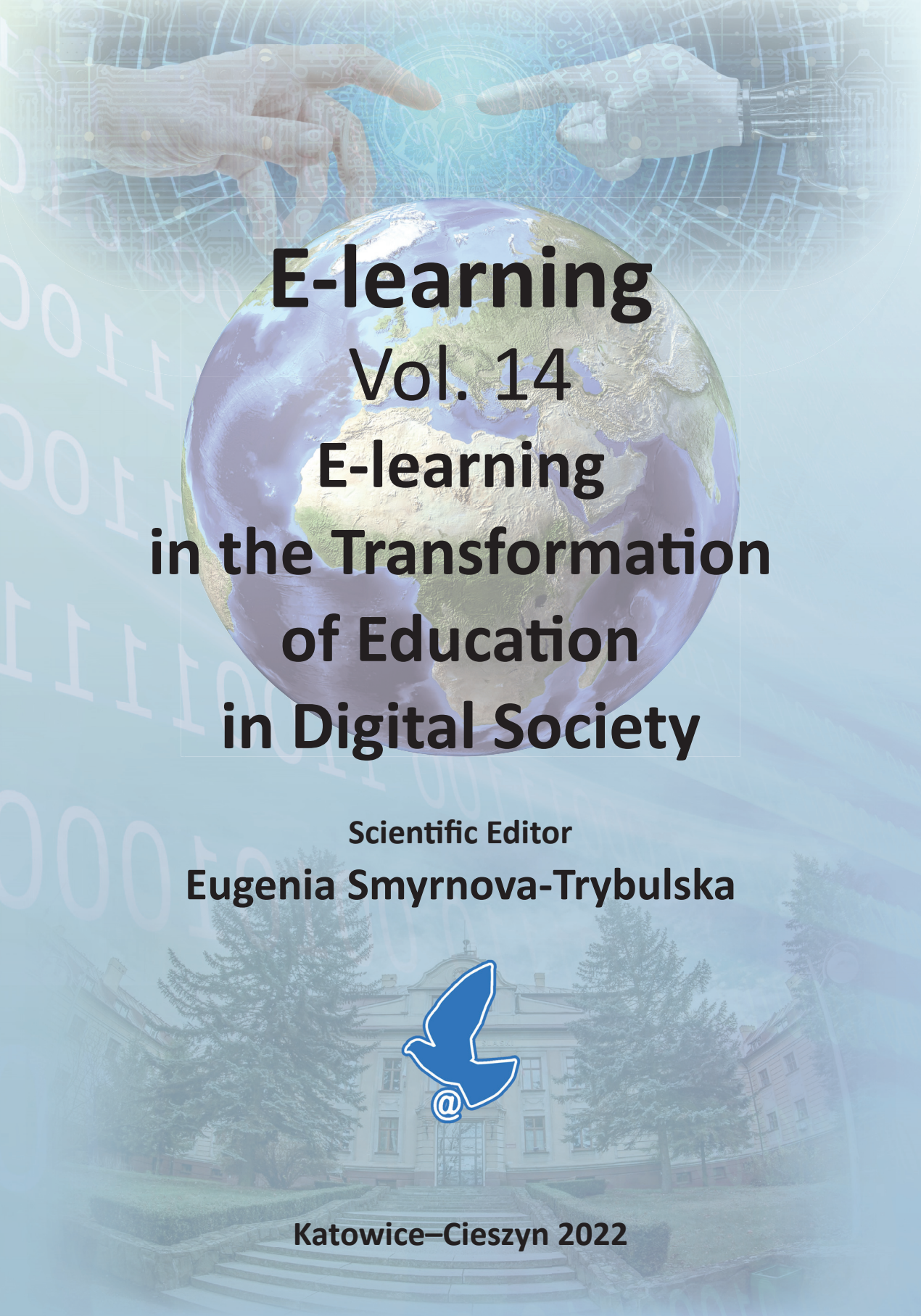


E-learning
Vol. 14
E-learning in the Transformation of Education in Digital Society

Scientific Editor
Eugenia Smyrnova-Trybulska

Katowice–Cieszyn 2022

E-learning

Vol. 14

E-learning in the Transformation of Education in Digital Society

University of Silesia in Katowice
Faculty of Arts and Education Sciences
in Cieszyn

E-learning

Vol. 14

E-learning in the Transformation of Education in Digital Society

Monograph

Scientific Editor
Eugenia Smyrnova-Trybulska

Katowice–Cieszyn 2022

Reviewer: *Prof. Juan Arias* – University of Extremadura, Spain

Proofreading by: *Ryszard Kalamarz*

Technical editing and correction by:
Ireneusz Olsza, *Eugenia Smyrnova-Trybulska*

Cover design by: *Ireneusz Olsza*

E-learning Series is indexed in Journal Factor http://www.journalfactor.org*/, Academic Research Index https://www.researchbib.com/, JIFACTOR.ORG, ceon.pl, Polska Bibliografia Naukowa https://pbn.nauka.gov.pl 9th vol., 10th vol., 11th vol., 12th vol. and 13th vol. indexed in Web of Science Core Collection*
The E-learning series web-sites:
https://us.edu.pl/wydzial/wsne/nauka-i-badania/serie-wydawnicze/seria-e-learning
http://www.ig.studio-noa.pl/pubusc.html

ISSN 2451-3644 (print edition), **ISSN 2451-3652** (digital edition), **ISBN 978-83-66055-31-5**

Published by: STUDIO NOA for University of Silesia in Katowice
Faculty of Arts and Sciences of Education in Cieszyn

Printed in Poland

Scientific publication co-financed from the statutory research funds

Publication co-financed by the University of Silesia in Katowice

https://doi.org/10.34916/el.2022.14

This Monograph contains the Authors' own original work, not printed before in any other sources.

Scientific Programme Committee

Maria Potes Barbas – Polytechnic Institute of Santarém, the Open University in Lisbon, Portugal, Xabier Basogain – University of the Basque Country, Spain, Filipe Carrera – Lisbon University, Portugal, Sixto Cubo Delgado – University of Extremadura, Spain, Martin Drlik – Constantine the Philosopher University in Nitra, Slovakia, Prudencia Gutiérrez Esteban – University of Extremadura, Spain, Theo Hug – Innsbruck University, Austria, Zenon Gajdzica – University of Silesia in Katowice, Poland, Pedro Iasias, Queensland University, Brisbane, Australia, Tomayess Issa – Curtin University in Perth, Australia, Jana Kapounová – University of Ostrava, Czech Republic, Piet Kommers – University of Twente, The Netherlands, Kateřina Kostolányová – University of Ostrava, Czech Republic, Stefan M. Kwiatkowski – Academy of Special Pedagogy, Warsaw, Poland, Josef Malach – University of Ostrava, Czech Republic, Elspeth McKay – RMIT University, Melbourne, Australia, Nataliia Morze – Borys Grinchenko Kyiv University, Ukraine, Tatiana Noskova – Herzen State Pedagogical University of Russia, St.Petersburg, Russia, António dos Reis – The Graal Institute, Portugal, Eugenia Smyrnova-Trybulska – University of Silesia in Katowice, Poland, Halina Widła – University of Silesia in Katowice, Poland, Zygmunt Wróbel – University of Silesia in Katowice, Poland, Miroslav Zhaldak – Dragomanov National Pedagogical University in Kyiv, Ukraine

Editorial Board

Theodora Issa – Curtin University in Perth, Australia, Krzysztof Gurba – Pedagogical University of Krakow, Poland, Miroslav Hrubý – University of Defence, Czech Republic, Milena Janáková – Silesian University in Opava, Czech Republic, Theodora Issa – Curtin University in Perth, Australia, Rusudan Makhachashvili – Borys Grinchenko Kyiv University, Ukraine, Ewa Ogrodzka-Mazur – University of Silesia in Katowice, Poland, Tatiana Pavlova – Herzen State Pedagogical University of Russia, St.Petersburg, Russia, Paulo Pinto – The Lisbon Lusiada Uiversity, Portugal, Magdalena Roszak – Poznan University of Medical Sciences, Poland, David Richardson – Linnaeus University, Sweden, Halina Rusek – University of Silesia in Katowice, Poland, Nuria Salvador – 22nd Century Foundation – Spain, Iryna Sekret – Abant Izzet Baysal University, Bolu, Turkey, Eugenia Smyrnova-Trybulska – University of Silesia in Katowice, Poland, Aleksander Sadovoy – Dniprovsk State Technical University, Ukraine, Jana Šarmanová – TU-VSB, Ostrava, Czech Republic, Anna Szafrańska – University of Silesia in Katowice, Poland, Maciej Tanaś – Maria Grzegorzewska University, Warsaw, Poland, Milan Turčáni – Constantine the Philosopher University in Nitra, Slovak Republic, Max Ugaz – University of S. Martin de Porres, Peru, Dominik Vymětal – Silesian University in Opava, Czech Republic, Zsolt Lavicza – Johan Keppler, University, Linz, Austria

Reviewers (Peer- and double blind review)

Izabel Alvarez – Lisbon Lucíada University, Portugal, Tetiana Andriushchenko – MEI Cherkasy Regional Institute of Postgraduate education of Teachers of the Cherkasy Regional Council, Ukraine, Sixto Cubo Delgado – University of Extremadura, Spain, Martin Drlik – Constantine the Philosopher University in Nitra, Slovakia, Todorka Glushkova – Plovdiv University "Paisii Hilendarski", Bulgaria, Miroslav Hrubý – University of Defence, Tomasz Kopczyński – University of Silesia in Katowice, Poland, Lilla Korenova – Comenius University in Bratislava, Slovakia, Péter Körtesi – University of Miskolc, Hungary, Jarosław Krajka – Maria Curie-Skłodowska University, Lublin, Poland, Lyubov Lokhvytska – Hryhorii Skovoroda University in Pereiaslav, Ukraine, Elspeth McKay – RMIT University, Melbourne, Australia, Iwona Mokwa-Tarnowska – Gdańsk Technical University, Poland, Volodymyr Proshkin – Borys Grinchenko Kyiv University, Ukraine, Maryna Romaniukha – Dniprovsk State Technical University, Ukraine, Jan Skalka – Constantine the Philosopher University in Nitra, Slovakia, Anna Ślósarz – Pedagogical University of Krakow, Poland

TABLE OF CONTENTS

CHAPTER II.
New Methods and Technologies in E-learning.
Development of Key and Soft Competences by E-learning

CHAPTER III.
E-learning in STEM and STEAM Education

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 11–13
https://doi.org/10.34916/el.2022.14.01

INTRODUCTION

The theme of the 14th annual scientific international conference "Theoretical and Practical Aspects of Distance Learning" is *E-learning in the Transformation of Education in Digital Society.*

The 14th volume of the Series on E-learning monograph – *E-learning in the Transformation of Education in Digital Society* includes articles of authors from ten countries and from more than twenty universities, participants of the scientific international conference entitled "Theoretical and Practical Aspects of Distance Learning", subtitled: *E-learning in the Transformation of Education in Digital Society*, which was held on 17 and 18 October 2022 in hybrid mode, organized by the Faculty of Arts and Educational Sciences in Cieszyn, the Faculty of Social Sciences, the Institute of Pedagogy, the Faculty of Science and Technology, the Institute of Computer Science, University of Silesia in Katowice, Poland. Co-organizers and Partners: University of Ostrava (UO), Czech Republic, Silesian University in Opava (SU), Czech Republic, Constantine the Philosopher University in Nitra (UKF) Slovakia, University of Extremadura (UEx), Spain, University of Twente (UT), The Netherlands, Lisbon Lucíada University (LU), Portugal, Curtin University in Perth (CU), Australia, Borys Grinchenko Kyiv University (BGKU), Ukraine, Herzen State Pedagogical University of Russia, St. Petersburg (HSPU), Russian Federation, Dniprovsk State Technical University (DSTU), Ukraine, IADIS – International Association for Development of the Information Society, a non-profit association, Polish Pedagogical Society, Branch in Cieszyn, Polish Scientific Society for Internet Education, Association of Academic E-learning, Poland.

Experts on e-learning from 12 countries, in particular Austria, Australia, Bulgaria, Czechia, Georgia, Poland, Portugal, Slovakia, Spain, Russia, Ukraine, Turkey, reflect on *E-learning in the Transformation of Education in Digital Society*, E-learning in the time of COVID-19 and after this time, presented research results, contemporary trends and scientific and educational projects devoted to MOOCs, artificial intelligence (AI), augmented reality (AR), virtual reality (VR), selected Web 2.0 and Web 3.0 technology, LMS, CMS, STEM, mobile learning and other topics.

The speakers from the Comenius University in Bratislava (Slovakia), University of Silesia in Katowice (Poland), Plovdiv University "Paisii Hilendarski" (Bulgaria), Borys Grinchenko Kyiv University (Ukraine), Gdańsk University of Technology (Poland), Ostrava University (Czech Republic), Dniprovsk State Technical University (Ukraine), Pedagogical University in Krakow (Poland), Herzen State Pedagogical University of Russia, St. Petersburg (Russian Federation), Extremadura University, Spain, K.D. Ushynskyi South Ukrainian National Pedagogical University (Ukraine),

Maria Curie-Skłodowska University, Lublin (Poland), Lesya Ukrainka Volyn National University, (Ukraine), Mykhailo Drahomanov National Pedagogical University, Kyiv, (Ukraine), Sumy State Pedagogical University (Ukraine), Technical University in Rzeszów (Poland), Izmail State University of Humanities (Ukraine), MEI Cherkasy Regional Institute of Postgraduate education of Teachers of the Cherkasy Regional Council (Ukraine), and other educational institutions delivered lectures, provided insights into interesting studies, presented their recent research results and discussed their further scientific work.

The authors include experts, well-known scholars, young researchers, highly trained academic lecturers with long experience in the field of e-learning, PhD students, distance course developers, authors of multimedia teaching materials, designers of websites and educational sites.

I am convinced that this monograph will be an interesting and valuable publication, describing the theoretical, methodological and practical issues in the field of E-learning in the Transformation of Education in Digital Society offering proposals of solutions to certain important problems and showing the road to further work in this field, allowing exchange of experiences of scholars from various universities from many European countries and other countries of the world.

This book includes a sequence of responses to numerous questions that have not been answered yet. The papers of the authors included in the monograph are an attempt at providing such answers. The aspects and problems discussed in the materials include the following:

1. **E-learning in the Transformation of Education in Digital Society**

- Contemporary trends in world e-learning in conditions of globalization, internationalization, mobilities.
- E-environment and cyberspace.
- Artificial intelligence (AI), augmented reality (AR), virtual reality (VR).
- Legal, social, human, scientific, technical aspects of distance learning and e-learning in different countries.
- European and national standards of e-learning quality evaluation.
- Psychological and ethical aspects of distance learning and e-learning.
- E-collaboration and e-communication in e-learning.
- E-environment of the contemporary university.
- SMART universities. SMART technology in education.
- E-learning in a sustainable society.
- Comparative approach in research on e-learning.

2. **E-learning: Methodology and tools development**

- E-learning and online learning.
- Blended learning.
- Innovative educational technologies, tools and methods for e-learning.
- Modern ICT Tools for e-learning in the time of COVID-19 pandemic – review, implementation, opportunities for effectiveness of learning and teaching.
- MOOCs – methodology of design, conducting, implementation and evaluation.
- Selected Web 2.0 and Web 3.0 technology.

- E-learning and effectiveness using of Learning Management System (LMS), CMS, VSCR, SSA, CSA.
- Cloud computing environment, social media, multimedia resources.
- Methodological tools. E-tutoring. (Video)tutorial design.
- Simulations, models in e-learning and distance learning.
- Networking, distance learning systems.
- Successful examples of m-learning, e-learning.
- Evaluation of synchronous and asynchronous teaching and learning, methodology and good examples.

