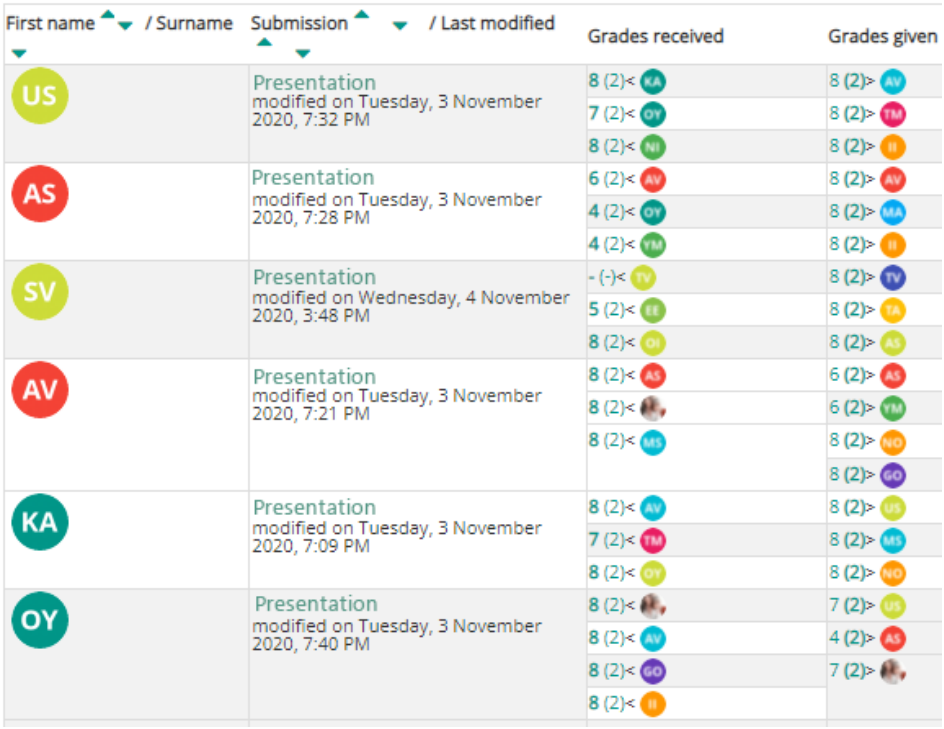

Figure 16: Results of assessment.

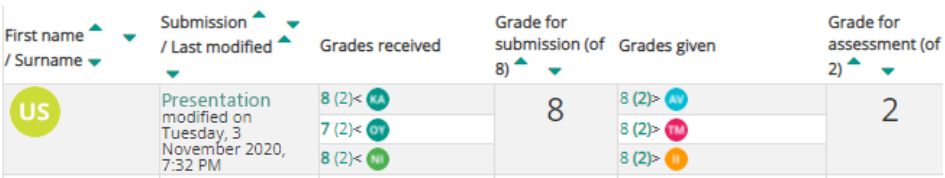

Figure 17: Grading evaluation.

The activity Wiki allows creating group projects in the mode Collaborative wiki (figure 18, 19), where each participant of the defined group can create and edit pages, add comments, files, and track history of changes.

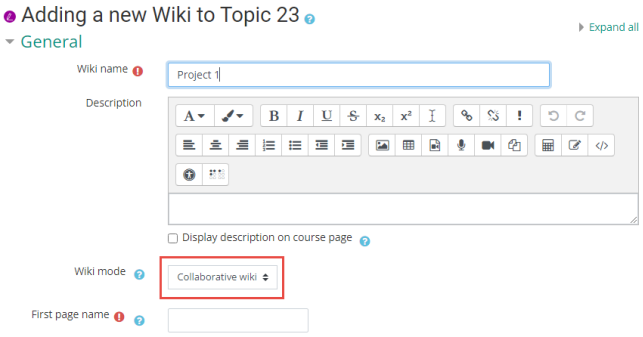

Figure 18: Settings of Wiki.

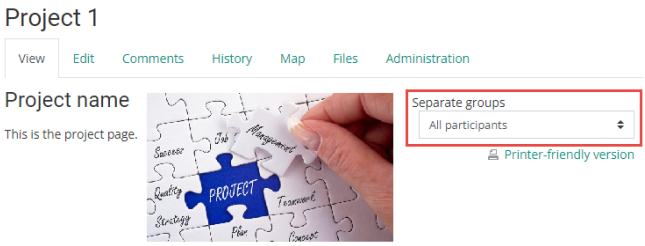

Figure 19: Wiki project.

The ways of wiki-technology usage for project activity support are: writing library-research papers (reports) – abstract for a paper, report analysis, evaluation/assessment; compilation of bibliography for a topic – annotated list of Internet resources; making a terms glossary for a topic; performing descriptive work; making instruction for performing operations; discussions on the level of a group/speciality; comparative analysis of different authors approaches to tasks or problems; systems classification design by the defined characteristics; defining criteria for events, phenomena, processes evaluation; projects presentation; group work and team project work, etc [14].

The activity Assignment has settings for group submission of performed tasks where the grade is given to all participants of the group for a finished project and an assignment can be submitted by each student separately or by a representative of a group for all group members at once (figure 20).

4 CONCLUSION AND FURTHER RESEARCH PERSPECTIVES

The E-learning system is an integral part of the educational process at a university today. That is why shifting its role from a place for data storage to a tool that can be used by teachers for implementation of innovative teaching methods is a logical step in digitalization of education. The experience of BGKU has shown that teachers

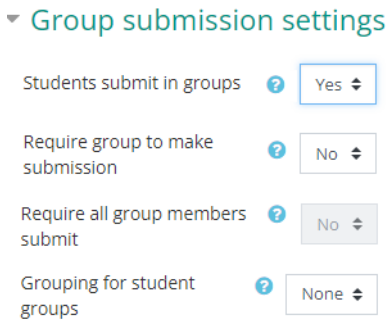

Figure 20: Assessment settings for project (group) work in Assignment.

actively use blended learning, problem-based learning, formative assessment and other methods in their teaching practice. However, they require additional training for wider usage of LMS Moodle tools. Such activities as Workshop, Wiki, Assignment, Google Meet for Moodle have high potential for implementation of innovative teaching methods especially under the conditions of distance learning and they should not be ignored in the process of postgraduate teachers education.

The research carried out in the framework of the article can be used as a basis for planning and designing further teacher training on utilization of the e-learning system activities and resources for innovative teaching methods implementation.

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Digital Drawing and Painting in the Training of Bachelors of Professional Education: Experience of Blended Learning

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ABSTRACT

The aim of the study is to solve the problem of insufficient training of specialists who are able to meet the growing demand for projects in the digital design and computer games industry. Based on the analysis of the content of digital drawing and painting, two elective courses were implemented. They are: "Digital drawing with the basics of composition" and "Digital painting with the basics of color" for Bachelors of Professional Education majoring in digital technologies. In order to properly organize the process of blended learning, which was caused by quarantine restrictions due to the COVID-19 pandemic, appropriate tools to be used in the process of studying these courses, were selected. The Moodle distance learning platform and cloud technologies (Google Docs, Google Drive) were used to present theoretical material and set tasks for practical study. For operative communication with students VoIP program Discord was used. To develop students' skills of drawing from life and high-speed drawing we offered such Internet resources as Line of action, Character designs, Bodies in Motion, Human anatomy for artist. Approbation of the developed courses in the institution of higher education in the conditions of blended learning and the results of the survey of students proved the effectiveness of the developed courses.

CCS CONCEPTS

• **Social and professional topics** → **Computing education**; • **Applied computing** → **E-learning**; • **Human-centered computing** → **Visualization techniques**.

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KEYWORDS

professional education, digital technologies, Bachelor's degree, digital painting, digital drawing, teaching methods

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1 INTRODUCTION

1.1 Problem statement

Professional training of Bachelors in Professional Education in the specialty "Computer Technology" ("Digital Technology" [4]) in Ukraine is implemented in accordance with the [2]. These areas include: 01 Education / Pedagogy, specialty 015 Professional education (by specialization), which is responsible for the International Standard Classification of Education [1] field 0188 Inter-disciplinary programs and qualifications involving education. According to the Standard of Higher Education of Ukraine [3], the training consists of two aspects: pedagogical training in teaching according to the specialization in the institutions of professional (vocational and technical) education, institutions of higher professional education (Bachelor's level) and professional (engineering) training. Professional training includes the courses aimed at mastering digital technologies for displaying, using, creating, processing, collecting, transmitting, distributing, storing, protecting and destroying information and data [8]. One of these technologies is computer graphics, which allows you to work with digital images of different formats (raster, vector) and type (two-dimensional, three-dimensional, animation, multimedia).

Computer graphics means have brought to life such new types of fine arts as digital drawing and digital painting, which lay the foundations for creating various types of digital visualizations, animations, illustrations, as well as graphic elements of computer games, virtual and augmented reality, design of web-resources, software interfaces and other digital design objects. Modern labor

market, digital design and computer games industry need specialists with such skills [6].

1.2 Problem state of the art

To identify the state of the problem of training Bachelors capable of implementing the tasks of digital drawing and painting and apply them in the field of digital design and computer games, we analyzed the Bachelor's curricula of the following specializations: "Digital Technology", 021 "Audiovisual Arts and Production (0211 Audio-Visual Techniques and Media Production) and 022 "Design" (0212 Fashion, Interior and Industrial Design). The analysis was carried out on the basis of open data and information resources of higher education institutions. We excluded from the analysis the curricula of those higher educational institutions, which official sites contained no complete information on the content of the curricula.

The analysis of curricula of Bachelors of Professional Education majoring in "Digital Technologies" allows us to state the fact that the curricula do not include courses which deal with the study of digital drawing and painting (table 1). The study of the content of the curricula and syllabuses suggests that some issues related to these new types of fine arts are covered in Bachelor's programs of this specialization, but they are not enough to develop the ability to design elements of computer games, virtual and augmented reality, software interfaces and other digital design objects.

The analysis of the curricula 021 "Audiovisual Art and Production" and 022 "Design" allowed us to identify which courses related to digital painting are studied by students (tables 2, 3).

Thus, the results of the analysis raise the problem of insufficient training of specialists who are able to meet the growing demand for projects in the digital design and computer games industry. Therefore, it is advisable to introduce digital drawing and painting in the process of Bachelors' of Professional Education training, due to the fact that they must have the appropriate knowledge and skills to teach students in the institutions of professional (vocational) education. They also should be able to design and create digital images of raster, vector and mixed types.

Therefore, there appears the urgent need to develop the content of courses on digital drawing and painting for the future teachers of professional education, who will specialize in teaching digital technologies in professional (vocational) institutions of higher education and apply these skills in professional activities.

1.3 COVID-19 pandemic challenges

During the COVID-19 pandemic, most educational institutions were forced to switch to blended and distance learning [13]. As a result, the learning process had to be quickly adapted to a new learning environment. It is not a problem if the university has a well-established distance learning system on the Moodle platform [12], both teachers and students have the experience in using it properly [14], and are aware of how to use video conferencing and VoIP programs [9] and cloud technologies [15], if they are able to present theoretical material and set tasks for practical work online. However, under these conditions it is not only important to identify the content of "Digital drawing with the basics of composition" and "Digital painting with the basics of color" courses, but also to select the means of blending digital drawing and painting, as well as approbation of developed courses in the process of training Bachelors of Professional Education in a higher education institution in the conditions blended learning.

2 RESULTS

In order to analyze the content of teaching digital drawing, we searched for books in Scopus, ERIC and Google Books according to a search query "digital drawing". As a result of the search we have found 541 research works in Scopus (thematic sections: Social Sciences, Arts and Humanities, Computer Science), 25 – in ERIC, and 340 – in Google Books. Among them, open-access books and those materials that fully relate to the content of teaching digital drawing were singled out. In particular, the book "Drawing Shortcuts: Developing Quick Drawing Skills Using Today's Technology" written by Leggitt [10] was analyzed. In this book the author shows how communicating with hand drawings combined with digital technology can be ingeniously simple, presents practical techniques for improving drawing efficiency and effectiveness by combining traditional drawing methods with the latest digital technology, including 3D modeling with SketchUp.

Xu [19] in his book "Drawing in the Digital Age: An Observational Method for Artists and Animators", teaches a new observational method based on math and computer graphics principles, offers an innovative approach that shows you how to use both sides of your brain to make drawing easier and more accurate.

Amoroso [5] brings together contributions from some of the leading landscape departments in the world to explore the variety in digital illustration methods. In each chapter, leading lecturers, professors and practitioners in the field of landscape architecture explain a specific digital approach with the use of images from their department to show how each technique can be used in inspirational examples.

A modern view of drawing methods in architectural design and 3D modeling was proposed by Melendez [11]. The author offers to use digital means and computational processes to study digital tools, techniques, and workflows for producing architectural design drawings (plans, sections, elevations, axonometrics, and perspectives), using contemporary 2D drawing, 3D modeling design software and visual programming.

Analysis of the content of online digital drawing courses on such sites as Udemy, Skillshare, LinkedIn Learning, Artcraft, Domestika allowed us to conclude that the vast majority of them are aimed at the development of individual skills (drawing perspective, drawing fantasy portraits, drawing characters, Fashion Sketch, sketching, drawing anime, etc.) and mastering various graphic editors (Adobe Photoshop CC, Adobe Fresco, Procreate, SketchBook Pro, etc.). Several courses offer the basics of drawing. In particular, in the 3-part course "How to Draw and Sketch for Absolute Beginners" (Udemy) R. Graysonn teaches drawing lines and shapes, promotes understanding of the basics of volume, light, shadow and composition, develops the skills of drawing the environment and objects in perspective, provides basics of isometric perspective, shading of objects, reproduction of light and shadow, surfaces and textures. B. Koshu's "Digital Drawing" course (Artcraft), which consists of 8 classes, reveals the following issues: primitive-based

Table 1: The results of the analysis of curricula of specialization 015.39 "Professional Education (Digital Technologies)"

No	Institution of higher education	Curriculum	Compulsory courses	Elective courses
1	National Pedagogical Dragomanov University https://kist.ipf.npu.edu.ua/bakalavr	Computer Technologies in Management and Learning	Engineering and Computer Graphics	Descriptive Geometry and Drawings Computer Design Web Design
2	Lutsk National Technical University http://lutsk-ntu.com.ua/uk/osvitno-profesiyna-programa-pershogo-bakalavrskogo-rivnya-0	Professional Education (Computer Technologies)	Engineering and Computer Graphics, Computer Design and Multimedia, Web Technology and Web Design	3D Modeling and Animation
3	Pavlo Tychyna Uman State Pedagogical University https://udpu.edu.ua/navchannia/osvitni-prohramy	Professional Education (Computer Technologies)	Engineering and Computer Graphics	Publishing Systems Web Technologies and Web Design
4	Ternopil Volodymyr Hnatiuk National Pedagogical University http://tnpu.edu.ua/nzhenerno-pedagog-chniy-fakultet.php	Professional Education (Computer Technologies)	Engineering and Computer Graphics	3D Modeling, Animation and Video Editing Computer Design and Multimedia Web Design Technologies of 3D Printing Vector Image Processing Technologies
5	Ukrainian Engineering Pedagogics Academy http://www.uipa.edu.ua/ua/educative-work/osvitni-prohramy/622-2011-12-09-21-56-46/osvitni-prohramy-2019/6480-zatverdzheni-osvitni-programi	Professional Education (Computer Technologies)	Engineering and Computer Graphics Technologies of Processing Text and Graphic Information	(not available in free access)
6	Rivne State Humanitarian University http://www.rshu.edu.ua/navchannia/osvitni-prohramy/bakalavr/2029-op-bakalavr-2021-rik-vprovadzhennia	Professional Education (Digital Technologies)	Engineering and Computer Graphics, Animation and Video Editing	Publishing Systems Web Technologies and Web Design
7	Volodymyr Vynnychenko Central Ukrainian State Pedagogical University https://phm.cuspu.edu.ua/kafedri/kafedra-teoriji-ta-metodiki-tekhnologichnoji-pidgotovki-okhoroni-pratsi-ta-bezpeki-zhittediyalnosti/opp/profesiina-osvita-tsyfrovi-tekhnolohii.html	Professional Education (Digital Technologies)	Engineering and Computer Graphics, Computer Design and Multimedia	Fundamentals of Design Multimedia, Animation, Video Editing Professional Work with Graphics Packages Computer Modeling and Visualization Technology for Creating Multimedia Web-program
8	Lviv Polytechnic National University https://lpnu.ua/osvita/pro-osvitni-programy/pershyi-riven-vyshchoi-osvity	Professional Education (Digital Technologies)	-	Computer Graphics in the Professional Activity
9	Berdiansk State Pedagogical University https://bdpu.org.ua/opp/bakalavr/pb-2020	Professional Education (Computer Technologies)	Engineering and Computer Graphics	Computer Graphics Packages 3D Modeling and Animation
10	Vinnitsia Mykhailo Kotsiubynskyi State Pedagogical University http://ito.vspu.net	Professional Education (Computer Technologies in Management and Learning)	Engineering and Computer Graphics	(not available in free access)
11	Volodymyr Dahl East Ukrainian National University http://mdl.snu.edu.ua/course/view.php?id=434	Professional Education (Digital Technologies)	-	(not available in free access)
12	Kyiv National University of Construction and Architecture http://vstup.knuba.edu.ua/ukr/?page_id=5206	Professional Education (Digital Technologies)	Engineering and Computer Graphics, Computer Design and Multimedia	(not available in free access)
13	National University of Water Management and Environmental Sciences https://start.nuwm.edu.ua/osvitni-prohramy/item/profesiina-osvita-kompiuterni-tekhnolohii	Digital Technologies of Distance Education	Engineering and Computer Graphics, Web Technologies and Web Design	(not available in free access)

Table 2: The results of the analysis of curricula of specialty 021 "Audiovisual Art and Production"

Institution of higher education	Curriculum	Compulsory courses	Elective courses
Private Institution of Higher Education "Kyiv International University" https://kymu.edu.ua/instituti-ta-fakulteti/institut-zhurnalistiki/audiovizualne-mistetstvo-ta-virobnitstvo/	Audiovisual Art and Production	–	Digital Technologies in Cinema and Television Directing an Animated Film Animation Computer Design
Kyiv National I.K. Karpenko-Karyi Theatre, Cinema And Television University https://www.knutkt.edu.ua/struktura/ekannymustectva/kino.html#ref04	Directing an Animated Film	3D Animation, Theory and Practice of Computer Graphics	(not available in free access)

drawing, basic shape usage, auxiliary volume drawing and kinematic schemes, basic drawing principles, work with home tasks, main aspects of training, concept of an object's shape and volume, structure of light and shadow in objects, main features and patterns in work with chiaroscuro, types of perspective, work with lines and color in perspective, work with light and shadow in perspective, basics of composition, sequence of work with a picture, methods, and options for creating fast sketches, quick solutions – 80% of the results in 20% of the time.

While researching the content of teaching digital drawing, we analyzed textbooks on academic drawing, methodological foundations of drawing, technical drawing, basics of composition and perspective, as well as graphic drawing for designers. It was done in order to find ways to transform the methods and techniques of traditional (non-digital) drawing into the process of teaching students digital drawing.

2.1 Analysis of the content of teaching digital painting

In order to analyze the content of teaching digital painting, we used the search query "digital painting". As a result of the search we have found 67 works in Scopus (thematic sections: Social Sciences, Arts and Humanities, Computer Science), 50 – in ERIC, and 322 sources in Google Books. Among these sources we have analyzed open-access books and those that fully address the content of digital painting. In particular, in our opinion, the most meaningful are the books by Tonge [17] "Bold Visions: A Digital Painting Bible" [17] and "Digital Painting Tricks & Techniques: 100 Ways to Improve Your CG Art" [18]. In the first book the author goes through the core art techniques such as colour, lighting, composition, research, materials and stuff like that. These concepts are explained by great illustrations as examples, and the techniques and tips are presented in a pointer style as well as in the form of several step-by-step workflow screenshots. Another book provides all the advice artists need to transform their digital painting from brush, lighting and color basics to special effects, working with layers, and speed and matte painting. Author has divided the instruction into beginner, intermediate and advanced skill levels. This allows you to individualize the learning process, depending on the initial skills of students and their level of professionalism in digital painting.

An interesting approach is proposed in the book "Digital Character Painting Using Photoshop CS3" [16]. In this book, Seegmiller [16] combined training in character design and digital painting. The subject is not only about the theory of how to make images in two dimensions but often how to create a specific effect in a specific application. The book is in three parts. Part I deals with character design and coming up with the ideas that are worth visualizing. Part II is a brief review of some traditional artistic principles that will improve your art skills when you incorporate them into digital painting. Part III shows you how to solve some of the visual problems that will always be present when you are painting digital art.

The book by Jackson [7] "Digital Painting Techniques" covers digital painting, editing, compositing and digital illustration. Each chapter is based on the knowledge learned in the previous chapter; thus, later chapters in the book stimulate readers to create advanced digital painting compositing pipelines, use alpha channels, masking, selection sets, blending mode, special effects, edit layers and similar advanced compositing tools. There is even coverage at the end of this book, regarding data footprint optimization, as well as creating digital image compositing pipelines using open source platforms such as Java, JavaFX, HTML5, CSS3, JavaScript, Scripting, and Android Studio.

As a result of the analyses of the content of online digital painting courses on such sites as Udemy, CG master academy, CG spectrum, Skillshare, Domestika, we concluded that there are courses for both beginners and professionals, as well as those that offer an introduction to the fundamentals of digital painting ("Digital Drawing in Photoshop for Beginners", "The Ultimate Digital Painting Course – Beginner to Advanced", "CGMA: Digital Painting"). There are also some courses that teach certain aspects (portrait painting, landscape painting, mastering lighting and shading, character painting) and those teaching digital painting tricks to develop the skills of a concept artist, illustrator, video game designer, etc. While analyzing the content of teaching digital painting, we analyzed textbooks on traditional painting and color science in order to find educational materials that can be used in the process of teaching computer graphics to Bachelors of Professional Education.

2.2 Development of the content of disciplines "Digital drawing with the basics of composition" and "Digital painting with the basics of color"

Today, the concept of computer art includes both works of traditional art, transferred to a new digital environment that imitates the original material carrier, and fundamentally new types of art works,

Table 3: The results of the analysis of curricula of specialty 022 "Design"

Institution of higher education	Curriculum	Compulsory courses	Elective courses
Interregional Academy of Personnel Management https://cutt.ly/EAbDOUo	Web Design	Computer Design	Basics of 3D Modeling; Animation Graphics
Kharkiv State Academy of Design and Fine Arts https://cutt.ly/oAbFNWM	Graphic Design	Computer Graphics	(not available in free access)
Borys Grinchenko Kyiv University https://cutt.ly/lAbDEOq	Graphic Design	Web and Media Design	Computer Technology in the Environment Design
H.S. Skovoroda Kharkiv National Pedagogical University https://cutt.ly/uAbFLwG	Graphic Design	Computer Technology (by specializations)	Picture in Animation Motion Graphics; 3D Modeling and Animation; Computer Simulation; Art Technologies in Motion Graphics; Web Design; Basics of Motion Design; UX/UI design
Zaporizhzhia National University https://cutt.ly/LAbD4G3	Graphic Design	Computer Technologies and 3D Modeling	Application of Computer Graphics in Project Activities; Web Design; Game Design; UX/UI Design; Concept Art
Luhansk Taras Shevchenko National University http://surl.li/ajlbo	Graphic Design	Computer Technology in Graphic Design, Digital Media Design	(not available in free access)
Kherson National Technical University https://cutt.ly/8AbFAhX	Graphic Design	-	Computer Technology in Design Computer Graphics and Animation
Zaporizhzhia Polytechnic National University https://zp.edu.ua/kafedra-dizaynu	Graphic Design	Computer Graphics	Engineering and Computer Graphics; Introduction to Computer Technology; Fundamentals of CAD Technologies
Ternopil Volodymyr Hnatiuk National Pedagogical University https://cutt.ly/UAbDkjD	Design	Computer Graphics	Web Design; 3D Modeling; Motion Design; Game Design
Khmelnytskyi National University https://cutt.ly/PAbFEIB	Graphic Design	Computer Design-Graphics Computer-Aided Design	Computer Formatting; Fundamentals of Computer Design
National Academy of Visual Arts and Architecture https://cutt.ly/TAbFYMc	Graphic Design	Computer Composition	Computer-Aided Design
National Academy of Government Managerial Staff of Culture and Arts https://cutt.ly/LAbFaBN	Graphic Design	Computer-Aided Design	(not available in free access)
Kryvyi Rih State Pedagogical University https://cutt.ly/JAbDwMG	Graphic Design	Computer Technologies in Design	Multimedia Design
Oles Honchar Dnipro National University https://cutt.ly/4AbFtmJ	Design	Means of Computer Design	Design of Logos and Layouts in Adobe Illustrator; Fundamentals of Print Layout in Indesign; Fundamentals of Drawing in AutoCad; Fundamentals of 3D Modeling in 3dsMax; 3D Visualization with 3dsMax/Blender
Mykhailo Boichuk Kyiv State Academy of Decorative-Applied Arts and Design https://cutt.ly/0AbSBjz	Design	Computer Technologies	Computer Technologies (by specializations); Web Design
National Aviation University	Design	Computer Modeling, Computer Design Practice	(not available in free access)
Kyiv National University of Trade And Economics	Design	Digital Technologies in Design	Web; Design and Web Programming; Animation and Video Design
Open International University of Human Development "Ukraine"	Design	Computer Technologies of Design, Information Technology in Graphic Design	(not available in free access)
Lutsk National Technical University	Design	Fundamentals of Computer Design	Computer Design of the Environment
O.M. Beketov Kharkiv National University of Urban Economy	Design	Computer Technology in Design; Foundations of Game Design; 3D Modeling and CAD Technology in Design; Digital and Analog Media Design	(not available in free access)

which main environment is a digital one. Based on this and the analysis of textbooks, manuals, books and online courses on traditional and digital drawing and painting, we have designed the content of two elective courses for Bachelors of Professional Education, majoring in digital technology. Both courses are interdisciplinary and multithematic, as they include concepts and theories of computer science (binary code, presentation of graphic information in digital format, types of computer graphics, graphic file formats, etc.), fine arts (basics of composition, basics of color), digital drawing and painting (computer graphics, digital art, interactive art, vector graphics, raster graphics, fractal graphics, three-dimensional graphics, concept art, pixel art, motion design, indexed color, chroma subsampling, bit depth, etc.).

Theoretical material of the course "Digital drawing with the basics of composition" is represented by the following topics: content, aims and objectives of drawing; digital drawing tools; graphic drawing for designers; types of perspectives; construction of various bodies and objects in perspective; concept of texture and structure; concept of composition in fine and digital art; principles of composition in art and design; types and categories of composition; drawing the figure, face and parts of the human body. The course includes the following practical tasks: creating sketches and line art, hatching, drawing 1-Point, 2-Point and 3-Point perspectives, drawing bodies and objects in perspective, drawing textures, displaying dynamics in the composition, 3D drawing, drawing a figure and a person's face, drawing a fashion illustration, using the principle of "golden ratio" in drawing. The course offers students the following topics for their self-study: morphology of drawing theory, Adobe Fresco – a program for the latest styluses and touch devices, criteria for successful design, theory and practice of fast drawing, drawing figures in motion.

Theoretical material of "Digital painting with the basics of color" course contains the following topics: the essence, the specificity, types and styles of painting; digital painting as a new direction in art; materials and tools for digital painting; techniques of digital painting; color and light, color models in digital painting; color contrast and harmony; detailing and transmission of light and shadow in digital painting; concept and design of digital work; composition, perspective, proportions and scale in digital painting; texturing and reproduction of materials; images of human figures; painting the space and terrestrial landscapes; painting structures and vehicles. In practical classes, students are offered the following tasks: to create images with a mouse manipulator, to simulate watercolor painting, to master the skills of working with the shape and location of objects in space (still life painting), to master speed painting skills, to learn to paint in different styles and genres (marine, Chinese painting, vector painting, landscape, portrait). Topics for self-study include acquaintance with the works of foreign and Ukrainian digital artists, polygonal art, principles of painting realistic hair, portrait, air, ground and water.

2.3 Results of courses approbation

Two proposed courses in digital drawing and painting were tested in the second semester during the adaptive quarantine caused by the COVID-19 pandemic. Therefore, the learning process was carried out in the conditions of blended learning. The blended learning model involved a combination of face-to-face classes and distance learning. The students get acquainted with the theoretical material not in the university but via the distance learning system on the Moodle platform [14]. Practical tasks were mainly performed in the laboratory, using graphic computer tablets and appropriate software (Adobe Photoshop, Adobe InDesign, Corel Painter, Gimp, Krita, Inkscape). Blended techniques were also used: students were not restricted in using traditional or digital drawing tools. If the epidemiological situation got worse and students were forced to perform practical tasks at home, they used the technical equipment available at home. Therefore, the requirement to perform practical tasks was not based only on the use of digital tools.