3. **E-learning and STEAM Education**

- Immersive learning environments. Blockchain. Bots.
- Robots and coding in education.
- Internet of things. 3D printing.
- STEM education – contemporary trends and challenges.
- Distance learning in humanities and science.
- Quality of teaching, training.
- E-learning for science and technologies.

4. **Development of Key and Soft Competences and E-learning**

- Effective development of teachers' digital skills.
- Key competences and soft skills in the digital society.
- Use of e-learning in improving the level of students' digital competences.
- E-learning for humanities and social sciences.
- E-learning and lifelong learning.
- Self-learning based on e-learning and Internet technology.

The publishing of this monograph is a good example of broadening and strengthening international cooperation. I am very grateful for all the valuable remarks and suggestions that contributed to the quality of the publication. At this point, I especially want to thank Prof. Ryszard Kalamarz for his help in editing and proofreading this publication. I would also like to thank the authors for preparing their articles and giving permission for their publication and the reviewers and experts who evaluated and reviewed the manuscripts, contributing to the quality of the monograph. I wish all readers a pleasant read. Thank you.

Eugenia Smyrnova-Trybulska

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 15–28
https://doi.org/10.34916/el.2022.14.02

PROPOSAL OF ARTIFICIAL INTELLIGENCE EDUCATIONAL MODEL USING ACTIVE LEARNING IN A VIRTUAL LEARNING ENVIRONMENT

Jan Skalka[1] **& Martin Drlik**[2]
[1,2] Constantine the Philosopher University in Nitra
[1] jskalka@ukf.sk, ORCID 0000-0003-2211-2794
[2] mdrlik@ukf.sk, ORCID 0000-0002-5958-7147

Abstract: *Artificial Intelligence (AI) is currently one of the fastest-growing areas, but pedagogical research on the design of curriculum and teaching methods for AI education is relatively rare. The article aims to identify techniques and content used in university AI teaching and its pros and cons. Subsequently, it identifies suitable forms of AI teaching for MOOCs, based on the experience and the possibilities of integration into the most modern educational environments. As a result, the article proposes an educational model based on a combination of active learning and a virtual learning environment that supports the distribution of educational content to the broadest possible groups of people interested in AI. At the same time, it describes the requirements and process of integrating the Jupyter notebook microenvironment into an independent web application, which is an essential prerequisite for connecting MOOC and computing server infrastructure.*

Keywords: artificial intelligence learning, virtual learning environment, active learning, e-learning, Jupyter notebook technology.

INTRODUCTION

Artificial Intelligence (AI) is currently one of the fastest-growing areas, which shows a growing demand for experts with advanced knowledge and the ability to learn and discover new approaches. According to (Acemoglu & Restrepo, 2020), AI, as a technology platform, can automate tasks previously performed by humans and generate new tasks and activities in which humans can be productively employed. However, recent technological changes are moving towards automation with insufficient focus on defining new jobs. This choice may result in stagnant demand for the labour market, a declining share of labour in national income, rising inequality and reduced productivity growth. Therefore, each country needs to respond and

adapt to the changes that the implementation of AI brings in various areas of human activities (European Commission, 2021), (Zhang & Lu, 2021).
Moreover, this trend must be reflected first and foremost by the educational institutions that train future leaders and employees in this field. Due to the difficulty of individual areas of AI, this task falls to the greatest extent to universities. The advantage is that universities can fully benefit from the digital skills their students acquired at lower levels of study; the disadvantage is that only a tiny part of students choose to study AI as a part of IT. Furthermore, universities must deal with the consequences of AI mystification in the media and the complexity of the issues. Mastering practically every field of AI is complicated and requires prerequisites in the knowledge of mathematics, programming, statistics, etc. Therefore, universities must reconsider the form and structure of the educational content to increase the number of stakeholders interested in AI careers (Gao, Li, & Liu, 2021) (Chen, Chen, & Lin, 2020).
The article presents a proposal for an educational model based on a combination of active learning and a virtual learning environment that supports the distribution of educational content to the broadest possible groups of people interested in AI. At the same time, it presents the technological requirements for a tool supporting AI teaching and a case study within the FITPED-AI project (https://www.fitped.eu).
The article consists of three main parts. The first one focuses on identifying best practices and content used in university teaching of AI and its pros and cons. The second part identifies suitable forms of AI teaching for MOOCs while building on the authors' experience and the possibilities of integration into the most modern educational environments. The last part presents a case study of the design and implementation of an educational environment supporting AI teaching.

1. ARTIFICIAL INTELLIGENCE EDUCATION

In this part, the article focuses on the presentation of best practices and content taught at universities in the field of AI.
In research connecting AI and education, the authors aim most often on AI contribution and application in education (Chassignol, Khoroshavin, Klimova, & Bilyatdinova, 2018), adoption of AI in the university environment (Rico-Bautista et al., 2021) or to specific scientific or educational areas in which AI tools are used (Xu & Babaian, 2021), (Lindqwister, Hassanpour, Lewis, & Sin, 2021).
A study (Xu & Babaian, 2021) shows widespread agreement that introductory AI courses are generally challenging to teach in engineering programmes despite growing enthusiasm for AI education. (Eaton et al., 2018) and (Langley, 2019) state that the primary reason is the required broad scope of students' entry knowledge and the complexity of AI caused by many advanced topics and techniques. A secondary reason is the constant updating of content due to the research and creation of new types of AI applications, which causes rapid obsolescence of knowledge, often in a short time. Integrating AI into the engineering study brings many advanced topics such as pattern identification, decision-making, and combining them into higher levels of reasoning abilities, sequential control, plan generation and integrated intelligent agents. Langley (Langley, 2019) defines the following requirements supporting integration:

- Present a system perspective that shows how mechanisms interact to produce intelligence (to combat views that AI is a collection of disconnected algorithms).
- Give students experience with encoding representational content that mechanisms interpret to produce behaviour (to clarify the centrality of structured representations in intelligent agents).
- Present topics in a cumulative manner, with later material layered on the earlier content, much as calculus builds on algebra, which draws on arithmetic (to emphasise the hierarchical character of intelligence).
- Teach students not only how to use AI methods but how to construct them from simpler components (to give them the ability to develop their own mechanisms when existing ones do not suffice).
- Cover important abilities exhibited in human intelligence even when challenging to formalise (to show the link between AI and psychology that address many of the same core phenomena).

The reason for these requirements is a lack of understanding of the basic principles of AI, the solution of isolated (partial, abstract) problems, as well as the fact that AI teaching is currently mainly oriented to the use of existing libraries without the necessity of an internal understanding of their principles. According to (Xu & Babaian, 2021), pedagogical research on the design of curriculum and teaching methods for AI training is relatively rare.

Considering the scope of the AI introduction curriculum, a typical representative of which is e.g. a book (Russell & Norvig, 2021), used in teaching in more than 1500 universities, integrating the above requirements is almost impossible. However, preparing educational content that can capture and retain the interest of students less skilled in abstract thinking is a constant challenge for authors. This statement is evidenced by a number of publications aimed at providing basic knowledge in the field of AI (Finlay, 2020), (Ertel, 2018), (Flasiński, 2016), (Jackson, 2019).

A popular output aimed at popularising artificial intelligence to the public is the course Elements of AI (https://www.elementsofai.com/) developed by the University of Helsinki and first launched in Finland in 2018. This course presents elements, problems, and selected solutions from the field of AI at the level of secondary school knowledge in an exciting way. According to (Heintz & Roos, 2021), the overall experience of setting up and running the course was very interesting and rewarding. Moreover, its impact was considerable, with many companies requesting the opportunity for their employees to participate in the course.

The requirements for effectively providing basic knowledge of AI to as wide a community as possible come from several basic views. From the point of view of user comfort, it is desirable to apply modern principles of digital content creation (Smyrnova-Trybulska, Noskova, Pavlova, Yakovleva, & Morze, 2016), (Latwal, Sharma, Mahajan, & Kommers, 2020). The focus of the task should guarantee the acquisition of skills and experience in accordance with the principles presented in (Capay, Skalka, & Drlik, 2017). Combined with the results of the analysis of the Elements of AI course platform, the general content requirements can be established as follows:

- active learning – the emphasis must be on dynamic content; the content creator must prefer explanations using examples and solving tasks,
- allow students to make mistakes and look for better solutions – prioritise content in the form of activities allowing them to make mistakes, optimise the solution, improve, and compete with each other,
- prioritise practicality at the expense of abstractness, even if the practical solution does not quite correspond to the theoretical basis – especially in the introductory chapters, where it is necessary to "build the user's relationship with AI",
- put less emphasis on the amount of content versus more focus on understanding it and building practical skills,
- divide the content into smaller units and "close them", thanks to which the student will have the feeling that he has already mastered some areas, even if they are only a prerequisite for understanding other topics,
- to support the mutual evaluation of students' solutions, the benefit of which is the understanding of different ways of thinking and approaches to solutions.

Even though we can find many courses focused on AI and specific areas of AI on educational portals (Table 1), they mostly do not meet the requirements mentioned above.

Table 1. Some types of AI-focused courses/educational materials on selected educational platforms (in August 2022). The content of AI and Data Science often overlaps in the courses, so this area was also included in the survey (Other popular portals, e.g. Khanacademy.org, and Udacity.com, contained a significantly smaller number of courses covering the given areas)

Educational portal	Artificial Intelligence	Data Science	Machine Learning	Deep Learning	Natural Language Processing
Coursera.org	731	1.506	676	269	79
Edx.org	242	345	208	224	12
Udemy.com *number of users in Udemy courses*	353 *2.435 mil. learners*	2.593 *6.5 mil. learners*	624 *7.0 mil. learners*	238 *1.75 mil. learners*	97 *0.565 mil. learners*
Total	**1.316**	**4.444**	**1.138**	**731**	**188**

Source: Own work.

The reason is that the creation of such content is demanding and laborious, and there is a risk that during the preparation of the learning materials, the content will become outdated before they are completed. As a result, linear courses in the form of video lectures or video tutorials of varying quality are created. Moreover, despite the success and indisputable quality of the content, they often include the shortcomings mentioned in (Langley, 2019).

The data in Table 1 shows a strong interest in AI and selected areas that overlap or are part of it.

2. LEARNING FORMS SUITABLE FOR TEACHING AI

In this part, the article focuses on identifying suitable forms for teaching AI while looking for often used features in teaching programming, which has been the subject of intensive research in recent years.

The primary target group of university students focused on IT expects an effective acquisition of knowledge and practical skills, emphasising simplification. In other words, they wish to learn highly specialised knowledge and skills in AI following their habits to be ready for a career in AI (regardless of whether they finally choose it). Therefore, increasing the level of highly specialised knowledge and skills of students who consider or have already decided on a career in AI will be realised using a work-based learning strategy with elements of active-based, collaborate-based and problem-based learning.

Active learning, which transfers responsibility for progress in the educational process to the student, is one of the most effective and probably suitable forms of education for building knowledge and skills in AI. According to (Hartikainen, Rintala, Pylväs, & Nokelainen, 2019), active learning as an instructional approach includes different forms of activation, such as increased physical activity, interaction, social collaboration, deeper processing, elaboration, exploration of the material, etc. Active learning from this point of view is defined and viewed mostly through student activation. Other authors (Markant, Ruggeri, Gureckis, & Xu, 2016) proved that active learning leads to better outcomes than passive forms of instruction.

If it is considered that studying AI represents the same leap in thinking as learning to program, then it has to be also taken into account the results of flipped classroom experiments (D'Souza & Rodrigues, 2015), (Özyurt & Özyurt, 2018), (Peethambaran, Renumol, & Murthy, 2018). This method is one of the few that undoubtedly improves student results. However, its success is strongly conditioned by strict adherence to defined rules and measures that ensure students do their homework honestly (Skalka & Drlik, 2020).

Another provably functional and currently functioning approach is microlearning supporting and enabling study within short intervals (Carter & Youssef-Morgan, 2022). Moreover, if it is supplemented with appropriate gamification elements, it will demonstrably increase the satisfaction and motivation of students (Gasca-Hurtado & Gomez-Alvarez, 2021).

Based on (Skalka et al., 2021), it can be stated that the combination of micro-learning, gamification, immediate feedback, and the automatically evaluated programme assessment increased the quality of the training of experts in the field of programming. These elements represent the basis, integrated into the educational environment, enabling self-study with the automatic evaluation of results within the framework of microlearning, as well as automatic evaluation of programmes and provision of feedback. The virtual learning environment Priscilla (Skalka & Drlik, 2018a) can serve as an example and starting solution.

What does teaching AI require in addition to teaching programming? Suppose the teaching of AI follows the teaching of programming supported by an educational system with the features mentioned above. In that case, it is appropriate to integrate AI content into the same environment.

As a result, students meet a familiar environment and are not distracted by unknown functionalities and rules. They can thus fully concentrate on studying the content. However, from the view of the system creators, it is essential to identify the modules necessary to explain the initial problems of AI and thus ensure the closest possible connection between the perception of the real world and its transformation into tasks. For this purpose, the careful development of interactive modules enabling various kinds of experimentation (decision making, deductive reasoning, genetic algorithms, heuristic algorithms, etc.) is necessary.

The work of a data scientist is very often intertwined with the use of an environment using Jupyter notebooks where students write code that processes data and generates outputs prepared for interpretation. Sometimes the work ends at this point, and sometimes, the result is a model that will be deployed to solve the problems of the given class. If the student should follow these steps, he needs a tool that allows him to experiment with data, obtain the created model, verify its functionality, success, overfitting, speed, etc.

In the context of the existing educational system supporting the teaching of programming and the requirements mentioned above for AI education, the learning objects for AI courses can be defined as follows:

- microlearning – introduction to the issue, familiarisation with terms, presentation of superficial relationships and practice of simple tasks,
- automatic source code evaluation – will be available to prepare assignments, especially in the case of initial familiarisation with libraries,
- domain- and problem-specific independent modules enabling the solution of specific tasks defined as snapshots of reality; this part represents the most time-consuming activity of creating tasks focused primarily on motivating and building the educator's relationship with AI,
- Jupyter notebook ecosystem – represents an environment in which students, who master the essential topics, can experiment and transform real-world problems into it; mastering this environment is also a prerequisite for applying in the field of Data Science and/or AI, where Jupyter notebooks are widely used,
- collaboration, competition, and gamification – the training of AI professionals should be implemented through a learning strategy integrating the parts of active, collaborative and problem-based learning, using gamification and competition, which can make learning more interesting, more fun, more friendly, and more practical.

3. CASE STUDY: TECHNOLOGICAL BACKGROUND FOR AI LEARNING ENVIRONMENT

The last part presents the design of an educational model suitable for teaching AI and its support through a software solution.

As the output of the FITPED and FITPED-AI project consortium consisted of universities and SME organisations, the educational model and virtual learning environment focused on teaching programming languages were designed and implemented (Skalka & Drlík, 2018a).

The system combines microlearning and automatic evaluation of source codes, but it was designed to support the integration of other elements and activities as efficiently as possible. The system includes a web development environment that allows writing, running, and debugging programs without installing any supporting applications on the computer (Figure 1). Instead, the code is saved, executed and run on the server.

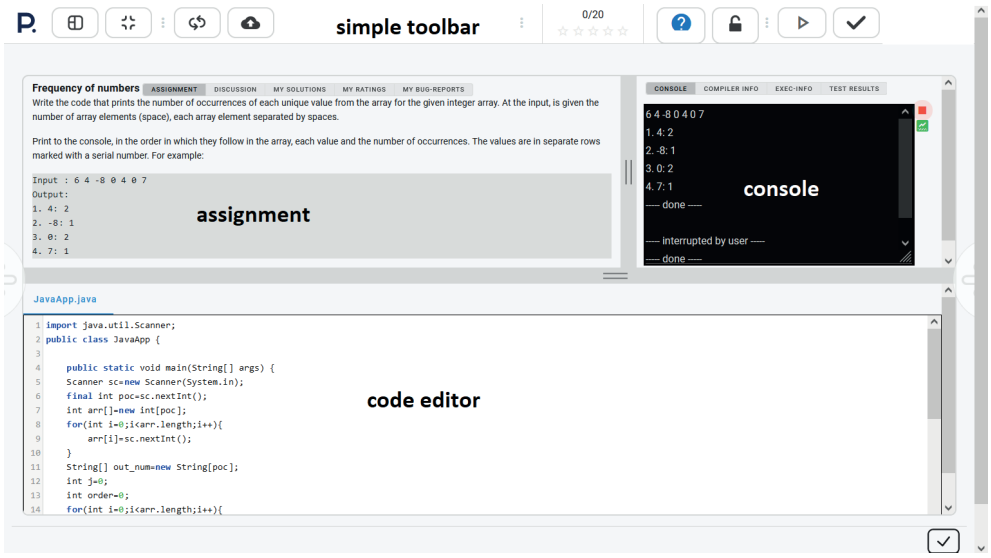


Figure 1. Web interface dedicated to solving and code writing in PRISCILLA system

Source: Own work.

To leave task solving to powerful server processors is a standard approach even in environments oriented to solving AI tasks. The primary reason is that to obtain a result, the programs, in many cases, need high performance and a long time, which cannot generally be provided on local devices.

The requirement for solving tasks and experimenting with data is currently most often implemented by Jupyter notebook technology (Pérez & Granger, 2015). Thanks to its openness, simplicity, and constant development, it has become a popular tool in teams focused on Data Science and AI. Currently, it is used not only as a format used in the processing of Data Science but also in education (Johnson, 2020). Its strength lies in combining text, source code and editing and running this code any time with a single click. Furthermore, the results can be displayed as part of the document content.

Jupyter server/notebook technology has a significant disadvantage, which was recently identified by the authors during its maturation – to use the computing and processing components, it is necessary to run the content from the given server – because notebooks could work via localhost by default (Project Jupyter, 2022). This approach made cooperation with other systems and front-end applications difficult or impossible.

The Jupyter Kernel Gateway (JKG) technology is currently used as one of the alternatives enabling the communication between an independent front-end and a Jupyter server running on the backend. According to (Project Jupyter Team, 2022), JKG is a web server that provides headless access to Jupyter kernels. As a result, the independent applications communicate with the kernels remotely through REST calls and WebSockets rather than ZeroMQ (Hintjens, 2013) messages.
Thanks to JKG, it was possible to implement modules that ensured communication with the Python language kernels, usually used to solve Data Science and AI tasks. A single kernel can be simultaneously connected to one or more front-ends.
In order to integrate the Jupyter infrastructure into the used Priscilla system and enable communication with Python kernels, it was necessary to create a clone of the design of a standard Jupyter notebook and enrich it with possible additional features (the ability to stop the program, friendly insertion of input data into the running program, the ability to combine with rich text, etc.) An example of the prepared content (from the FITPED-AI project) is presented in Figure 2.

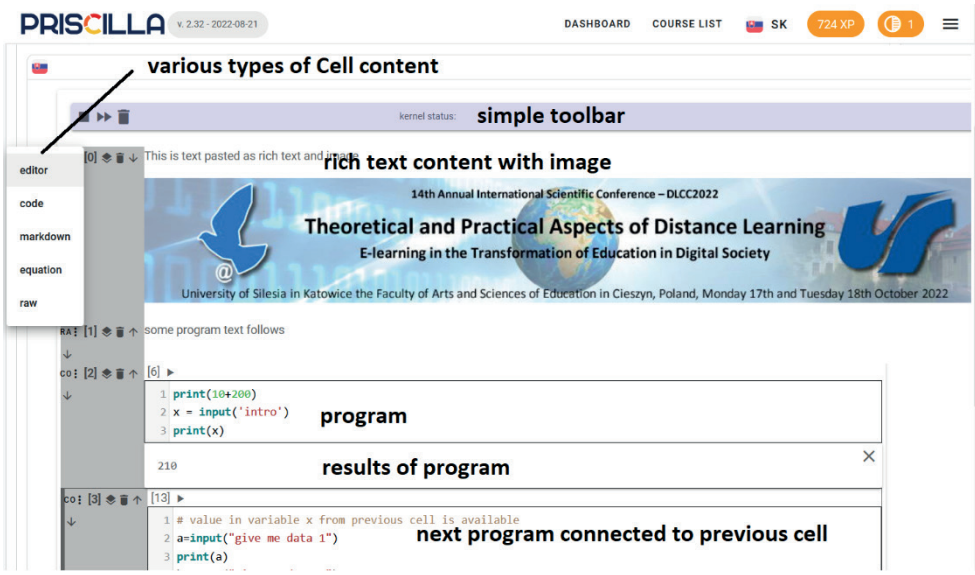
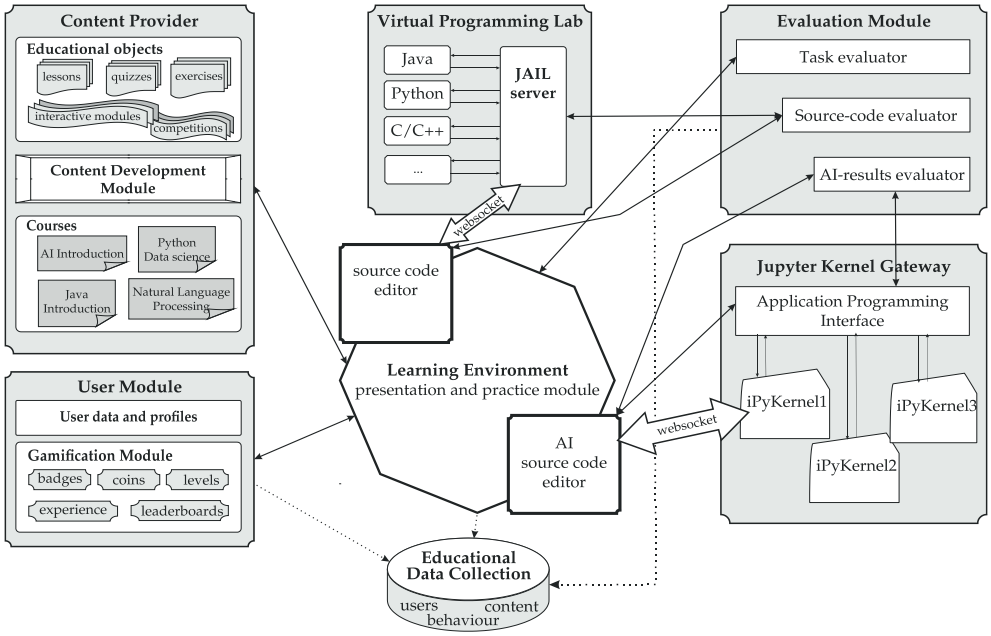


Figure 2. Integration of the Jupyter notebook design into the Priscilla system (a case study of the FITPED-AI project)

Source: Own work.

Integration of the Jupyter notebook clone environment with the backend technology of the Jupyter server and proven features of the Priscilla system provides the new system with all the original benefits (microlearning, gamification, automatic evaluation of source code, communication between users, etc.). A new logical and communication structure is presented in Figure 3.
The key part of the model is the **Learning environment**, which provides the content for the user/student and communicates with other modules with the aim of, e.g.

checking the answer correctness, logging the student's activity and attempts, providing assistance or help etc.
The Learning environment also includes separate modules dedicated to code writing or AI task solving in the Jupyter microenvironment (presented in Figures 1 and 2). These modules require communication with modules executing programs.



F i g u r e 3. Logical and communication structure of the technological solution ensuring coverage of the requirements of the educational model over the Priscilla system (a case study of the FITPED-AI project)

S o u r c e: Own work.

The first module is the web interface of the **source code editor**, with the backend covered by the Virtual Programming Lab server (Rodríguez-del-Pino, Rubio-Royo, & Hernández-Figueroa, 2012), which supports the execution of programs in various codes. Communication starts initially via REST API and then continues via WebSocket. The results of the program can be verified against the expected inputs, or the environment allows only program execution and communication through the console (entering inputs and reading outputs).
AI source code editor is defined by a structure consisting of cells that can contain various forms of text (images or equations) and source code currently in Python. The code in each cell can be executed independently, or the cells can contain pieces of code that follow each other. Each cell can be run separately and any number of times. When the code is started for the first time, a kernel is created on the server (via the REST API) in **Jupyter Kernel Gateway**. This kernel then communicates with the user via WebSocket. Listing of results and loading of inputs takes place in its front-end interface. The results are always listed under the cell whose code was run.

The evaluation module checks the correctness of the answers on three levels at the moment when the user decides to submit the task. Currently, three types of verification are available – validation of the solution from microlearning (compares against the database of correct answers), verification of the correctness of the program and verification of the results of the AI program (compares against the defined correct outputs for the prepared inputs).
All user attempts and responses are stored by the **Educational Data Collection module** tools, scored concerning gamification rules in the **Gamification module**, and logged as problematic in case of non-standard behaviour within the System module.
The **Content provider** is an essential part of the system. It ensures the creation of content based on individual types of educational objects and enables their organisation into lessons, chapters, courses, competitions, etc. In addition, questionnaires and discussions about the content are part of the module.
New modules of the system are currently in pilot operation, and content creation for courses in AI has been started.

CONCLUSION

The article aimed to propose an educational model supporting effective education in the field of AI.
In the first part, the forms and techniques used in teaching AI were presented, primarily within the subject defined as an introduction to AI. Most authors encountered the problems of the lack of research in AI education and the high demands on students' entry knowledge. Therefore, it is evident that the teaching of AI needs to be precisely planned within the study programme and define the study subject prerequisites that must be passed before starting the AI study.
In the second part, the forms of education that are accepted by nowadays students and, at the same time, can be used as part of AI teaching were presented. Tools providing immediate feedback, either based on the evaluation of the text response or the evaluation of the source code, were confirmed as suitable forms of content provision.
Finally, in the third part, the educational model was presented with the software technology enabling creating, solving and verifying the results of student solutions. This model copies the technologies used in AI in the labour market. At the same time, it enables the creation of educational content in a form accessible to a broad audience, thanks to the fact that it does not require any configuration or installation of software.
Newly developed modules needed to teach artificial intelligence courses will provide immediate feedback and support students' projects in artificial intelligence. The created educational content will consist of lessons for learning prerequisites of AI, classes for teaching basics of AI (Data Preparation, Knowledge Discovery, Artificial Intelligence, Machine Learning) and courses for teaching application domains of AI (Natural Language Processing, Educational Data Mining, Cybersecurity). In addition, educational data will be collected within several rounds of courses, which will be used for identifying students' behaviour and problem areas in the educational content and teaching process.

The steps leading to the creation of a mature graduate of a study covering the field of artificial intelligence with an IT orientation can be defined in two layers:

- Artificial intelligence demystification – on the one hand, artificial intelligence is not expected to solve all the world's problems. But on the other hand, many tabloid authors present it as the greatest danger for future generations. The content and activities should answer questions about what AI really is, its potential, and its risks for society.
- Knowledge and skills development to create solutions based on artificial intelligence mastery of AI technologies – the training courses should provide all the knowledge needed to understand the principles and design their solutions based on AI. They should also present specific solutions in knowledge discovery, cyber security, recommender systems, natural language processing and learning analytics.

ACKNOWLEDGEMENTS

The following grants funded this research: Science Grant Agency of the Ministry of Education of the Slovak Republic, grant number: 1/0490/22 "Design and Evaluation of Selected Learning Analytics Methods for Understanding and Improving the Learning Process and Virtual Learning Environment", European Commission under the ERASMUS+ Programme 2021, KA2, grant number: 2021-1-SK01-KA220-HED-000032095 "Future IT Professionals EDucation in Artificial Intelligence", the Ministry of Education of Slovakia, grant number 004UKF-2-1/2021 "Preparation and development of teaching courses in English with a focus on artificial intelligence in the form of blended-learning", and Ministry of Education of Slovakia, grant number: 2020/8148:34-A1101 "Support for the development of practical skills of UKF students in Nitra".

REFERENCES

Acemoglu, D. & Restrepo, P. (2020). The wrong kind of AI? Artificial intelligence and the future of labour demand. *Cambridge Journal of Regions, Economy and Society*, *13*(1). Retrieved from https://doi.org/10.1093/cjres/rsz022.

Capay, M., Skalka, J., & Drlik, M. (2017). Computer science learning activities based on experience. In *IEEE Global Engineering Education Conference, EDUCON*. Retrieved from https://doi.org/10.1109/EDUCON.2017.7943025.

Carter, J.W. & Youssef-Morgan, C. (2022). Psychological capital development effectiveness of face-to-face, online, and Micro-learning interventions. *Education and Information Technologies*. Retrieved from https://doi.org/10.1007/s10639-021-10824-5.

Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018). Artificial Intelligence trends in education: A narrative overview. In *Procedia Computer Science* (Vol. 136). Retrieved from https://doi.org/10.1016/j.procs.2018.08.233.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access*, *8*. Retrieved from https://doi.org/10.1109/ACCESS.2020.2988510.

D'Souza, M.J. & Rodrigues, P. (2015). Investigating the effectiveness of the flipped classroom in an introductory programming course. *New Educational Review*, *40*(2). Retrieved from https://doi.org/10.15804/tner.2015.40.2.11.

Eaton, E., Koenig, S., Schulz, C., Maurelli, F., Lee, J., Eckroth, J., … Williams, T. (2018). Blue sky ideas in artificial intelligence education from the EAAI 2017 new and future AI educator program. *AI Matters*, *3*(4). Retrieved from https://doi.org/10.1145/3175502.3175509.

Ertel, W. (2018). *Introduction to artificial intelligence*. Springer. ISBN 978-3-319-58486-7.

European Commission (2021). A European approach to Artificial intelligence. *A European Approach to Artificial Intelligence*.

Finlay, J. (2020). *An introduction to artificial intelligence*. CRC Press.

Flasiński, M. (2016). *Introduction to artificial intelligence*. Springer.

Gao, P., Li, J., & Liu, S. (2021). An Introduction to Key Technology in Artificial Intelligence and big Data Driven e-Learning and e-Education. *Mobile Networks and Applications*. Retrieved from https://doi.org/10.1007/s11036-021-01777-7.

Gasca-Hurtado, G.P. & Gomez-Alvarez, M.C. (2021). Mobile application based on gamification to promote microlearning in Software Engineering. In *Iberian Conference on Information Systems and Technologies, CISTI*. Retrieved from https://doi.org/10.23919/CISTI52073.2021.9476569.

Hartikainen, S., Rintala, H., Pylväs, L., & Nokelainen, P. (2019). The concept of active learning and the measurement of learning outcomes: A review of research in engineering higher education. *Education Sciences*, *9*(4). Retrieved from https://doi.org/10.3390/educsci9040276.

Heintz, F. & Roos, T. (2021). Elements of AI – Teaching the Basics of AI to Everyone in Sweden. In *EDULEARN21 Proceedings* (Vol. 1). Retrieved from https://doi.org/10.21125/edulearn.2021.0559.

Hintjens, P. (2013). *ZeroMQ: messaging for many applications*. O'Reilly Media, Inc.

Jackson, P.C. (2019). *Introduction to artificial intelligence*. Courier Dover Publications.

Johnson, J.W. (2020). Benefits and Pitfalls of Jupyter Notebooks in the Classroom. In *SIGITE 2020 – Proceedings of the 21st Annual Conference on Information Technology Education*. Retrieved from https://doi.org/10.1145/3368308.3415397.