Assessment of learning outcomes of these two courses was carried out by evaluating students' reports on the practical tasks fulfillment and tests. To receive a high score, the report should have contained step-by-step screenshots of the practical task, the file in the format of the editor used and the file in graphic format (GIF, JPEG, PNG, TIFF, SVG) (figures 1, 2). If students have not been presented in the classroom during the lesson, they sent a report by e-mail to the teacher.

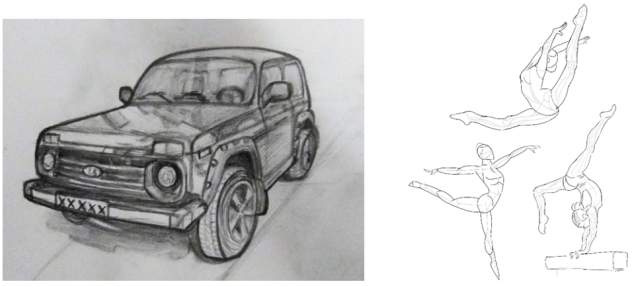

Figure 1: Examples of students' practical tasks fulfillment in "Digital drawing with the basics of composition" course.

Figure 2: Examples of students' practical tasks fulfillment in "Digital painting with the basics of color" course.

In order to receive feedback from students during their studies and at the end of the course, the following questions were asked:

- Is the content of the course and its individual components (lectures, practical classes, tests) clear?
- Is the content sufficient enough to study digital drawing and painting? Which topic interested you the most?

- Is there enough time for practical tasks?
- Does the content correspond to the modern development of digital technologies?
- Can the course content and objectives be considered as practice-oriented ones?

Summarizing the responses of students who did these two courses, the following conclusions were made. The vast majority of students (80%) consider the content of the course and its individual components clear and sufficient for the digital drawing and painting learning. Students displayed no interest to the topics that reveal the issues of construction of various bodies and objects in perspective. The tasks of hatching and texturing, drawing fashion illustrations, figures, faces and parts of the human body and creating a drawing in the style of Chinese painting turned out to be difficult for the students. The majority of students (60%) noted that they had spent more time on some tasks than the teacher had planned, in particular, for digital painting. While responding to the question on the relevance of the courses content to the modern development of digital technologies the students' responses were distributed as follows: 20% of students responded that it was fully relevant, 60% of students said that it was mostly relevant, 20% – agreed partially. The majority of respondents (80%) consider the courses content and objectives to be practice-oriented ones. Thus, the results of the survey of students provide grounds for a positive assessment of the developed courses content and their further improvement, in particular in terms of their modernization and review of the time allotted for practical tasks.

3 CONCLUSIONS

The development of digital technologies and the needs of the labor market in computer graphics professionals capable of working in the digital design and computer games industry have highlighted the need to find ways to equip the students with modern tools for creating and processing digital images of various formats and types. Such new types of fine arts as digital drawing and digital painting are aimed at creating graphic elements of computer games, virtual and augmented reality, web resources, software interfaces, etc. The study of these contemporary fine arts industries by Bachelors of Professional Education majoring in digital Technologies provides a growing digital design and computer games industry with professionals. The analysis of the curricula for Bachelors of Professional Education majoring in Digital Technologies and Bachelors majoring in 021 "Audiovisual Art and Production" and 022 "Design" showed that insufficient attention was paid to the training of such specialists.

Therefore, the research solved the following tasks: 1) the content of the courses "Digital drawing with the basics of composition" and "Digital painting with the basics of color" was identified; it is represented by theoretical materials, practical tasks and questions for self-study; 2) software for the organization of blended learning (Moodle, Discord, Google Docs, Google Drive) was selected and students' skills of drawing from nature (Bodies in Motion, Human anatomy for artist) and speed drawing (Line of action, Character designs) in the conditions of blended learning were developed; 3) the approbation of the developed courses in the process of Bachelors' of Professional Education training in the institution of higher education in the conditions of blended learning was carried out; the results of which by means of interrogation of students proved expediency of the developed content of disciplines and used software.

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Digital Interoperability of Foreign Languages Education

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ABSTRACT

The focus of the inquiry is on the analysis of multipurpose, universal and interdisciplinary digitally enhances skillsets for stakeholders of European and Oriental Languages HEI programs in Ukraine in the timeframe of COVID-19 emergency digitization measures of March 2020 to October 2021. The study highlights a broad spectrum of issues, relevant for the global social and educational context: changes of the interdisciplinary avenues of development of digital education in the COVID-19 and post-pandemic paradigm; transformations of the network society and education in the digital age; the ratio of personal experiences and anticipations, challenges and technical advances that inform quality assessment of online and hybrid educational formats in emergency digitization context. The study introduces a computational framework of digital interoperability and interdisciplinarity of foreign languages education. The empirical data is collected through a survey that served to assess the digitally enhanced dimensions of interdisciplinarity, facilitated by the interoperable nature of correlation between digital communication skills and soft skills in Foreign Languages Education.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in collaborative and social computing**;

KEYWORDS

digital interoperability, interdiciplinarity, digital education, digital competence, digital communication

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1 INTRODUCTION

Transformation of the knowledge economy, the general state of singularity [2] of technological development in the XXI century, elaboration of Industry 4.0 [15] (AI-operated production) and phases of Web technology evolution (Web 2.0 – interaction through social media, Web 3.0 – Internet of things [13], Web 4.0 – interaction informed by machine learning [27], Web 5.0 – intelligent personal agents [35]), establishment of networked society and new media ecology [16], emergency digitization due to quarantine measures has called for revision of job market demands for Arts and Humanities graduates' skillsets through interdisciplinary and cross-sectorial lens. Thus, a reevaluation of the interdisciplinary trends that drive the progress of digital education is in order.

The concept of meta-trends, transforming the world was introduced by Snyder [38] and is precipitated on universal connectivity as a permeating factor for development of technological trends. Across different predicative Global Trends frameworks [1, 2, 9], the following aspects of technological development are featured:

- evolutionary quality of technology (breakthroughs) (GT 2025);
- accessible quality of technologies (GT 2030);
- transformative nature of technology (GT 2040).

Accordingly, the intellectualization of worldwide culture presupposes a subjectively new way to deal with getting the cycles of equal advancement of human exercises and mental experiences. That is the strategic reasoning behind the idea of "noosphere". Noosphere is the solidarity of "nature" and culture, particularly from the point in time when the intellectual culture, through the impact on the biosphere and geosphere, becomes the force of an unconventional "geological power" [42].

The noosphere is characterized as the current progressive phase of the biosphere, related with the development of mankind in it [20, 42], and is deciphered as a feature of the planetary invironment with clues of human activities.

The necessary component of the Noosphere is distinguished as the Technosphere – a multitude of man-made items (innovations) created with assistance of technologies, and biological objects transformed because of technologenic development of humanity [29]. Likewise, the digital domain (digital reality, the internet) is seen as a multi-layered plane of blendings of the real world, human experience and activity informed with by the digital innovations; technogenic reality, a part of the technosphere of being [21, 30].

The Technospheric perspective change in the domain of Foreign Languages Education (FLE), initiated by iterative crisis digitalization measures, resulted in the need to make swift thorough moves [28, 31, 39] to accomplish the following efficient outcomes: a) to adjust the existent instructive contexts to digital, remote and hybrid designs; b) to update digital competence of all participants of the learning process; c) to actuate complex interdisciplinary ranges of abilities and competencies; d) to present practical digital solutions for the enhanced quality of formal and informal educational communication.

The study objectives span the following dimensions:

(1) to unveil an extent of summed up hypothetical and applied issues and models, penetrating the social communication and digital learning setting worldwide through the range of online instructive activities in the time period of the pandemic emergency digitization measures of 2020–2021;
(2) to overview the applied cases and best practices being developed for digitally assisted multipurpose direction, comprehensiveness, and interdisciplinarity of FLE (foreign languages education) through the range of learning activities the time period of the pandemic emergency digitization measures of 2020–2021.

The inquiry allows to diagnose in-depth the dimensions of interdiciplinarity, universality and transdiciplinarity, coordinated by the interoperability of global sustainable development goals [5, 24], soft skills [3, 16, 17, 34, 41, 43–45] and digital communication skills [4, 7, 8, 11, 18, 32] that ensure the success of digital education at different stages of emergency digitization measures of the pandemic.

The **mixed inquiry method** through **online survey analysis** is employed for the analysis of vocational competence and potential employability of HEI foreign languages majors. The empirical sample comprises of 618 respondents across 4 years (Freshman to Senior) of the Bachelor's projects in European (Spanish, Italian, French, English) and Oriental (Mandarin Chinese, Japanese) languages in capital city and regional HEI of Ukraine.

The survey design incorporates the qualitative and quantitative assessment of the a range of variable dimensions:

- profiling of interoperable digital and soft communicative competences, amplified by foreign languages education;
- estimation of the universality/ubiquity/versatility of FLE in the digital age;
- assessment of the linguistic training interdisciplinarity in the digital age;
- identification of social spheres that are amenable for a vocational skillset of foreign languages education;
- identification of necessity for upskilling by FLE majors in correspondence with the dynamic job market demands of the digital age.

The investigation of standards of universality and interdisciplinary of digital learning in Arts and Humanities and in FLE specifically is an element of the overarching research project TRANSITION: Transformation, Network, Society and Education [31–33].

2 FINDINGS

2.1 Conceptual Grid of Digital Education

Digital foreign languages education is profiled across the following dimensions:

- INTERDISCIPLINARITY
- TREND
- UNIVERSALITY
- DIGITAL EDUCATION
- INTEROPERABILITY

INTERDISCIPLINARITY is synthetically perceived as an amalgamation of several knowledge domains into a uniform range of inquiry and activity [14, 19, 22, 26].

UNIVERSALITY is disclosed as a quality of an item or state to be ubiquitous, or to encompass everything [10]. The property of universality/ubiquity in this inquiry is attributed to digital communication activity.

DIGITAL INTEROPERABILITY is identified through different lenses [25, 37] as a feature of items and systems, that permits their structure to be understandable and compatible with digital items and systems.

Within the paradigm of digital education in Arts and Humanities, the concept of interoperability addresses the property of practical, unique interconnectivity between the source and target areas of expert substance, theoretical content, related areas of scientific and universal data, and spheres of expert and social application and communicaiton, enhanced by the digital transformation paradigm [6]. Degrees of interoperability facilitated the assessment of interdiciplinarity and universality of activities and competencies of Arts and Humanities students and faculty.

The generalized construct of multiple disciplinarity [12, 40] is structured through an interconnected grid of concepts:

- Multi-disciplinarity;
- Interdisciplinarity;
- Transdiciplinarity.

Multi-disciplinarity is in this manner recognized as an assembly of fields of information, that contain the perception of a specific item, issue or sphere.

Interdisciplinarity in this regard is deciphered as the interconnectivity of various circles of information that contained the substance of an issue or area.

Trans-disciplinarity, in this manner, is seen as a transformative output of blending various interconnected information areas

Interdisciplinarity, as applied to digital learning is, henceforth, disclosed in this study as a computational grid of disciplinary dimensions (figure 1) interconnected within the framework of digital transformation:

(1) Row 1 – variations of disciplinarity types;
(2) Row 2 – components of digital education;
(3) Row 3 – tools of digital education.

Multidisciplinarity is manifested in the form of education design and content input that spans different knowledge domains. Multidisciplinary *input* thus serves the following purpose:

(1) to cover the thematic scope of foreign languages education;
(2) to establish meaning and referents of the conceptual and terminological grid;

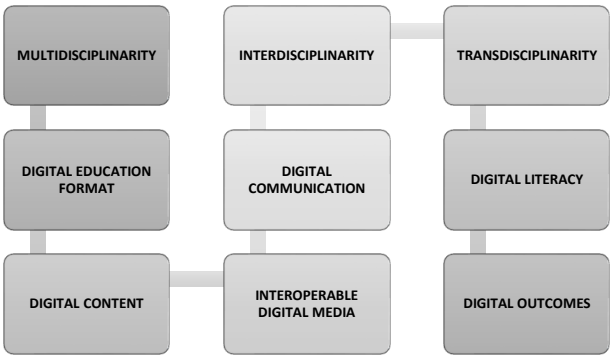

Figure 1: Multi-disciplinary framework in digital education.

(3) to cover the broad scope of cognitive presupposition for communication in professional contexts.

Interdisciplinarity of the digital education *content* is perceived as internal interrelation between theoretical and applied areas of knowledge, external interconnectivity of Arts and Humanities content with unrelated or semi-related knowledge spheres (computer science, digital humanities, physiology, anthropology, philosophy etc.).

Transdisciplinary dimension of FLE *output* is disclosed through the pervasive quality of target information areas and thorough ubiquity (or universal applicability) of skills and competences as well as the universal humanitarian outlook of FLE graduates.

Interdisciplinarity and transdisciplinarity of acquired skills anhance universal employability and both horizontal and vertical professional mobility of Arts and Humanities majors on the digital job market across different social domains.

Job market demands for graduates in Arts and Humanities (FLE) graduates in 2020–2021 incorporate a range of digital professional areas: ONLINE EDUCATION; COMPUTER ASSISTED TRANSLATION AND COPYEDITING; NATURAL LANGUAGE PROCESSING; SMM; DIGITAL CONTENT-CREATION; IT, GAMING INDUSTRY.

2.2 Interoperable Communicative Dimensions of Digital Education

Interoperable quality of vocational competencies, procured through advanced digital learning, is guaranteed by the communicativity of interdisciplinary skills and competencies. The center cross-sectorial space that is referential for essential skills (interactive abilities, emotional intellect, cooperation, collaboration, digital literacy/ICT competence), vital for instructive objectives accomplishment, is COMMUNICATION.

The digital component of communicative interoperability of e-learning originates from the design of Noosphere [42] and the composition of its elements:

- ANTHROPOSPHERE – a multitude of individuals, their exercises and accomplishments;
- SOCIOSPHERE – an assembly of social variables typical for this phase of social advancement;
- TECHNOSPHERE – a multitude of technogenic items made by man, and items of nature, modified because of technological activity.

Given the idea of progressively digitized setting of foreign languages education and open application ("the Technospheric shift" [32]), it is recommended to consider the various kinds of data source and data objective (human and machine/software) in the design of the basic Communication model (Cf. Shannon [36]), when communication is treated as the center variable of interoperability of source and target information and application areas (figure 2).

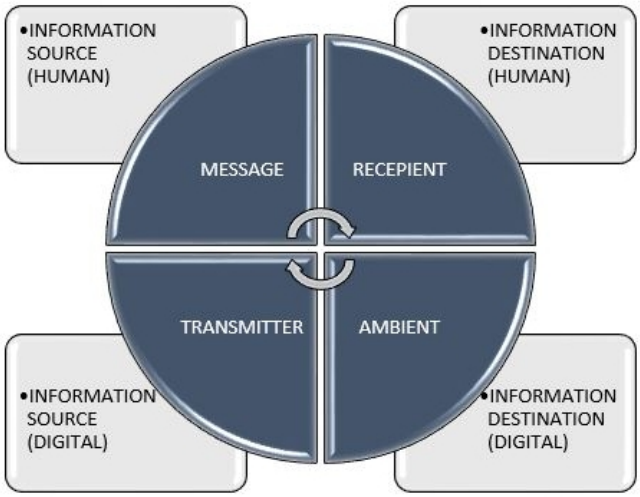

Figure 2: Communication model in digital education.

Consequently, an interdisciplinary elements model of online/digital learning, structured according to the communicative nature of interaction of its participants and elements, is devised (figure 3).

The proposed model reveals the idea of open communication in digital instruction across such focus aspects:

(1) EXODISCIPLINARY DIMENSION revealed through the interoperable coordination of
   (a) human subject of training and digital environment;
   (b) human subject of instruction and digital artifacts;
(2) ENDODISCIPLINARY DIMENSION revealed through the interoperable coordination of
   (a) human subject of instruction and another human in the digital environment;
   (b) a human stakeholder of instruction and computerized simulacra;
(3) EXTRADISCIPLINARY DIMENSION revealed through the interoperable coordination of
   (a) human subject of learning and the machine (AI) as a subject of instruction or as a wellspring of instructive information;
   (b) human and post-human stakeholders of learning.

Hence, the major interdiciplinarity, that the pandemic induced digitized procedural changes forced on the instructive cycle in the area of Arts and Humanities, is checked by a unified structure of correspondence between the elements of a pivotal communicative

Figure 3: Interdisciplinary dimensions of digital education.

ability [23], including a different range of abilities, and different parts of digital literacy in Arts and Humanities [4, 8, 11, 18], used in the instructive interaction.

In view of the interdisciplinary informative and computerized interoperability matrix the accompanying turnpikes of digital changes in foreign languages education are recognized: DIGITAL HUMANITIES; NLP, DATA SCIENCE, MACHINE LEARNING; E-LEARNING.

Generally speaking, the communicative dimension in digital education is fulfilled through such aspects:

(1) Data-driven, soft competencies dwelling (Web 3.0 sort);
(2) Data-driven, hard competencies dwelling (Web 4.0 sort);
(3) Emotional Intelligence (EQ)-driven, soft competencies dwelling (Web 2.0 sort);
(4) Emotional Intelligence (EQ)-driven, hard competencies dwelling (Web 5.0 sort).

The open interdisciplinary organization in advanced education is expounded with the assistance of such computerized devices and instructive technologies as LMS; Web 2.0 training through online communication; formal, casual, and semi-formal computerized networks of information (research online communities, communities of knowledge).

In this manner, the communication designs in digital learning follow the overall patterns of Web communication (Web X.0 model), appropriated across two axes: X – content direction and Y – kinds of competencies necessary (figure 4).

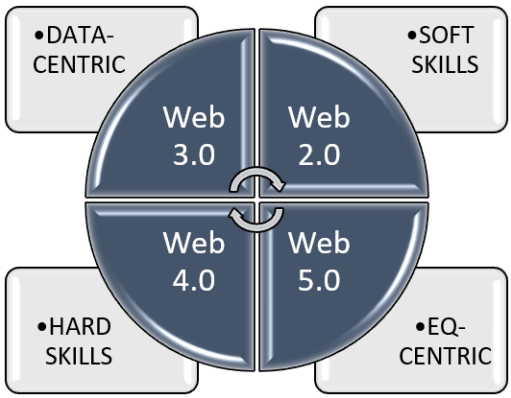

Figure 4: Network-type Communication Pattern in FLE.

2.3 Digital Interoperability of Foreign Languages Education: Survey Results

Foreign Languages Education, within the structure of this inquiry, this study is diagnosed based on the computational grid of the interdiciplinarity of curriculum: INPUT ⇒ CONTENT ⇒ OUTPUT.

Multidisciplinary INPUT analysis permitted to pinpoint the what informed the choice of career in foreign languages major programs:

- Freshmen (students of the 1st year of studies) scored such target spheres that define the choice of FLE programs as highest:
  – proficiency in a foreign language (27%);
  – private sector or business (26%);
  – education (different tiers) (25%).
- Freshmen (students of the 1st year of studies) scored such target spheres that define the choice of FLE programs as lowest:
  – translation, interpreting (2%);
  – IT career (23%);
  – becoming a public servant (24%).
- Seniors (students of the 4th year of studies) scored such target spheres that define the choice of FLE programs as highest:
  – becoming a public servant (31%);
  – IT career (24%);
  – private sector or business (24%).
- Seniors (students of the 4th year of studies) scored such target spheres that define the choice of FLE programs as lowest:
  – translation, interpretation (1,2%);
  – education (different tiers) (20%);
  – proficiency in a foreign language (24%).

Digital domains (Computer science, IT) have lowered the score of multi-disciplinary potential level of FLE INPUT but gained the transdisciplinary potential score of FLE OUTPUT as of 2020 (the start of worldwide emergeny digitization measures).

The transdiscilplinary potential of FLE across accommodating and amenable social spheres is distributed as follows (table 1).

Table 1: Social spheres most accommodating or lucrative for a foreign languages education

The social spheres that are amenable for a foreign languages education?	Mean
Private sector / business sector	77%
Civil service/education	69%
Foreign economic activity	59%
IT industry	50%
Social services	51%

The transdiscilplinary potential of FLE across different social areas across contrasting periods of FLE is distributed in the following manner (social domains ranked by the highest score 5):

- Freshmen stakeholders ranked such social spheres as highest in FLE applicability:
  - Private sector/business sector – 80%
  - Manufactufing/Law/Social services – 68%
  - IT industry – 43%
- Senior stakeholders ranked such social spheres as highest in FLE applicability:
  - Agriculture – 67%
  - IT industry – 57%
  - Finance/Law – 56%

The top scoring areas of transdisciplinarity in FLE application are the Private business area (77%), Public assistance area (69%) and Foreign economy area (59%). IT area is assessed among top 5 socio-economic domains for FLE application (50%).

Evaluation of skills in FLE across tiers of training provided the eloquent outcomes, regarding the capability of foreign languages education to improve interoperability of soft and vocational competences. Crucial interoperable (soft) skills, across different competency models, were determined as amplified by FLE:

- Average scores of highest ranking interoperable skills, facilitated by FLE (1st year students – INPUT):
  - Digital literacy – 3,39
  - Problem solving – 3,31
  - Communication – 3,27
  - Creativity – 3,26
  - Critical thinking – 3,22
  - Innovativity – 3,24
  - Team-work – 3,25
- Average scores of highest ranking interoperable skills, facilitated by FLE (4th year students – OUTPUT):
  - Digital literacy – 4,41
  - Communication – 4,61
  - Creativity – 4,49
  - Critical thinking – 4,61
  - Innovativity – 4,51
  - Problem solving – 4,49

Digital literacy is highlighted as an interoperable skill, enhanced via FLE, over various tiers of learning, apparently, because digital literacy is considered a core literacy in the pandemic timespan, that facilitates foreign languages education and facilitated utilization of other types of communicative soft skills.

Comparison of interoperable skills amplified by FLE is shown in figure 5.

Interdisciplinarity of FLE was assessed across several key dimensions (figure 6):

- Freshmen respondents ranked such dimensions of FLE interdiciplinarity as highest:
  - Proficiency in multiple foreign languages – 81%
  - Arts and humanities – 81,2%
  - Educational and teaching competencies – 60%
  - Geopolitics and history – 50%
  - Digital linguistics and language data processings – 43%
- Senior respondents ranked such dimensions of FLE interdiciplinarity as highest:
  - Proficiency in multiple foreign languages – 62,2%
  - Arts and humanities – 65%
  - Applied skills (programming, statistical analysis) – 36%
  - Geopolitics and current affairs – 33%

Digital domain is of steady interdisciplinary importance for perception of FLE content. However, respondents, that enrolled in the year 2021 evaluate digital language and data processing ranking higher than programming and computer science skills as an interdisciplinary feature of FLE.

The necessity for interdisciplinary upskilling or reskilling (figure 7), upon completion of a FLE program is estimated across different parameters.

Freshmen stakeholders determine necessity to reskill or upskill upon graduation in FLE across the following planes:

- Need to study an adjacent Arts and Humanities area – 58%
- Need to master an applied/technical specialty – 18,2%

For FLE INPUT timeframe (1st and 2nd year respondents) the necessity for interdisciplinary upskilling in adjacent Arts and Humanities areas is dominant.

Senior stakeholders determine necessity to reskill or upskill upon graduation in FLE across the following planes:

- Need to study an adjacent Arts and Humanities area – 45,3%
- Need to master an applied/technical specialty – 36%

For FLE OUTPUT timeframe (4th and 3rd year respondents) the necessity for interdisciplinary upskilling in adjacent Arts and Humanities areas and for cross-domain reskilling in a digital/computer science sphere, is dominant, in full correspondence with the concept of transdisciplinarity of foreign languages HEI programs in the digital age.

3 CONCLUSONS

The exhaustive diagnostics of the components of interdiciplinarity, universality and transdisciplinarity of FLE unveiled the interoperability of soft skills and digital competencies across differentiating phases of foreign languages training by understudies of various tiers of the Bachelor's program and early vocation preparing.

Digital real, digital communication and digital competence are surveyed as interoperable dimensions that facilitate interdiciplinarity regarding FLE in the stretch of time of the most recent 5 years (2017–2021).

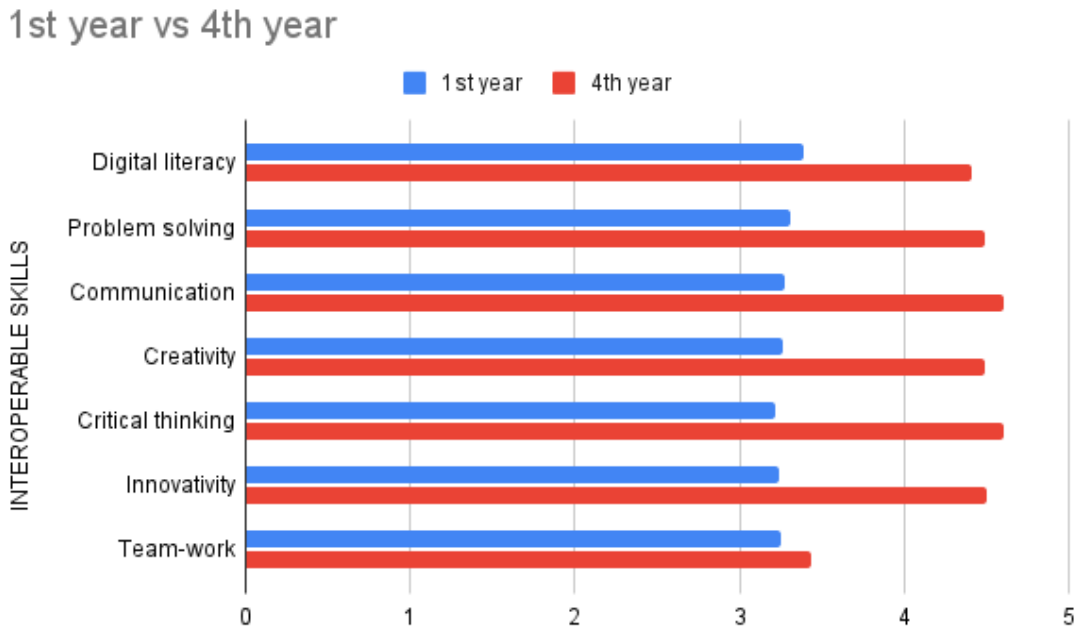

Figure 5: Comparison of interoperable skills enhanced by FLE.

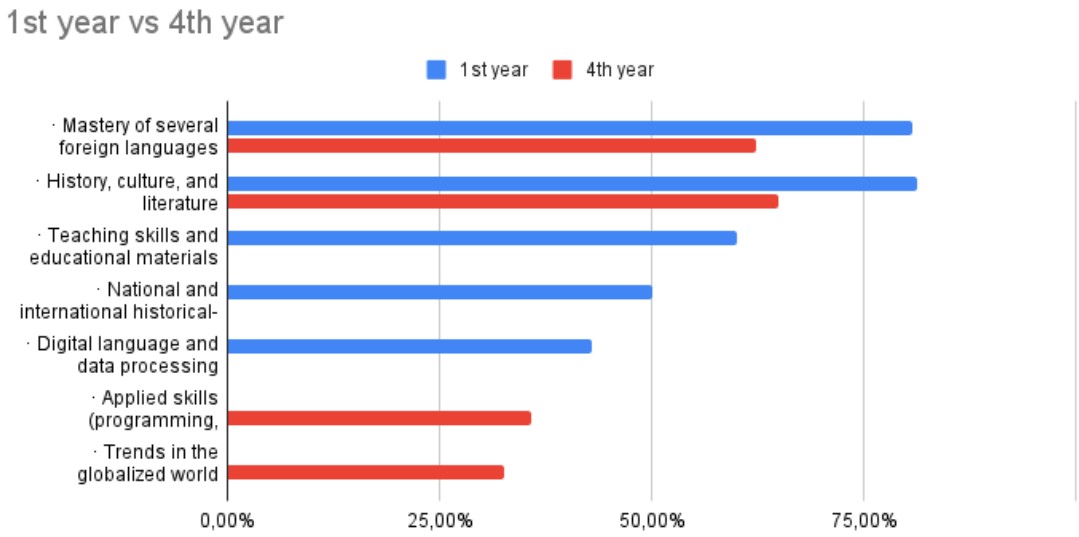

Figure 6: Interdisciplinarity of FLE assessment.

The computational system approach permits to dependably gauge the various disciplinarity proportions of the FLE work process (input – content – output).