Langley, P. (2019). An integrative framework for artificial intelligence education. In *33rd AAAI Conference on Artificial Intelligence, AAAI 2019, 31st Innovative Applications of Artificial Intelligence Conference, IAAI 2019 and the 9th AAAI Symposium on Educational Advances in Artificial Intelligence, EAAI 2019*. Retrieved from https://doi.org/10.1609/aaai.v33i01.33019670.

Latwal, G.S., Sharma, S.K., Mahajan, P., & Kommers, P. (2020). *Role of ICT in Higher Education: Trends, Problems, and Prospects*. CRC Press.

Lindqwister, A.L., Hassanpour, S., Lewis, P.J., & Sin, J.M. (2021). AI-RADS: An Artificial Intelligence Curriculum for Residents. *Academic Radiology*, *28*(12). Retrieved from https://doi.org/10.1016/j.acra.2020.09.017.

Markant, D.B., Ruggeri, A., Gureckis, T.M., & Xu, F. (2016). Enhanced Memory as a Common Effect of Active Learning. *Mind, Brain, and Education*. Retrieved from https://doi.org/10.1111/mbe.12117.

Özyurt, H. & Özyurt, Ö. (2018). Analysing the effects of adapted flipped classroom approach on computer programming success, attitude toward programming, and programming self-efficacy. *Computer Applications in Engineering Education*, *26*(6). Retrieved from https://doi.org/10.1002/cae.21973.

Peethambaran, M.K.P., Renumol, V.G., & Murthy, S. (2018). Flipped Classroom Strategy to Help Underachievers in Java Programming. In *Proceedings – 2018 6th International Conference on Learning and Teaching in Computing and Engineering, LaTiCE 2018*. Retrieved from https://doi.org/10.1109/LaTICE.2018.000-7.

Pérez, F. & Granger, B.E. (2015). Project Jupyter : Computational Narratives as the Engine of Collaborative Data Science. *UC Berkeley* (April).

Project Jupyter (2022). Standalone Jupyter server enhancement. Retrieved 30 August 2022, from https://jupyter.org/enhancement-proposals/28-jupyter-server/jupyter-server.html.

Project Jupyter Team (2022). Jupyter Kernel Gateway. Retrieved 30 August 2020, from https://jupyter-kernel-gateway.readthedocs.io/en/latest/.

Rico-Bautista, D., Medina-Cardenas, Y., Coronel-Rojas, L.A., Cuesta-Quintero, F., Maestre-Gongora, G., & Guerrero, C.D. (2021). Smart University: Key Factors for an Artificial Intelligence Adoption Model. In *Advances in Intelligent Systems and Computing* (Vol. 1307 AISC). Retrieved from https://doi.org/10.1007/978-981-33-4565-2_10.

Rodríguez-del-Pino, J.C., Rubio-Royo, E., & Hernández-Figueroa, Z. (2012). A Virtual Programming Lab for Moodle with automatic assessment and anti-plagiarism features. *Conference on E-Learning, e-Business, Entreprise Information Systems, & e-Government*.

Russell, S. & Norvig, P. (2021). Artificial Intelligence A Modern Approach (4th Edition). *Pearson Series*.

Skalka, J. & Drlik, M. (2018a). Priscilla – Proposal of System Architecture for Programming Learning and Teaching Environment. *IEEE International Conference on Application of Information and Communication Technologies*. Retrieved from https://publons.com/publon/27387754/.

Skalka, J. & Drlik, M. (2020). Automated assessment and microlearning units as predictors of at-risk students and students' outcomes in the introductory programming courses. *Applied Sciences (Switzerland)*, *10*(13). Retrieved from https://doi.org/10.3390/app10134566.

Skalka, J. & Drlík, M. (2018b). *Conceptual framework of microlearning-based training mobile application for improving programming skills. Advances in Intelligent Systems and Computing* (Vol. 725). Retrieved from https://doi.org/10.1007/978-3-319-75175-7_22.

Skalka, J., Drlik, M., Benko, L., Kapusta, J., Del Pino, J.C.R., Smyrnova-Trybulska, E., … Turcinek, P. (2021). Conceptual framework for programming skills development based on microlearning and automated source code evaluation in virtual learning environment. *Sustainability (Switzerland)*, *13*(6). Retrieved from https://doi.org/10.3390/su13063293.

Smyrnova-Trybulska, E., Noskova, T., Pavlova, T., Yakovleva, O., & Morze, N. (2016). New educational strategies in contemporary digital environment. *International Journal of Continuing Engineering Education and Life-Long Learning*, *26*(1). Retrieved from https://doi.org/10.1504/IJCEELL.2016.075036.

Xu, J.J. & Babaian, T. (2021). Artificial intelligence in business curriculum: The pedagogy and learning outcomes. *International Journal of Management Education*, *19*(3). Retrieved from https://doi.org/10.1016/j.ijme.2021.100550.

Zhang, C. & Lu, Y. (2021). Study on artificial intelligence: The state of the art and future prospects. *Journal of Industrial Information Integration*, *23*. Retrieved from https://doi.org/10.1016/j.jii.2021.100224.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 29–47
https://doi.org/10.34916/el.2022.14.03

CURRENT CHALLENGES TO THE DIGITALIZATION OF HIGHER EDUCATION IN UKRAINE

Nataliia Sorokina[1], **Oksana Shelomovska**[2], **Liudmila Sorokina**[3], **& Maryna Romaniukha**[4]
[1] Dnipro University of Technology, 49005, 19 Dmytra Yavornytskoho Ave, Dnipro
[2,3,4] DSTU, Kamianske, Dniprobudivska st.2,
[1] sorokina.dridu@gmail.com, ORCID 0000-0002-0804-330X
[2] o_nix@ukr.net, ORCID 0000-0003-3409-9435
[3] sludmila1906@gmail.com, ORCID 0000-0003-4875-2896
[4] romanuks@ukr.net, ORCID 0000-0001-7623-2690

Abstract: *The article examines the peculiarities of digitalization of the educational process of higher education institutions of Ukraine and reveals the impact of the COVID-19 pandemic. It was found that modern world challenges have become a turning point for rapid innovations in the field of education. In particular, the COVID-19 pandemic created a unique opportunity for the unprepared introduction of digital technologies into the educational process, and with the beginning of the war in Ukraine, the digital format of education became almost the only opportunity to obtain higher education. It is noted that in the conditions of digitization of the educational process, distance education has become more and more widespread, the specialty of which is the provision of educational services through the use of modern information and communication technologies in education. The authors emphasize the advantages of distance learning in higher education institutions of Ukraine, the main ones being: temporal, geographical, psychological, ergonomic ones and others. It is highlighted that the problematic aspects in the process of organizing distance learning are related to: the need for high internal motivation of the student; the problem of quality control of education and academic dishonesty; technical flaws; the problem of student identification; lack of live dialogue with the teacher; lack of digital competences, etc. Based on the analysis of secondary data, the dynamics of processes related to the use of digital distance learning technologies in the conditions of nationwide quarantine are outlined; also analysed are the factors that negatively affect the quality of implementation of digital learning technologies in higher education institutions. It was emphasized that owing to digitalization, the educational process becomes more personalized, mobile, accessible and flexible. The authors analysed the opinions of students, professors and educational*

management in order to see the chronological development of e-learning all over Ukraine and in a particular city of Ukraine in the period 2020–2022. The general opinion in the dynamics is that the quality of e-learning is improving, however the local trends are that students need to improve self-management skills, they demand more practically-oriented tasks in digital mode which can potentially develop better digital competence to navigate through elaborate e-learning environments and feel more confident in learning as it is.

Keywords: higher education, digitalization, educational process, distance learning, digital technologies, higher education institutions, students, professors.

INTRODUCTION

In the last few years, the whole world has found itself in the midst of global challenges that have fundamentally changed it. Higher education was not an exception. First, the COVID-19 pandemic, then the full-scale war in Ukraine caused the objective necessity of higher education institutions to switch to distance education. Before the start of the pandemic, distance education was used as a supplement to the main mode of education, whereas since 2020, educators were forced to switch to distance format. In such conditions, there is an extensive growth of educational resources and platforms that rely on the use of digital technologies in their activities in Ukraine and globally. It should be noted that the design of higher education has significantly changed over the past few decades thanks to new information technologies, interactive forms of communication and communication, which introduced major improvements into the way knowledge is reproduced, both from the point of view of the organization of the educational process, and from the point of view of mastering and perception of information. Digitization of education has become one of the priorities of the Ministry of Education and Science of Ukraine in recent years. Owing to a carefully organized digital environment, higher education has become more accessible and comfortable, which is extremely important in the conditions of minimal costs – time, financial, and human resources. And for today's youth, it is also a familiar environment which has all the conditions for its development.

1. THE RESEARCH PROBLEM AND METHODOLOGY

Ukrainian scientific community is intensely discussing the digitalization of the educational process, with the various aspects of it getting more and more attention. However positive the very fact of this discussion is, we would like to stress that a considerable number of scientific works are rather one-sided and somewhat fragmentary, since they are devoted to the introduction of certain information and communication technologies into the educational process either exclusively from the technical side, or from the social one, being a certain reflection of teachers on their own experience of working with the latest teaching aids.

The research into the issue of digitalization of education produced lately a number of the scientific investigations devoted to the creation of digital universities and the introduction of digital campuses.

In particular, there was carried out a comprehensive comparative analysis of the best practices implemented in the European educational space within the "digital campus" project (Buynytska et al., 2020). It is worth studying an elaborate design of a unified information environment of the university providing the information requests of students, teachers, and employees as fully as possible through the digital transformation of educational as well as financial and economic processes at the university (Guzhva, 2019). The advantages and disadvantages of digitalization of higher education in the context of building a digital university are discussed in detail by a research team (Nagorny et al., 2022).

An important contribution to the development of the topic of digitalization of higher education was made by Morze and Smyrnova-Trybulska, who in their numerous publications bring forward the issue of self-assessment of the level of digitalization of an educational institution under the conditions of the transformation of secondary education (Morze, Kucherovska, & Smyrnova-Trybulska, 2020), ways of developing a smart university (Morze, Nepreyenko, & Smyrnova-Trybulska, 2020), the advantages of creating and distributing electronic educational courses (Morze et al., 2021). Another study on the evolution of distance learning claims that at the second stage of the digitalization of the educational process, after adaptation to its features, it is easier to feel the potential of positive opportunities for participants (Shchetinina et al., 2021).

Introduction of new technologies doesn't always go smoothly. Thus, for its effective implementation e-learning needs to be seen as a promise of new opportunities, and not as an environment to reproduce traditional teaching (Ananga, 2020). Researchers emphasize that COVID-19 demands to introduce new ways of teaching (Domínguez-Lloria et al., 2021).

Bazelyuk stresses that for higher education in modern conditions it is crucial to evolve to non-linear educational trajectories promoting openness; expand beyond the current array of qualifications; support digitization and educational reform; however, widening access to higher education should go hand in hand with the improvement of its quality (Bazelyuk, 2021). Prokopenko and Dotsenko outline the main factors determining the effectiveness of the introduction of digital technologies into the system of higher education, namely, a sufficient level of digital competences among those seeking education, and the functioning of higher education institutions as a space for designing and piloting social reforms aimed at ensuring opportunities for the society to use the advantages of digitalization (Prokopenko & Dotsenko, 2021).

In modern Ukrainian conditions, it is relevant to consider the introduction of distance learning not as an addition to offline learning, but as another form of education. Thus, researchers stress the main advantages of distance learning and outline the difficulties of organizing distance education for higher education institutions, enterprises and organizations (Galetsky & Galecka, 2018); design the concept of distance education, based on the principles of humanism, the priority of the pedagogical approach in the design of the educational process, the pedagogical expediency of the use of information technologies, the security of information that circulates in the distance education system, visibility, systematicity and consistency of distance education, research, accessibility, communicativeness of education, etc. (Grebennikova, 2019). Meanwhile,

a number of scholars emphasize the fact that in Ukraine there are still no clear technological tools for authenticating students, that is, they perform a number of tests and tasks for self-control remotely, but they have to take the final exams "face-to-face" (Danylchuk & Melnyk, 2020). In this context, Prysiazhniuk concludes that along with the shift to distance learning a motivated student saw the advantages of distance learning, instead, an unscrupulous diploma seeker took advantage of difficulties in his or her own way, and usually the difficulties were imaginary (Prysiazhniuk, 2021). The authors of this study previously researched various aspects of the optimization of the educational process in higher education based on the implementation and active use of digital technologies, in particular network communication as a means of teacher-student interaction (Shelomovska et al., 2017); online resources (Shelomovska et al., 2018) and mass media in e-learning conditions (Shelomovska et al., 2019); cloud technologies in the training of students of socio-behavioral specialties and public servants in universities in the conditions of a global pandemic (Shelomovska et al., 2020). However, the academic community of Ukraine is only starting to discuss the ongoing evolution of e-learning and distance learning that is currently observed. Besides, the developments and trends typical of a bigger university might be somewhat different for a smaller university, as well as for those functioning in smaller cities.

Thus, the aim of this review is to demonstrate some considerations as to the developments of digital education in Ukraine in the period 2020–2022 (first quarter), spurred by the global pandemic and currently, war hostilities.

To study the current evolution of online and distance learning we are relying on analytical literature review as well as discussing the main trends of e-learning in Ukraine with specific local trends in Kamianske, assessed by students and professors from all over Ukraine and by the students from Dniprovsky State Technical University.

The theoretical background of the study is shaped by basic principles and provisions in the area of higher education of Ukraine. The review demanded historical-logical and systematic approaches, general and special methods, in particular: monographic and abstract-logical methods; methods of observation and generalization as well as elements of quantitative analysis.

To discuss the opinions of students and staff we involved three anonymous sociological surveys:

- the State Education Quality Service of Ukraine prepared an informational and analytical report on the state of the use of distance learning technologies in higher education institutions of Ukraine (2020);
- Analytical report on trends in the organization of the educational process in institutions of professional pre-higher and higher education under quarantine conditions in the 2020/2021 academic year;
- sociological research conducted among the students of Kamianske (January, 2022).

2. ACADEMIC AND SOCIO-POLITICAL CONTEXT OF E-LEARNING IN UKRAINE

2.1. Distance learning in academic discourse

It is noteworthy that during the 20th century the process of modernization of higher education was mainly understood as updating its content. But the 21st century it became an exception. As a result of the quarantine measures caused by the spread of the COVID-19 pandemic, there grew a need to introduce fundamental improvements into the forms and methods of learning, methods of interpersonal communication, the system of organizing the educational process and the creation of an effective digital educational space enhanced by the digitization of education. As it was stressed by the Minister of Education and Science of Ukraine Serhiy Shkarlet, "Digitalization of education is one of the priorities of the Ministry of Education and Culture for the development of distance learning opportunities. Therefore, among the key tasks for today is the approval of the Concept of digital transformation of education and science, providing educational institutions with digital infrastructure and improving digital competence of academic staff" (Digitalization of education, 2021).

The main tasks of digitalization of education comprise: improving the staff's digital skills and competences, developing digital infrastructure in higher education institutions; involving digital resources, making a gradual switch from paper to digital media in education and management; developing a system of universal student identification, automated management of his portfolio; elaborating distance learning. Therefore, the digitalization of education will contribute to the fact that classes, reporting, and record books will be transferred to the online format; students will be able to attend classes from their homes; electronic resources will be used instead of traditional textbooks more often; educational institutions will be equipped with modern devices: computers and other gadgets, interactive whiteboards, projectors. Over time, the educational process will undergo significant changes due to the process of digitalization, since the introduction of digital educational technologies involves a complete reformatting of classes in higher education institutions.

In the conditions of modern challenges, the digitalization of the educational process is connected, first of all, with the elaboration of distance learning. A forced rapid transition to this form of education motivated the academic management to take a new look at their professional activities, to realistically assess the level of digital competence of academic staff, to assess the level of electronic, information and digital educational resources involved in universities. Therefore, digitalization of the educational process is caused, first of all, by the need for the widespread implementation of innovative technologies, the emergence of new requirements for specialists, in particular for the formation of key competences, and the new digital generation.

S. Brammer and T. Clark in their article on education and its management in the conditions of the pandemic note that COVID-19 left a considerable mark on the design of the university's academic year, and students suffered the most, since it was their interests that became the focus of business schools when developing and implementing relevant measures. As the pandemic unfolded in January and February 2020, major

adjustments were introduced to the clarity and timeliness of feedback to stakeholders, especially students and faculty" (Brammer & Clark, 2020). All the teaching and research staff had to look for optimal solutions to design and implement the educational process in a remote format. Therefore, in the conditions of digitalization of the educational process, distance learning has become increasingly widespread. However, the feedback from students is to be studied in detail. The Akcil and Bastas pay particular attention to the students' attitudes to e-learning during the COVID-19 pandemic (Akcil & Bastas, 2021).Gopal, Singh, & Aggarwal revealed four factors that affected students' satisfaction with study during the COVID-19 pandemic: quality of professor, course design, prompt feedback, and student's expectations. The results confirmed that students' learning satisfaction improved their overall performance (Gopal, Singh, & Aggarwal, 2021).

In modern scientific discourse, the phenomenon of distance learning is described by different terms. Commonly used terms include *e-learning* or *online learning*; *virtual learning*, which usually refers to courses that take place outside the classroom; *part-time education*, a long-established method where one-to-one instruction is delivered by mail. The analysis of the scientific literature shows that currently there is no unified approach to defining the essence of the concept "distance learning". In particular, B. Holmberg and O. Simpson define distance learning as a new specific form of education that involves certain approaches, methods, didactic means of interaction between the teacher and students (Holmberg, 2005; Simpson, 2002). S. Nipper believes that distance learning is an educational system based on computer telecommunications with the use of modern pedagogical and information technologies, such as e-mail, television and the Internet, where students obtain educational services without visiting an educational institution (Nipper, 1989).

In the publications of the United States Distance Learning Association (USDLA), "Distance Learning" is defined as a type of learning that is used to determine the physical distance of teachers and people receiving education during the educational process, which in its turn, increases students' responsibility for their learning, which takes place at a distance. In particular, distance learning includes distance teaching (activity of a teacher in the educational process of a higher educational institution) and distance learning (students' cognitive activity). The association identified a number of factors that characterize distance education in the conditions of global digitization:

- minimum teacher-to-student interaction in the classroom;
- technological means to improve the assimilation of educational material;
- self-control as a priority area of knowledge assessment;
- interactive communication between students, teachers and academic administration (The theory and practice…, 2011).

The difference between the terms *distance learning* and *distance education* is that the provision of higher education is controlled by higher education institutions and professors, while the student is responsible for learning, i.e. distance learning is the result of distance education. The concept *learning* in the works of modern scientists is defined as a purposeful, organized process of pedagogical interaction between a professor and a university student, while the term "education" contains elements

of a socially significant component, a systematic approach to learning and obtaining learning results. Another noteworthy aspect of distance learning is the application of new telecommunication technologies that do not change the organization of higher education and it remains traditional (Grebennikova, 2019). Therefore, many scientists come to the conclusion that distance learning is a form of learning using computer and telecommunication technologies that provide interactive collaboration between teachers and students at various stages of learning and independent work with digital resources. This is an ideal solution for those who prefer modern information technologies in education and value their time.

2.2. Common advantages and disadvantages of distance learning

The main essential advantages of distance learning are:

- time benefits. A distance learning student saves the traveling time to the university. They can independently decide when and how much time during the semester they devote to studying the material and can make an individual study schedule;
- geographical advantages. Students can study from their home or office, located anywhere on the planet. The student does not depend on the location of the educational institution: in any place, at any time, they can be involved in the educational process. All you need to start learning is a computer with internet access. The absence of the need to visit a higher educational institution every day is an undoubted advantage for people with disabilities, parents with small children, for those who live in hard-to-reach areas, in modern conditions this is relevant for students who are in the occupied territories or have acquired the status of internally displaced persons;
- psychological benefits. Passing exams and studying in a calm environment. Interim assessment of students in distance courses takes place in the form of online tests, so students have less reason to worry. The possibility of subjective assessment is excluded: the system that checks the correctness of the answers to the test questions will not be affected by the student's success in other subjects, their social status and other factors;
- ergonomic advantages. Convenience, where each student can choose their own rhythm and mode of acquiring knowledge in a comfortable environment, which will favorably affect the learning process itself. It is not necessary to study at the same pace as other students. The applicant can always return to studying more complex issues, repeatedly watch video lectures, re-read correspondence with the professor, and can skip topics that are already known. The main thing is to successfully pass interim and final assessment;
- financial advantages (reduction of travel expenses, rent of premises, minimum bureaucratic work;
- study incorporated into professional activity. It is not mandatory to take a leave at the main place of work, i.e. to travel. It is also possible to study remotely at several courses or in several educational institutions simultaneously;
- free access to various information sources 24/7. Access to all necessary literature is available to the student after registration in the distance learning

system. They can receive study materials by e-mail. The problem of lack or absence of textbooks, teaching aids or methodical materials disappears;

- mobility. Communication with teachers is carried out in various ways: both online and offline. Consulting with a teacher via e-mail is sometimes more efficient and faster than scheduling a personal meeting for face-to-face or part-time studies;
- digitalization. Distance education contributes to the gradual digitalization of the educational space, because information is exchanged through centralized portals in online format, and completed assignments or lecture recordings are always available on university servers. Digitization makes it easier to track plagiarism (especially text), which creates an open and honest environment for knowledge exchange and potentially reduces corruption and makes education more environmentally-friendly (instead of piles of papers and inconvenient sources, almost all participants in the educational process use electronic media) (Danylchuk & Melnyk, 2020; Lopa, 2019).

Digitalization of the educational process, in particular distance learning, is distinguished by high interactivity and a system for managing the cognitive activity of students of higher education, provides for differentiation and individualization of training in accordance with the needs and individual student's profile. When using distance learning methods, an organic combination is observed of the teacher's competence, information technologies with the student's wishes and purposefulness. An important task of distance learning is the development of intellectual and creative abilities of an individual with the help of free and open use of all educational resources and programs, including those available on the Internet.

The introduction of distance learning is based on the fact that the training of a specialist in higher education is aimed at the development of professional competence and the formation of their own personality, which determines the creation of a favourable psychological climate, the development of the student's creative individuality in the educational process of higher education (Vasilyeva, 2022).

In modern institutions of higher education, the digital format of education is based on a client-oriented approach, which is an important advantage for those who study. When receiving education remotely, students of higher education do not face the problem of lack of textbooks, study guides, methodological recommendations, since in most educational institutions that use distance learning, the educational process is carried out by providing each student with a separate user area in a secure part of the educational portal.

However, along with many advantages, the experience of recent digitalization of the educational process in Ukraine has triggered a number of challenges. It comes as no surprise that some university students consider online education an extremely stressful activity, to an extent that it critically affects their overall health and social life.

Besides, as it was rightly noted by Prysiazhniuk, the transition to distance education not only aggravated, so to speak, "old diseases", but also gave rise to new ones. Some students suddenly "disappeared" from their computers, not to mention the microphones and cameras on them. This made feedback communication, which is so important in the educational process, difficult. There is also the sad practice of

communicating with a virtual audience without visual contact. Currently, we do not have statistics that would testify about the different modes of student participation in classes. Sometimes, when you address someone present during a seminar (not to mention a lecture), the person is, sadly, absent. Or the meeting has long ended, while the participant is still online (Prysiazhniuk, 2021).

Thus, the main disadvantages of the digitalization of the educational process when organizing distance learning are related to:

- the challenge of learning quality control and academic dishonesty (it is impossible to determine the student's knowledge level due to remote knowledge control, which can be discredited by dishonest use of materials or hints);
- lack of high internal motivation of the student, because the opportunity to study at a convenient time can turn into constant procrastination, rather than systematic learning (the result of distance learning depends only on the self-discipline of the student of higher education, which is not always at the proper level);
- imperfection of technical facilities;
- the problem of student identification;
- lack of a live dialogue with the teacher (the lesson loses its emotional color, which leads to a decrease in students' interest in the material. The organization of the upbringing component of the educational process presents a special problem. It is really demanding to have feedback in terms of upbringing without proper communication with the professor, and no advanced technical means can help here);
- loss of interest in learning;
- lack of digital competences;
- difficulty in organizing practical classes;
- lack of a competitive spirit (with face-to-face training, due to time constraints, students try to show the maximum of their knowledge, prepare for classes more responsibly).

The main feature of distance learning is its psychological aspect, primarily for the student of higher education, because the effectiveness of the study, which is mainly of independent character, depends by 95% on the student, their will, attention, perseverance and self-control. Distance education is more appropriate as an additional type of education, when there is a certain knowledge base obtained by the student in full-time form. With this design the student comes with high motivation – to improve the level of qualifications to obtain, for instance, a higher-paying job.

2.3. Current challenges and threats to efficiency of e-learning in Ukraine

It should be noted that the day after February 24, 2022, the start of the full-scale invasion of Ukraine by Russian troops, the Ministry of Education and Science of Ukraine (MESU) recommended stopping the educational process in educational institutions of all levels. Consequently, everyone was on a two-week break. During this time, part of the territory of Ukraine was temporarily occupied, a number of cities and villages (Mariupol, Chernihiv, Sumy, Kharkiv and others) became the

scene of active hostilities. From March 14, the educational process began to resume in areas where it was relatively safe. Decisions about the possibility of training and its format were made by regional administrations and educational institutions. Most institutions of higher education have resumed distance learning, because it was this type of training that made it possible to organize the educational process in wartime conditions. In addition, the MESU recommended establishing special study conditions (individual study plan, dean's leaves) for students who are in the ranks of the Armed Forces of Ukraine or territorial defense.

As of March 31, 2022, according to the Ministry of Education and Culture, at least 18 higher education institutions were damaged and one was destroyed. Some universities were hit harder than others, forcing them to evacuate to safer cities. Ukraine already has the experience of evacuating universities. Thus, after 2014, part of the universities of Donetsk, Luhansk regions and Crimea were moved to safer cities within these regions or to other regions. This process is repeating itself. In particular, the State University of Biotechnology moved from Kharkiv to Transcarpathia. Part of the property of educational institutions in Uzhhorod and Mukachevo was transferred there. Azov State Technical University moved from Mariupol to Dnipro, where it was located on the basis of the National Technical University Dnipro Polytechnic. The Volodymyr Dahl Eastern Ukrainian National University was also evacuated from Severodonetsk to Kamianets-Podilskyi and the Luhansk Medical University from Rubizhne to Rivne (both were previously evacuated from Luhansk). Today, the number of universities requiring evacuation has already increased (Nazarenko, Kohut, & Zherobkina, 2022). Evidently, the blow inflicted on Ukraine as an independent state has brought a lot of painful disruption into the educational process and is exposing the weakest links in the system.

3. RESEARCH RESULTS: DISCUSSING STUDENTS' AND TEACHERS' OPINIONS

Evidently, with the beginning of war, the digital format of education became almost the only possibility of obtaining higher education. Universities are trying to adapt to these conditions, taking into account their experience during the pandemic. It is undeniable that the Ukrainian market of educational services has undergone significant changes since the beginning of the COVID-19 pandemic. There are several official analytical documents that summarize problematic issues of the quality of educational services during the quarantine period and determine the dynamics of processes related to the use of digital distance learning technologies in the conditions of nationwide quarantine. In our opinion, it is advisable to analyse them in order to identify and take into account problematic points in the digitalization of the educational process in the conditions of modern challenges, namely in the period of a full-scale war.

In 2020 the State Education Quality Service of Ukraine prepared an informational and analytical report discussing factors that negatively affect the quality of digital learning technologies and lead, in particular, to a low level of student engagement in learning. The analysis showed that the interviewed university students most often face the problem of the lack of uninterrupted access to the Internet (38%), every

fourth notes that there is no necessary equipment at home, 15% of the students lack the necessary skills to work with technology, and every fourth university student surveyed stresses the lack of self-organization. These reasons can complicate the timely participation in distance learning. In addition, university students seriously consider other factors that complicate distance learning: every third respondent admits the possibility of biased assessment, the consequence of which, obviously, is the irregularity of communication with the teacher, which was confirmed by 25% of the surveyed students (Figure 1) (Informational and analytical report, 2020).

Interestingly, there was conducted another anonymous online survey of applicants for higher education, pedagogical and scientific teaching staff, as well as representatives of academic administration of universities (hereinafter – HEIs) aiming to assess the level of satisfaction of the participants of the educational process with the organization and quality of distance learning, conducted in the 2020/2021 academic year by the State Service for the Quality of Education of Ukraine. 9,184 respondents from all regions of Ukraine took part in this survey (Informational and analytical report, 2020).

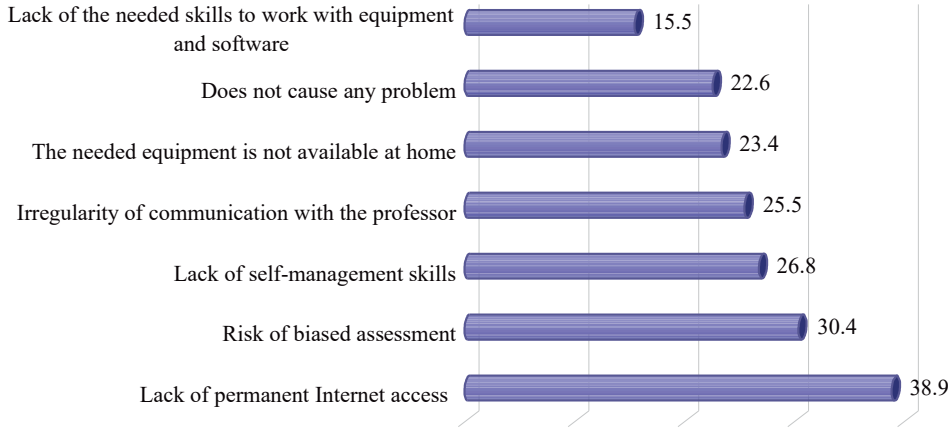


Figure 1. Problems faced by students during distance learning, in %

Source: Informational and analytical report on the results of a survey on the state of use of distance learning technologies in higher education institutions of Ukraine, 2020.

The analytical note emphasized that during the spring period of the national quarantine in 2020, higher education institutions were operating under a complete lockdown with the need to quickly change the model of providing educational services, while in the 2020/2021 academic year they were given the opportunity to provide a mixed mode of study (both face-to-face and remotely), taking into account the epidemic situation in the respective region. In accordance with this, the respondents recognized that the quality of the provision of educational services by higher education institutions in the 2020/2021 academic year compared to the previous period has improved. This was stressed by 64.9% of the surveyed respondents, while 27.6% believe that the quality of education has not changed, and 7.5% believe it has worsened. Interestingly, almost 90% of heads of higher education institutions believe that the quality of educational services increased significantly in 2021 compared to 2020. And a little

more than 60% of students and teachers agreed with this opinion (Analytical Report on Trends, 2021).