Multidisciplinary input of FLE is overwhelmed by the linguistic proficiency, paying little heed to application space and tier of training. Interdiciplinarity of FLE is assessed as interconnectivity of such center spaces of information: history, culture, and discourse; geopolitics; programming, digital language processing.

The predominant interoperable abilities, obtained through FLE, are: correspondence, passionate keenness, imagination, critical thinking and advancement. Computerized education highlights as a conspicuous interoperable ability, working with the use of different kinds of delicate abilities of the open nature in broad semantic preparation.

The necessity for interoperable competencies improvement and development of FLE comprehensiveness in proficient application incorporate tansdiciplinary re-skilling over cross-domains areas, not associated with language learning and communication (data processing, technology development, software engineering, design, finance). These discoveries are in a roundabout way certified by

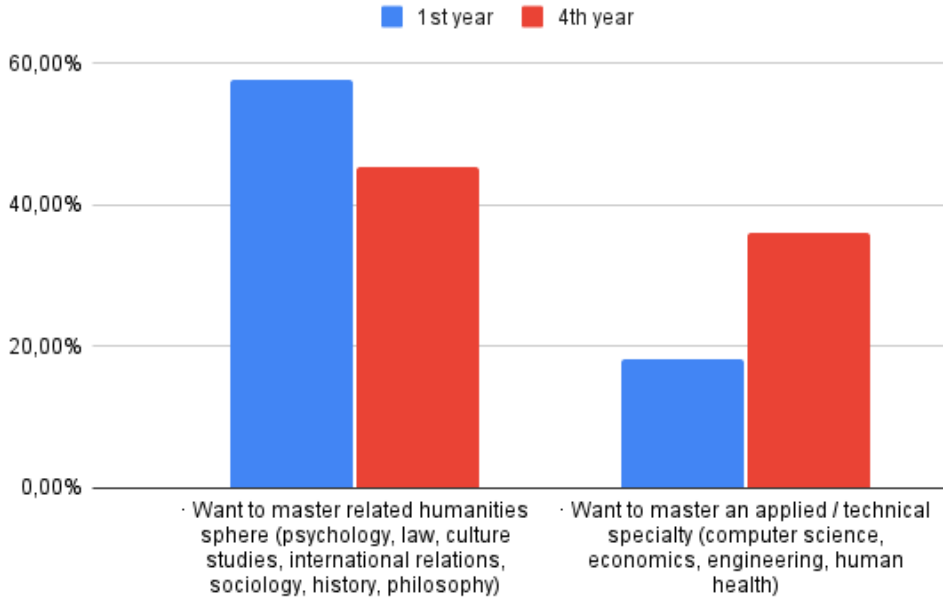

Figure 7: Interdisciplinary upskilling or reskilling in FLE assessment.

the transdisciplinary capability of FLE across various social areas (Knowledge economy, IT area, Public service area, Foreign economy area, Finance).

The inquiry results illuminate the induction regarding the accompanying proposals for FLE:

- Basic audit of the educational plan content to oblige the elements of multi-disciplinary digital humanities assumptions for the FLE students in the digital era;
- Audit and update of the FLE educational program content interconnectivity and learning results to oblige the interoperable connection point of competencies, modified to be compatible with language application in the digitized world;
- To devise an adaptable model of FLE content improvement to meet the dynamic transdisciplinary prerequisites of the digital jab market in Industry 4.0.

The inquiry results will be further amended in the vein of evaluation of the interdisciplinary and interoperable digital competence flexibility for different groups of FLE students and faculty, as indicated by jobs and undertakings instrumental for the language acquisition process, as well as per age and section of digital education level.

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Creation and Development of the Digital Learning Environment in Educational Institutions

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ABSTRACT

The modern digital learning environment of educational institutions should be flexible and personalized, meet the needs, requirements and wishes of teachers, students and the educational institution. Education with the use of digital tools has become relevant today in the quarantine of COVID-19. The educational process takes place regardless of time and place. It requires quick and easy access to information and educational resources. The digital learning environment of the educational institutions provides these conditions. The components of the digital learning environment of the educational institutions should provide the main functions in the process of learning and education: learning, communication, cooperation, assessment and testing, planning and management, presentation and evaluation of tasks. The approach of creating and using the digital learning environment of the educational institutions involves the use of all its elements, namely: IT services, applications, systems, etc., which can be easily combined, updated, added, deleted, changed. This approach will create and develop the digital learning environment of the educational institutions that can be adapted to innovation in education and ICT.

CCS CONCEPTS

• **Digital Learning Environment** → Teachers; Educators; Learning; • **Learning Environment**;

KEYWORDS

educators, educational institutions, digital learning environment, information and communication technologies

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1 INTRODUCTION

An urgent issue of modern education is the effective use of the potential of information and communication technologies. The Digital Agenda for Europe is one of the leading initiatives in the framework of the European Union's socioeconomic economic development strategy "Europe 2020", adopted by the European Council in 2010. The introduction of e-learning (eLearning) is a leading direction of modernization of educational policy in European countries. The implementation of IT should be reflected in the curricula, integrated into the content of education, included in the criteria for evaluating learning outcomes, the document states. Thus, the modern educational environment acquires the features of digital [1].

The processes of formation and development of the digital learning environment in educational institutions of Ukraine have been taking place in recent years. The organization of a new educational environment requires extensive use of ITs, multimedia teaching tools and resources, etc., as stated in the Draft Concept of Digital Transformation of Education and Science for the period up to 2026 [6], the concept of the New Ukrainian School (NUS) [29]. IT provide equal access to digital educational resources and environments. The use of ITs has become more acute during the COVID-19 pandemic. Today, learning is increasingly taking place in distance and mixed formats. The results of research conducted by scientists of the Institute for Digitalisation of Education of the NAES of Ukraine, revealed gaps in teachers' mastery of IT [12, 13]. Surveys were gathered 607 respondents (2020) and 1463 respondents (2021) – teachers, school administrators, methodists and in-service teacher training professors answered on the questionnaire from all-over Ukraine. International research states that every fifth student does not reach the basic level of IT proficiency and only 39% of teachers in the EU consider themselves knowledgeable users of IT [17, 20]. The Digital Education Action Plan (2021-2027) presented by the European Commission has identified two strategic priorities: promoting a highly efficient digital education ecosystem and raising the level of digital skills and competences for the digital age [4]. The digital learning environment should be part of the modern digital ecosystem.

The Ukrainian educational community, with the support of the Ministry of Education and Science of Ukraine, initiated the creation of the National Digital Education Platform. However, this platform is under development. Research on aspects of the development of the digital learning environment is an urgent problem for the modern education system of Ukraine.

The purpose of the article is to consider the main characteristics of the digital learning environment of educational institutions, to identify approaches to its creation and to identify the components of the digital learning environment. Summarizing the results of the study allowed formulating recommendations for educators conducting procedure for creating and using the digital learning environment of educational institutions.

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2 LITERATURE REVIEW

The analysis of the research problem was based on the study of international and Ukrainian documents, resolutions, frameworks, analytical materials. They determine the strategic directions and general trends in the development of education in the context of digital transformations. The concept of New Ukrainian School, Digital Agenda for Europe, Digital Competence Framework for Educators (DigCompEdu) [3], the Digital Education Action Plan (2021-2027) and others deserve special attention. The process of formation and development of the digital learning environment is a new phenomenon in education. This problem is of interest to researchers in the field of education.

The research of many Ukrainian and foreign scientists is devoted to the problem of development and development of the digital environment in education. Considerable attention is paid to the digitisation of education and the development of the educational environment, in particular in the works of Bykov et al. [9], Oliynyk et al. [18], Ovcharuk [19], Spirin et al. [24], Striuk et al. [25]. Some aspects of the creation and development of digital educational environments are considered in the works of Lytvynova [16], Shyshkina [22] (development trends of cloud-oriented environment), Ivanjuk [14], Soroko [23], Vakaliuk [27] (main components of computer-oriented environment), Hrytsenchuk [11], Brand-Gruwe et al. [8] (teaching and learning in the digital educational environment), Poldner [21] (didactic functions of virtual learning environments), ref [5] (components of the environment), ref [2] (characteristics of personally oriented environment), Tondeur et al. [26] (approaches to creation and development of digital environments), Aboites et al. [7], Knight [15] (digital educational hubs), van der Kaap and Visser [28] (development trends of the digital educational environments).

3 RESEARCH RESULTS

The theoretical basis for the construction and development of the digital learning environment, which determines the principles of its creation and development, is the work of scientists. Thus, [10] believes that the learning environment is an artificially constructed system, the components of which create the necessary conditions for achieving the goals of the educational process. The structure of the learning environment determines its internal organization, relationship and interdependence between the elements that are, on the one hand, the attributes or aspects of consideration that determine its content and material content, and on the other hand – the learning environment resources included in the activities of participants educational process, while acquiring the characteristics of means of teaching and education.

The digital learning environment of the future should be flexible and personalized, meet the needs and wishes of students, teachers and educational institutions, be independent of time and place, has quick and easy access to information and necessary materials. The use of IT infrastructure places high demands on archiving, security and manageability. The digital learning environment to support students and teachers in the learning process must include a coherent set of digital applications that require a new architecture for their integration.

The architecture of a user-centered the digital learning environment includes user interaction, process support, and data management. This makes it possible to use basic data in many programs and the learning process can be monitored transparently. In addition, applications must have individual settings for users. The digital learning environment offers the opportunity to personalize, create learning trajectories and collaborate in different formats and work at different levels. The Learning Management System (LMS), which is an example of a container application, provides functionality for communication, collaboration, testing, content component organization, and more. ILIAS, aTutor, Blackboard Learning System, Moodle are common among modern learning management systems.

Obviously, to create a single universal system that would meet the requirements and needs of all participants in the educational process is very difficult. Therefore, to develop the digital learning environment, Dutch researchers propose a modular approach, the so-called principle of LEGO blocks, which are components of the environment. Among the main functions to be provided by the components (blocks) of the environment: communication, collaboration, evaluation (testing), planning and management, presentation and evaluation of tasks. This approach to the creation and use of the digital learning environment involves a separate development of all its elements, namely: IT services, applications, systems, etc., which can be easily combined, updated, added, removed, replace. This will create and develop the digital learning environment that can be adapted to innovation in both education and IT [2].

Thus, the conditions for building an effective the digital learning environment are: standards and conceptual frameworks; infrastructure with integrative properties of the environment; access to the digital environment. Let's consider them in more detail.

Standards and conceptual frameworks form a holistic set of individual requirements that define the norms and approaches to how a particular system works. With the use of standards, data exchange can be simplified and operations will be carried out in a secure and reliable manner. Adapting the conceptual framework is also an important part of the process of building and using the digital environment, as different states often use different terms for the same concepts in education.

It should be recognized that existing tools and various applications are not yet sufficiently standardized and are not always compatible with each other, which complicates their practical application. For individual systems to function as one, it is necessary to ensure their integration. In the process of deploying the digital learning environment as an integrated infrastructure, Dutch scientists distinguish between visual integration, data integration and infrastructure integration (figure 1).

Access to the digital learning environment provides procedures that enable personalising, protection of information and systems and can be organized through identification, authentication and authorization. The organization of the access procedure is provided by defining the role played by the user personally or on the basis of belonging to a certain group of user.

The development of an integrated the digital learning environment is possible provided that basic systems, such as the Student Information System (SIS), are secure and reliable. Both the API standards and the work on the architectural vision in the process

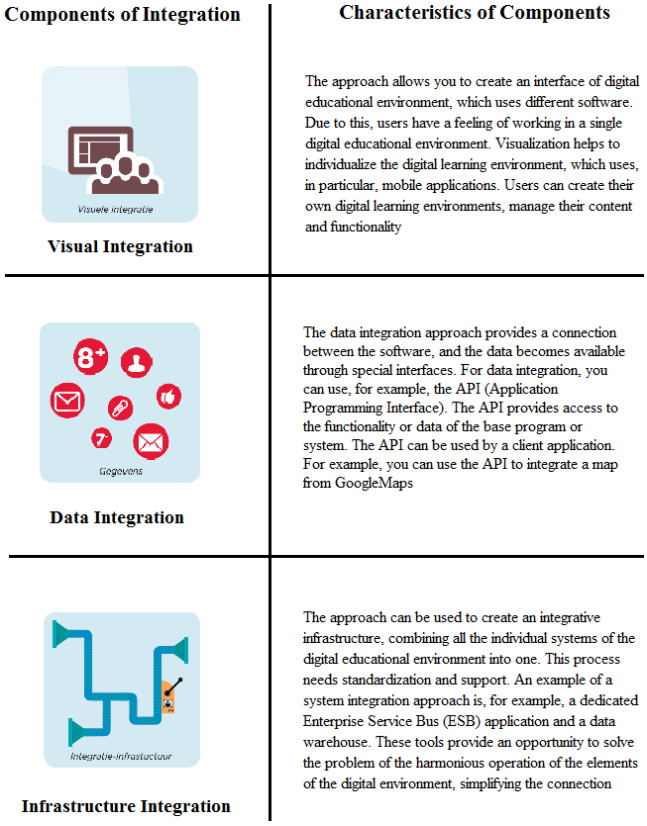

Figure 1: An integrative approach to building a digital educational environment based on the principle of LEGO blocks.

of application integration are important. Basically, this is done by using the functionality of many programs.

The components of the digital learning environment perform functions such as communication, collaboration, testing, planning, submission and assessment of tasks (submission of students' works and their evaluation). These components can be changed, filling them with additional functions, to replace them with others that better meet the learning objectives. In this way, the digital learning environment can always adapt to the latest developments in the field of education and respond to technological innovations.

4 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis of scientific and pedagogical works of foreign and domestic researchers, international documents of the Council of Europe, OECD and legislation, it is clarified that the digital educational environment is an effective tool in the educational process and in the process of professional self-improvement. Creating and maintaining a digital learning environment as part of the digital ecosystem is an important task of the education system.

The generalization of experience allowed to highlight the main features of the modern digital educational environment, including continuity and continuity, equal access to education, information security, mobility; interactivity, unity of purpose, content and focus on results; innovation and content with digital means, the ability to create their own digital resources and interaction of participants in the learning process in an unlimited open educational information space.

The stages of creating the digital learning environment should include measures that step by step implement the goals set by educational institutions.

Based on the work of scientists in the field of didactic and methodology, as well as domestic and international experience, we have developed a procedure for creating and using the digital learning environment.

The use of the digital learning environment from the standpoint of gradual creation and integration provides the formation and development of digital educational space with the direct participation of teachers, students and all educational stakeholders. The block diagram shows the relationships between the main elements (stages) of this process (figure 2).

Designing the digital learning environment includes the following stages: diagnosing the current situation, identifying problems and setting goals, analyzing and collecting information, selecting tools for the digital learning environment, designing an environment, setting up and implementing the digital learning environment, monitoring and evaluation, improvement. In addition, the following measures should be taken at these stages: motivate and involve teachers, head of educational institutions and stakeholders; ensure the functioning of the infrastructure of the institution where the digital learning environment is created; integrate the digital learning environment into the digital learning space.

Identifying problems and needs, setting goals includes defining the purpose and final results of the development and use of the digital learning environment. At the stage of determining the goal, the necessity and existence of the possibility of using the digital learning environment in the educational process is fixed.

There are certain conditions for initiating integration. The teacher manages the educational and information process within the discipline. Structured teaching materials become the basis for the formation of the digital learning environment, and the teacher uses them in the learning process.

Collection of information, analysis and forecasting include: collection of data on sources in your subject in Ukraine and abroad, teaching materials, projects, educational programs, networks of teachers and educators, etc.

Forecasting and planning involves defining goals, objectives and prospects for building the digital learning environment in stages.

The selection of the digital learning environment includes: definition of approaches and criteria for digital tools; definition and study of their features and properties of components, definition of the corresponding standards.

Environment design includes: the process of creating a project environment, its prototype (beta-version), development of terms of reference and determination of methods of its manufacture. At the same time, a system approach is used for design. It provides a description of the structure of the system, the type of communications, the definition of attributes, components, characteristics, analysis of environmental influences. Digital learning tools must also be chosen. Teachers and students choose these tools. They must meet the educational and professional needs and requirements of

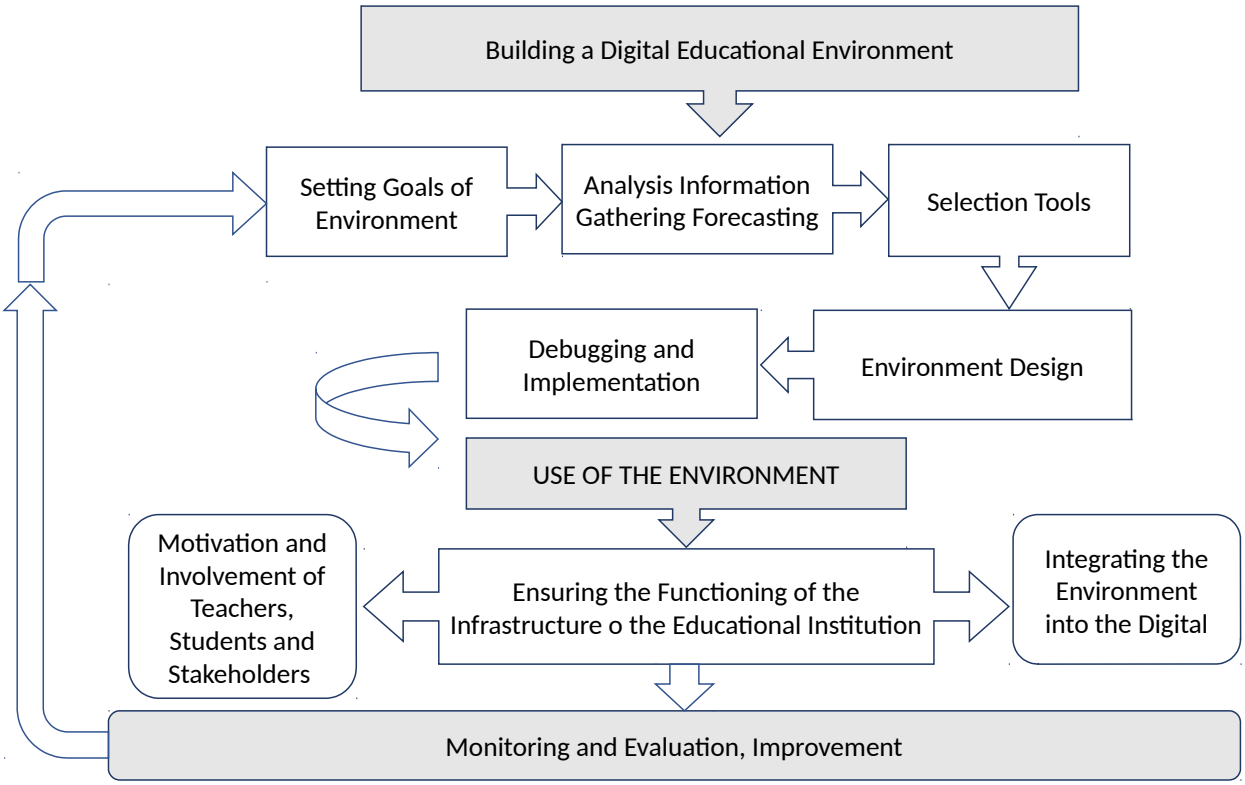

Figure 2: The procedure for creating and using the digital learning environment.

teachers and students, in particular as regards their effective and safe use.

Establishment and implementation of digital learning environment includes filling the educational environment with technological (software, information and organizational) resources. Important components are: appropriate computer equipment, the functioning of the Internet, Wi-Fi technology; software resources (virus and license security, software compatibility); academic component (scientific and methodological support, compliance with professional and educational standards, standard and working programs, elective programs, instructional and organizational documentation, digital didactic material, guidelines for the use of hardware and software products, etc.); social (ethical, culturological, normative-legal aspects); personal (IT literacy, psychological readiness, availability of teachers and students to subject-subject interaction in the digital learning environment).

The process of monitoring, evaluating and improving digital learning environment involves tracking resource load statistics. The use of the digital educational tools demonstrates their relevance and necessity. It is important to monitor student progress and teacher development, identify problems, supplement and correct teaching materials, various types of assessment of the level of mastery of teachers and students' methods of using the digital educational environment.

Summing up, we note that important aspects in the development of modern digital educational environment are: compliance with the principles of continuity and consistency, equal access to education, anti-discrimination, gender equality, information security, mobility; interactivity; involvement in the professional development of teachers and professional interaction of various actors and stakeholders; unity of purpose, content and focus on results; innovation and content with digital means; the ability to create their own digital resources and interaction of participants in the learning process in an unlimited open educational information space.

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Digital Educational Environment of a Modern University: Theory, Practice and Administration

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ABSTRACT

The article reveals theoretical and practical aspects of the digital educational environment of a university. The main normative and legal documents of Ukraine regulating the informatization of the sphere of national education are determined. The experience of introduction of the system of electronic educational courses by the leading institutions of higher education of Ukraine is analysed; the concepts of "distance education", "digital educational environment", "educational management" are specified. It has been found that education is a social institution with its own laws, principles and regulations, so the ability to manage education is as important and difficult as finding the right vector for development of all mankind. The benefits of education transformation are listed: development of students' self-determination, ability to concentrate on the most valuable teaching material; increase of mobility of personality, ability to adapt to the dynamic environment; ensuring cooperation with diverse audiences; creating an individualized educational trajectory of the student; comfortable learning environment. An attempt is made to identify the definition of "digital educational environment" as a set of relevant resources that is able to ensure the implementation of educational, scientific, international and managerial activities of higher educational institutions. It was established that higher educational institutions of Ukraine in the conditions of distance learning increase the capacity of the digital educational environment. The conditions and modern vectors of information educational development are considered, and the basic problems, needed to be resolved at the state level, are defined. Strengths (flexible schedule of educational tasks, provision of inclusiveness, control and evaluation of the results of educational activities, individual consultations in remote mode, etc.) and weaknesses revealed of the development of the digital educational environment (the delay in the creation of digital training courses, lack of information literacy of teachers, low level of integration of digital learning environment and teaching disciplines, etc.). Presented the model of digital education environment of the university from the position of organizational and administrative activity. Described four operational modules of the specified model: scientific and technical module (repository, open publication system, digitalization of the library fund); educational module (electronic management system of educational courses, online learning, control of students' knowledge quality); administrative module (electronic document management, education environment management, digital archive, online questionnaires, operational process management, digital security systems, innovative activities in the education and information environment); informational module (official website of the institution of higher education, personal pages of teachers, 3D-courses, pages of the university in social networks). It is established that the level of compliance of all activities of the designated operational areas is an indicator of the successful functioning of the university under the conditions of digitalization of the educational environment.

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CCS CONCEPTS

• **Applied computing** → *Learning management systems*; *Distance learning*; **E-learning**.

KEYWORDS

digital educational environment, Moodle, distance education, model of digital educational environment of the university

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1 INTRODUCTION

The complex social challenges posed by the global COVID-19 pandemic have not left any area of public life unchanged. The spheres of material (industry, transport, construction, types of household services) and intangible (education, culture, art) production faced the need for partial or complete transition to the digital environment. Not all of them succeeded with maximum efficiency at once: there was a lack of experience in the digital environment, there was a lack of specialists and equipment. The same problems befell the educational environment of Ukrainian education, which found itself in a situation of distance learning [29].

For the higher educational sector, this situation has become a kind of challenge, a call for action, and general secondary educational institutions are on the verge of disrupting the educational process, caused by a lack of computer technologies for both students and teachers, low level of information, communication competence

of participants in the educational process, sometimes the lack of Internet, etc.

Distance education has been introduced in Ukraine for almost 30 years [20]. This is evidenced by the legal framework of Ukraine, which regulates the informatization of education as a priority of state educational policy: Laws of Ukraine "On the basic principles of information society in Ukraine for 2007–2015" [3], "On Education" [8], "On Higher Education" [7], Order of the Ministry of Education and Science "On approval of the Regulation on distance learning" [5], Order of the Cabinet of Ministers "On approval of the State Program "Information and communication technologies in education and science for 2006–2010" [2], "On Approval of the Distance Learning System Development Program for 2004–2006" [1], Decree of the President of Ukraine "On the National Strategy for Development of Education in Ukraine until 2021" [6], Resolution of the Verkhovna Rada of Ukraine "On the recommendation of parliamentary hearings on topic: "Strategy of innovative development of Ukraine for 2010–2020 in the context of globalization challenges" [4], etc. In general, the legal documents defining the principles of distance learning in Ukraine are balanced and in line with modern demands of educational institutions. Today, material and technical problems that need to be addressed at the state level in the near future are still relevant.

However, the main achievements in the organization of distance education have occurred over the past two years. The vast majority of higher educational institutions in Ukraine have mastered the LMS Moodle [23]. In addition to Moodle, among the distance learning technologies the most popular and convenient platforms were: Zoom, Google Classroom, Kahoot, Google Meet, EdEra, Prometheus, etc. Of course, in the conditions of abrupt transition to online learning, the primary means of communication with students of all levels were such popular messengers and services as: Viber, Telegram, Messenger, WhatsApp, Instagram.

It was found that the introduction of distance learning at different educational levels is relevant among scientists both theorists and practitioners. The demand of the society is such that it requires radically new approaches to the organization of the educational process.

The *purpose of the article* is to analyze the digital educational environment of a higher educational institution through the prism of the theory and practice of educational management.

The defined purpose causes the following tasks:

(1) To determine the current state of theoretical development of basic concepts in the field of digital educational space.
(2) To analyze the state of use of the digital educational environment in the universities of Ukraine.

This problem remains relevant given that the intensive search for forms, methods and adequate means that would increase the effectiveness of training of future professionals in the current challenges that force the introduction of blended learning.

2 RESEARCH OF THE TERMINOLOGY OF THE DIGITAL EDUCATIONAL ENVIRONMENT

The logic of the study requires clarification of such key concepts as: "distance education", "digital educational environment", "educational management".

The website of the Ministry of Education and Science of Ukraine states that "distance education is an opportunity to study and receive the necessary knowledge remotely from school at any convenient time" [22]. There is also a list of distance learning models, including: independent study of the material (external); university studies; cooperation of educational institutions; autonomous educational institutions; autonomous educational systems; distance learning using multimedia programs.

Distance learning is a set of modern technologies that provide delivery of information interactively by means of use of information and communication technologies from those who teach (teachers, prominent figures in certain fields of science, politicians) to those who study (students or listeners).

The transition to distance learning was not easy for anyone: educators, teachers, parents, and even academics were put in a time limit. It was necessary to organize the educational process as quickly and as smoothly as possible in accordance with the conditions of the general quarantine. Experience has shown that distance education has many advantages, including the following:

- flexibility (adjusting the distance learning course to the level of knowledge and training of education students);
- innovation (implementation of the latest psychological and pedagogical and special methodological developments);
- usability (no pressure to the venue and time);
- economic efficiency (organization of distance learning is cheaper than traditional);
- modularity (design of the distance learning course in such a way that it takes into account different levels of training of educational specialists);
- diagnostics (more opportunities to control the quality of learning);
- geographical non-limitation (the absence of geographical obstacles to obtain education at various educational institutions of the world).

Today's digital university is a thoroughly changed structure, the content of education, approaches to administration, human capital development, scientific activities, the quality management system of education [21].

Digitalization is a reflection of the current paradigm of social development, in which competitiveness and efficiency are vital qualities. Digitization helps to simplify the educational process, making it more flexible and adapted to the realities of today, which ensures the formation of competitive professionals [16, p. 188].

According to Zaika [36], the main advantages of the digital transformation of the educational process are the following:

- a flexible schedule of educational work and, accordingly, the possibility of choosing the individual pace of the educational plan is created;

- the conditions for the implementation of inclusive education are being created;
- the structure of the teacher's activity is changing; the main functions that take up most of his or her time are: design of educational work, preparation of teaching assignments for self-study of the whole content of the discipline, control assignments with the levels of protection of validity of the results, individual counseling in distance mode, control and evaluation of the results of educational work;
- the organization of training and management of the educational process is changing. The first priority is the organization of the training of independent work of education students and coordination of their activities through distance learning tools. The main efforts are focused on the organization of the educational process, taking into account the characteristics, aspirations and abilities of each educational student;
- academic mobility in a digital education environment will enable education students to change their educational path at any time with minimal loss of time and maximum retention of academic achievements obtained in the previous stages of education.

At the same time, there are still a lot of unresolved problems. Thus, we agree with the opinion of Kucherak [19], who outlines these problems of development of the digital education environment:

- lack of scientific systematic planning, blindness in construction. In the construction of digital environment to some universities lack scientific and well-organized general plan;
- the distinction of building digital learning resources. Digital learning environment is a complex system, which mainly consists of two parts: hardware environment and software environment. However, in the process of building the digital educational environment, many universities emphasize the construction of hardware and neglect the construction of software. To ensure the quality and quantity of digital resources it is important to provide quality educational resources for frontal teaching;
- information literacy of teachers and digital skills must be improved. The teaching mode in the digital educational environment differs greatly from the traditional teaching mode and imposes high demands on instructors. Teachers use traditional educational ideas and educational concepts, it is difficult for them to accept new ideas and concepts based on digital learning. On the other hand, due to the lack of necessary training and various forms of continuous education it is important for teachers to technically adapt to the new requirements of the digital learning environment;
- maintenance of the information system does not work. The university uses more varied information systems. At the same time, they also face a lot of management problems and receive a lot of additional workload, including maintenance of equipment, information security, data management, etc.
- the level of integration of the digital educational environment and teaching disciplines is far from reaching the level of deep integration. An incomplete number of digital teaching models have not been truly integrated into conventional teaching. Various technologies have not become organically integrated, but brought a lot of work for teachers.

We are convinced the distance learning process allows the higher education applicants to receive a quality educational service, plan and implement an individual educational trajectory, use the benefits of dual education to improve their professional competence, and combine the participants of the educational process beyond age, social limitations, health, increasing the social and professional mobility of the population.

We agree with the position that distance learning is a fundamentally new educational system, which includes the following components: e-learning course management system (platform, website, environment) with all the necessary means of communication; database of educational materials; monitoring and evaluation tools; participants in the educational process (subjects and technical specialists).

According to Voronova [32], the rapid development of the digital educational environment leads to the fact that the management system of distance learning, distribution of educational materials with shared access for participants in the educational process up to this day were educational innovations, and now are quite traditional. This can be evidenced at least by the fact that educational institutions of all levels in Ukraine do not just try, but actually work remotely: classes take place according to schedule, teachers have developed and actively use a set of control (final, thematic) tasks to test knowledge, etc. And it is worth noting the organization of a pilot external independent evaluation for graduates of general secondary and vocational education remotely in 2020, which ensured, above all, the compliance with anti-epidemic safety measures for all participants, establishing a realistic assessment of their own capabilities and level of knowledge in the chosen subject by students, and the Ukrainian Centre for Educational Quality [10] had the opportunity to test the power of the digital environment and the professionalism of a team of specialists.

Digital educational environment is a set of tools, resources and services of information and communication networks that provide communication, interaction, learning, participation in virtual learning communities to form the relevant competencies of students [34]. A modern university graduate must have such a set of competencies that would ensure his high competitiveness in the labor market. And taking into account global changes in society, its rapid digitalization, information and communication competence of a specialist in any field of activity becomes leading.

Studying the use of informational and educational environment, Zabolotna and Ilchenko [35, p. 6] note, that the single informational environment allows optimal and effective solution of the following problems:

- transition from reproductive to creative and consultative activities;
- providing participants in the educational process with access to information related to planning, organizing and monitoring of the educational process;
- Ensuring communicative interaction between teachers, education students and the administration of the school;

- effective use of educational and methodological complexes that are constantly updated in accordance with the requirements.

According to Bykov et al. [13], the informatization of education directly depends on the objective conditions and current trends in the information society, which include:

- ensuring the mobility of information and communication activities of participants in the educational process in the information space;
- development of cloud computing and virtualization technologies, corporate, public and hybrid ICT infrastructures;
- accumulation and processing of significant amounts of digital data, formation and use of electronic information databases and systems, in particular scientific libraries and scientometric databases;
- deployment of topology of broadband high-speed electronic communication channels;
- progress of robotics, robot technical systems, in particular, 3D printers and 3D scanners;
- development of the software production industry (publication of electronic educational resources);
- expansion of networks of ICT service providers, primarily cloud services, and networks of data processing centers.

Investigating the current state of use in the domestic educational space of cloud-based systems (a system that has the ability to automatically adjust its parameters to different individual characteristics and educational needs of participants in the learning process [21, p. 8]), Vyshnivskyi et al. [33] determine that for effective interaction of all participants in the educational process the digital environment is possible only with the use of electronic textbooks, repositories of digital educational resources, virtual laboratories, multimedia teaching aids, rating systems for assessing the achievements of students.

Distance learning is carried out by home technologies: pedagogical and information and communication. Pedagogical technologies of distance learning are technologies of intermediary active communication between teachers and students using telecommunications. The teaching material is presented in a structured and electronic form [15].

Information and communication technologies of distance learning are technologies of creation, transmission, storage of educational materials, organization and support of the educational process of distance learning through telecommunications. Distance learning technologies in higher education reveal the possibilities of a positive impact on the solution of the following problems in the training of future professionals [25]:

- increasing the level of quality of education in higher education institutions;
- implementation of the needs of future graduates in educational services;
- increasing the professional mobility and activity of future graduates;
- formation of a unified educational space within the framework of higher education;
- individualization of education with the mass nature of higher education.

For example, in the Kryvyi Rih State Pedagogical University to improve the level of information and communication competence was organized by the course to improve the qualification on the theme: "Information and communication technologies in full-time (blended) learning" [23]. The teaching staff was able to take these courses under the supervision of the chair of the Department of Computer Science and Applied Mathematics. During the lessons the teachers were directly trained to work in the educational environment, namely:

- create e-mail and work with a google disk (creating files, downloading documents, making URL links, etc.);
- work in Moodle (enroll and enroll students in the course, regulate the time of students' performance of educational activities, fill in the electronic magazine and the message of success);
- model own educational course, enforce its structural elements (syllabus of the discipline, lecture plan, practical training plan, guidelines, independent work, individual tasks, questions for self-monitoring, module control work, examination test, etc.);
- use forms of work (scientific quizzes, crossword puzzles, etc.) that are interesting for students;
- perform open and uninterrupted monitoring of the students' knowledge quality.

Among those who took advanced courses, each department of the university had a manager – a person who has access to the creation of new courses for members of their department and provides advice without intermediary on the work in Moodle [11]. Thus, modern information and communication technologies are the basis, which the digital environment is not only formed on, but also directly implemented through a system of principles and technologies for the development of the educational system.

Therefore, for the effective functioning of the digital education environment of the educational institution, the aspect of its management is important. For a deeper understanding of this issue, let us analyze the scientific works of the researchers on the problems of education management.

Management in the broadest sense of the word is the theory and practice of managing social organizations. Education is a social institution, where there are its own laws, principles and regulations. Accordingly, being able to manage education is as important and difficult as finding the right vector for the development of all mankind.

The management of the educational process is a successive sprinkling of clearly defined procedures for educational and cognitive activities. The peculiarity of managerial activity in education lies in the constant search for new approaches to the implementation of such activity.

Management in education has its own specifics and laws. The specificity of education management lies in the peculiarities of the subject product, value and results of work of the education manager. The subject of work of the manager of the educational process is the activity of the subject of management. The work product is information about the educational process. The means of work is the word, the language. The result of work of the manager is

the level of literacy, education and development of the object of management – educational learners.

The main functions of management in education:

- making logical decisions;
- organizing the implementation of the decisions taken;
- bringing the decision to the participants;
- creation of conditions for effective work of the educational institution;
- creation of proper conditions of activity for each participant of the educational process;
- motivation and stimulation of activity of the participants of the educational process;
- control of implementation of decisions.

The understanding of education management has three dimensions: from the position of hierarchy in the organization, where the leading tool is the influence on the person from above; from the position of culture (social norms, values, specifics of behavior, etc.); from the position of market relations, i.e. equitable relations horizontally, which are based on partnership in the organization of joint activities and the provision of educational services [26].

Educational management is not a new concept for Ukrainian education. Batsurovska and Samoilenko [12], Doronina [14], Kondratyeva [17], Nikolaienko et al. [25], Osadcha [27], Tkachenko and Khmelnytska [31] determine the features in the understanding of the definition of "educational management" (figure 1).

So, the knowledge and ability to use the functions of management – planning, organization, motivation, coordination, control – is an integral part of the managerial competence of the head of the educational institution.

3 ANALYSIS OF DIGITAL EDUCATIONAL ENVIRONMENTS OF UKRAINIAN UNIVERSITIES

To obtain objective results of the analysis of digital environments of domestic universities, we choose higher education institutions from one economic region of Ukraine, in particular the Central-Eastern and various branches – agrarian (National University of Life and Environmental Sciences of Ukraine), classical (Sumy State University), technical (Black Sea National University named after Petro Mohyla) and pedagogical (Kryvyi Rih State Pedagogical University).

The Centre for Information and Communication and Distance Learning Technologies has been established at the National University of Life and Environmental Sciences of Ukraine [24]. The main areas of its work include: development of methods and creation of electronic learning resources for distance learning; support of resources of scientific and educational consultative environment.

During the existence of the centre, an educational and information portal was developed and implemented in the educational activities of the university (download of lecture materials with multimedia presentations, materials for laboratory and practical classes; implementation of modular and final quality control of educational activities of students); institutional repository (electronic archive of articles of scientific and pedagogical workers; conference materials; dissertation abstracts; diploma theses of students; methodical materials to ensure the educational process, etc.); agrarian open encyclopedia (materials for distance self-education; harmonized standards); site "Agrarian sector of Ukraine" (the basis of the national remote information and advisory system in the fields of agricultural production and in the field of agricultural science and education).

Sumy State University, in addition to Moodle platform, provides distance learning for students through an open electronic resource of structured collections of organizational, educational and methodological materials of disciplines, which is included in training, retraining and advanced training programs for various levels of education and additional educational programs (OpenCourseWare) [30].

Ostrovska [28], analysing the possibilities of Moodle system of the Black Sea National University named after Petro Mohyla as a basic platform for the introduction of distance education notes the following advantages [9]:

- placement of information materials intended for applicants for higher education for independent preparation for classes (calls for videos, PowerPoint-presentations, lectures, plans for seminars and practical classes, electronic versions of recommended scientific sources, questions for final control, etc.);
- organization of direct communication between students and a teacher by means of a chat;
- implementation of computer control of learning outcomes (modular tests, tests, exams);
- transparent evaluation of the work performed by students.

For comparison, let's take another institution of higher education – Kryvyi Rih State Pedagogical University with its system of management of educational electronic courses [18]. University administrators monitored the use of the system by participants in the educational process. According to the results, it was found that the vast majority of scientific and pedagogical staff of the university (more than 75%) use it to organize and manage the educational process. Analysts have found that there is a need to intensify the use of Moodle platform in various forms of learning, including laboratory and seminar classes. It was established that the most popular are the use of resources for organization of independent work of higher education and control measures (current, modular, credit, etc.).

The model of digital educational environment of the university, proposed by the authors, includes four operational modules. Let's describe each of them.

Scientific and technological module. Nowadays universities are becoming research centers that actively develop new technologies. The scientific structure is located in the digital dimension of the educational institution and includes a depository (for archiving scientific works of teachers and students); open publication system (a special platform of the university for submitting scientific works for publication); digitalization of library forms (to increase the possibility of using the sources in a remote format).

The educational module. Digitalization has become an indicator of the quality of educational services. The main advantage of educational electronic platforms is the possibility of using their potential regardless of external socio-political factors (lockdown, local conflicts, natural disasters, teaching foreigners). This area includes an electronic management system for educational courses, educational process (various forms of learning), the possibility of conducting

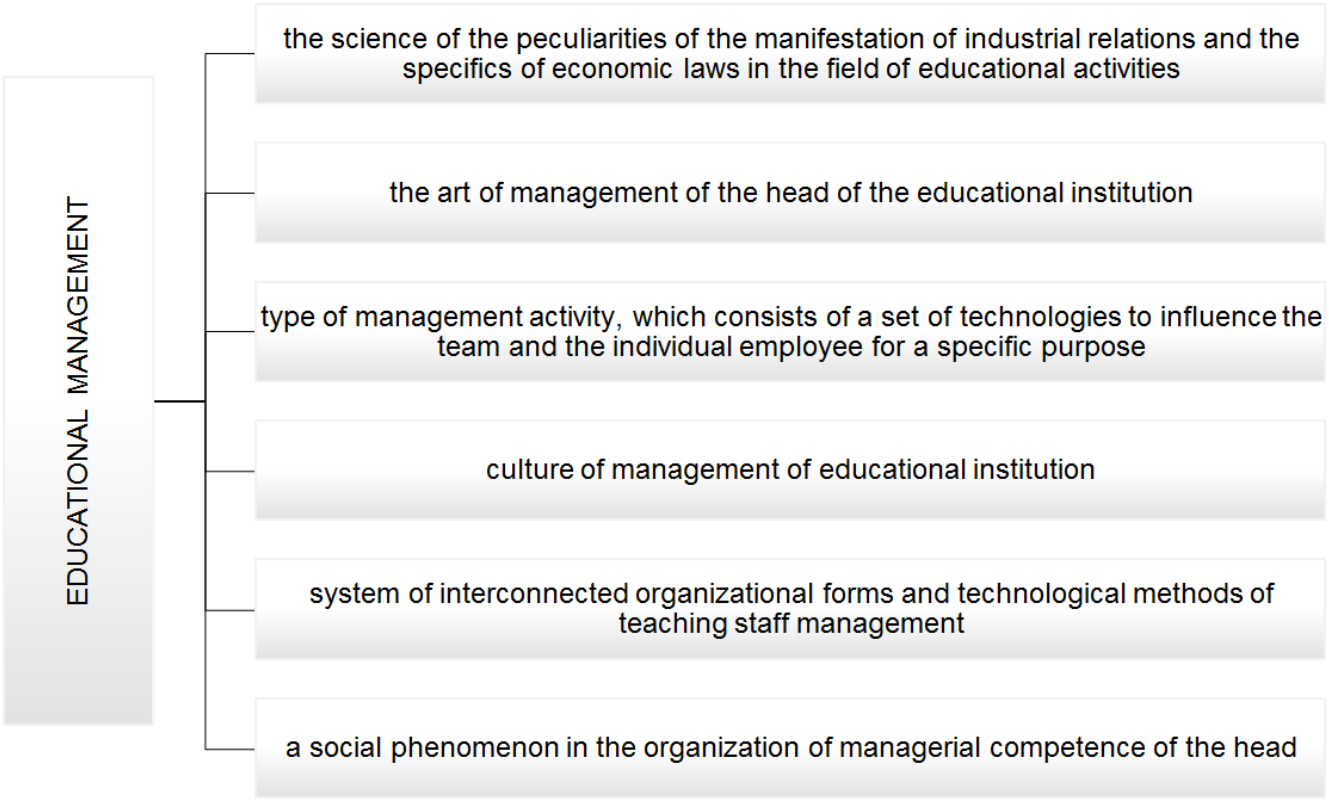

Figure 1: Positions on the definition of "educational management".

classes in online format, control of the quality of students' knowledge.

The administrative module is represented by the activities of individual structural units of the university, which carry out organizational and administrative supervision of the educational process and service supervision of educational students. Electronic document management, management of the educational environment, digital archives, online-enrollment, operational management of processes, digital security systems, innovative activities in the educational and information environment – components of administration.

The informational module includes the ability to collect, process, systematize and store up-to-date data about the educational institution, its infrastructure, instructors, etc. Such information is important for the popularization of higher education institution, the formation of a positive image, improving the position of the school in the national educational ratings, for monitoring the quality of educational services.

Given the purpose of the study, the analysis of scientific achievements and existing models of management of educational environments of domestic universities, we offer a model (figure 2).

Summarizing the modules of the model, we state that they are the components of organizational management of the institution of higher education in modern conditions. The presented model demonstrates the synergy and interdependence of all areas for the successful administration of the university, in particular the digital educational environment.

4 CONCLUSIONS

Today in Ukraine there is a modern educational space with all the conditions for mastering basic competencies (informational, social, interactive). Education will become more accessible and comfortable due to the organized digital environment. First, it will really save time, financial and human resources. Secondly, the digital environment today is one that is fully exploited by young people and can serve as a breeding ground for the implementation of any innovations.

Currently, the quality use of the digital education environment by many educational institutions remains a challenge due to a number of problems: Lack of a clear scientifically based plan for development of the digital environment; inadequacy of digital educational courses for the consumer of educational services; low level of information and communication competence of individual educational specialists and educators, etc.

As a result of the analysis of theoretical sources the need for standardization of the definition of **"digital educational environment of the university"** in the scientific and practical plane for its wide use in the scientific environment, educational process, other spheres, branches of science and technology is established. The system of management of electronic educational courses is an

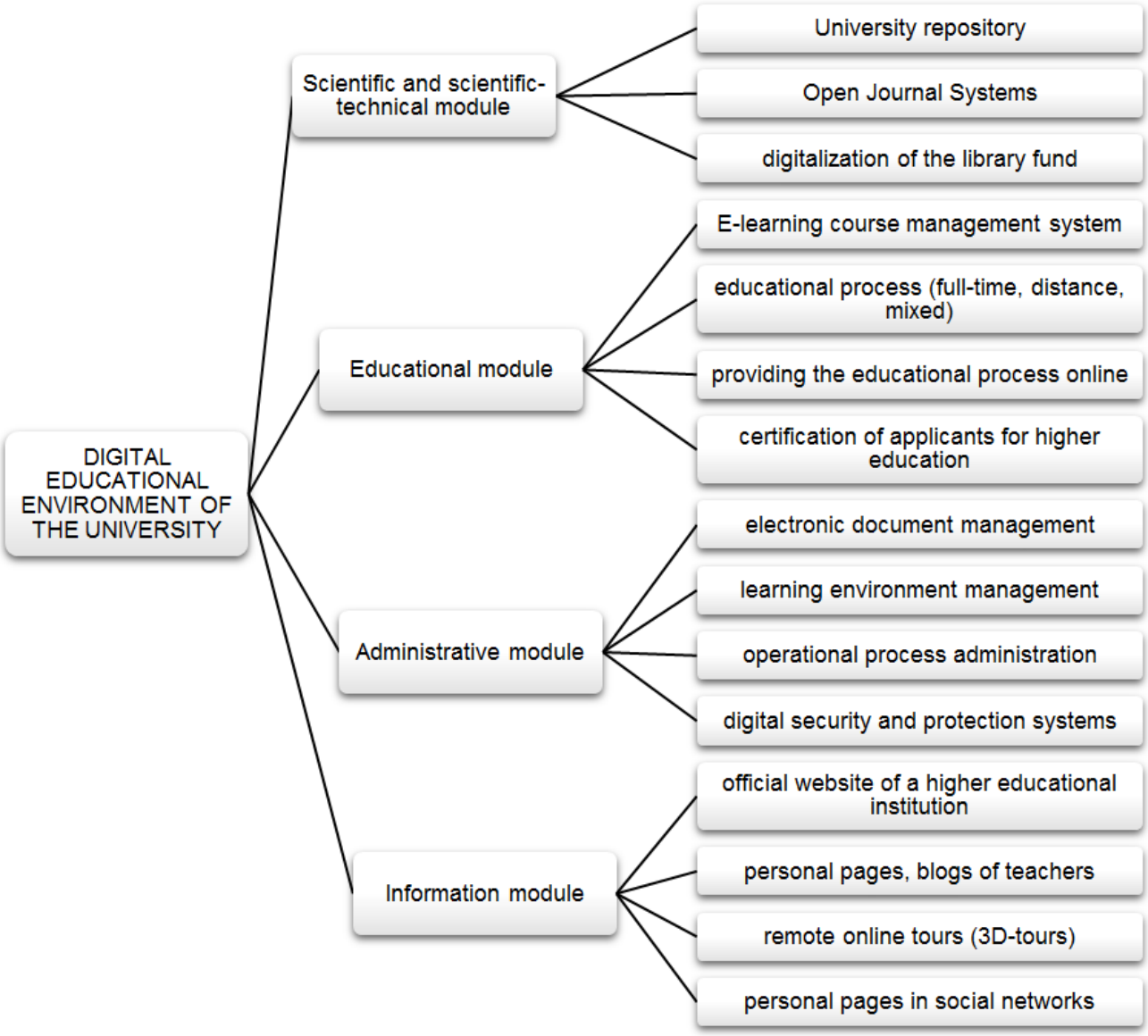

Figure 2: Model of digital educational environment of the university.

integral part of the educational environment of the university, but not the only one.

Thus, we offer our own interpretation of the definition: "digital educational environment of the university" is a set of resources aimed at organizing and ensuring the educational process, implementation of scientific, technical and international activities, creating conditions for educational services and management of higher education.

Given the imperfection of the existing model of digitalization of education, the lack of clear instructional materials in the national legal field and the experience of domestic universities, we offer ongoing training, seminars or refresher courses for research and teaching staff (3–4 ECTS credits per academic year) concerning use of resources of the digital educational environment of the university in different forms of educational work, in different forms of education (full-time, part-time, evening education) and learning conditions (full-time, distance, mixed). This will allow to increase the level of information and communication competence of teachers, and accordingly to increase the quality of educational services, including distantly. Today, every leader of an educational institution is aware of the inevitable digital transformation. In terms of digital transformation the successful development of an educational institution requires managers with the latest competencies.

The process of administration of the digital educational environment of the university should be systemic, logical and universal for different fields of knowledge and specialties, and cross-sectoral in

providing management activities in higher education. The proposed model of digital education environment of the university is a combination of interconnected operational areas of activity (scientific and technical and scientific-technical, educational, administrative and informational), which ensure the successful functioning of the entire institution of higher education in a distance and full-time education environment.

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The Use of Open Electronic Scientific and Educational Systems to Support the Professional Activities of Research and Teaching Staff of Ukrainian Universities and Scientific Institutions

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ABSTRACT

The article is devoted to the analysis and description of open electronic scientific and educational systems (OESES) and their use by scientific and pedagogical staff in Ukrainian universities and research institutions. The contribution of the use of open electronic systems by scientists and professors into the professional activity is considered. The results of experimental verification of the use of OESES and their impact on the research competence of teachers and researchers are presented. Based on the analysis of domestic and international research, the authors' own experience, the concept of open electronic educational systems designed to effectively organize and support research in education, pedagogy, social and behavioral sciences. The results of experimental research on the development of information and research competence of Ukrainian teachers and researchers during the use of open electronic systems are presented. The necessity of creating an environment for the development of information and research competence of university teachers and scientists is substantiated. The scientific novelty is based on the obtained results and is that it is proposed to include in the structure of such environment the following elements: scientific electronic libraries, electronic open journal systems (EOJS), scientometric databases, electronic social networks, and quality assessment systems for pedagogical tests, digital identification systems for scientists and scientific publications, software verification uniqueness of texts. Today, these tools are in demand and widely used for the organization of scientific and educational activities in educational institutions and research institutions around the world.

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CCS CONCEPTS

• **Open Electronic Scientific and Educational Systems** → Electronic libraries; Electronic scientific journals; Scientific databases; Social networks;

KEYWORDS

open electronic systems, open electronic scientific and educational systems (OESES), electronic libraries, electronic scientific journals, scientific databases, social networks, universities, teachers, researchers, pedagogical staff, information and research competence

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1 INTRODUCTION

The dynamic development of modern information technologies and the use of electronic forms of data have allowed to find new approaches to the use of information resources by teachers and scientists in universities and research institutions, as well as to organize the processes of publishing, storing and disseminating scientific information. In this context, open electronic resources play a significant role in creating the conditions to support research and the educational process.

In the "Strategy for the Development of the Information Society in Ukraine" [11] the importance of the Ukrainian segment of the Internet as one of the most important tools for the development of the information society and state competitiveness is a priority, in particular. At the state level, appropriate programs and projects are generated and reproduced, aimed at creating the necessary conditions, development and integration of information systems, networks, resources and information technologies to provide citizens and society with timely, reliable and complete information [2].

In modern conditions of high competition of universities and research institutions there are a number of important tasks of information and communication support of educational and scientific activities [3]. These activities include: creation of repositories of information resources, their organization and integration; development of means and methods of public access of users to electronic sources; ensuring the correct attribution of information resources with their authors, appropriate classification and organization in electronic systems; exchange of experience and cooperation of domestic and international researchers to accelerate the receipt of research results; evaluation of professional activity of scientific and scientific-pedagogical workers, productivity and efficiency of their research, in particular by citing published scientific works; the need to increase the level of motivation and interest of participants in the educational process to use electronic scientific and educational resources and services. One of the approaches to solve these problems is the use of OESES – automated information systems that contain data mainly educational and scientific, provide information support for education and science and technologically use computer information and communication platform for transportation and processing of information objects [33].

Open electronic scientific and educational systems are automated information systems (AIS) that contain data of mainly educational and scientific orientation, provide information support of education and science and technologically use computer information and communication platform for transport and processing of information objects and projects. Such systems make it possible to solve a wide range of tasks, including: search, storage, transmission, analytical and statistical processing of empirical data, evaluation of publishing activity of scientists, the level of efficiency of their scientific activity; evaluation of the effectiveness of scientific and pedagogical research, etc.

For scientific and pedagogical workers an important task today is the acquisition of knowledge, skills and abilities to combine with electronic scientific educational systems, bibliometric, webometric and scientometric databases, catalogs, creating author profiles and identifiers, features of publishing in domestic and international publications, increasing bibliometric indicators. It is important to develop competence in working with information resources in international information and analytical databases. Therefore, the possession of information and research competence by scientists is a necessary condition for successful professional activity in scientific institutions, higher education institutions and the system of postgraduate education. The problem today is the low level of information and research competence of research and teaching staff, the use of outdated approaches to learning and low motivation of the subjects of the educational process to use advanced ICT. Today, the digital competence of research and teaching staff and the ability to use the resources of open science is crucial for the competitiveness of the country's economy and for the development of the digital society as a whole. Implementation of the main provisions of the Digital Competence framework [1, 15], harmonization with the Digital Agenda [4] and EU Digital Single Market [16] are the topical initiatives that have an exceptional impact on education and science in Ukraine.

The aim of the paper is to identify tools of OESES that support the professional activities of research and teaching staff, and to investigate their impact on the level of information and research competence, and provide recommendations for Ukrainian specialists.

2 LITERATURE REVIEW

A significant number of scientists have studied the theoretical and practical aspects of the creation and use of OESES. Novitckii et al. [24] are developing models of information and analytical support for pedagogical research using electronic open electronic journal systems (OEJS). In particular, Novitckii et al. [24] have identified the following software components: electronic libraries (EB), OEJS, platforms for web conferencing, scientometric databases, tools for checking the texts of publications for anti-plagiarism, electronic social networks and more. The problem of functional features and main characteristics of software for creating electronic libraries, in particular on DSpace and EPrints platforms, in order to use them in higher education and research institutions was investigated in [24]. Nazarovets [23] studied the introduction of the Open Ukrainian Citation Index (OUCI) project, its functioning and development prospects. The use of the open electronic journal systems system as a cloud-oriented service of preservation and access to scientific resources within the project "Scientific Periodicals of Ukraine" in the Vernadsky National Library of Ukraine was described by Solovianenko [32].

Lugovyi et al. [21] studied experience of functioning of scientific periodicals in the conditions of digitalization, their indexation in domestic and international specialized digital publishing services and scientometric databases. Abuelrub and Hasan [8] developed

an evaluation framework that contains a set of basic criteria and quality indicators of electronic open journal systems, and it can be used for design, development and use of individual samples of EOJS. Brangier et al. [9] highlight the main functions of the digital library (archiving resources, ensuring the reliability and relevance of data, providing tools for analyzing materials, identification of scientific, educational institution and researcher, integration with social networks, encouraging users to self-archive knowledge exchange). The authors of [9] conclude that it is necessary to formalize the needs of users through the establishment of a user-oriented process of designing digital library. With this in mind, Tatnall and Davey [34] analyze the experience of creating a model for evaluating the quality of research based on the analysis of electronic library resources. They note that the model pays unjustifiably much attention to financial monitoring. Instead, the problems of communication of researchers working in separate or related fields of science and education are more relevant [34]. Dempsey and Malpas [13] study the evolution of the digital academic library. It has been established that libraries are moving from a digital repository model to a wide range of services, including research data management, analysis and visualization of experimental data, formation of electronic portfolios of researchers and laboratories, library support for young scientists, integration of library content into institutional management systems, training, providing infrastructure for research networks. Dempsey and Malpas [13], Essmiller et al. [14], Ozdemir and Hendricks [30] states a positive experience from the publication of university textbooks and manuals in open electronic libraries.

It is important to note the work of the network called DELOS Network of Excellence on Digital Libraries partially funded by the European Commission in the framework of the Information Society Technologies Program. This network provides an opportunity to join the community of professionals, educators and students at various stages in their academic careers to constantly update their knowledge on the use of digital libraries [5]. In particular, Castelli et al. [12] focus on interoperability issues as considered a key step to move from isolated digital archives and digital libraries towards a common information space that allow users to browse through different resources within a single integrated environment. Innocenti et al. [17] propose the vision and the policy that governs how a digital library is instantiated and run. They firstly presented the results of the experimental study indicating a high relevance for approaching policy interoperability not only from a technical perspective but also from an organisational and semantic point of view [17].