Switching from the all-Ukrainian trends to more local ones, it is worth discussing the data of the latest sociological research conducted among the student youth of Kamianske in January 2022 through an online survey (n = 245 respondents). It was found that the biggest problems for students are challenges of self-organization and compliance with the regime – 32.4% and 31.1%, respectively. Other 12.6% of respondents have problems with the technology necessary for comfortable distance learning, and 23.2% find it difficult to answer this question (Table 1). The data about local youth as of 2022 demonstrate that university students of Kamianske lack the crucial skills of self-organization and time-management which are not at the top of the agenda among Ukrainian students on average.

At the same time, almost one out of three students (35.3%) believes that the quality of education using the distance learning system has rather deteriorated in the conditions of the COVID-19 pandemic. However, only 3% less respondents (32.4%) assessed the transition to distance education as a positive fact and noted that it rather improved its quality than worsened. 13.7% spoke of a significant improvement in the quality of education with the use of digital technologies, and 7.5% spoke of deterioration.

Table 1. Problems, faced by the students in distance learning, in %

Which problems do you face in distance learning during lockdown?	in %
Self-organization	32.4
Following the timetable	31.1
Lack of the needed equipment	12.6
Hard to say	22.3
Other challenges	
– during distance learning professors and students have much higher needs than during traditional classes	0.8
– lack of leisure time	0.8

Source: Own research.

This state of affairs, in our opinion, is caused by the fact that not all modern Ukrainian higher education was ready to use distance education as the main form of education, which was manifested in a significant number of shortcomings. In confirmation thereof, we note that almost 2/3 of respondents are ready to use distance learning only as an addition to traditional learning – 63.9%.

And in this respect, in our opinion, it is necessary to focus attention, first of all, on the psychological unpreparedness of both students and teachers to function in the conditions of distance education in the perfect version of its design for a long time. Indeed, at the beginning, most universities and the students themselves were not ready for such an immediate transition from traditional to distance learning, as they needed time to adapt the standard curriculum to the realities of distance learning. Some were able to adapt and found significant prospects in it, while others totally

neglected the fact that distance learning is also learning, only enhanced by digital technologies, and not the opportunity to do private things during class time. Today, in the conditions of martial law, everyone appreciated the advantages of distance education and adapted to such training.

According to the authors' research, it was established that for the student youth of Kamianske, the main advantage of distance learning is the ability to combine work and study. This was confirmed by 43.1% of respondents (Table 2).

The next meaningful advantage for the respondents is the flexibility of the educational process – 41.2% of the respondents stressed this, the same number of people marked as important the option "Learning in a comfortable environment". "A chance to gain practical skills" as well as "Swift update of the content of learning materials" both gained 31.4%. For 22.5%, the main advantage of distance learning is the technology-intensiveness of the learning process – people are attracted by the modernity of this learning method. 1.8% could not answer this question.

Table 2. Advantages of distance learning, own research, in %

Which advantage of distance learning are of specific value for you personally?	in %
A chance to combine work and studies	43.1
Flexibility of the educational process	41.2
Learning in comfortable and pleasing environment	41.2
A chance to gain practical skills	31.4
Swift update of the content of learning materials	31.4
Highly technology-intensive learning process	22.5
Hard to say	10.8

Source: Own research.

Overall in Ukraine as of 2020, the analysis of the use of distance learning digital technologies showed that every seventh respondent (15% of students' responses) believes that distance learning is not effective. The rest of the respondents generally positively consider the possibility of effective training using the specified technologies. Every second university student considers three digital tools to be the most efficient for organizing the educational process: messengers (Viber, Messenger, Telegram and others) – 51.5% of respondents, virtual educational environments (Moodle and others) – 50.1%, video conferencing tools (ZOOM, Skype, Meet and others) – 46.8% responses. The opinion of scientific and pedagogical workers regarding the distribution of distance learning tools in terms of effectiveness generally correlates with the vision of the student audience. However, scientific and pedagogical staff generally see virtual educational environments as a priority in terms of efficiency (70.1%), while the efficiency of messengers was confirmed by only 41% of responses (Figure 2). (Informational and analytical report, 2020).

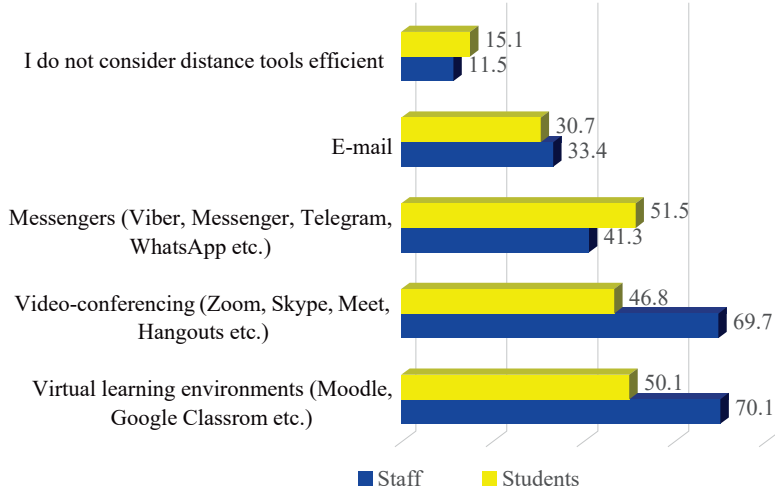


Figure 2. Digital technologies used by participants of the educational process in distance format, in %

Source: Informational and analytical report on the results of a survey on the state of use of distance learning technologies in higher education institutions of Ukraine, 2020.

According to a smaller sociological survey conducted in Kamianske in January 2022, electronic educational materials are considered the most convenient among the forms and methods of distance learning – 45.6% of respondents. Next in popularity come various messengers – 36.9%, webcams and online communication – 34%, forums and electronic libraries – 28.2% each, e-mail – 26.2%. While almost every fifth respondent could not decide on an answer (20.4), which actually indicates their lack of interest in distance learning (Table 3).

Table 3. The most user-friendly forms and methods of distance learning, according to modern students, in %

Which forms and methods of distance learning are the most user-friendly?	in %
Electronic learning materials on university website or repository	45.6
Messengers	36.9
Online-communication with web-cameras	34
Forums	28.2
Electronic libraries	28.2
E-mail	26.2
Hard to say	20.4

Source: Own research.

However, despite the fact that we have already lived to the end of the third academic year in the conditions of a pandemic and currently also a war, Ukrainian higher education still shows signs of unpreparedness for the full-scale digitalization of the edu-

cational process: lack of material and technical equipment, lack of practical digital competences, as well as lack of appropriate methodological recommendations on the organization of the educational process (Nazarenko & Polishchuk, 2021). In addition, there is a lack of data to critically assess the state of (un)readiness of the educational system for digitalization. During this time, international expert organizations have developed quite a number of recommendations for the organization of distance learning, preserving the quality of education and the health of students and educators. For example, the European Commission approved the Digital Education Action Plan for 2021–2027. It emphasizes two important areas of work:

- promoting the development of effective digital education system (infrastructure, communication, technical means, development of teaching competences, high-quality educational content);
- improving digital skills (basic digital skills from an early age, combating misinformation, ensuring equal access of women and girls to digital education, etc.) (Digital Education Action Plan).

Ukraine is in a painful need of such an action plan, although various aspects of distance education in Ukraine are regulated by normative documents, namely: National Doctrine of Education Development, laws of Ukraine On Education, On Higher Education, On the National Informatization Programme, the Order of the Ministry of Education and Science of Ukraine On Approval of the Regulation on Distance Learning. The division of efforts offered within the framework of the Digital Education Action Plan is a logical and rational plan, however it is crucial to take into account the challenges of evolution of the e-learning in Ukraine in period 2020–2022.

CONCLUSION

The COVID-19 pandemic has created a unique opportunity for the spontaneous introduction of digital technologies into the educational process. In fact, in many countries of the world, an unexpected large-scale experiment on digitalization of the educational process was launched. Therefore, the temporary reaction of higher education institutions to the crisis is becoming a long-term digital transformation of higher education. Undoubtedly, the use of digital technologies made it possible to quickly design the educational process in distance format. At the same time, higher education institutions of Ukraine, in conditions of the digitalization of the educational process, faced a number of challenges, namely: the specific combining of elements of information and communication technologies, present in every educational institution, with technical means of education to generate effective network tools; defining the role, tasks and types of involvement for research and academic staff in the midst of active elaboration and use of digital technologies into the educational process; replacing the traditional classroom educational environment with a virtual network; searching for appropriate methods and tools of distance learning; establishing effective communication for all participants of the educational process in the network environment.

Assessing the developments of e-learning in Ukraine in the period 2020–2022 (first quarter), spurred by the global pandemic and currently, war hostilities it was possible to see a positive trend, as the respondents in Ukraine on average recognized that the

quality of the provision of educational services by higher education institutions in the 2020/2021 academic year compared to the previous period (2020) has improved. However, with the positive trend in the background, the local research of students' opinions revealed a number of specific trends in Dniprovsky State Technical University. Flexibility as the most powerful trend of e-learning remains valid, which is confirmed by the questionnaire. However, the possibility and chances of gaining practical skills in e-format seems to be low. This is evidently an area of future effort or the educational management and the staff. In order to remain flexible as e-learning usually offers but offer more connection with professional life, the institution is supposed to develop more practical tasks, competence-based tasks, especially if they are so welcome by the participants.

The solution mentioned above will potentially improve the general digital competence of the students. As demonstrated by both the all-Ukrainian and local research in Kamianske, sadly, it is the staff who tend to be more aware of the potential of digital learning environments, while students prefer to use less technologically-heavy environments as messengers, chats, emails, etc.

The data allowed us the expose another uncomfortable truth about local youth in Kamianske as of 2022. The university students seriously lack the crucial skills of self-organization and time-management which, on average, are not at the top of the agenda among Ukrainian students. Evidently, the blow inflicted on Ukraine as an independent state has brought a lot of painful disruption into the educational process and is exposing the weakest links in the system and might continue to do so. It is crucial to mend this low self-management trend among the city students. However, in order to see the influence of war hostilities on Ukrainian e-learning there is a need for further research.

REFERENCES

Akcil, U. & Bastas, M. (2021). Examination of University Students' Attitudes towards E-learning during the COVID-19 Pandemic Process and the Relationship of Digital Citizenship. *Contemporary Educational Technology*, *13*(1), ep291. https://doi.org/10.30935/cedtech/9341.

Analitichna dovidka schodo tendentsiy organizatsiyi distantsiynogo navchannya u zakladah fahovoyi peredvischoyi ta vischoyi osviti v umovah karantinu u 2020/2021 navchalnomu rotsi (za rezultatami onlayn-anketuvannya uchasnikiv osvitnogo protsesu). [Analytical report on trends in the organization of the educational process in institutions of professional pre-higher and higher education under quarantine conditions in the 2020/2021 academic year (based on the results of an online survey of participants in the educational process)]. *State service for the education quality of Ukraine*. 2021. Retrieved from https://sqe.gov.ua/wp-content/uploads/2021/05/ANALITICHNA_DOVIDKA_Opituvannya_FPO_ZVO_DSYAO_05.2021.pdf (accessed 1.06.2022).

Ananga, P. (2020). Pedagogical considerations of e-learning in education for development in the face of COVID-19. *International Journal of Technology in Education and Science (IJTES)*, *4*(4), 310–321. https://doi.org/10.46328/ijtes.v4i4.123.

Anderson, T. (2011). The theory and practice of online learning (2011). 2nd ed., 472 p. Athabasca University Press. ISBN 978-1-897425-08-4.

Bazelyuk, O. (2021). Osoblivosti tsifrovizatsiyi vischoyi osviti v suchasnih umovah. [Features of digitization of higher education in modern conditions]. Retrieved from: http://pi.iod.gov.ua/images/pdf/2021_2/5.pdf (accessed 20.05.2022).

Brammer, S. & Clark, T. (2020). COVID-19 and Management Education: Reflections on Challenges, Opportunities, and Potential Futures. *British Journal of Management*, *31*, 453–456. https://doi.org/10.1111/1467-8551.12425.

Buynytska, O., Varchenko-Trotsenko, L., & Grytseliak, B. (2020). Tsifrovizatsiya zaklady vischoyi osviti. [Digitalization of a higher education institution]. *Educological discourse*, *1*(28). Retrieved from https://elibrary.kubg.edu.ua/id/eprint/31370/1/O_Buinytska_L_Varchenko_B_Hrytseliak_OD_28_NDLIO.pdf (accessed 6.06.2022). https://doi.org/10.28925/2312-5829.2020.1.6.

Chakraborty, P., Mittal, P., Gupta, M.S., Yadav, S., & Arora, A. (2021). Opinion of students on online education during the COVID-19 pandemic. *Human Behavior and Emerging Technologies*, *3*(3), 357–365. https://doi.org/10.1002/hbe2.240.

Danylchuk, O. & Melnyk, D. (2020). Perevahy ta nedoliky dystantsiinoho navchannia u ZVO. [Advantages and disadvantages of distance learning in higher education institutions]. *Scientific Collection "InterConf" 3*(36): with the Proceedings of the 7th International Scientific and Practical Conference "Challenges In Science Of Nowadays". (November 26–28, 2020) in Washington, USA: EnDeavours Publisher, 404–409.

Digital Education Action Plan (2021–2027). European Education Area URL: https://education.ec.europa.eu/focus-topics/digital-education/action-plan (accessed 5.05.2022).

Goozhva, V. (2019). Tsifrova transformatsiya universitetiv. [Digital transformation of universities]. *Eastern Europe: Economy, Business and Management*, *4*(21). Retrieved from https://ir.kneu.edu.ua/bitstream/handle/2010/36938/H_01_2019.pdf?sequence=1&isAllowed=y (accessed 5.06.2022).

Gopal, R., Singh, V., & Aggarwal, A. (2021). Impact of online classes on the satisfaction and performance of students during the pandemic period of COVID-19. *Education and Information Technologies*, *26*. https://doi.org/10.1007/s10639-021-10523-1.

Holmberg, B. (2005). The Evolution, Principles and Practices of Distance Education. Oldenburg : Bibliotheks und Informations system der Universitat Oldenburg, 2005, 171 p.

Hriebiennikova, N.V. (2019) Pryntsypy dystantsiinoi osvity. [Principles of distance education]. Retrieved from https://er.knutd.edu.ua/bitstream/123456789/14952/1/DPGN2019_P043-048.pdf (accessed 1.07.2022).

Informatsiino-analitychna dovidka pro rezultaty opytuvannia shchodo stanu vykorystannia tekhnolohii dystantsiinoho navchannia u zakladakh vyshchoi osvity Ukrainy. Derzhavna sluzhba yakosti osvity Ukrainy (2020). [Informational and analytical report on the results of a survey on the state of use of distance learning technologies in higher education institutions of Ukraine. State Education Quality Service of Ukraine]. Retrieved from https://old.sqe.gov.ua/images/materials/%D0%BE%D0%BF%D0%B8%D1%82%D1%83%D0%B2%D0%B0%D0%BD%D0%BD%D1%8F/%D0%B7%D0%B2%D0%BE/%D0%9E%D0%BF%D0%B8%D1%82%D1%83%D0%B2%D0%B0%D0%BD%D0%BD%D1%8F_%D0%B4%D0%B8%D1%81%D1%82%D0%B0%D0%BD%D1%86%D1%96%D0%B9%D0%BD%D0%B5%20%D0%BD%D0%B0%D0%B2%D1%87%D0%B0%D0%BD%D0%BD%D1%8F_%D0%97%D0%92%D0%9E.pdf (accessed 10.07.2022).

Lopa, L.B. (2019). Onlain-osvita yak osnovnyi trend vyvchennia ekonomiky. [Online education as the main trend in the study of economics]. *Pryazovsky Economic Bulletin. Zaporizhzhia, 4*, 11–15.