Since 2008, an attempt has been made to investigate and evaluate existing electronic open systems to support research in Ukraine. The following systems have been identified: Connexions / Rhaptos, DiVA (Digital VertenskapligaArkivet), GNU EPrints, DPubS, Open Journal System, Hyperjournal, Topaz. At the same time, we note that their use for the development of information and scientific competence of scientific and scientific-pedagogical workers is insufficiently reflected in methodological developments, curricula. From other hand Ovcharuk and Ivaniuk [26], Ovcharuk et al. [27, 28, 29] investigate the integration of the domestic education programs for teachers and students into the European learning environments using ICT. These researchers draw attention to the importance of achieving the required level of digital competence for teaching and learning that meets European frameworks and standards. When researching the level of competence of teachers, they found the need to pay attention to the development of training programs that contain information about learning environments and electronic educational systems necessary for the skilled performance of work in educational institutions [18, 22, 24, 25, 33].

3 RESEARCH METHOD

To achieve this goal, the authors used a number of methods: data analysis, generalization of the experience of using open educational and scientific systems by Ukrainian specialists. To verify the level of information and research competence of scientific and pedagogical workers, questionnaire and evaluation methods were used, questionnaires were used and mathematical processing of the obtained data was carried out. The authors also hypothesized the study. The research hypothesis was that if a specially developed methodology based on the use of OESES is introduced in the process of training and advanced training of scientific and scientific-pedagogical workers, it will be possible to increase the level of development of their information research competence.

4 RESEARCH RESULTS

The most common in the use of electronic educational systems by teachers and researchers include: electronic research libraries and repositories, electronic social and professional networks, digital identifiers of ratings of scientists, systems for collecting statistics of publications and achievements of scientists [6, 10]. That is why today the urgent task for scientific and scientific-pedagogical workers is to acquire knowledge, develop skills and abilities to combine with open electronic systems, collect statistics, process them and analyze them for effective research.

Electronic libraries which provide access to information resources in electronic form have a special role in expanding access to information for educators and researchers. Today they are part of the educational information space, as well as the national library and information fund of the country. Scientific electronic library is a distributed information environment of integrated educational and scientific academic resources, which allows accumulating, store and using publicly available collections of electronic documents through global data networks. According to Witten et al. [35], the most suitable for creating and maintaining the electronic libraries are software platforms DSpace and Eprints. Among these platforms, the Eprints system should be singled out, which is a convenient means to ensure the functionality of the scientific electronic library and support research on the implementation of tasks of analysis of psychological, pedagogical, methodological, special literature in accordance with the problems of these studies. In Ukraine the EPrints system is used in the following institutions of Ukraine: National Academy of Educational Sciences of Ukraine (http://lib.iitta.gov.ua/); Institute of Software Systems of National Academy of Sciences of Ukraine (http://eprints.isofts.kiev.ua/); The National University “Ostroh Academy” (http://eprints.oa.edu.ua/); Zhytomyr Ivan Franko State University (http://eprints.zu.edu.ua/); O. M. Beketov National University of Urban Economy in Kharkiv (http://eprints.kname.edu.ua/) and others.

The **EPrints** system supports a range of metadata sets, including Dublin Core, which is considered basic for the use of the OAI-PMH metadata exchange protocol (Open Archives Initiative – Protocol for Metadata Harvesting), which provides global access and search services. The Open Archives Initiative (OAI) develops and promotes interoperability standards in order to effectively disseminate electronic resources and increase the availability of exchange scientific information. The ERrints system satisfies all the requirements for the creation and maintenance of the library, namely: ensures the creation of electronic catalogs of library collections, their full functioning and development; increases the level of automation of libraries through the use of modern licensed software products; has the ability to use existing hardware; supports various file formats: HTML, PDF, Postscript, MS PowerPoint, MS Word, etc., can perform full-text and advanced searches, has flexible administration of access rights, etc. [31].

DSpace is open source repository applications that allows you to capture, store, index, preserve and distribute your digital material including text, video, audio and data. DSpace provides a way to manage materials and publications in a professionally maintained repository to give them greater visibility and accessibility over time. There are over 2000 digital repositories worldwide using the DSpace application for a variety of digital archiving needs. DSpace is most often used as an institutional repository – a platform that provides access to research output, scholarly publications, library collections, and more. It has three main roles: facilitates the capture and ingest of materials, including metadata about the materials; facilitates easy access to the materials, both by listing and searching; facilitates the long-term preservation of the materials [7].

The central place in the modern model of scientific communication is occupied by **electronic scientific journals**. In view of this spread, ICTs are gaining ground for the deployment and maintenance of scientific periodicals on the Internet – EOJS, that is an open source software platforms that provide the organization and decentralized remote management of the full cycle of the editorial and publishing process of electronic scientific journals, namely the support of the processes of submission, review, literary editing, correction, layout and publication of articles with their subsequent storage, distribution and indexing on the Internet. Electronic open journal systems today are the basis for coverage of scientific publications and research results of teachers and scientists, as well as the exchange of the most relevant information through editing and scientific communication of the participants of the publication. In particular, for the deployment and maintenance of electronic scientific journals on the Internet, electronic open journal systems serve as the open source software platforms that provide organization and decentralized remote control of the full cycle of the editorial and publishing process of electronic scientific journals, namely the support of submission processes. These systems support reviewing, literary editing, editing, layout and publication of articles with their subsequent storage, distribution and indexing on the Internet. One of the popular electronic open journal systems is **OJS** (https://pkp.sfu.ca/ojs) – a software platform to support the publishing and management of electronic scientific journals, developed within the Public Knowledge Project in 2001 in order to provide open access to research results and their dissemination on the Internet. It is the most widely used open source journal publishing platform in existence, with over 25,000 journals using it worldwide [31].

For effective and informed use of open educational systems, scientific and scientific-pedagogical workers must have a sufficient level of information and research competence. To identify the level and rating of the scholar the international **scientific databases** are used. The most popular and in demand in the use of international scientific databases are: Scopus, WoS, Google Scholar etc. The purpose of these databases is to track citations and ratings of scientists, research teams, to determine the impact factor of scientific publications, as well as their impact on the education sector.

A social networks are the virtual platforms that provides the means to communicate, support, create, build, display, and organize social contacts, including the exchange of data between users, and necessarily involves the prior creation of an account. The social network is a convenient way to interact between researchers from different countries and share experiences and disseminate research results, observe participants' reactions to discussions or information about certain issues (like it or not), invite people to participate in various scientific events, etc. The most common among scientists and teachers are social networks, which are filled with unique opportunities for learning and sharing experiences. Today we include: Instagram, Facebook and Twitter. For example, the Instagram network is now widely used among medical students for educational purposes. Today, Instagram has become one of the world's largest social networks, with more than 700 million registered users. Instagram can also be used for professional development and training. YouTube is a popular Internet host for hosting videos for free. Users can add, view and comment on certain videos. With its simplicity and ease of use, YouTube has become one of the most popular places to host videos. The service contains both professional and amateur videos, including video blogs. For example, this host has the ability download video tutorials, comment on them and conduct live stream.

In order to study the state of use of scientific and scientific and pedagogical workers of ICT tools in professional activities, to identify ICT tools that are used and can be useful for publishing and disseminating research results, as well as the attitude of scientific and scientific and pedagogical workers to use such tools in professional activities, the authors conducted an experimental study. It was important to determine the level of *information and research competence* of Ukrainian researchers and teachers. **Information research competence** of a teacher or researcher is presented as the most adequate, proportional set of professional, informational, communicative, personal qualities of the teacher, which allow him to achieve high results in both scientific and educational process. Determinant for the field of ICT in education and development of information and educational space of Ukraine is the creation of targeted information and educational environment for continuous development of information and research competence of pedagogical and scientific-pedagogical workers, librarians and education managers, acquainting them with new developments in ICT; advanced training of employees of IT divisions of methodical services, educational institutions, scientific institutions and education management bodies of pedagogical workers taking into account features of different levels of education, different types of educational institutions.

A specially developed methodology based on the use of OESES is introduced in the process of training and advanced training of scientific and scientific-pedagogical workers at the formative stage of the experimental study during 2019–2020. A training program was developed for scientific and scientific-pedagogical workers "Use of scientific electronic library services" (https://lib.iitta.gov.ua/717683/). The program includes four content modules, 2 of which belong to its invariant and 2 – to the variable component: electronic libraries, author profiles ORCID and Publons in scientific and pedagogical activities; services of scientific electronic libraries; editing services. The program is built on a modular system, according to the target category of students (users, editors of electronic libraries and administrators). 28 study hours are allocated for studying the educational material of the program. Training took place through lectures, seminars, practical independent or individual work, counseling, control measures to assess academic achievement. Learning process of students was implemented remotely and face-to-face on the basis of software platforms to support e-learning Moodle, Easygenerator, Wordpress, Prometheus and others.

Training and methodological support included a number of materials, namely: guidelines for students: "Using the services of the electronic library of the institution: guidelines" (https://lib.iitta.gov.ua/6259/), "Using the statistical module IRStats2 of the electronic library of the National Academy of Educational Sciences of Ukraine: methodical recommendations" (https://lib.iitta.gov.ua/705245/), "Recommendations on creation and use of the ORCID identifier for scientific and scientific-pedagogical workers: methodical recommendations" (https://lib.iitta.gov.ua/711636/), "Recommendations for users to include information resources in the Electronic Library of the National Academy of Educational Sciences of Ukraine" (https://lib.iitta.gov.ua/708197/); questions for self-control, lists of recommended sources, task cards for practical and training classes, presentations, test tasks, a set of individual practical tasks; questionnaires.

The main objectives of the training program were: to acquaint students with the theoretical and organizational foundations of the information infrastructure of the electronic library; to teach the creation and use of author profiles in ORCID and Publons in scientific and pedagogical activities; to form skills of search of actual scientific publications, authors and results of scientific researches, entering of own resources in storage, use of statistical services of electronic library; to form practical skills of the editor on formation of resources of the electronic library, filling in and editing of the form of the description of resources, search of deposits; formation of the library administrator's skills in the structure of the tree of subjects of the electronic library of the National Academy of Educational Sciences of Ukraine, performance of editing functions, work with system tools, configuration of subjects of the electronic library of the National Academy of Educational Sciences of Ukraine; increasing the level of information and research competence of scientific and scientific-pedagogical workers.

The following components of information-research competence of scientific and scientific-pedagogical workers were determined: value-motivational, cognitive, operational-activity and research component. A value-motivational includes: awareness of the need to use OESES in the professional activities of the scientists and interest in obtaining relevant, additional information about their functions; systematic use of OESES in the process of conducting scientific and pedagogical research. A cognitive component includes: knowledge about basic concepts regarding the use of OESES in research work; awareness of existing OESES support for scientific and pedagogical research. Operational component includes: the ability to select the optimal OESES at each stage of scientific and pedagogical research; ability to use the necessary OESES functionality to solve a specific research problem. The research component includes: rapid response to the emergence of new OESES in the course of research; ability to deepen knowledge, skills and abilities to work with OESES.

Assessment of the levels of formation of information and research competence of students was carried out at three levels: basic, intermediate and high. At the beginning and at the end of the training the developed questionnaires were used [20].

The purpose of the formative stage was to test the effectiveness of the developed methodology based on the use of OESES to increase the level of development of information research competence of scientific and scientific and pedagogical workers in the process of their training and retraining. Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, Educational and Scientific Institute of Continuing Education of the National Aviation University, Zhytomyr Ivan Franko State University and scientific institutions of the National Academy of Educational Sciences of Ukraine became the experimental base of the research at the formative stage. 142 respondents took part in the pedagogical experiment, 71 of them were included in the experimental group (EG) and 71 – in the control group (CG). In the process of the formative stage of the pedagogical experiment, data processing, comparison of research results, their analysis were carried out; description of the progress and conduct of research based on methods of statistical data processing, generalization, comparison and design of the results obtained at the beginning and end of the formative stage of the experiment in CG and EG. At the beginning and at the end of the formative stage in CG and EG, the levels of development of information and research competence of scientific and scientific-pedagogical workers at basic, intermediate and high levels were assessed. For this purpose, survey and testing methods were used. EG was trained in accordance with the method of using OESES for the development of this competence of scientific and scientific-pedagogical workers. On the basis of Institute for Digitalisation of Education of the NAES of Ukraine and in the above institutions were held trainings, seminars, workshops on scientometrics and the use of OESES to develop their competence, scientific and scientific-pedagogical staff developed by the authors of the article teaching materials described in the work [19]. In addition, research and teaching staff trained in EG were trained as trainers for colleagues. Scientific and scientific and pedagogical workers, who have expressed a desire to study traditionally, in particular independently, entered the CG.

The results of the survey at the ascertaining stage of the experimental study showed that among the most actively used by scientific and scientific-pedagogical workers in their professional activities OESES are domestic scientific electronic libraries and electronic professional publications (89% of respondents), platforms for online conferences / webinars (79%), foreign electronic scientific libraries (71%), as well as resources for creating personal identifiers of scientists (61%). About half of scientists use scientometric

databases (54%), cloud research and education services (50%), blogs of scientists / teachers and sites of international projects (46%). Significantly less scientists use information and analytical portals, systems and catalogs (39%) and systems for checking scientific texts for plagiarism (29%).

The personal profile of a scientist in scientometric systems Google Scholar and "Bibliometrics of Ukrainian Science" have 282 (86%) scientific and scientific-pedagogical workers, 223 (68%) – have the author's identifier ORCID, and 105 (32%) – Publons (ResearcherID), in Scopus scientometric database did not register any of the respondents. 46 (14%) respondents do not have a profile on any of the above-mentioned resources. 69 (21%) respondents use a Web of Science product such as the Web of Science Core Collection and 36 (11%) researchers use the Journal Citation Report and Essential Science Indicators. 223 (68%) respondents do not use this scientometric database at all. The presence of a personal profile in the Electronic Library of the National Academy of Educational Sciences of Ukraine was confirmed by 282 (86%) researchers and tracking statistics on the publication and dissemination of own scientific materials using the statistical module of the IRStats2 library – 200 (61%). Among the most used by scientific and scientific-pedagogical workers in the professional activity of cloud scientific-educational services were Google Scholar – 233 (71%), Google Docs – 128 (39%), Microsoft Office 365 – 127 (39%) and One Drive – 105(32%); and social networks Facebook – 292 (89%), Google+ – 141 (43%) and LinkedIn – 128 (39%).

Electronic scientific and educational systems were used by scientific and scientific-pedagogical workers in their professional activities usually for the following purposes: to search for information on the research problem – 282 (86%); publication of scientific works – 223 (68%); scientific communication – 210 (64%); conducting seminars, web conferences – 200 (61%); for joint work with colleagues – 164 (50%); collection of statistical data – 141 (43%); monitoring – 128 (39%); conducting surveys – 128 (39%); rating determination – 105 (32%); distance learning – 95 (29%); creation of websites and blogs – 59 (18%).

Regarding the question of which electronic scientific and educational systems are useful in professional activities, 223 (68%) respondents did not provide answers at all. Other respondents noted the importance of using electronic libraries – 59 (18%), electronic scientific publications – 36 (11%), cloud services Google and Microsoft – 37 (11%), as well as – 13 (4%) – Telegram channels, Google Scholar services, platforms for webinars and conferences, EBSCO resources, etc.

To determine the levels of development of the value-motivational component of information research competence of scientific and scientific-pedagogical workers at the formative stage of the experiment, the obtained data are compared with general estimates of the levels of development of components of this competence, which are given in table 1.

The values at the beginning and end of the stage of the pedagogical experiment in CG and EG were obtained as the arithmetic mean of the relative values of individual scores of scientific and scientific-pedagogical workers in CG and EG, respectively. Analysis of the results of the pedagogical experiment led to the conclusion: at the beginning of the pedagogical experiment the level of development of the value-motivational component of information research competence in CG was 21%, in EG 24% and was below baseline (<30%), and at the end of pedagogical experiment development of the value-motivational component of competence increased to 49% of the basic level (30-50%), and in EG – to 75% (51-75%) of the intermediate level. The dynamics of changes between the levels of development of the value-motivational component is 23% higher in EG than in CG. The implementation of pedagogical influences in the process of purposeful learning on the development of the value-motivational component of the ID competence of scientific and scientific-pedagogical workers forms awareness of the need to use OESES in the professional activity of a scientist and stimulates interest in obtaining relevant, additional information use of OESES in the process of conducting scientific and pedagogical research. The dynamics of changes in the levels of development of the value-motivational component at the beginning and end of the pedagogical experiment between CG and EG is presented in figure 1.

Table 1: General assessments of the levels of development of the components of information and research competence of scientific and scientific and pedagogical workers

Level	Indicator
Basic	30–50%
Medium	51–75%
High	76–100%

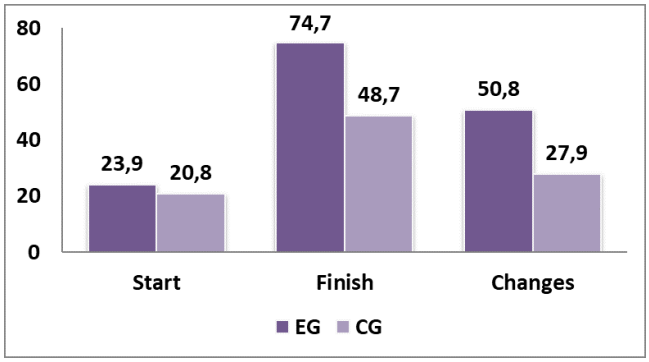

Figure 1: Dynamics of changes in the cognitive component at the beginning and end of the pedagogical experiment between CG and EG (arithmetic mean of the relative values of individual scores).

The analysis of the results of the pedagogical experiment allowed to reach the following conclusion: at the beginning of the pedagogical experiment the level of development of the cognitive component of information and scientific competence of scientific and scientific-pedagogical workers in CG was 30%, in EG 34% and was at the basic level the end of the pedagogical experiment in the CG group increased to 75% of the average level (51–75%), and in the EG – to 94% (76–100%) of the high level. The dynamics of changes between the levels of development of the cognitive component is 16% higher in EG than in CG. The increase in the level of development of the cognitive component in the experimental group is due

to the fact that scientific and scientific-pedagogical workers have been trained in the appropriate method of using open electronic scientific-educational systems for the development of information and scientific competence of scientific and scientific-pedagogical workers.

At the beginning of the pedagogical experiment the level of development of the operational component of information research competence in CG was 24%, in EG 26%, which is below the baseline (<30%), and at the end of the pedagogical experiment in CG the level of development of operational component ID increased to 51% and reached an average (51–75%), and in EG – up to 80% (76–100%) of a high level. The dynamics of changes between the levels of development of the value-motivational component is 27% higher in EG than in CG.

At the beginning of the experiment, the level of the research component of the competence in CG was 24%, and in EG 29% (30-50%), which is below the baseline level. At the end of the experiment, the level of the research component of information research competence in CG was 68% and corresponded to the average level (50–75%), and in EG – 90% (75–100%) and corresponded to a high level. The dynamics of changes in the research component at the beginning and end of the pedagogical experiment between CG and EG is presented in figure 2.

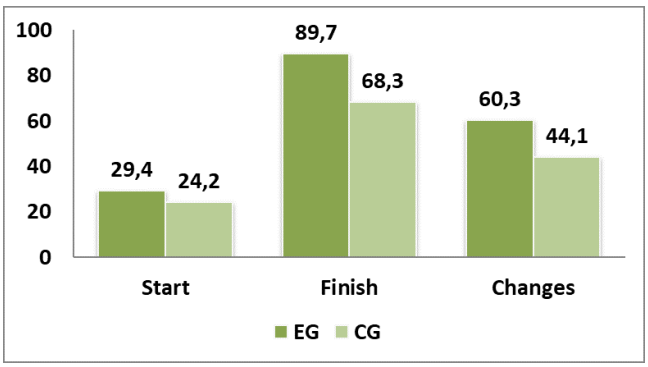

Figure 2: Dynamics of changes in the levels of development of the research component at the beginning and end of the pedagogical experiment in CG and EG (arithmetic mean of the relative values of individual scores).

After elaboration of the components of information research competence of scientific and scientific-pedagogical workers (value-motivational, cognitive, operational-activity and research) the value of information-research competence in general was determined as the arithmetic mean of the corresponding values of its components. Analysis of the results of the pedagogical experiment on all components of the competence of scientific and scientific-pedagogical workers allowed us to conclude: at the beginning of the pedagogical experiment the level of information research competence of scientific and scientific-pedagogical workers in CG was 25% and in EG 28% below baseline (<30%), and at the end of the pedagogical experiment in CG the level of the competence increased to 58%, which corresponds to the average level (51-75%), and in EG – to 83%, which corresponds to a high level (75-100%). The dynamics of changes in the levels of development of the competence of scientific and scientific-pedagogical workers at the beginning and end of the pedagogical experiment between CG and EG is presented in figure 3.

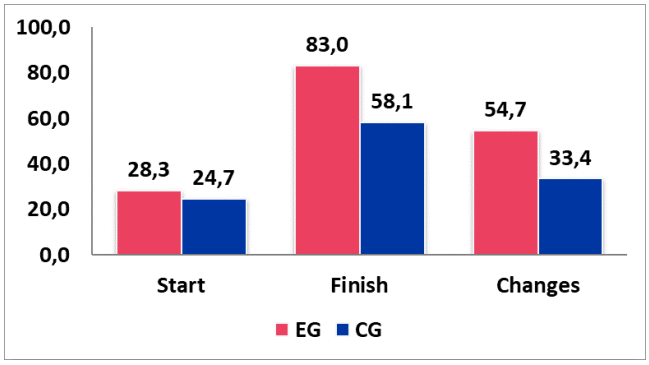

Figure 3: Dynamics of changes in the levels of development of information research competence of scientific and scientific-pedagogical workers at the beginning and end of the pedagogical experiment between CG and EG (arithmetic mean of relative values of individual scores).

After analysis, we conclude that at the beginning of the pedagogical experiment of information research competence of researchers and pedagogical workers in CG and EG were below baseline, and at the end of the pedagogical experiment in CG the level of this competence increased to medium, and in EG to high level.

5 CONCLUSIONS AND RECOMMENDATIONS

The problem of using OESES for the development of information and research competence of scientific and pedagogical workers is relevant and needs further study. The analysis of publications and Internet resources shows that OESES is a popular tool in the organization of educational and scientific activities. For their effective application it is necessary to develop appropriate methods that determine the development of information and research competence of scientists. Analyzing the obtained experimental data, we can state:

(1) Electronic professional publications, digital libraries, platforms for online conferences, scientometric databases, electronic social networks, digital identification systems for scientists and scientific publications are the OESES that are most often used in the activities of domestic scientific and pedagogical workers. Unjustifiably little attention in Ukraine is paid by researchers to the use of information and analytical portals, software for automatic tracking of text matches and borrowing sites of international projects, as evidenced by the results of the observational experiment, own publications on the uniqueness of the text.
(2) The vast majority of Ukrainian scientific and scientific-pedagogical workers are aware of the need to use OESES in their own professional activities. The introduction of the author's

methodology allowed to significantly increasing the indicators of the value-motivational component of the information and scientific competence.

(3) The development of the operational component of the information and scientific competence is most dynamic in the process of purposeful, systematic and comprehensive use of OESES. In this regard, a combined approach can be considered, which is a combination of technical, editorial, administrative requirements, intrinsic motivation and personal beliefs of scientists. Therefore, it is necessary to form in each researcher not only the belief in the need for systematic use of OESES, but the conscious need to conduct research with their help. We can also recommend conducting the series of trainings on how to use OESES for scientific and scientific-pedagogical workers that will contribute to the formation of their readiness to use new technologies and to reach modern open science resources by Ukrainian specialists.

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Digital Competence of Future Researchers: Empirical Research of PhD Students of Ukrainian University

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ABSTRACT

The article analyzes the experience of Jisc, which provides digital solutions for education and research in the UK, which became the basis for additional research on scaling the Jisc Reseacher model for the formation of digital competence of graduate students in higher education in different countries. The digital competence of the PhD students researcher of a particular educational institution is considered as a factor influencing the quality of education and the readiness of PhD students for its development. The result of the study is to determine the readiness of PhD students of Borys Grinchenko Kyiv University to acquire and develop their own digital competence of the researcher. The readiness to acquire and develop digital competence of graduate students both at the level of resource provision and basic digital competence and motivation of future researchers was confirmed by conducting a survey of the experimental group of graduate students of the 1st year of study. To identify general or specific problems for graduate students based on the analysis of average group values for each group of Jisc Reseacher competencies, unformed digital competencies of researchers were identified and the author's interpretation of the causes and prospects of development was given.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in collaborative and social computing**;

KEYWORDS

Digital Competence, Digital Research, evaluation, PhD students, higher education, empirical research

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1 INTRODUCTION

The development of modern digital technologies and their implementation affect the nature of manufacturing, scientific studies, education, culture, everyday life, social relations and structures. Accordingly, the demand for training competitive specialists is growing increasingly relevant considering a strengthening role of scientific studies and their digitalization. However, according to Duke and Denicolo [4], despite a rising international demand for highly qualified personnel that possess the skills of promoting research in the field of innovation, diversifying programmes to train PhD students and expectations of integration of prospective researchers into the global scientific space often remain unrealized. In this context, it is worthwhile to consider a number of governmental initiatives from different countries and international documents, namely those concerning the development of the digital open science as an innovative way to integrate science into society, wherein the studies are conducted, publicized and interpreted with the aid of digital tools and are available in open access. Thus, the need to train digital competences in researchers is growing more relevant [6].

Durette et al. [5] identify 6 main categories (knowledge and technical skills', transferable competences that can be formalized, transferable competences that cannot be formalized, dispositions, behaviors, meta-competencies) for the core competences of PhD students acquired through higher education [5], whereas more of them are formed to a greater extent through practical experience of conducting real studies than in the process of studying certain theoretical subject [10], is the grounds for making the assumption that subjects of the educational and scientific process in higher education establishments are primarily consumers of services and content of digital environments [11]. That is, they look for and process resources in order to obtain what they want, yet, they are not used to creating digital products and content of their own. Therefore, notwithstanding the significance of development of digital

learning environments, it is important for professors and students (in this case, PhD students) to be incentivized and trained to use technological means for both educational activity and scientific studies realization [14]. In this context, researchers in the field of education use education analytics data, namely those concerning the attitude of professors and students towards institutional learning environment, in order to provide new understanding of teaching and studying [7, 13]. For instance, the analysis of digital competences in PhD students in universities in Mexico carried out in [12] is the basis for making the assumption that forming digital competences is more effective in the process of distance learning. However, the researchers' digital competences level is insufficient for the effective realization of the digital open science.

The objective of this study is to identify the level of a researcher's digital competence based on the example of PhD students of an education institution as the factor affecting the quality of learning and the/readiness of PhD students to advance.

The obtained results can be helpful for researchers in the field of education sciences as well as for representatives of structural units of higher education institutions for identifying the spheres wherein the development of digital skills is necessary as well as creating favourable conditions for the PhD students to acquire them.

In order to achieve the objective of our study we set the following tasks:

(1) To determine the readiness of PhD students of Borys Grinchenko Kyiv University (BGKU) to acquire and develop the researcher's digital competence of their own;
(2) Assessment of digital researcher level of 1st year PhD students based on the Jisc Reseacher profile in order to identify general or specific issues for researchers.

2 RESEARCH DESIGN

In our study, in order to conduct expert assessment, in this case the level of researchers' digital competence, a sample statistical survey was employed as one of the methods for monitoring and evaluation of effectiveness of education projects realization according to Wagner et al. [15].

In order to formulate the questionnaire, we based it on Researcher profile as the structure element of digital capabilities Jisc (https://digitalcapability.jisc.ac.uk/what-is-digital-capability/), that focuses on digital capabilities relevant for both young and experienced scholars of higher education. Since we employed descriptor characteristics from the official profile of digital researcher Jisc Reseacher [2], the additional validation of questionnaire reliability was not performed.

For the convenience of data processing, every descriptor [2] has been encoded by us (figure 1). For example, J1. ICT (digital) proficiency:

J1.1. Digital proficiency
J1.1.1. Use of ICT devices, software and services
J1.1.2. Use of specialized (for a particular field of research) ICT devices, software and services
J1.1.3. Staying up to date with digital technologies as they evolve
J1.1.4. Understanding the specifics of conducting research (in a particular area) and selection of methods and tools

In order to conduct the survey among PhD students we used questionnaire (https://cutt.ly/BYWcIbi), consisting of 7 main sections. Six sections contain questions for identifying the groups of competences according to Jisc recommendations [1] (64 questions total). The last section requests to fill in the personal profile of the respondent (age, IT access level, scientometric databases, self-assessment of the level of digital competences etc.).