Morze, N.V., Kucherovska, V.O., & Smyrnova-Trybulska, E. (2020). Samootsinyuvannya rivnya tsifrovizatsiyi osvitnogo zakladu za umov transformatsiyi serednoyi osviti. [Self-assessment of the level of digitalization of an educational institution under the conditions of transformation of secondary education]. *Open educational e-environment of a modern university, 8*, 72–87. Retrieved from: http://nbuv.gov.ua/UJRN/oeeemu_2020_8_10/ (accessed 5.06.2022). https://doi.org/10.28925/2414-0325.2020.8.8.

Morze, N.V., Nepreenko, L.S., Smyrnova-Trybulska, E. (2020). Shlyahi rozvitku smart-universitetu (dosvid Kiyivskogo universitetu imeni Borisa Grinchenka). [Ways of developing a smart university (the experience of Borys Grinchenko Kyiv University)]. *Open educational e-environment of a modern university.* Vol. 8, 191–205. Retrieved from: http://nbuv.gov.ua/UJRN/oeeemu_2020_8_19 (accessed 8.06.2022). https://doi.org/10.28925/2414-0325.2020.8.17.

Morze, N., Varthenko-Trotsenko, L., Terlecka, T., & Smyrnova-Trybulska, E. (2021). Implementation of adaptive learning at higher education institutions by means of Moodle LMS. *Journal of Physics: Conference Series 1840* . Retrieved from: https://iopscience.iop.org/article/10.1088/1742-6596/1840/1/012062/pdf (accessed 7.06. 2022). https://doi.org/10.1088/1742-6596/1840/1/012062.

Nagorniy, V.V., Donchenko, A.O., & Nagorna, N.O. (2022). Zastosuvannya tsifrovizatsiyi navchalnogo prostoru v zakladi vischoyi osviti. [Application of digitization of educational space in a higher education institution]. *Innovations in medical education: prospects, challenges and opportunities:* materials of the all-Ukraine science and practice conf. from international with participation, Zaporizhia, January 21, 2022. Zaporizhia: ZSMU. 411–417. Retrieved from URL: http://dspace.zsmu.edu.ua/bitstream/123456789/16150/1/%D0%97%D0%90%D0%A1%D0%A2%D0%9E%D0%A1%D0%A3%D0%92%D0%90%D0%9D%D0%9D%D0%AF%20%D0%A6%D0%98%D0%A4%D0%A0%D0%9E%D0%92%D0%86%D0%97%D0%90%D0%A6%D0%86%D0%87.pdf (accessed 1.05.2022).

Nazarenko, Yu. & Polishchuk, O. (2021). Osvita v umovakh pandemii u 2020/2021 rotsi: analiz problem i naslidkiv. [Education in pandemic conditions in 2020/2021: analysis of problems and consequences]. *Analytical center Cedos*. Retrieved from https://cedos.org.ua/researches/osvita-v-umovah-pandemiyi-analiz-problem-i-naslidkiv/ (accessed 25.08.2021).

Nazarenko, Yu., Kohut, I., & Zherobkina, T. (2022). Osvita i viina v Ukraini (24 liutoho – 1 kvitnia 2022): monitorynh. [Education and war in Ukraine (February 24 – April 1, 2022): monitoring]. *Cedos Analytical Center.* 06.04.2022 10p. Retrieved from URL: https://cedos.org.ua/wp-content/uploads/osvita-i-vijna-v-ukra%D1%97ni.pdf (accessed 1.07.2022).

Nipper, S. (1989). Third generation distance learning and computer conferencing. in: mindweave: communication, computers and distance education. Eds. R.D. Mason, A.R. Kaye. Oxford: Pergamon Press, 1989 (pp. 63–70).

Prokopenko, A.I. & Dotsenko, S.O. (2021). Tsifrovyzatsiya sistemi vischoyi osviti v umovah pandemiyi COVID-19. [Digitization of the higher education system in the conditions of the COVID-19 pandemic]. Retrieved from https://dspace.hnpu.edu.ua/handle/123456789/5292 (accessed 20.05.2022). ISBN 978-617-7886-20-3.

Prysiazhniuk, Yu. (2021). Dystantsiine navchannia v konteksti komunikatsii vykladach – student: problema efektyvnosti. [Distance learning in the context of teacher-student communication: the problem of effectiveness]. *Organization of the educational process in the conditions of distance learning in higher education: methodology, technique, practice: Proceedings of all-Ukrainian scientific and methodical conference, Kyiv, May 20, 2021*. Eds.: N. Levytska, O. Sylka, L. Prybluda, & O. Pylypenko. Kyiv: NUFT (pp. 28–34).

Schetinina, L.V., Rudakova, S.G., Danilevich, N.S., & Monastirska, H.R. (2021). Tsifrovizatsiya navchalnogo protsesu: poglyad studentiv. [Digitization of the educational process: the view of students]. *Business Inform*, *2*, 94–98. Retrieved from: https://www.business-inform.net/article/?year=2021&abstract=2021_2_0_94_98 (accessed 7.06.2022). https://doi.org/10.32983/2222-4459-2021-2-94-98.

Shelomovska, O., Sorokina, N., Romaniukha, M., & Bohomaz, K. (2017). Network communication as a means of improving the efficiency of teacher-student interaction. In E. Smyrnova-Trybulska (Ed.). *Effective Development of Teachers' Skills in the Area of ICT and E-learning*. "E-learning" 9. Katowice–Cieszyn: STUDIO NOA for University of Silesia (pp. 389–407). ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-60071-96-0.

Shelomovska, O., Sorokina, L., & Romaniukha, M. (2018). Educational online-resources in teaching sociology: Ukrainian experience. In E. Smyrnova-Trybulska (Ed.). *E-learning and Smart Learning Environment for the Preparation of New Generation Specialists*. "E-learning" 10. Katowice–Cieszyn: STUDIO NOA for University of Silesia (pp. 291–310). ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-05-6. http://doi.org/10.34916/el.2018.10.

Shelomovska, O., Sorokina, L., Romaniukha, M., Sorokina, N., & Machulina, I. (2019). Educational potential of mass-media: reality and prospects for e-learning. In E. Smyrnova-Trybulska (Ed.). *E-learning and STEM Education*. "E-learning" 11 (pp. 671–690). ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-12-4. http://doi.org/10.34916/el.2019.11.

Shelomovska, O., Sorokina, L., Romaniukha, M., Sorokina, N., & Machulina, I. (2020). Cloud technologies for university training of students in socio-humanitarian specialties and future public servants in a global pandemic. In E. Smyrnova-Trybulska (Ed.). *Innovative Educational Technologies, Tools and Methods for E-learning*. "E-learning" 12 (pp. 159–171). ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-19-3. https://doi.org/10.34916/el.2020.12.

Simpson, O. (2002). Supporting student in online, open and distance learning. London: Kogan page Limited, 237 p.

Tsyfrovizatsiia osvity, dosvid rehioniv, aktualnist dlia pozashkillia. [Digitization of education, regional experience, relevance for extracurricular activities]. *Ministry of Education and Science, May 7, 2021 [Official webpage]*. Retrieved from URL: https://mon.gov.ua/ua/news/cifrovizaciya-osviti-dosvid-regioniv-aktualnist-dlya-pozashkillya-vidbulas-onlajn-sesiya-shodo-distancijnogo-navchannya (accessed 10.05.2022).

Vasylieva, O. (2022). Psykholohichni osoblyvosti dystantsiinoho navchannia v pidhotovtsi maibutnikh psykholohiv. [Psychological features of distance learning in the training of future psychologists]. *Scientific Bulletin of the Izmail State Humanitarian University*. Series: *Pedagogical sciences*. Iss. *58*, 36–44.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 48–62
https://doi.org/10.34916/el.2022.14.04

FORMATION OF INFORMATION AND COMMUNICATION COMPETENCE IN SPECIALISTS OF PRESCHOOL EDUCATION AS THE DEMAND OF MODERN TIMES

Tetiana Andriushchenko[1], Liubov Lokhvytska[2], Oleksandr Semenov[3], & Nataliia Semenova[4]
[1] MEI Cherkasy Regional Institute of Postgraduate education of Teachers of the Cherkasy Regional Council, 38/1 Bydhoshchska Str., Cherkasy, 18003, Ukraine
[2] Hryhorii Skovoroda University in Pereiaslav, 30, Sukhomlynskyi str., Pereiaslav, 08401, Ukraine
[3,4] Lesya Ukrainka Volyn National University, 13 Voli Ave., Lutsk, 43025, Ukraine
[1] antatko97@gmail.com, ORCID 0000-0002-9881-5018
[2] lokhvytska@gmail.com, ORCID 0000-0001-6852-5477
[3] o_semen@yahoo.com, ORCID 0000-0002-3839-4725
[4] natsemenova@ukr.net, ORCID 0000-0002-5247-7439

Abstract: *The article deals with the necessity of mastering modern information and communication technologies (ICT) by specialists of preschool education and the effective use of such technologies during the educational process in preschool educational institutions. It determined the task of forming teachers' information and communication competence as one of the dominant at the present stage of development of the digital society, as it is vital for both personal growth and professional duties. The aim was to highlight the results of the study in the context of clarifying the organizational and pedagogical conditions for the content of formation of information and communication competence in preschool education institutions. The pedagogical research was carried out in 4 stages: ascertaining, preparatory, formative and control. It involved pedagogical workers of 6 preschool education institutions in Cherkasy, Uman, Smila in Cherkasy region and Pereiaslav, Kyiv region of Ukraine (46 people in total). According to the results of research-experimental work the effectiveness of the use of certain organizational and pedagogical conditions for the formation of information-communication competence in preschool teachers was proved. A holistic and systematic process of awareness of the use of ICT will contribute to the formation of information and communication competence in preschool education specialists.*

Keywords: digitalization of modern preschool education; information and communication technologies; information and communication competence; organizational-pedagogical conditions; preschool education specialists; children of senior preschool age; preschool educational institution.

INTRODUCTION

The realities of contemporary Ukrainian society have determined the need for teachers to master modern information and communication technologies (ICT) and their effective use in the educational process at all levels. Teachers are forced to quickly master the information and communication competences of ICT application to stimulate children's attention via online communication and classes, implementing the main regulatory documents in the field of education (Law of Ukraine "On Education", 2017). This has put new demands on preschool education specialists, which did not have to respond to before and obliged, first of all, to strengthen the process of forming important competences and master certain information and communication technologies (Council Recommendation on Key Competences for LifeLong Learning, 2018). On the one hand, the issue of digitalization in preschool education in Ukraine is already quite relevant, since teachers often use a variety of information and communication technologies in the organization of educational process (during classes, entertainment, holidays, etc.). On the other hand, the challenge of the time is the formation of information and communication competence for effective educational work of teachers with preschoolers.

The regulatory documents governing preschool education in Ukrainian society emphasise the need for widespread use of modern digital technologies in educational process and management of educational institutions (The Basic Component of Preschool Education, 2021). This may become a tool to ensure the success of the Ukrainian education system. In order to improve the quality of education, the use of information and communication technologies should move from individual projects to a systematic process which covers all aspects of education.

To date, a number of studies have been carried out in national and foreign science based on the introduction of information and communication technologies in the educational process, in particular as a tool for improving the quality of education (it improves the educational process and increases its effectiveness – Boiko, Morze, & Varchenko-Trotsenko, 2020; Bylieva & Nordmann, 2022; Lopushinsky, 2018; Redecker, 2017; Tatnall, 2020), the development of the child's personality (activates the process of human cognition of environment and itself – Al-Hassan, 2020; Masoumi, 2021; Mörk, 2021; Otterborn, Schönborn, & Hultén, 2019; Pulak, 2018; Rahiem, 2021; Veličković & Stošić, 2016), information and methodological implementation and management of the educational process, communication of its subjects, automation of control and correction of learning outcomes.

Nowadays information and communication technologies have become a very powerful tool for teaching, upbringing and development of children, their implementation enables teachers to solve pedagogical problems at a higher level. This concept fully applies to preschool education, which aims to ensure the holistic development of the

child, his/her physical, intellectual and creative abilities through education, upbringing, socialization and the formation of necessary life skills as noted by Chen et al. (2018), Lokhvytska & Martovytska (2021), Nazarenko & Andriushchenko (2019), S. Semchuk, Skripnik, & B. Semchuk (2018) and others. This actualizes the problem of effective use of the potential of information and communication technologies as a tool for improving the quality of modern preschool education.

Object of research – educational process of preschool education institution.

Subject of research – the formation of information and communication competence in preschool education specialists as subjects of the educational process.

The aim of the article is to highlight the results of the study of organizational and pedagogical conditions in the semantic context of the formation of information and communication competence in preschool education specialists.

The research questions of the problem covered:

1. study of organizational and pedagogical conditions of the formation of information and communication competence of preschool education specialists;
2. diagnostics of teachers' readiness to use information and communication competence in professional activities;
3. providing a resource base for the organization of the digital environment of preschool education institutions;
4. introduction of information and communication technologies to the educational process, aimed at formingrelevant competences in children of senior preschool age (in accordance with the requirements of the State Standard of Preschool Education of Ukraine – Basic Component of Preschool Education, 2021);
5. substantiation of the feasibility of using information and communication technologies to establish partnerships between preschool educational institutions and preschoolers' parents.

General research hypothesis. The formation of information and communication competence of preschool education specialists as a subject of educational process will be effective if it is carried out within the framework of their thorough preparation, which includes the stages: ascertaining, preparatory, formative and control.

The general hypothesis is specified in ***partial hypotheses***: the formation of information and communication competence in preschool education specialists will be effective if the following organizational and pedagogical conditions are implemented:

- providing management of the process of using information andcommunication technologies in preschool education institutions;
- systematic training of teachers to use information and communication technologies in professional activities and development of information and communication competence;
- using information and communication technologies in organization of education, upbringing and development of children of senior preschool age;
- establishing partnership with parents of pupils by means of information and communication technologies.

1. THEORETICAL FOUNDATIONS OF THE RESEARCH

There have been studies on different aspects of improving the digitalization of education through the creation of information and educational space (Bykov, 2019; Bylieva & Nordmann, 2022; Eurén, 2018; Lopushinsky, 2018); the use of information and communication technologies in the organization of personality-oriented distance education, which integrates pedagogical and telecommunication technologies (Chen et al., 2018; Masoumi, 2021; Nazarenko & Andriushchenko, 2019; Tatnall, 2020; Veličković & Stošić, 2016); introduction of multimedia technologies in the educational process with students (Boiko, Morze, & Varchenko-Trotsenko, 2020; Lokhvytska & Martovytska, 2021; Moiseienko et al., 2019); formation of personal information and communication competence (Roszak & Kołodziejczak, 2017; S. Semchuk, Skripnik, & B. Semchuk, 2018; Vuorikari et al., 2016); combination of social partnership and education network (Pulak, 2018) and others .

Researchers Al-Hassan (2020), Chen et al. (2018), Masoumi (2021), Mörk (2021), Nazarenko & Andriushchenko (2019), Otterborn, Schönborn, & and Hultén (2019), Rahiem (2021), Veličković & Stošić (2016) define preschool education as a process and result of the comprehensive development of the child's personality, creating comfortable conditions for the formation of a physically, psychologically and socially mature personality, giving preschoolers the opportunity to realize their natural potential and creative abilities. We support the positions of scientists that in order to achieve the effectiveness of preschool education it is necessary to update all its components, in particular – the content, methods, forms and means of upbringing and education based on information-and communication technologies, which requires the formation of information and communication competence in preschool education specialists.