The survey involved 46 1st year PhD students of BGKU. The PhD students were asked to assess the statements provided in the questionnaire referring to researcher's digital competency, e.g. Management of research data securely within legal and ethical frameworks, on a 5 point scale (0 – incapable, 4 – expert level).

The respondent's assessment of each of the statements of the questionnaire can be considered as a function of the general latent factor. Therefore, we considered that a greater positive assessment of a respondent's assertion corresponds to a higher level of development of his or her digital competency.

The processing and analysis of the results of the study involved the use of the Likert [3] as a scoring scale of average values in a group in order to analyse each descriptor.

During the data analysis a set of methods and models was used to calculate all descriptive statistics. The choice of certain indicators was determined by the type of data, evaluation scale and limitations of the methods use. SPSS [9] was used for calculations.

Certainly, while the local context of the study and comparatively low number of survey participants (the number of PhD students in the educational institution) is limiting to the number of respondents to a certain extent, it still enables us to draw certain conclusions concerning the existing trends and patterns and can be scaled both on the level of conducting methodology and expansion of pedagogical experiment.

3 RESULTS

3.1 Identifying of Readiness to Acquire and Develop Researcher's Digital Competence

Since access to technical devices and the Internet (v1, table 1), as well as access to scientometric databases (v2) are vital conditions for assessment of PhD students readiness to acquire and develop digital competence of researcher, these questions were included in the developed questionnaire. The results have shown that the majority of respondents have access to both computer equipment and scientometric databases. It should be noted that for each function descriptive statistics were calculated and frequency distributions were constructed (table 1).

For acquisition and development of digital competence of researcher that follows digital competence of citizens, the level of this competence is significant (v5). Most respondents assessed their level as average and above average. It corresponds to the research findings described in [8] Since Spearman's correlation between the level of their own digital competence and answers to the questions concerning awareness of the set of instruments for conducting research was above 0.5, we can argue that there is a relation between self-assessment of PhD students and their readiness to digitalization of their own scholarly activity.

In order to determine the existing experience of PhD students concerning the effectiveness of their scholarly activity (which can

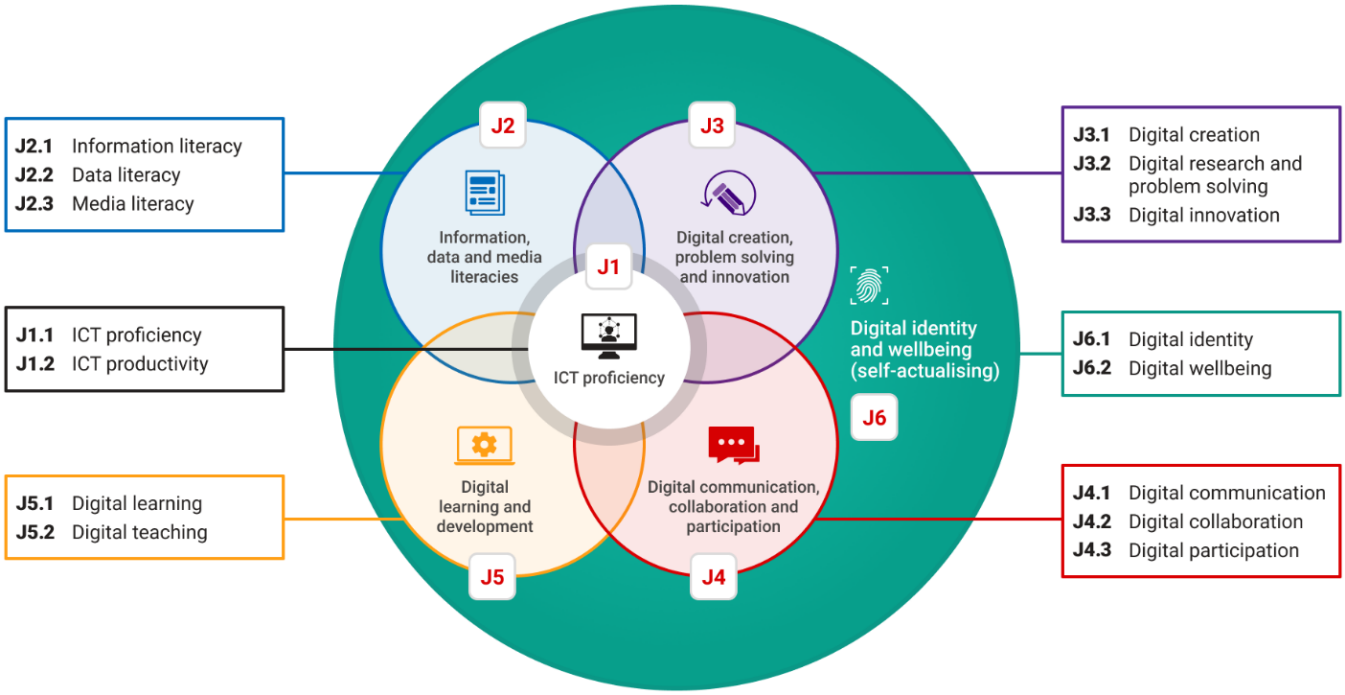


Figure 1: The structure of digital competence of PhD students based on Jisc Reseacher profile.

Table 1: The main characteristics of the respondents

Characteristic	Value	Percentage statistics
Access to mobile and technical devices (v1)	Always	63.9%
	Sometimes	30.6%
	I can use digital devices very rarely	5.6%
Access to scientometric databases (v2)	Always	8.3%
	Sometimes	63.9%
	Access is limited, since access additional funds are needed for full	27.8%
ResearchGate social network account (v3)	Yes, I am an active participant	11.1%
	Yes, but I hardly ever use it	25%
	No, but I am planning to make one	38.9%
	No, and I do not consider it necessary	25%
Scientometric database account (WOS, Scopus or Google Scholar) (v4)	Yes, and I have publications that are indexed in the appropriate database	19.4%
	Yes, I have one, but no publications of my own	27.8%
	No, but I am planning to make one	41.7%
	No, and I do not consider it necessary	11.1%
Own level of digital competence (v5)	1	5.6%
	2	22.2%
	3	44.4%
	4	27.8%
Age	Respondent's age	Mean=26
		Median=25,0
		Mode=24,0

also be evaluated as the motivation to acquire digital competence of researcher), we asked questions about having their own profile in scientometric databases (Google Scholar, Scopus or Publons – v4) and ResearchGate social network (v3). The last is confirmed by results of research, in particular by Yu et al. [16]), which prove that activity in ResearchGate is an effective altimetric indicator for active researchers. The findings show that the majority of the respondents do not have said profiles, however they would like to acquire this experience and believe it to be an important condition for self-realization as researchers. At the same time, there is a statistical relationship between the level of competence of respondents and the answers to these questions. Therefore, we can argue that the experimental group of PhD students have sufficient level of digital competence of citizens and readiness to acquire and develop digital competence of researchers.

3.2 Study of Formation of Digital Competence of Researchers

As a result of the analysis of respondents' answers regarding the level of acquisition of groups of digital competences of researcher (figure 1) frequency distributions of respondents' scores on each question, as well as by total values were plotted. As shown in figure 2, the significant number of studied characteristics and limited number of respondents prevented us from drawing unambiguous conclusions concerning the main trends of acquisition by PhD students of digital competences of researchers and determining their level.

Distributions of total scores for every question of the questionnaire are far from normal, which prevents us from relying on average values in order to draw conclusions or making assumptions. Therefore, in order to determine separate (unformed) competences of researchers, we analyzed the mean group values for each group of competences Jisc Reseacher (figures 3, 4, 5). Since we rely on PhD students' self-assessment results, we are primarily interested in competences the formation of which is estimated below the threshold value of average (i.e., less than 2). We will consider these competences unformed.

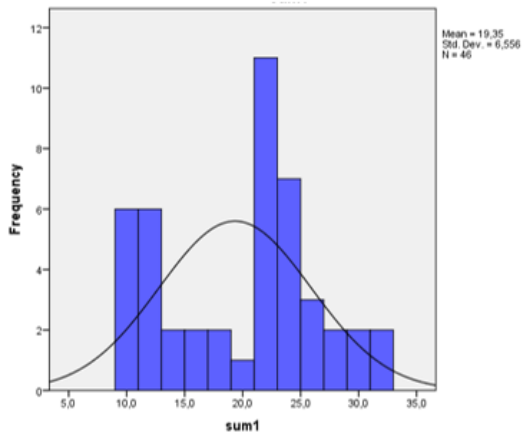
As we can see in figure 3, among respondents the unformed competences are those concerning understanding the specifics of conducting a study in a particular field and selection of methods and tools (J1.1.2) as well as the use of specialized ICT devices, software and services (J1.1.4) – mean value equals 1.8 and 1.9 respectively. The lowest (mean value equals 1.6) competence turned out to be the ability to find ICT solutions to problems that arise in the course of research and scholarly activity (J1.2.2). Another one in need of improvement (mean value equals 1.8) is the ability to critically assess the benefits/constraints of ICT applications for specific research tasks (J1.2.3). These results can be attributed to the limited experience of PhD students in conducting scientific research.

Data literacy (J2.2) is not formed in PhD students, which can be explained by the low general culture of data management and digitalization of this process. Along with that, respondents also note only partially formed Information literacy (J2.1) and Media literacy (J2.3). In this case, however, the group mean values approach the threshold value of the average. The following turned out to be the least formed (mean value equals 1.8): "Understand the rules of copyright and open alternatives e.g. Creative Commons as they apply to digital information" (J2.1.6) and "Choose and use media resources to express scholarly ideas with an awareness of design, audience, impact, accessibility" (J2.3.2). Possible causes of this condition include insufficient level of publicizing and promotion of research results of universities on the Internet, consequently, PhD students have lower number of cases of digital science implementation. In addition, unformed J2.2.3 (Apply to the relevant ethical bodies for permission to collate and use research data – mean value 1.7) can be interpreted as a problem that concerns compliance with copyright and academic integrity.

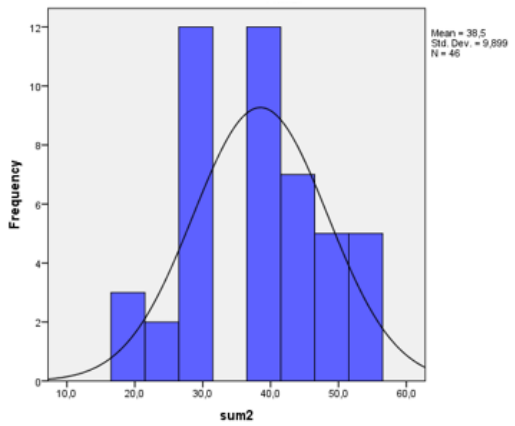
The PhD students believe that among the components belonging to Digital creation, problem-solving and innovation (figure 4), they only have one capability formed (mean value equals 2.6), which is Use a range of digital media to communicate research findings and scholarly ideas (J3.1.1) from the group of competences Digital creation (J3.1). Respondents reported the most problems (mean value equals 1.6) with understanding how digital technologies are changing the field of research with respect to questions and challenges, methods, theories and values (J3.2.6), indicating a weak involvement in real research projects, the closedness of domestic (the study focuses on the Ukrainian context) university science or low motivation of graduate students. Mean value of 1.7 is also attributed to the formation of J3.1.2 (Creation of other digital artefacts according to the subject of scholarship and the needs of stakeholders), however, in this case an assumption can be made about the ambiguity of interpretation of the said question.

As for Digital communication, collaboration and participation (J4), the results are considerably better. Share and amplify messages across networks; share research data, references and resources (J4.3.3) is the least formed (with mean value 1.75). Considerable improvement is required for competences marked as Design digital communications for a range of scholarly networks, purposes and audiences (J4.1.2), Participate in research teams using virtual environments and tools e.g. project management tools, shared calendars and tasks lists (J4.2.1), Participate in, facilitate and build digital networks around scholarly issues and concerns (J4.3.1) and Create positive connections with researchers in diverse fields of expertise (J4.3.2) (mean value equals 1.8). This situation can be explained by the lack (or insufficiency) of using the teaching method as research with IC support in the process of training graduate students or the insufficient number of learning and research projects involving graduate students of various specialties and external stakeholders.

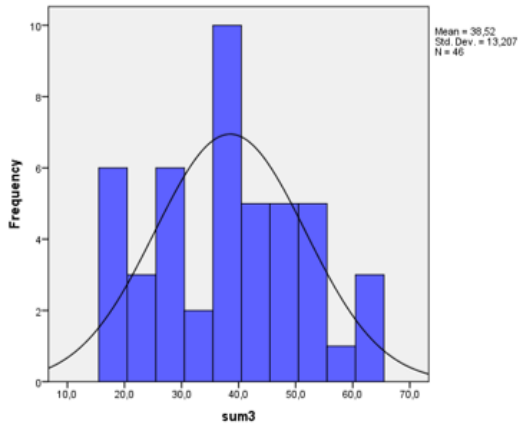
The final two groups of competences characterize the capability to "Digital learning and development" (J5) and "Digital identity and wellbeing" (J6). Self-assessment results show that respondents are capable of self-learning in the digital environment. Whereas Use of digital tools to: record events in the research process for planning, reflection and review; for self-analysis, reflection and monitoring of progress; to manage own time and tasks, attention and motivation in digital settings (J5.1.3) and Supporting others (research colleagues, undergraduate students etc) to develop practices of digital scholarship (J5.2.1) are not formed (mean value equals 1.7). As stated above, insufficient involvement in science projects with digital support can be considered as one of the reasons for the weak motivation and unformed ability to conscious use of digital



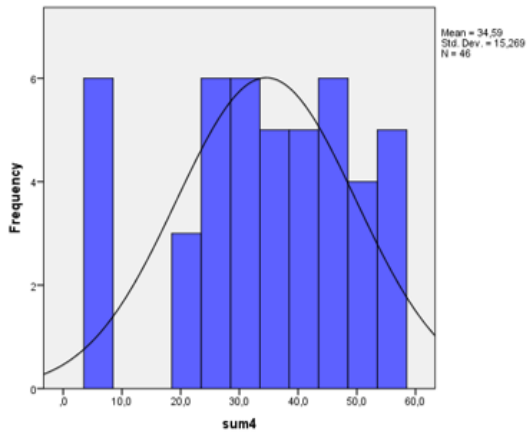
"Digital proficiency" (J1)



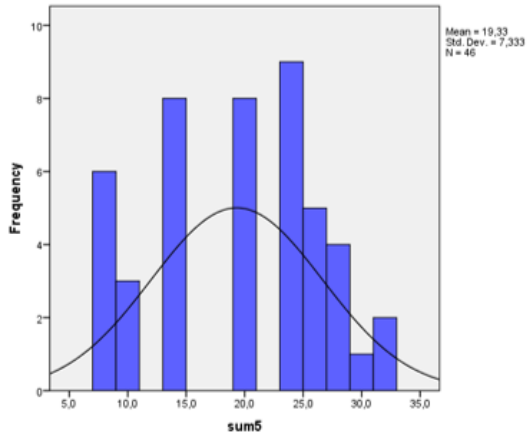
"Information, data and media literacies" (J2)



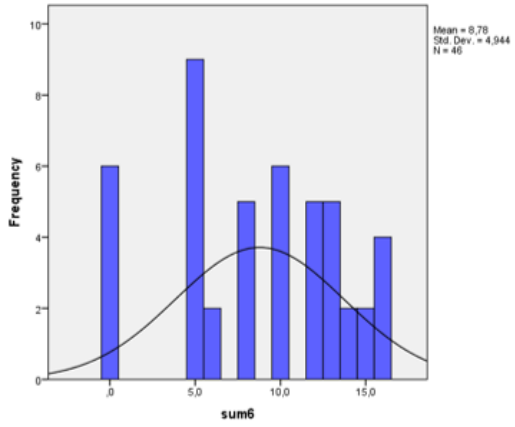
"Digital creation, problem-solving and innovation" (J3)



"Digital communication, collaboration and participation" (J4)



"Digital learning and development" (J5)



"Digital identity and wellbeing" (J6)

Figure 2: Distribution diagrams of total scores based on groups of digital competences of researchers.

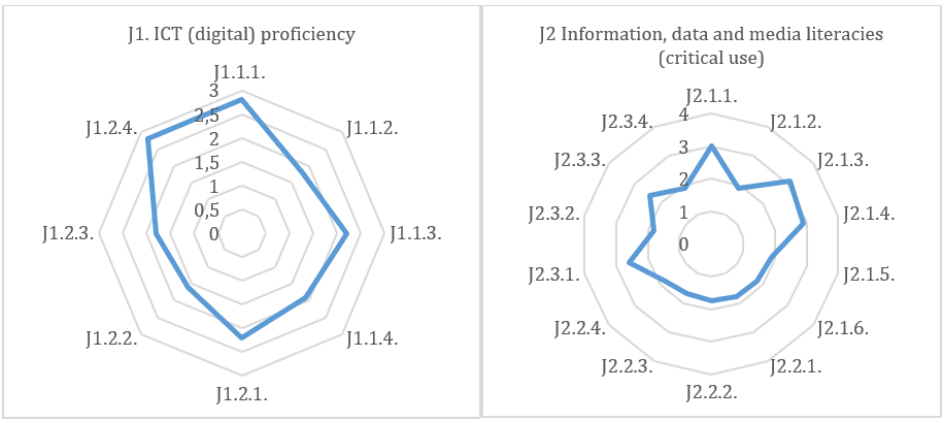


Figure 3: Mean group values – self-assessment results of the elements "Digital proficiency" (J1) and "Information, data and media literacies" (J2).

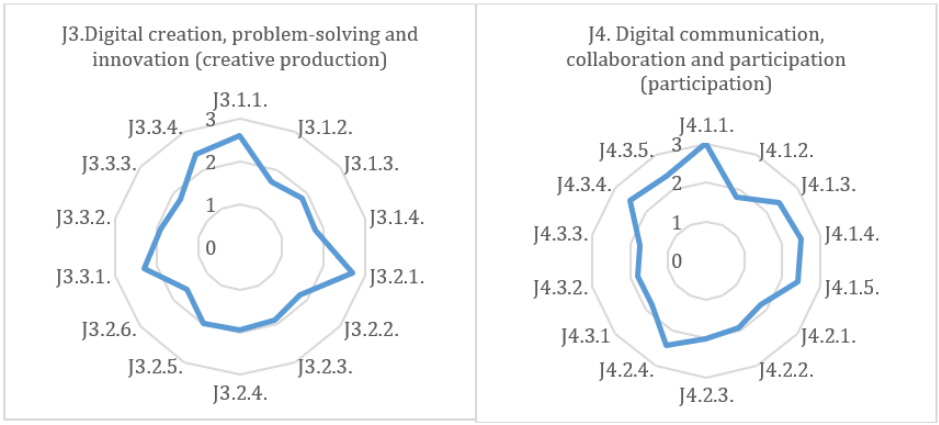


Figure 4: Mean group values – self-assessment results of the elements "Digital creation, problem-solving and innovation" (J3) and "Digital communication, collaboration and participation" (J4)

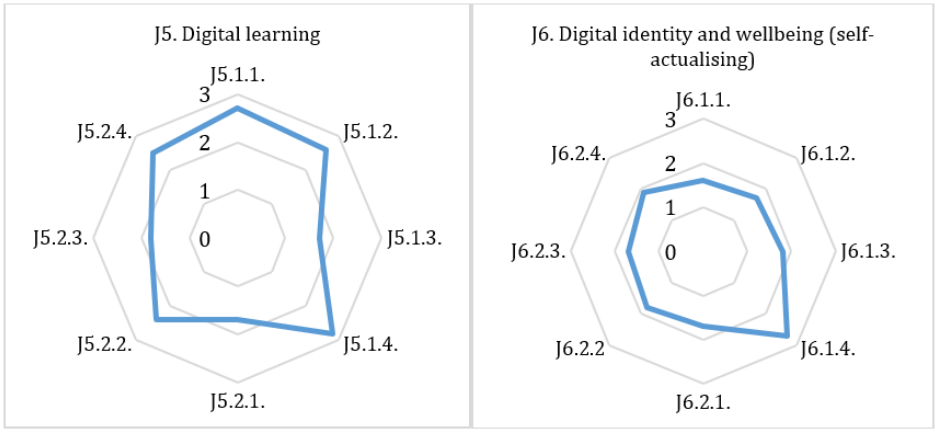


Figure 5: Mean group meanings – self-assessment results for the elements "Digital learning and development" (J5) and "Digital identity and wellbeing" (J6)

tools of research planning, implementation support and progress monitoring. Respectively, lack of experience leads to unwillingness to be engaged in digital interaction and even less so to support and motivate others.

As for questions from the section Digital identity and wellbeing, out of 8 elements (figure 5) post-graduate students report only the ability to Understand the reputational benefits and risks of digital participation as a researcher (J6.1.4) as formed (mean value equals 2.7). However, the latter can be interpreted as readiness to self-identification and professional development of future scholars. The responsibility of the university is to create appropriate conditions for this.

4 CONCLUSIONS AND DISCUSSIONS

The digital transformation of scientific research and communication is a challenge and at the same time a chance for higher education institutions in the context of training and future "digital" researchers.

Jisc's experience in providing digital solutions for education and research in the UK is the basis for further research on the scaling of the Jisc Reseacher model in order to build the digital competence of PhD students in higher education institutions in various countries.

Based on the results of the conducted empirical study:

(1) The readiness to acquire and develop digital competence of PhD students, both at the level of resource provision and basic digital competence and motivation of future researchers, is confirmed (according to the results of an online survey of a separate experimental group);
(2) In order to identify problems, either general or specific to PhD students both in the context of training in higher education institutions and individual digital research practices, based on the analysis of average group values for each Jisc Reseacher competence group, unformed digital competences of researchers are revealed, and authors' interpretation of causes and prospects of developments is provided.

As a result of self-assessment of 46 PhD students of BGKU, 37 of 64 Jisc Reseacher digital competences were unformed (average group value of less than 2), of which 9 are close to the threshold (1.9). According to the respondents, the least formed (the average value of 1.6) are the competences related to the digitalization of research, in particular, in terms of finding ICT solutions to problems that arise in the course of research and scholarly activity (J1.2.2), understanding how digital technologies are changing the field of research with respect to questions and challenges, methods, theories and values (J3.2.6), developing and projecting a positive digital identity or identities as a researcher (J6.1.1). At the level of general categories, competences from categories J2.2 (Data literacy) and J6.2 (Digital wellbeing) were not formed. Problems with copyright and adherence to the principles of academic integrity were also identified. In general, the received results correlate with the research on digital competence formedness of Mexican HEIs students [12]: the educational level does not influence on researchers' digital competence formedness, but digital competence should be a part of the graduation profile of a researcher.

At the same time, the readiness of graduate students of Ukrainian HEIs to self-determination and professional development as future digital scientists and analysis of the results of self-assessment of the researcher's digital competence indicate the need and possibility of its formation during studies for the master's degree in higher education institutions. The initial diagnosis, intervention for its development and permanent monitoring is essential. The present study serves to identify the usefulness of an instrument to measure digital competence of future researchers and its results to make decisions about the actions that in educational and pedagogical management should be carried out.

Prospects for further research include designing or updating of curricula and graduate training programmes in higher education institutions in the context of the formation of digital competence of future researchers. Further research on this topic should also consider larger populations to identify whether the results of the consistency and internal validity analysis are due to sample size. Likewise, it would be worth applying the instrument longitudinally to identify if the progress of the program being studied influences the development of digital skills.

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Educating Future Digital Leaders: Developing e-Governance Curriculum in Estonia and Ukraine

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ABSTRACT

The successful transformation of a country to an advanced digital state is substantially dependent on education and more specifically, the development of an e-Governance curriculum in higher institutions. Estonia as a role model has demonstrated that e-Governance implementation significantly stems from a strong collaboration between stakeholders such as the state, private sector, and academia. This study aims to examine the risk factors of e-Governance curriculum development in an emergent e-democracy state – Ukraine, and how lessons learnt from Estonia's digital transformation can be used for coping with underlying risks. To conduct this research, a survey on Digital Competence in e-Governance Education in Ukraine was conducted along with analyzing secondary data related to Estonia's case. The results suggest that issues related to e-Governance curriculum implementation in Ukraine include comprehensive factors like low digital competence and low awareness in available trainings in e-Governance, as well as access to technology and respected e-learning sources. Thus, the recommendations which stem from Estonia's experience as an e-state are suggested for overcoming the risk factors that Ukraine faces in e-governance curriculum development.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in collaborative and social computing**;

KEYWORDS

e-Governance, ICT in Education, Curriculum, Digital Leadership

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1 INTRODUCTION

Comprehensive factors of social transformation (globalization, digitization, development of a new media ecology) highlight the development of various types of meaningful networking structures in the knowledge economy: knowledge networks, professional networks and networked society overall. Subsequently, networked society as a global institution in the knowledge economy context calls for the implementation of networked governance. Networked, accessible and equipollent governance structures are facilitated by the electronic medium (interface, tools, communication). This way, E-government is defined as the use of digital communications devices to provide public services to citizens and other persons in a country or region. E-government offers new opportunities for more direct and convenient citizen access to government, and for government provision of services directly to citizens [13].

Interoperable with the notion of e-Governance is the notion of E-democracy. E-democracy or digital democracy is the use of information and communication technology in political and governance processes to promote democracy [13]. E-democracy encompasses social, economic and cultural conditions that enable the free and equal practice of political self-determination [8]. Digital democracy is ambient of the full-scale implementation of the concept of digital citizenship [16] crucial for global economic and political development. Digital citizenship can be fostered through e-democracy education of various types: formal, informal, life-long for in-service officials.

The topical need to revisit and reexamine the established models of e-democracy and e-Governance education arises from the changes that networked societies experienced due to the global pandemic COVID-19. The global pandemic and subsequent quarantine measures and restrictions have posed an array of challenges to the structure and procedure of e-Governance institutional operations and e-Governance training, subsequently. In the educational sphere, the result of the COVID-19 pandemic development was the need to take quick action in order to achieve such desirable results:

a) To adapt the educational scenarios to digital or hybrid formats;
b) To activate skillsets, underutilized in the practice of digital citizenship;

c) To enhance ICT competence in e-Governance services of all participants of the educational process as well as of all stakeholders of e-democracy institutions across the board.

Therefore, the inquiry overarching **objective** *is to critically review the best practices of two contrastive cases of e-Governance curriculum implementation in higher education of a fully functional e-state (Estonia) and an emergent e-state (Ukraine).* The study empirical findings are carried out within the framework of the joint international Ukraine-Estonia project Counseling Ukrainian universities on "E-government Masters study program development and awareness raising on e-Governance" of Tallinn Technological University, Borys Grinchenko Kyiv University, National Academy of Governance of the President of Ukraine.

2 LITERATURE REVIEW

In the technology-driven era, development of the e-Governance studies is highly important. Considering that it is an interdisciplinary study that stands on several pillars such as technology, governance, economy, law and politics, e-Governance educational programs are remarkably compound. On the contrary to such study programs' importance, it is notable that research conducted on the given area is limited. However, several authors have contributed in the following manner.

The research on Master's studies on e-Governance Administration, a program which is taught in Law of School of Lithuania, discusses that due to novelty and the interdisciplinary nature of e-Governance programs, there are a plethora of emerging issues that have to be addressed [5]. One of the major problems arises from the gap that lays between the academic knowledge and practical application of the program [5]. Besides, there are other questions that have to be examined, for example, "how to integrate technological skills with social, political and economic knowledge in comprehensive and to modern public management-oriented conceptual unit" [5]. Janowski et al. [11] suggest a theoretical model to improve the respected programs in a comprehensive manner. Thus, the developed theoretical framework incorporated the following questions to be addressed when improving or creating the e-Governance graduate programs: who (learner), why (role), what (competency), how (program), where (school) and when (prerequisites) [11]. According to the Janowski et al. [11], "theoretical framework can be used in various ways:

(1) as a tool for landscaping, comparing and analyzing the offerings by different programs;
(2) as a tool applied to individual programs to help students make decisions on the ways to approve them or to highlight possible improvements;
(3) as a tool to help to design new programs;
(4) as a tool to detect and correct inconsistencies within a program" [11].

Pappel et al. [18] discusses the most notable impediments of the respected program development. Also, it emphasizes the importance of how the given curriculum facilitates theoretical knowledge implementation in practice considering that it provides a broad range of courses that stem from the interdisciplinary character of the program [18].

Anohina-Naumeca et al. [4] emphasizes that due to the fact that interoperability is one of the key aspects of cross-border e-services of EU countries, courses concerning interoperability have to be offered to students.

Biasiotti and Nannucci [6] argues that teaching e-Government in Italy is critical for e-Government implementation in the country. It also reviews a number of initiatives taken by public and private universities in cooperation with Ministries for delivering trainings to the public servants. Also, the research highlights the fact that existing courses focus on technical and legal aspects of e-Governance and lack interdisciplinary character [6].

3 METHODOLOGY AND DESIGN

In order to conduct the research, the following methodology was chosen: a survey on Digital Competence in e-Governance Education in Ukraine was conducted along with analyzing secondary data to Estonia's case. The study design of the inquiry methodology included the following procedural steps:

(1) e-Governance activity, experience and application profiling;
(2) Overview of e-Governance case-studies in Estonia and Ukraine for the purpose of the contrast and comparison of an established and an emergent e-Governance paradigm;
(3) The online survey method (based on Dillman's concept of mixed media and mixed mode surveys [7]) applied to assess e-Governance experiences and practices by relevant groups of stakeholders;
(4) e-Governance curriculum development recommendations, outline and projected study results, tailored to the overall context of European integration and stakeholders' target group needs.

Based on the activity profile (e-Governance) a survey was conducted among the stakeholders of electronic government institutions – in-service government officials and students of government management programs. The survey comprised of 13 questions total (multiple choice and Likert-scale score), divided into such groups: 1) questions on overall experiences in e-government; 2) questions on the needs and modes of e-Governance education; 3) questions on e-democracy as a social. A sample of 70 respondents took part in the survey.

In-service and in-training government officials of Ukraine comprised the sample of respondents. The distribution of demand for e-Governance education is generally in keeping with the higher educational landscape estimate of 2020.

Higher education technology landscape 2020 [9] was prognosticated to include the following components: institutional IT infrastructure; admissions and enrolment management; ICT tools for performance assessment; ICT tools for student distinction. The inquiry elaboration premise included identification of ICT competency principles, derivative of 21st century skills [3, 4, 10, 15, 17] for educational purposes and profiled digital literacy requirements in the educational and civil service spheres:

(1) *UNESCO Framework* [2] is based on the core ICT competence principle: the need to be able to help the students actualize soft skills through using ICT so they will be effective citizens
(2) *Liberal Arts (Digital Humanities) ICT proficiency profile*, according to the European e-competence framework guideline

[10], includes the following key components: training to reach predefined standards of ICT technical /business competence; analyzing skills gaps; defining and implementing ICT training policy to address organizational skill needs and gaps.

(3) *Digital Competence framework* [4] consists of 5 core parameters assessed according to proficiency: 1) Information and data literacy; 2) Communication and collaboration; 3) Digital content creation; 4) Safety; 5) Problem-solving.

4 CASE-STUDY: ESTONIA SUCCESS STORY

4.1 Historical Overview

Estonia's transformation from a post-soviet country to a digital state has been a complex process. It evolved around a rapid technological development which was in parallel with a socio-political change. The path towards becoming one of the most advanced digital societies in the world [3] has been compound with a number of socio-political, legal, economic, and technological aspects. Some of the factors dis-cussed below facilitated e-Governance adoption and brought the country to the advanced digitalization level.

To begin with, after the restoration of independence in 1991, the political elite agreed on adopting e-Governance as a founding niche of the country [17].

However, hereby, it is notable that the chosen path would be impossible to take and maintain without a strong public-private partnership that played a critical role in designing e-Governance policies and increasing overall e-Governance awareness in society. Thus, as a result of successful cooperation between these two stakeholders, Estonia has developed advanced public e-services which are available on the citizen's platform and which operated through X-Road – a data exchange layer used by a number of Estonian state authorities [23]. Other than a public-private partnership, one more factor that had a catalyst effect was a legal one. Due to the Soviet past, and newly restored independence, the state had to start from scratch in terms of a legal framework which played a positive role in the given moment considering that there were no laws that would obstruct new processes.

Also, it is notable that one of the key contributors has been the program e-LocGov model which raised awareness and successful systematic introduction of e-Government at the local level [19]. It is noteworthy that Estonia has significantly focused on the marketing of e-Governance related matters included but not limited to e-Residency and paperless management (e-LocGov model) – initiatives that have also been great contributors in e-nation branding concept [12, 19].

Successful transformation of Estonia would be impossible without a focus on education field. When it comes to the legal framework, as mentioned above, the country had to make a fresh start, but in the case of the ICT competence, there was a solid ground prepared which facilitated the transformation problem and played a role of impetus [12]. Thus, strong ICT education has been a driveforce of these developments. Success in this particular filed would unattainable without the collaboration of public authorities, the private sector and academia. Also, other than the strong will of the involved stakeholders, one more critical element of progress in ICT education laid in strong ICT infrastructure which was already available by that time [12]. Digital competence would be impossible to develop without such educational initiative as Tiger Leap "which was launched in 1996 and laid a ground for the education system and society as a whole to be prepared for the rapid technological developments of the Information Age" [12].

4.2 ICT-related Courses Taught in Leading Universities of Estonia

Strong ICT infrastructure, both: public and private, and R&D policies were one of the major pillars of the e-Governance development process. Hereby it is notable that leading educational institutions such as Tallinn University of Technology, Tallinn University and University of Tartu, have actively been engaged in the given process as one of the driving force of Estonia's successful transformation to the advanced digital state.

Tallinn University of Technology largely contributes to the IT knowledge of the country. The obtainable programs provided by the School of IT are as followed: Cyber Security, Communicative Electronics, Computer and Systems Engineering, e-Governance technologies and Services, Digital Health, Software Engineering – a joint program with the University of Tartu [14]. Programs by School of Business and Governance: Technology Governance and Digital Transformation, Public Sector Innovation and e-Governance – a joint program with the University of Leuven and University of Münster [14]. As also mentioned in the strategic development plan of the university: "The mission of Tallinn University of Technology (TalTech) is to be a promoter of science, technology and innovation and a leading provider of engineering and economic education in Estonia" [21].

When it comes to the University of Tartu, the following Master courses are available: Education Technology, Politics and Governance in the Digital Age, Information Technology Law, Innovation and Technology Management, Sound and Visual Technology, Computer Science, Materials Science and Technology, Robotics and Computer Engineering, Software Engineering, Cyber Security – a joint program with the Tallinn University of Technology, Smart Mobility Data and Analytics – joint program with EIT Urban Mobility Master School [22]. As the University of Tartu strategic plan states, the university focuses on strengthening e-learning: "We support using e-learning opportunities both abroad and in different regions in Estonia…We contribute to information technology capabilities and make sure that the data of the university become valuable and available assets" [25].

In the case of the Tallinn University, ICT-related programs that followed: Digital Learning Games, Human-Computer Interaction, Open Society Technologies, Educational Innovation and Leadership, Human Rights in the Digital Society [24]. As the strategic plan of the university states, "in order to support open governance, citizen subjectivity and democracy on the level of the state and the local government as well on a level broader than the state, we shall develop knowledge dissemination practices and research methods based on the principles of knowledge-based policymaking" [20].

5 CASE-STUDY – UKRAINE, THE EMERGENT E-DEMOCRACY

According to the Cabinet of Ministers of Ukraine mandate "On approval of the e-government in Ukraine development concept" [1] e-Governance is one of the tools of the information society elaboration, the implementation of which will facilitate conditions for open and transparent public administration. As is stated: *"Today, one of Ukraine's priorities is the development of the information society, which can be defined as targeting interests of the people, open to all and aimed at forming an innovative model of high-tech society where every citizen can create and accumulate data and knowledge, have free access thereof, use and share it to allow each person to actualize their potential for personal and social development and quality of life improvement"* [1].

The institutional level of e-Governance implementation in Ukraine comprised of the following core initiatives: the development of e-Governance in Ukraine is impossible without appropriate training of relevant qualified professionals. The inquiry object, thus, is the case study of e-Governance experience and application by relevant stakeholders as a prerequisite of curriculum development. The canvas sweep of the e-Governance programs available in higher educational institutions and non-governmental organizations of Ukraine has been analyzed in view of the core needs and expectations of the e-Governance curriculum, disclosed in the survey.

The established and active e-Governance curricula of five institutions were analyzed: 1) Borys Grinchenko Kyiv University (BGKU) (Kyiv, Ukraine); 2) National Association of Civil Service (NACS); 3) National Academy of State Governance (NAPA); 3) National Center of E-governance support (NCEGS); 4) Kyiv Polytechnic Institute (KPI). The sweep comprises of 3 formal higher educational institutions (BGKU, NAPA, KPI) and 2 informal educational institutions (NACS and NCEGS). *The educational institutions that have a varified history of an implemented e-Governance curriculum on different levels (full major degree curriculum, full minor degree curriculum (specialization), micro-credential curriculum) were selected for best practices analysis.* The sample structure comprises of 3 formal higher educational institutions (BGKU, NAPA, KPI) and 2 informal educational institutions (NACS and NCEGS).

The educational formats, efficient or sought after in the area of governance digitization (table 1) are distributed as such:

(1) One off training and workshops (40%);
(2) Persistent online courses (34,3%);
(3) Webinars (22,9%).

Table 1: Educational formats in the area of e-Governance per sampled educational institutions

EI	One off training and workshop	Persistent online courses	Webinars
BGKU	+	+	+
NACS	+	+	+
NAPA	+	-	+
NCEGS	+	-	+
KPI	+	-	-

The estimation of the educational formats, efficient or sought after in the area of governance digitization, designed into the existent e-Governance curricula are calculated against the surveyed expectations of the stakeholders in the following way: One-off trainings and workshops – 100% efficiency of implementation in the e-curriculum design; Webinars – 80% efficiency of implementation in the e-curriculum design; Persistent online courses – 60% efficiency of implementation in the e-curriculum design.

According to the level of accessibility of e-Governance learning formats – only two higher educational institutions (Borys Grinchenko Kyiv University and National Academy of State Governance) of formal learning provide the most widely accessible formal and informal learning format.

The respondents identified the key educational components needed in the sphere of governance digitization (table 2): 1) e-service design and development (72,9%); 2) data protection (67,1%); 3) cyber security and integrity (47,1%); 4) case studies for digital skills development (41,4%); 5) case studies for digital transformations (34,3%).

The estimation of the learning key educational components needed in the sphere of governance digitization, designed into the existent e-Governance curricula are calculated against the surveyed expectations of the stakeholders in the following way: e-service design and development – 100% efficiency of implementation in the e-curriculum design; case studies for digital skills development – 60% efficiency of implementation in the e-curriculum design; case studies for digital transformations – 60% efficiency of implementation in the e-curriculum design; cybersecurity and integrity – 40% efficiency of implementation in the e-curriculum design; data protection – 20% efficiency of implementation in the e-curriculum design.

As is evident from the comparative analysis of e-Governance curricula, the majority of institutions in Ukraine do not cater in full to the estimated needs and expectations of the e-Governance curriculum design, informed by empirical practices of the stakeholders.

When asked to assess the learning outcomes needed for efficient use of digital technologies upon completion of an e-Governance study course, in-service and in-training governance stakeholders identified the following top-scoring priorities (table 3): 1) Digital services development (67,1%); 2) Digital databases operation (60%); 3) Digital literacy and digital skills (58,6%); 4) Digital workplace tools proficiency (48,6%); 4) Re-engineering of government services (44,3%).

The estimation of the learning outcomes efficiency, designed into the existent e-Governance curricula can be, therefore calculated against the surveyed expectations of the stakeholders in the following way: Digital services development – 80% efficiency of implementation in the e-curriculum design; Digital workplace tools proficiency – 60% efficiency of implementation in the e-curriculum design; Re-engineering of government services – 60% efficiency of implementation in the e-curriculum design; Digital databases operation – 20% efficiency of implementation in the e-curriculum design.

Overall, as of the year 2020, formal educational establishments in Ukraine provide an e-Governance curriculum, more customized

Table 2: Key educational components in e-Governance curriculum per sampled educational institutions

EI	E-service design and development	Data protection	Cyber security and integrity	Case studies for digital skills development	Case studies for digital transformations
BGKU	+	+	+	+	-
NACS	+	-	+	-	-
NAPA	+	-	-	+	+
NCEGS	+	-	-	-	+
KPI	+	-	-	+	+

Table 3: Key learning outcomes in e-governance curriculum per sampled educational institutions

EI	Digital services development	Digital databases operation	Digital literacy and digital skills	Digital workplace tools proficiency	Re-engineering of government services
BGKU	+	+	+	+	-
NACS	-	-	-	+	+
NAPA	+	-	+	+	-
NCEGS	+	-	-	-	+
KPI	+	-	-	-	+

to the meta-evaluated needs of e-citizenship and e-Governance stakeholders in the context of knowledge economy.

6 CONCLUSION

In the cases of Estonia and Ukraine, the impact areas of e-Governance curriculum development include the public sector domains: higher education (development and implementation of generic study programs of e-Governance); civil society institutions and public sector (development of a comprehensive e-democracy educational standard); democratic institutions (raising awareness and provision of comprehensive, advanced training for institutional decision-makers in principles and vehicles of e-Governance).

In the emergent e-state of Ukraine, which is also a developing economy and a developing democracy, there may arise risks in the workflow of e-Governance curriculum implementation, such as low digital competence of stakeholders; low awareness of the options and formats of customized in-service training in e-democracy; impaled access to e-learning resources and impediments in access to technology overall.

Considering the success story of Estonia in implementing functional e-Governance and e-citizenship institutions, the main recommendations can be introduced:

(1) with the provision of supplementary ICT competence development for the general public;
(2) with the introduction of systemic changes into the vaster areas of education curricula to accommodate functional hard skills (data-bases processing, data analysis, service tools development);
(3) diversification of accessible formats of formal and informal e-Governance training which are customized to different groups of stakeholders;
(4) awareness-raising in the public sector on the sufficiency of e-democracy training for civil society development in the context of knowledge economy through augmentative dissemination means (social media, mass media, public engagement).

Future work can incorporate comparative analyses of emergent e-democracies in various sociopolitical and cultural contexts; the case-studies of e-Governance education implementation in different countries of the European Union; the comparative studies of national and international e-Governance curricula.

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Emoji Explication in Digital Communication: Logical-Phenomenological Experiment

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ABSTRACT

The paper examines the digital linguistic sign Emoji in digital communication through the logical-linguistic lens. It is concluded that the explication of the content plane and expression plane of an optical digital sign due to the bilaterality of its structure is inexhaustible, because emoji optics include psychophysiological factors that appeal to both linguistic and extralinguistic elements of sign formation. Consequently, the substrate for the study of the emoji sign is its polylaterality. The latter allows the synthesis of structural (logical) with the conceptual (phenomenological) level of explication of the sign, because the plane of content and the plane of expression of the optical sign in digital communication is both in its form and in the semantic load. The study focuses on an empirical experiment – an online survey called "Emoji-association", which contains 147 perceptions and interpretations of emoji signs from recipients. The experiment results are tested through G. Frege's semantic triangle, which schematically demonstrates a bilateral approach to the plane of content, depending on both the abstract denotation (word proper) and the specific meaning. With emphasis on polylaterality and its verification, hypothetical-deductive syllogisms are created, which includes interpretive tokens, which, according to digital analysis of answers using the web-application package Voyant Tools, are more common in frequency. According to the results of the experimental logical-linguistic approach to the study of the emoji sign in digital communication, it is concluded that the logical tools applied in the study, provide for the fractalization of agrammatical formants of the emoji sign with the verbal versions of its formants, with subsequent verification of both.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in collaborative and social computing**;

KEYWORDS

emoji, digital communication, digital humanities, G. Frege's semantic triangle, polylaterality, syllogism, structure, qualia

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1 INTRODUCTION

If to consider tokens not from the point of view of semantics, but from the point of view of semiotics, i.e. as signs in a form, then it can exist outside the context. Thus, the word acquires the characteristics of the code, which requires testing and verification not only in terms of content but also in terms of expression, i.e. in the appeal to the optics of the sign (especially true for digital, graphic-based communication), taking into account the individual characteristics of the semantic load of the sign. Pavlov [9] once addressed all the above, and in particular – the impossibility of reproducing the meaning of the internal form of the word. It was he who nominated the word only as a stimulus, which replaces direct signals, where the generalization of the semantic load, expressed by the token itself, presupposes polysemy. According to the latter, it is concluded that its optical reproduction is necessary to concretize the plane of the content of a sign.

Therefore, it is possible to appeal to the semantic triangle of Gottlob Frege [3, 5] (figure 1), which schematically demonstrates a bilateral approach to the plane of word content, depending on both the abstract denotation (the word proper) and the specific meaning. Defining the meanings that a person connects with the world at a certain period of life, we, according to the semantic concept of the scientist, being, energy), which has nothing to do with the arbitrariness of individual perceptions, despite the fact that these meanings may belong to completely opposite or even non-existent objects. Therefore, the search for truth in being or, as closer to logic, the truth of being is somehow a "language game", which, in turn, was revealed in detail by Ludwig Wittgenstein – it all depends on

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the movement of the structure (language), which eventually forms a structure (grid) depending on the meaning laid down by us in it. All this appeals to the synthesis of extralinguistic and linguistic factors, which are divided into natural and acquired. The construction of language belongs to the logical substrate of the study of the emoji sign, and the perception of recipients – to the phenomenological. Thus, the semantic triangle is introduced into the experiment to formalize what is not subject to final verification – the idea of the meaning of the sign, because, as the logician points out, the idea is completely subjective, because we can never determine how the sign and ideas, especially since one person may have different images of one sign at different times in life, not to mention the impossibility of two different people to find any identical ideas.

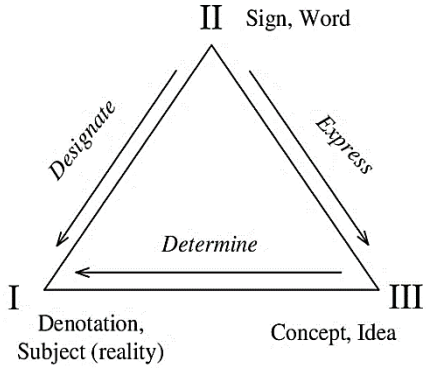

Figure 1: Semantic triangle of Gottlob Frege.

Thus, the formation of an optical plane of a sign content with explication of specific (individual) preconditions and features with complete exclusion of conditionality, inherent in polysemy with its semantic reproduction, which can be traced only in context, passes into the psychophysiological plane of research of the optical sign as an object in digital communication.

147 respondents aged 10 to 70 participated in the survey. Such a large-scale coverage of the age category allowed to fundamentally reflect the picture of the world and digital literacy of mentally different representatives, and also allowed to distinguish groups of people whose linguistic pattern differs significantly from respondents of other age categories. All this is directly reproduced in the interpretation of the optical digital sign. Thus, the results of the experiment show that emoji is used more by respondents whose age category is from 10 to 20 years, and to a lesser extent – from 40 years. Accordingly, such results explain the verbal skills of the recipients, depending on professional and mental qualities. It is this conclusion, based on the results of the survey and allowed to consider the emoji sign from two antithetical positions – logic and phenomenology in order to trace and analyze the difference between static conditionality of the sign (i.e. its structure and nomenclature assigned to it in computer life) and dynamic perception of a particular sign, the dynamics of which is manifested in natural (age, gender) and acquired (education, society, cultural paradigm, profession, experience) factors.

First of all, it should be noted that we are not talking only about the mental factors of the formation and explication of the sign provided by the CNS, which is what psycholinguistics emphasizes. The study adheres to the belief that the mental paradigm of the sign cannot be considered without taking into account the physiological paradigm, which includes ethnolinguistics with its mental frames, depending on both mental (tradition, upbringing, culture) and physiological conditions inherent only in a particular ethnic group (features of the structure of articulation, physiognomy, sign language), as well as without taking into account the logical apparatus of agrammatization of the optical sign.

Therefore, the objective of this study is the empirical decoding of the emoji signs in digital communication in a synergetic conglomerate of formalistic (logical) and phenomenological (natural, biological, psychophysiological, philosophical) levels with the output of the results on the truth table with their subsequent verification of implied features of meaning.

The study of groundwork principles of optical signs generic, reliable recognition and surface/implied semantic verification in digital communication is a parcel of an interdisciplinary framework project TRANSITION: Transformation, Network, Society and Education [8].

2 REVIEW OF THE LITERATURE, CONCEPTUAL FRAMEWORK, AND HYPOTHESES

For a real full-fledged (complex, synergetic) connection of language and speech, the essence of language must be a category of being – the being of the essence. After all, only the category of being determines the synthesis of semantic linguistic experience – historical, social, collective, individual (including mental). All of the above has led to the interpretation and study of language as being and vice versa, because being is the whole phenomenology of language to the phenomenology of a single linguistic fact in its specific speech application. To explain a certain phenomenon subordinated to the broad meaning of being, language is needed as a systematizer and construct, in turn, language, in terms of systematization and construction, and becomes the existential dimension through which both cognition and the formation of new things are possible.

Appealing to Aristotle's teaching on the transformation of physics into a cognizable essence (language), which is defined as true or false, and which is always material, the problem of the relationship between language and being is also of interest to logic. Trying to rationalize this relationship, scientists turn to the fundamental maxim of Plato, which is that the ontological counterparts of truth and error are the categories of being and non-being, which, in turn, allows the application of the principle of duality to the statements that operate in these categories, and hence to the analysis of ontological problems [10, p. 48].

The principle of duality, which became basic with the advent of the works of structural scientists, paradigmatizes, in fact, all the fundamental definitions of the concept of being (general-specific, broad-narrow, abstract-material) in one plane, appealing to the fact that for scientific knowledge of being (the organon, according to Aristotle) the presence of a paradigm expressed by a dichotomy is a necessary condition. After all, dichotomy verifies the bilaterality of any sign, and therefore, its study is subject to the trajectory

of knowledge from the phenomenological (mythological, psychological, theological, etc.) to the formal (logical-linguistic) level or vice versa. The latter became possible with the advent of classical logic, which, in fact, is designed to interpret the logic of existence. Logician and philosopher Frege [2, p. 180] immanently points to another step, following the bilaterality of de Saussure [1], – to multimodality and polysemioticity – polylaterality [6, p. 142] of the same sign. Immanently, because he does not speak directly about the polysemiotic nature of the sign. This conclusion was made possible by the introduction of Frege's formal language, which, in fact, is the mobile construct capable of forming new meanings of the same signs. Thus, the logician concludes the following [2, p. 313]:

(1) Signs that do not denote any objects also have meaning;
(2) Many meanings can be connected with one subject;
(3) Knowing the meaning of a sign or its expression, we will not always be able to identify the object that the sign signifies. And the establishment of this correspondence between the sign and the expression is precisely the essence of scientific discoveries;
(4) The meaning is objective and intersubjective, accessible for clear understanding to all communicators;
(5) Meaning is not a psychological formation of an individual, nor his subjective idea of the subject.

Frege is primarily a logician, and at one time was fundamentally opposed to psychology in logic, so the 5th position, although natural in the context of the position of the scientist, raises the most questions from linguists, in particular from psycholinguists, because the generation of content plane and sign expression plane occurs in the human brain, directly depending on the central nervous system (CNS) – this is in relation to internal factors. The materialization of language is inseparable depending on the processes of the CNS, which forms in the brain a signaling system provided by internal (genetic, ethnic, etc.) and external (cultural, educational, etc.) factors. Each communication point of the system sends a signal to the next, combining with each other, some of them work simultaneously, and thus at the final point the signal is transmitted to the left hemisphere – to the Broca's and Wernicke's area, which reproduces the human articulatory apparatus. The perception of the signal by the Wernicke's area precedes the Broca's area, because it is also responsible for the perception and assimilation of oral and written speech at the same time, i.e. it is the center of word decoding. For example, the meaning of a word and its understanding by a person is considered as a natural part of the general speech and speech mechanism. And this mechanism is formed in the human CNS on the basis of external perception of speech, and the output has its variable reproduction.

However, it is also necessary to take into account mental frames (cognitive processes in the human brain, depending on anthropological and geographical factors) and external factors – culture, upbringing, environment, social order and so on. However, Frege does not exclude in his position the above: it is important for a scientist to have a tool (formal language) to express both the meaning of the sign and the possibility of meaning, i.e., as he notes, "some sign (a word, a phrase or a graphic symbol) is not thought only in connection with the signified, which could be called the meaning of the sign, but also in connection with the fact that I would like to call the meaning of the sign that contains the method of data (signified)" [2]. In order to verify this fractalization of the meaning of the sign into the signifier and the signified by Frege, a semantic triangle was created. Defining the meanings that a person connects with the world at a certain period of life, according to the semantic concept of the scientist, we are dealing with objective material (physics, being, energy), which has nothing to do with the arbitrariness of individual perceptions, despite that these meanings may belong to completely opposite or even non-existent objects. Therefore, the search for truth in being or, as closer to logic, the truth of being is somehow a "language game", which was revealed in detail by Wittgenstein [11] – it all depends on the movement of the structure (language), which eventually forms a structure (network) depending on the meaning input.

3 RESEARCH METHODOLOGY

In the paper following methods are applied:

- the empirical method – in order to study the phenomenon of emoji sign decoding in digital communication by experiment and rational processing of the obtained data;
- the structural method – in order to identify and analyze structural elements, individual components, categories, etc. that form the emoji sign;
- the method of the component analysis – in order to identify the minimum semantic elements that form the content component of the sign;
- the semiotic method – in order to study the emoji sign from the standpoint of its organization, the properties of its elements and categories;
- the logical-analytical methods, namely the methods of induction and deduction, which allow to consider the content of the object, specifying and generalizing its concept;
- the method of formalization as the study of an object by reflecting its structure in symbolic form;
- statistical methods involving the use of different formulas to identify the rules of distribution of language units in digital communication, to measure the relationships between language elements, to establish trends in the development and functioning of language, to establish the relationship between qualitative and quantitative characteristics of language of digital communication;
- logical-mathematical methods with elements of language modeling and the hypothetical-deductive method of language research.

4 FINDINGS AND DISCUSSION

The immediate study task was to terminate (in a nominal sense) a specific EMOJI sign in digital communication, taking into account its surface and latent structural and semantic features. The preliminary conclusion of our experiment was the derivation of the hypothesis about the dichotomous conditionality of the emoji sign, which reveals differentiation depending on the above factors. Thus, this explains the nomination of the emoji sign as polylateral in content. Therefore, the study turned to the semantic triangle of G. Frege, taking into account its modification into qualia – the term qualia was "introduced into analytical philosophy to denote

the most common thing for us: how things look to us" an applied previously to the study of semiotics of digital communication [6, 8]. They can be defined as qualities or sensations, such as redness or pain, and are considered separately from their impact on behavior, as well as from any physical conditions that may have caused them. In more precise philosophical terms, qualia is a property of sensory experience. The functionality of qualia is explained by the example of a red apple, i.e. in this case qualia is redness, not the apple itself or its properties. We can note that extensionally "redness" is a signification of the denotation "apple" [4, 9].

Subsequently, the inquiry takes for consideration the emoji sign – SMILING FACE WITH OPEN MOUTH AND COLD SWEAT EMOJI [U + 1F605 (128517)] (figure. 2).

Figure 2: Smiling face with open mouth and cold sweat emoji.

All the proposed associations for the emoji sign (figure 3) were selected from an online survey "Emoji-association", devised and tested by the authorial team (147 responses total in the form of free-range associations), from 21.01.2021 onward, https://goo-gl.me/tawmx).

The three most frequently used tokens, which formed the basis of a simple categorical syllogism, were grouped by genus and species. COMIC is a category of the genus, because it contains a generalized characteristics of the concept of "comic", which, in turn, is branched off into smaller (more specific, more detailed) ones.

Thus, according to the frequency of use of the same or similar synonymous associations, tokens were distinguished that belong to one category | the comical |. Therefore, the selection of tokens "laughter", "joy" is evident as the surface semantic features of the sign. The token "inconvenience" is perceived as immediately gleaned through the sign interpretation to a lesser extent. It can be presumed that the association of discomfort is due to the specifics of the visualization of the sign in digital communication, namely – its aquatic element – a signifier, resembling a sweat-bead flowing from the forehead. The latter, in turn, is a figurative (experienced) signifier that expresses fear, insecurity, which is visualized as sweat from the forehead. In selected associations there are also concepts synonymous with inconvenience: awkwardness, shyness, embarrassment, tension, panic, nervous, and therefore, it is necessary to introduce the most commonly used semantic feature "inconvenience" to the terminology of the syllogism, along with the tokens "laughter" and "joy".

To verify the inherence of additional semantic features of the emoji sign, the following complex implicative sentence is constructed, from the predicative parts of which a simple categorical syllogism is formed:

If any laughter prolongs life, and any joy prolongs laughter, it means that any joy prolongs life

A general affirmative proposition (Barbara mode, AAA) is formed, which can be structurally represented by the following formula:

$$(Asm \cap Amp) \supset Asp \tag{1}$$

The following terms are distinguished: greater foundation (p) – joy; smaller base (s) – laughter; middle term (m) – awkwardness. Let's construct a syllogism according to the first mode Barbara AAA:

Any awkwardness is eliminated with joy.
Any laughter eliminates the awkwardness.
Any laughter is a joy.

Let's try to follow the path of set-theoretic interpretation, where P has the value of the truth domain of the predicate $P(x)$, and prove the truth of the syllogism by the Barbara mode:

$$\forall\chi(M(\chi) \to P(\chi)), \forall\chi(S(\chi) \to M(\chi)), \forall\chi(S(\chi) \to P(\chi)) \tag{2}$$

1. $\chi \in M \to \chi \in P$
2. $\chi \in S \to \chi \in M$
3. $\chi \in S$ ($supposition$)
4. $\chi \in M$ ($modus\ ponens$, 3, 2)
5. $\chi \in M$ ($modus\ ponens$, 4, 1)
6. $\chi \in S \to \chi \in P$ ($introduction \to$)

According to the obtained data, the formula is devised with the subsequent verification using truth tables (tables 1, 2, 3, 4, 5):
$M \Rightarrow P \cap S \Rightarrow M \Rightarrow S \Rightarrow P$

Table 1: Conjunction $P \cap S$

P	$P \cap S$	Results
t	t	t
t	f	f
f	t	f
f	f	f
t	t	t
t	f	f
f	t	f
f	f	f

Table 2: Conventionality / implication $S \Rightarrow P$

P	$S \Rightarrow P$	Results
t	t	t
f	t	t
t	f	f
f	f	t
t	t	t
f	t	f
t	f	f
f	f	t

Heretofore, having verified the syllogism with the help of the truth table, one can see that the syllogism is true – one that is formally constructed correctly.

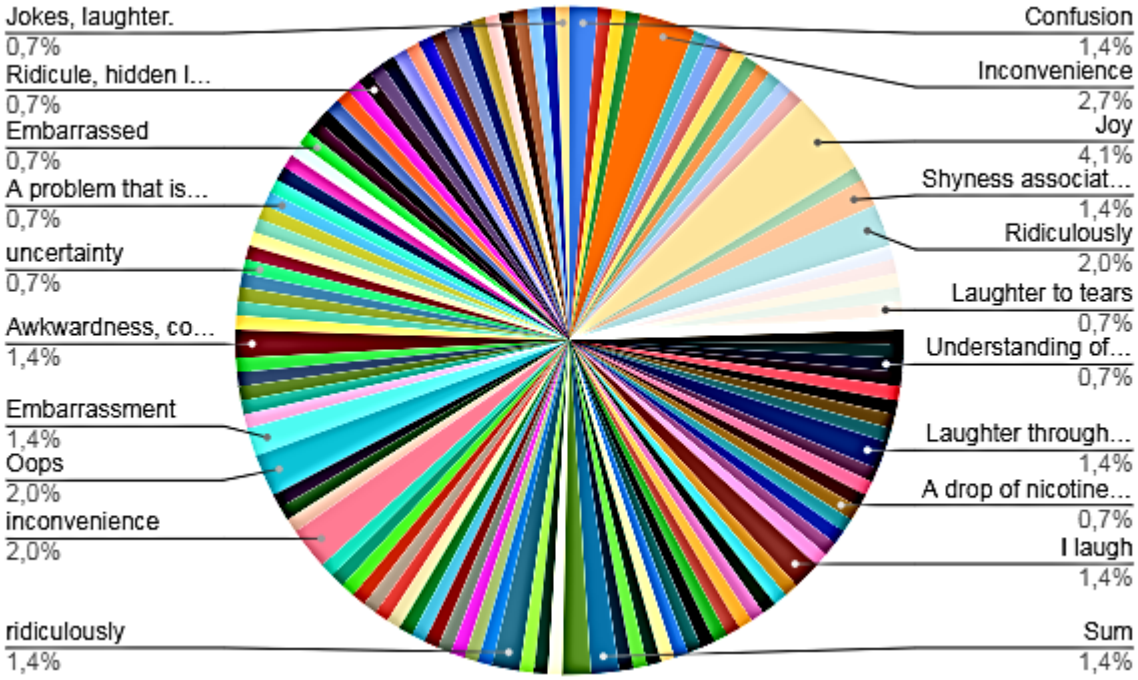

Figure 3: Recipients' association with the sign "Smiling face with open mouth and cold sweat emoji".

Figure 4: Frequency of use cirrus of the same associations via an online application "Voyant Tools" (https://voyant-tools.org/).

Table 3: Conventionality / implication $M \Rightarrow S \Rightarrow P$

P	$M \Rightarrow S \Rightarrow P$	Results
t	t	t
t	t	t
t	f	f
t	t	t
f	t	t
f	t	t
f	f	t
f	t	t

Table 4: Conventionality / implication $P \cap S \Rightarrow M \Rightarrow S \Rightarrow P$

$P \cap S$	$M \Rightarrow S \Rightarrow P$	Results
t	t	t
f	t	t
f	f	t
f	t	t
t	t	t
f	t	t
f	t	t
f	t	t

Table 5: Conventionality / implication $M \Rightarrow P \cap S \Rightarrow M \Rightarrow S \Rightarrow P$

M	$P \cap S \Rightarrow M \Rightarrow S \Rightarrow P$	Results
t	t	t
t	t	t
t	t	t
t	t	t
f	t	t
f	t	t
f	t	t
f	t	t

Note that the feature "inconvenience", due to the subjectivation of the vision of communicants in the digital ambient, is not a semantic constant, but only an interpretant, which was introduced into the syllogism. Thus, it is taken into account that the sign SMILING FACE WITH OPEN MOUTH AND COLD SWEAT EMOJI represents a subset of a larger set of meanings in the category | the comical | in digital communication, and the given sign reproduces a specific notion (laughter), which is one of the concepts of the comical.

Let us visualize the experiment with G. Frege's triangle sign and interpreter qualification, entering the terms of the obtained and verified syllogism into the triangle (figure 5).

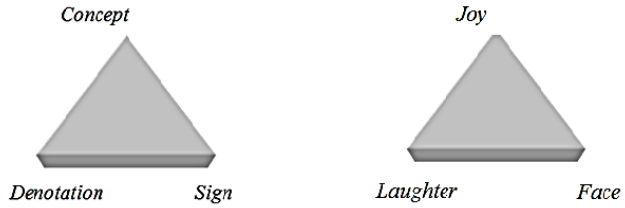

Figure 5: Verification of interpretants qualiacation by G. Frege's semantic triangle.

5 CONCLUSIONS

The authors' appeal to the science of logic as a substrate of a structural approach to the study of language signs is primarily revealed not in human cognitive processes during speech, but in the rules and norms of transition from one sign structure and at the same time from one sign meaning to other such categories. That is, thus, with an appeal to the normative (formal) conditions, the truth of the language sign is ensured as a result. The latter is divided into two areas: 1) structural (internal) and 2) phenomenological (external) areas, which, as we emphasize in our study, in the study of language signs can not be considered unilaterally, because it eliminates the causal relationship of sign generation. Thus, polylaterality is formed, the characteristic feature of which is not only in the structural aspects of the sign, but also in his cognitive experience, which, in fact, forms a language map, in particular – and individual human language. In turn, the individual language, to which L. Wittgenstein appealed in his teachings, is a product of structuring and restructuring of language signs, and therefore, is a cognitive result of previously tested formalizations with signs. Such formalization should be called logical operations, because "language games" are the process of generating a single semantic field for the interpretation of a sign, however – this semantic field can be visualized in one optical sign with an attached signifier and signifier. However, in the process of interpretation we encounter the cognitive processes of the human CNS, i.e. the human brain, reading the sign as a fact of information, triggers mental activity dependent on genetic, educational, cultural, geographical, etc. factors of speech as a result of cognitive processes. At the end of the above we are dealing with the perception of a linguistic sign, which is a priori formed in the subjective part of human existence. All this has allowed us to create a syllogism that is based on the perceptions of the respondents and on a nomen linked to the emoji sign in the computer being. The syllogism was verified with the truth tables.

Approbation and verification of the emoji sign surface and latent meaning in digital communication is possible on both logical and phenomenological levels simultaneously, taking into account all tiers of the essence of being in relation to the perception and interpretation of the sign by the recipient. In particular, it is about real/objective being with its psychophysiological prerequisites for development (nature as a mentality due to geographical, climatic, historical, etc. factors), biology (physiology, human psychology = physiognomic features of a particular person) and abstract being, which, in turn, determines the structuring of essence and existence both in reality and in digital format (computer being). The logical tools that were used involve fractalization of the agrammatized formants of the emoji sign with the verbal versions of its formants with subsequent logical verification of both.

This approach to the study of emoji signs aims to demonstrate the possibility of application of a logical-linguistic methodology to

test the perception and interpretation (and hence, the representative speech acts) of any emoji sign in digital communication.

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Case Study: Citizen Science in Digital Humanities context

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ABSTRACT

Modern academic librarians strive to qualitatively meet the information needs of their users. At the same time, librarians seek to take an active part in the organization and conduct of research. In this paper, we present the successful experience of Borys Grinchenko Kyiv University (Ukraine) in working on the wiki project "Dictionary of Borys Grinchenko" which uses elements of digital humanities, citizen science and gamification. The main aim of this project is to involve university students in getting acquainted with the Dictionary of the famous Ukrainian ethnographer and ethnographer Borys Grinchenko (1863–1910). During the project, students compete among themselves who will add the most quality explanations and visualizations of the Grinchenko's Dictionary words to the University wiki portal. The results show that this project not only promotes the development of university web resources but also promotes cultural heritage, develop successful team building, helps to the involvement of students in research activities. This experience will be useful for other academic libraries looking for ways to join the digital humanities and can be replicated in small, low-budget academic institutions.

CCS CONCEPTS

• **Human-centered computing → Wikis**.

KEYWORDS

Digital humanities, Citizen science, Citizen humanities, crowdsourcing, gamification

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1 INTRODUCTION

The development of Digital Humanities (hereafter DH) at the present stage opens new opportunities for scientific libraries and poses new tasks and challenges. On the one hand, research libraries can become centers for conducting DH research and implementing relevant digital projects. At the same time, despite the fact that DH dates back to the middle of the last century, this area of work is relatively new for academic librarians. Therefore, academic librarians are still working to better understand their role in this new academic system, to acquire relevant skills, tools and technical means. In this paper, we describe in detail a real example of the implementation of the DH project, which can be implemented in many other university libraries, as it uses well-known practices in modern library work, such as crowdsourcing and gamification.

Today, many libraries are running large-scale projects related to the digitization of printed materials. Similarly, many research libraries actively support and promote the open institutional repositories of their institutions, and their users are interested in effectively presenting their research results in the public domain to support the ideas of open science. Academic librarians have been working for a long time to provide their users with relevant materials and tools for research, so it is logical that modern librarians are interested in continuing these processes in the framework of DH projects.

2 BACKGROUND

Today, the Humanities' science community is demonstrating its readiness to use the achievements of information science and new computer technologies to gain new opportunities for research. And this interest can be traced both among professional scientists and among students who are just beginning their research and want to be involved in the process of obtaining new scientific knowledge [14]. The opportunities offered by DH are increasingly attracting the attention of students that a humanities degree. Therefore, university librarians should integrate DH elements into their services and find ways to collaborate with faculty and students seeking to conduct research, create, and develop DH projects [4, 9]. At the same time, such cooperation of librarians with researchers and students should be based on the principles of equal partnership. Academic librarians should not be given the role of outside observers, as they will be able to provide relevant information and technical resources for research, teach users how to use these resources effectively and help each group of stakeholders contribute to research and development of DH projects [6, 11].

3 LITERATURE REVIEW

In the Humanities, there are already many research methods that allow you to gain new knowledge. However, the successful use of DH can expand the arsenal of these methods, and also can influence and partially transform the communication culture in the industry. The individual research remains widespread in the Humanities, and the researcher's subjective view is valued, while DH encourages the interdisciplinary collaboration - involving many researchers in the project through the use of digital tools, computational methods and open data [17]. Thus, the work of digital humanists contradicts the stereotypical notion of a lone scientist. The collaboration of

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researchers in the field of DH involves the use of common terminology, methods, theories, as well as the harmonization of work processes, values, goals and results of projects.

In this section, we will review the literature on DH, which focuses on the status and prospects of DH projects in academic libraries. The vast majority of DH projects described in the scientific literature are usually located in large research institutions in developed countries. However, areas of work related to the implementation of DH services and the implementation of relevant projects can also be used and put into practice in the work of small academic libraries in developing countries.

3.1 The Role of Libraries in Digital Humanities

As noted earlier, the mission of libraries is to meet the information needs of their users, it is important for modern academic librarians to understand the current issues of DH. Despite the prospect of using many new methods, practices and digital technologies [2], DH researchers face many barriers. These obstacles are primarily due to the fact that DH is still in the process of formation. While some researchers consider DH to be a well-established scientific discipline and appeal to numerous new specialized publications, obtained grant funding, implemented projects and vacancies [18], other scientists are much more cautious in their conclusions and point to the interdisciplinary nature of scientific projects and research in the field of DH.

Information technology itself is often a tool, an object of research, a research environment, so it is quite difficult to give an unambiguous definition of DH and today this term can be used in different meanings [23]. Also, new digital research methods are not always unambiguously positively perceived by scientists themselves. Not all scientists have felt the urgent need to integrate new digital tools into their research process [1], and therefore such scientists may be skeptical about the prospects for the development of DH as a separate scientific discipline.

However, regardless of how scientists perceive DH (as an established discipline, or simply as a set of convenient digital technologies), researchers agree that the work in DH is mainly related to such areas as: digitization, crowdsourcing, databases, digital curation, texts, editing, visualization, geospatial, gaming and code [7, 18]. Each of these key areas of DH has its own history of origin and development, but at the present stage, these areas are often combined to create new dynamic opportunities for the development of DH information resources and services in academic libraries.

Library science is very frequently mentioned in the context of DH and all researchers unanimously agree that academic libraries play a very important role in DH, regardless of the reasons for this connection [19]. Today, research libraries can successfully support research in DH, using existing developments to ensure the preservation, access and support of users of scientific and cultural collections, as well as providing physical and virtual spaces and tools for researchers, communities and volunteers. It is the development of active working collaboration with researchers that is a productive way to involve the library in the implementation of influential digital DH projects. At the same time, libraries do not need to be radically transformed to perform the relevant tasks of the DH project. It is enough for libraries to strategically focus their work on those areas of work in which they have already succeeded, and additionally offering partner researchers access to their infrastructure. In addition, research shows that with its stable infrastructure, libraries can help maintain uninterrupted access to ongoing DH projects and research results even after the end of the project [12], which is in the interests of the scientific community and regional communities for whom these projects are valuable.

Identifying the needs of researchers is an important task for the head of the research library, who has decided to take care of DH. As a rule, each research library already provides users with resources and services that meet the needs of DH to some extent. Thus, scientific libraries can store and organize various special collections of books, periodicals and other materials on the Humanities, digitize these library collections to facilitate the work of users, as well as to analyze large volumes of text using computer algorithms. Also in many scientific libraries there is a position of subject librarians [13, 27], who help scientists at different stages of their research. Traditionally, academic librarians provide services for collecting scientific literature and open data for researchers. And these things are also necessary when implementing DH projects in the library. Similarly, researchers may need access to specialized software or equipment, for example, to collect, analyze, visualize, and store scientific big data. The research library may share existing equipment, or use unused server space, organize training on the use of specific software or tools, or try to submit a joint grant project with researchers to obtain the necessary equipment.

Scientists working in a variety of scientific disciplines often depend on research services provided by government and commercial institutions. In this regard, various forms of inter-institutional scientific cooperation are very common today. Researchers that working in the Humanities have long-standing partnerships with academic libraries [21] and DH can give a new impetus to the development of library services and collaboration between librarians and humanities scholars. Many Ukrainian academic libraries also actively implement and offer new services for scientists [16], although most often of these services are universal and aimed at meeting the needs of scientists in different fields, not only for the Humanities.

The implementation of DH services in the work of scientific libraries requires, first of all, the availability of qualified staff with relevant skills. If earlier a significant part of research in the field of DH was related to text analysis [3], today researchers pay a lot of attention to non-textual materials, and this requires the use of various tools and relevant knowledge about their application. However, according to research, educational initiatives to train professionals to support DH projects have begun around the world relatively recently [5] and discussions are underway on a set of competencies for DH professionals [28]. At the same time, DH offers a new, interesting approach that can be useful both for the development of humanities research and for the transformation of library services. Therefore, it is necessary to fully support these processes, in particular as part of research activities of the university.

3.2 Citizen Science, Citizen Humanities and Gamification

According to the generally accepted notion: scientists are by all means trained specialists who work in appropriate institutions and

use special equipment. Accordingly, in order to become a scientist, you need to obtain the appropriate education, and people without special education cannot become direct participants in the process of acquiring new knowledge. However, the relationship between scientists and the public is now actively developing using new approaches, including crowdsourcing and crowdsolving. Also, a new vision of Open Science has been formed, which envisages a departure from the research culture, which focused its attention primarily on the final results. Instead, under the new Open Science approach, every step of research and data can be traced, verified, and reproduced.

Today, in many disciplines, scientists have managed to accumulate such large amounts of initial data that they are extremely difficult to analyze for a few scientists. At the same time, the development of computer technology has led to the fact that many users have tools with which they can conduct research without special education and technology. Thus, scientists began to use the practice of transferring some scientific activities to a large network of volunteers [22], and such scientific research that conducted entirely or partially by non-professional scientists is called "Citizen Science" (hereafter CS) [8]. This practice has its advantages. First, one can try to use the "wisdom of the crowd" and hope that a large group of people will do the job better than a limited number of professionals. Scientists can also use numerous volunteers to share routine tasks that cannot be automated. The combined strategies are often used, for example, in libraries when it is necessary to process large open electronic collections and improve the quality of metadata documents in these collections [25].

New trends and practices related to Open Science are actively developing in the Humanities, and CS in the humanities has even received a separate term – Citizen Humanities (hereafter CH) [24]. The use of practices that are now associated with CH has a long tradition in the Humanities. In contrast to the Natural sciences, where research results are usually disseminated in specialized journals among a narrow audience of specialists, the Humanities, on the other hand, address a wide audience through various channels of communication and the use of local languages. The development of digital technologies and DH tools has simply opened up new ways to involve citizens in the Humanities, to study cultural heritage, archives and libraries. Thus, CH can combine current public interests with scientific research, while gaining new knowledge, and at the same time explain to the public the need for the Humanities sciences for society.

The most common CH practices cover tasks related to the transcription of texts and the description of artifacts, which allows researchers to more quickly obtain the necessary information, as well as to identify new connections between the studied objects. Many components are required for the successful implementation of CS initiatives, but one of the main challenges is to attract numerous participants and motivate their active and long-term participation. In recent years, various CS projects have resorted to various gamification tools – attempts to make research tasks more like games, using a variety of game elements, including assessment and competition with other participants [22]. Presenting scientific information in research projects in this way makes the task more attractive in the eyes of the participants, promotes the involvement of activists, and encourages the public to long-term interaction and participation in research.

4 CASE STUDY

Borys Grinchenko Kyiv University successfully implemented an original DH project to include elements of Citizen Humanities and Gamification. Borys Grinchenko Kyiv University is located in Kyiv, Ukraine. The university consists of six institutes, four faculties and one university college with more than 9,000 students. Each year around 6000 teachers and school principals enhance their skills and gain qualifications at the university. The university is named after Borys Grinchenko (1863–1910) – in honor of the famous Ukrainian lexicographer, literary critic, ethnographer, historian, writer, teacher, publicist. Also, Borys Grinchenko is the author of the first dictionary of the Ukrainian language, which had a great influence on the establishment of the Ukrainian literary language and literary spelling.

At Borys Grinchenko Kyiv University, students and teachers of the university are involved in joint active scientific, educational and cultural activities, and various tools are used for such involvement. In particular, a university wiki portal has been created (http://wiki.kubg.edu.ua), which allows numerous users to quickly share knowledge. Compared to regular sites where content is provided primarily by the owner, the wiki portal offers content created by the users themselves. It has radically changed the common perception of how information is created, distributed and used [26].

The first collective project on the wiki portal of the Borys Grinchenko Kyiv University was the project "Dictionary of Borys Grinchenko" (started in 2011). The task of this wiki project is to involve students in getting acquainted with the unique dictionary of Borys Grinchenko [15]. Grinchenko's "Dictionary of the Ukrainian language" (approximately 68 thousand words) was first published in 1907–1909 in Kyiv, and it had a great influence on the establishment of the Ukrainian literary language and literary spelling, so the Dictionary has great historical and cultural value for Ukrainian linguists. In order to achieve this goal, all the words from the Dictionary were first posted in the form of articles on the wiki portal of the University. All Internet users were given the opportunity to supplement the interpretation and visualization of words from Grinchenko's dictionary on the wiki portal. As a result, they can add additional information links, images, audio and video to all words from the Grinchenko's dictionary. The basic wiki pages for this project were created by the IT in Education Laboratory of the Borys Grinchenko Kyiv University. Also, this university department was responsible for the technical support of this wiki portal.

For the purpose to draw public attention to the project and motivate users to actively editing and supplementing project pages, the University used elements of gamification, namely – launched the annual competition "Dictionary of Grinchenko and modernity" for the best explanation, interpretation and visualization of words from the Grinchenko's Dictionary. This competition is held in two stages. The first stage of the competition involves the placement on the University wiki portal of links, images, videos, texts that complement the explanation and visualize the words from the Dictionary. The participant selects the appropriate word and then additions materials in the selected wiki article, based on a specially created template.

Each participant could choose any word for work. Also, the same wiki page could be edited by several contestants. Recommendations for word visualization – the presence of additional correct and relevant links to other materials, the presence of multimedia elements, relations with foreign sources.

At the first stage, every University student can take part in the competition. User affiliation information is automatically recorded on the wiki portal, along with other information about the author of the page edit. Each faculty and institute of the university receives points according to the number of words processed by students studying at this faculty or institute. Criteria for evaluating and scoring points for the processed words are presented in the table 1. The participant of the competition for the description of one word from the dictionary could gain a maximum of 20 points. The quality of interpretations and visualizations of the words of Grinchenko's Dictionary was checked by the university professors, who agreed to help with this competition.

The second (final) stage of the competition takes place offline. A team of up to 5 people from each unit perform at the final stage of the competition. Team support groups are also invited, who can earn extra points for their team. Each team presents the 3 best interpreted words of their choice. Team presentations should combine creativity, theatricality, musicality and brightly reveal the chosen words (figuref 1). The performances of the teams are evaluated by a jury consisting of university staff, and the winner is determined on the basis of the total number of points received by the teams for all stages of the competition.

Figure 1: Students present interpreted words at the "Dictionary of Grinchenko and modernity" contest. (https://kubg.edu.ua/prouniversitet/news/podiji/5726-shchorichnyi-konkurs-slovnyk-borysa-hrinchenka-ta-suchasnist.html).

This competition is held at the Borys Grinchenko Kyiv University every year. Information about the competition and rules of participation are disseminated through online information resources of the university. There is also a curator at each faculty and institute who oversees this competition. The first stage of this competition lasts continuously throughout the year. The final takes place in December to sum up the results and determine the winners.

Since the creation of this project, the university's wiki portal has registered 8,920 users and made more than 350,000 page edits. Each year, contestants manage to add explanations and visualizations to about 1 thousand words. As of November 2021, users have processed more than 12,000 words of the Grinchenko Dictionary (17% of the total). Significant results of this project were not only the interpretation and visualization of words of the Dictionary, but also: promotion of cultural heritage, successful team building, active involvement of university students in scientific work that corresponds to DH approaches.

The use of gamification elements in the process of filling the wiki project pages "Dictionary of Borys Grinchenko" has become an influential factor in attracting users to this project. Using this experience of Grinchenko University in other institutions, it should be borne in mind that it is difficult to constantly attract the attention of potential participants to the competition throughout the year. This task requires the activity of the curators of the competition, as well as the timeliness and regularity of the relevant motivational posts for students on the university's website. Also, we consider the benefits of creating additional intermediate stages of the competition, creating a ranking of participants and determining the winners of the month.

5 FUTURE WORK

This experience of using gamification in the wiki project has led to further intensification of crowdsourcing activities and the creation of other DH projects in other departments of Grinchenko University, in particular in the university library. One of the promising new projects of the Borys Grinchenko Kyiv University Library is the creation of an electronic archive and text corpus of Borys Grinchenko. The purpose of this project is to popularize the scientifically verified work of Borys Grinchenko in the Ukrainian and world scientific community. The project envisages the creation of an open platform for the collection, preservation, organization and scientific processing of Borys Grinchenko's works, related documents, and photographic materials about him and his time.

This project will use electronic collection management systems and the introduction of technology of group scientific textual and academic processing of Grinchenko's works on the principles of crowdsourcing. The peculiarity of this project is not only to digitize and collect Grinchenko's works on a single web resource, but also to provide an opportunity to analyze this text corpus to various researchers (not only to professors and students of our university), with the involvement of the method of scientific crowdsourcing. We want to convert Borys Grinchenko's works to machine-readable format and allow researchers to analyze them using the library's software (which also needs to be developed), as well as using their own tools. We also plan that university professors from various scientific disciplines, including linguistics and computer science, will involve students in this research work to demonstrate how modern methods of computer analysis can be used to gain new knowledge from old texts.

Unfortunately, today many existing attempts to create digital archives of works by Ukrainian writers are limited to the presentation of the sources themselves without their scientific support and commentary. In addition, many machine-readable texts of classics

Table 1: Criteria for evaluating the quality of explanation and visualization of words in the competition "Dictionary of Grinchenko and modernity"

Evaluation criteria	Explanation of evaluation criteria
Modern Ukrainian dictionaries	The meaning of the word was found in modern dictionaries of the Ukrainian language - 3 points
Foreign dictionaries	The meaning of the word was found in the non-Ukrainian dictionaries - 3 points
Image	The description of the word contains correct images – 1 point
Audio	The description of the word contains correct audio – 1 point
Video	The description of the word contains correct video – 1 point
Interesting Facts	The description contains interesting facts related to this word – 1 point
Additional links available	The description of the word contains correct references to other resources – 1 point
Word usage	If the word is rarely used, the number of points is multiplied by 2

of Ukrainian literature available today do not come from original works of writers, but from Soviet publications, which could have been subjected to significant editorial interference and ideological distortion by Soviet censorship [20].

Some important steps in digitizing and presenting the Borys Grinchenko works have already been made by the Grinchenko University Library in previous years, but the results of these projects do not comply with FAIR principles [10]. These digitized documents and their metadata are available online to anyone under open licenses. However, our library resources are primarily aimed at meeting the needs of human users, and do not take into account modern requirements for interoperability. Now we want to correct this lack of library digital collections and make Grinchenko's texts available for analysis for both humans and machines.

The project is planned to be implemented in several stages:

(1) preparatory stage for digitization of documents and processing of digital material;
(2) installation and adjustment of the digital collection management system, development of the digital collection structure;
(3) filling this system with digital content, recognizing texts and converting them into machine-readable format;
(4) development of a prototype of the module of textual processing of texts and there are presented in the text corpus;
(5) use standard NLP methodology to convert the texts into a dataset of tokens such as meaningful terms and phrases;
(6) modernization of the existing web resource http://grinchenko.kubg.edu.ua/ using the above module; experimental approbation and testing of the prototype of the module.

The implementation of this library project will also provide an opportunity to develop experience in creating similar digital collections, which can be used to create a text corpus by other authors. In the long run, we want to create a Borys Grinchenko Kyiv University Library Research Center to develop software and cyberinfrastructure to enable advanced computational access to digital scientific historical texts in Ukrainian.

6 CONCLUSION

In this paper, we presented an example of implementation of the DH project in a small academic institution. One of the main factors for the success of the project is a developed system of partnerships within the institution (between teachers, students and university researchers), and the maintenance of information resources of the institution at the appropriate level. Academic librarians, as a rule, already have established cooperation with teachers and students. Therefore, librarians should use this experience and this advantage in their research, and actively use advanced DH and CS technologies in their work with the involvement of elements of gamification.

Ukrainian academic libraries have accumulated a lot of scientific, educational and cultural digital materials that are suitable for research using modern technical tools. University libraries can be a common platform for students, graduate students and faculty to work on joint DH projects, and together with librarians, they can all make a significant contribution to the development of the Humanities.

Today, the most academic libraries manage institutional repositories, combine all the institution's research resources into a single search interface, and seek to offer their users up-to-date services to best meet the information needs of researchers. DH projects can be very effective forms of work with users, which will give a new impetus to the development of the library business at the present stage. The availability of smartphones, wireless networks, the willingness of the younger generation to openly cooperate on the Internet are important factors in the possible future success of such projects.

Also, in addition to gaining new knowledge, DH and CS technologies can reveal the cultural potential of library collections, change and enrich existing approaches to the preservation and promotion of cultural heritage.

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