The study of the results of scientific research of the above scientists gives grounds to consider information and communication and digital technologies as an interactive multichannel tool for educational activities, and also indicates a significant educational potential of digital education, which should be possessed by preschool education specialists . Information and communication technologies allow: to use telecommunication space (Freeman et al., 2020); to carry out a qualified informative overview of partnership subjects; to combine individual and group forms of work, build individual educational trajectories (Lokhvytska & Martovytska, 2021; Tatnall, 2020); to create joint network content (Lopushinsky, 2018);toorganize remote forms of communication between the subjects of educational partnership (Roszak & Kołodziejczak, 2017); form basic competences for lifelong learning (Redecker, 2017; The Digital Competence Framework, 2020).

Therefore, we will on the content of the process of forming information and communication competence in preschool education specialists.

2. METHODS AND TECHNIQUES OF THE RESEARCH

The pedagogical experiment was carried out in 4 stages: *ascertaining, preparatory, formative and control*. The main directions of the use of information and communication technologies were identified on the basis of the ascertaining stage of the

experimental work. These directions may be simultaneously considered as *organisational and pedagogical conditions* for the formation of information and communication competence in preschool education specialists, in particular:

f. management of the process of using information andcommunication technologies in the work of preschool educational institutions;
g. formation of information and communication competence in specialists in preschool educational institutions and their preparation for the use information and-communication technologies in professional activities;
h. use of information and communication technologies in the organization of education, upbringing and development of preschool children;
i. establishing partnership with parents of preschoolers by means of information and communication technologies.

Considering the results of the examination, the content and strategic planning of the *management of the process of using ICT in the work of preschool educational institutions* at the next formative stage of the pedagogical experiment was determined .

In accordance with the purpose of the next formative stage of the pedagogical experiment, the implementation of the bank of electronic resources for the education of senior preschoolers was carried out.

The tasks of the control stage of pedagogical experiment were: diagnostic testing of information and communication competence of preschool education teachers and the degree of their readiness to use information and communication technologies in professional activities; comparison of the results of ascertaining and control diagnostics.

Participants. The experimental work, which took place during 2020–2021, involved teachers of 6 preschool educational institutions of the cities of Cherkasy, Uman, Smila of Cherkasy region and Pereiaslav, Kyiv region of Ukraine (a total of 46 people), who provided training, education and development of children of senior preschool age. The experimental work was aimed at studying the potential of information and communication technologies to improve the quality of education, upbringing and development of children of senior preschool age. This work was aimed at studying the organizational and pedagogical conditions for the formation of information and communication competence in preschool education specialists.

3. RESULTS OF THE RESEARCH

3.1. Ascertaining stage of research.

At the same stage of the experiment, a diagnostics of the state of readiness of specialists of preschool educational institutions to use ICT in the work was carried out. In our opinion, the state of teachers' readiness to use ICT in their professional activities depends on the level of their information and communication competence. Diagnostics of teachers' information and communication competence of teachers is carried out according to the following criteria and relevant indicators: *epistemological* (comprehensive knowledge about modern information and communication technologies, ICT tools used in preschool education and personal professional development); *motivational* (awareness of the importance of ICT for improving the

quality of preschool education, positive motivation to use ICT in work, desire for professional self-development throughICT); *activity* (level of proficiency of modern information and communication technologies, ICT skills, knowledge of ICT in the work of teachers); and professional development (level of knowledge of ICT in the work of teachers).

According to the results of the diagnostics, all respondents showed that they are able to write and edit text information, create and send email messages via the Internet, download some materials and resources from the Internet to a CD and vice versa, print information using a printer, etc. At the same time, 48.5% of the respondents indicated that they have some difficulties in creating multimedia presentations, 59.7% – in using electronic databases in the pedagogical sphere, 81.3% – in creating a personal professional electronic portfolio, 58.9% – in participating in electronic conferences and virtual professional communities. Unfortunately, 53.4% of teachers indicated that for different reasons they use traditional means of preschool education and their professional self-development in their work. In addition, 60.2% of respondents demonstrated very limited understanding of the use of modern ICT in their professional activities.

In general, the diagnostic data showed that 5.4% of preschool education teachers have a high level of information and communication awareness, 34.4% have a sufficient level and 60.2% of teachers have an insufficient level of information and communication competence.

3.2. Preparatory stage of research.

In all experimental institutions, it was planned to create material and technical conditions for the effective use of ICT in different spheres of preschool education; to search for pedagogical software tools necessary for quality preschool education and other digital educational resources; to prepare teachers to use ICT in the organization of preschool education and personal professional development; to create and/or maintain methodological support for the process of introducing ICT in preschool education.

The centre of the information and communication educational space of eachexperimental preschool institution was the website, the main sections of which were the following pages: main page; history of the institution; administration; teaching staff; work plan of the institution ; news; achievements; photos; methodological work; video presentations; information for parents; feedback (contacts, virtual consulting room).

In order to develop the information and communication competence of teachers *and their preparation for the use of information and communication and digital technologies in professional activities* in experimental preschool educational institutions, practical seminars were organised in full-time and distance form. Topics of the seminars: “Modern informative technologies”, “Methods of using computer games in preschool education”, “Methods of creating multimedia presentations for preschool education”, “Methods of creating digital didactic and developmental materials using Microsoft Office”, “ICT for learning mathematics by preschoolers”, “ICT for learning the alphabet and speech development of preschoolers”, “Web 2.0 services in preschool education”, “Google forms in working with parents of preschool children”,

"Creating a web portfolio using Word and PowerPoint", "Cloud technologies for professional self-development of preschool teachers".

Remote practical seminars of the declared topics were held in the form of webinars. During the experiment, such platforms as OpenMeetings, BigBlueButton, Microsoft Lync, Webex Cisco, Google Meet, Zoom, Adobe Connect were used to organise webinars. The most comfortable for the participants of the experimental work was the Adobe Connect platform, because its software allows teachers to take part in the webinar from anywhereusing their mobile devises. In addition, the Adobe Connect platform provides high-quality video and voice communication, text messaging in chat, makes it possible to use a "white board", demonstrate the "Desktop" and active software applications from the "speaker's" computer, exchange Microsoft Office (PDF) documents, use tools for polling and voting among the webinar participants. The participants of the experiment used Skype, Zoom to provide individual consultations on request on different aspects of ICT implementation in the field of preschool education.

For the purpose of personal professional development, teachers of experimental preschool educational institutions were recommended to use the electronic resources of the Cherkasy Regional Institute of Pedagogy and Psychology, in particular the section "Modern Methods of Preschool Education" and to join the work of Pedagogical Internet-club "Wonderland of Preschool Education", created on the Cherkasy Educational Portal – the website of the Cherkasy Regional Institute of Pedagogy and Psychology RIPET. Teachers also actively used the materials of the electronic publication "Pedrada: portal of educators of Ukraine" (https://www.pedrada.com.ua/), the Distance Academy (http://www.d-academy.com.ua/), took part in Internet seminars and web conferences on topical issues of preschool education.

In addition, preschool educational institutions formed creative groups of teachers in the main areas of ICT use to improve the quality of preschool education. For the effective work of each of the creative groups, in accordance with the objectives of the experiment, the goals were specified; instructions on the procedure for organising and conducting experimental work were developed, which were approved by issuing a corresponding order in preschool educational institutions. The efforts of the teachers of each creative group were aimed at processing scientific and methodological literature, studying and analyzing pedagogical experience on the use of ICT in the implementation of the tasks of the main educational lines, defined by the Basic Component of Preschool Education: "Child's Personality", "Child in Society", "Child in the natural environment", "Child in the World of Art", "Child's Play", "Child in Sensory and Cognitive Space" and "Child's Speech" (The Basic Component of Preschool Education, 2021).

In order to create personal digital resources for the education, upbringing and development of children of preschool age, participants of creative groups were recommended to use materials from the website "Funny Alphabet", "Thematic collection of drawings" (in English), "Collection of educational materials for children", "Children of Ukraine", "Library of the Ukrainian literature", "Governmental site for young citizens", "Children's site", "Children's fairy tales", "Children's portal Pustunchyk", "Children's site Levko", "Storyteller".

According to the results of the work of creative groups of specialists in preschool educational institutions, a bank of electronic resources of fairy tales, cartoons, documentaries of cognitive character for children, educational game programs, crosswords, songs and melodies, presentations for the implementation of all the above mentioned educational lines has been collected. Teachers also created collections of various sounds to be used in games and classes with children, reproduction of paintings by famous artists, video and music physical activities. A selection has been made of virtual tours of outstanding places in Ukraine and virtual excursions to museums of Ukraine. (Online excursion to Kolomyia Museum of Easter Egg painting, virtual tours to Ukrainian open-air museums, virtual excursions to zoos and aquariums of the world, etc.). Authors' digital resources prepared by creative groups were posted on the Cherkasy educational portal in the section "Collection of digital resources" (http://oipopp.ed-sp.net/taxonomy/term/207) and are actively used by teachers of experimental educational institutions in further experimental work.

3.3. Formative stage of research.

The article presents some examples of the use of ICT in the implementation of the task of the educational lines of the Basic Component of Preschool Education for the formation of relevant competences in children.

For the formation of *personal-assessing competence* in the work with senior preschoolers, teachers used the digital resource-presentation "Formation of the emotional experience of a preschooler by means of fairy tale" – for the formation of emotional activity as a component of the child's personal culture; "Ways to implement the tasks of emotional and value development in working with senior preschoolers" – to form children's ability to understand their own and other people's feelings; video game "Emotions with fish. Learning words" – to support and develop the emotional sphere of the child. Digital resources "Formation of health-saving competence of preschoolers" became very useful for the introduction of different kinds of sport and games, introduction of the idea that only healthy lifestyle will make them strong, healthy and cheerful. In order to improve the health of children, teachers of the experimental institutions used the digital resource "Colour Therapy". In addition, video activities "Glove" and "I have ten fingers" contributed to the strengthening of children's health and consolidation of knowledge about its preservation.

Formation of *social and communicative competence* by teaching children in the virtual school "Etiquette for kids" on the children's portal "Pustunchyk". Besides, during the lessons children analyzed the video files "ABC of politeness", "Evaluate the actions in fairy tales", "Good deeds", "Bad deeds". Ddigital resources were also usefulwith the help of which children got acquainted with their rights and duties. Riddles, illustrations, interesting tasks given in the presentation "Road signs – our helpers", motivated preschoolers to actively study traffic rules.

The content of the educational field *"Child in the environment"* provides for children to have knowledge about living organisms and their habitat, the diversity of natural phenomena, cause and effec relationships in the environment and the relationship of natural conditions, flora and fauna, the positive and negative impact of human activity on nature. The formation of *natural and ecological competence* was facilitated

by the use of multimedia projects "Formation of ecological awareness and competence in preschool children" which are represented by a number of presentations and video films "What do circles on hemp mean?", "Miraculous changes of a seed", "A droplet-traveler". Illustrative presentations "Ecological kaleidoscope" stimulated the development of logical thinking and children's knowledge expansion about the well-known winter natural phenomena. The digital resource "Fruit and Vegetables – Health Products", didactic computer game for preschoolers "Where is whose house?", online games "Hungry Bears" and "Feed the Dog", visits to virtual zoos not only enrich preschoolers' knowledge about the relationship between human health and nature, but also provide moral education of children.

The educational field *"Children in the World of Culture"* involves the formation of a sense of beauty in its various manifestations, aesthetic attitude to life, development of artistic abilities, formation of elementary labour, technological and artistic skills, independence, culture and safety of work. Visiting virtual museums of Ukraine, listening to Ukrainian music and getting acquainted with "famous voices of Ukraine" on the children's portal "Pustunchyk" contributed to the formation of *artistic and productive competence*; the use of multimedia games for the development of musical skills of preschoolers: "How Kolobok was travelling – the naure of music studied", "Cheerful notes", "Guess the melody". Musical anddidactic online games "Hares", "Try and guess" contributed to the formation of the ability to classify sounds and recognize musical instruments by sound. The use of the presentation "What are the books?" allowed teachers to expand children's knowledge about the variety of books and their importance.

The development of imagination, the formation of artistic skills, the ability to use a computer mouse contributed to the involvement of preschoolers to work in the graphic editor Paint. Children learnt to draw houses for magical characters, rainbow, sun, clouds and rain as well as to realise their own imagination. During the video lesson "Mixing primary colours" children actively used the knowledge gained in practice. Thanks to the digital resourse "Ukrainian writers for children", which contains presentations and audio files, children got acquainted with literature as an art of words. The video "How to behave in the theatre" helped children to learn and remember the rules of behaviour in cultural institutions.

The formation of *mathematical competence* is provided by the introduction of ICT in the educational process of experimental preschool educational institutions. Children learnt to work on the computer. While working the "Calculator" program, senior preschoolers learnt to type numbers, arithmetic signs, independently compose and solve tasks. Children were offered games "Number composition", "Which digit is missing?", "Which sign do you like?". In addition, in the graphic editor Paint children drew geometric shapes and fantasies with geometric shapes, colouring them in different colours: "Fir tree", "Mushroom", "Pyramid", "Mosaic", "Match the houses". The use of the cartoon "Learning colours and numbers" and video "Learning numbers" allowed to activate different analyzers in the process of teaching children mathematics. The use of online games also contributed to the acquisition of mathematical competence by senior preschoolers: "Lines for children", "Mickey Mouse: Counting together", "Make a decision", "Find the differences", "Learning numbers" and others.

The formation of *communicative competence* was facilitated by the use of the author's electronic manual "Fairy tale miracle" in the experimental work. During the presentation of letters to children, the program "Visiting Mother Goose" was used. Listening to musical and audio fairy tales "Ivan-Pobyvan", "Ivasyk-Telesyk" and others, posted on the website "Storyteller", as well as games for the development of coherent speech of preschoolers, contributed to the enrichment of children's vocabulary and the development of auditory memory. Working on the computer in a text editor, children improved their knowledge of grammar, learnt to type letters, syllables, words from familiar letters with one and two hands ("Create a word", "I say – you write!", "Familiar words").

The work, carried out in this way, convinced us that the use of ICT as a didactic tool helps to increase the motivation to learn in preschoolers, the development of creativity, children's attention, imagination, memory, logical thinking, is one of the conditions for creating a psychologically comfortable environment in preschool educational institutions and an important resource in improving the quality of education.

The pedagogical experiment explored the potential of ICT for *establishing partnerships between educational institutions and parents of preschoolers*. Thus, due to the created website, parents of preschoolers had the opportunity to learn about all the events which took place in each experimental institution, to quickly receive information about life in their child's group, as well as information of educational, methodological and developmental nature which they can use in their families. The website of the institution introduced the possibility of constant feedback from the families of pupils, facilitated the exchange of experience in raising children in families; quick response reaction of the teaching staff to the problems which most concern parents.

The experiment proved the effectiveness of using *e-mail, Viber* and *Telegram* as a quick, convenient and effective means of communication with parents of preschoolers was proved. During the preparation for different educational and developmental activities parents received invitations and necessary information as well as questionnaires and tests, which made it possible to study the point of view of the parental community on different issues, as well as to involve families of children in active participation in the educational process.

An effective form of partnership between teachers and parents of preschoolers was the *remote counselling centre*, which functioned through social networks Facebook and Skype. Family members had the opportunity to receive confidential and targeted information about their child's development, as well as competent answers from teachers, administration, practical psychologist, speech therapist, physical education instructor, music teacher, social teacher and nurse to topical issues related to the upbringing and education of their child.

Thus, we can state the significant potential of ICT for raising the level of parents' awareness about the quality of educational services in preschool educational institutions, providing the opportunity to receive information about the development of their child, improving the quality of pedagogical professional education and psychological support for parents and family members of preschoolers, creating conditions for partnership between teachers and parents on all issues of preschool education.

3.4. Control stage of research.

The results of the test diagnostics of information and communication competence of pedagogical workers of the experimental preschool educational institution showed an increase in the *high level* of its formation: from 5.4% at the ascertaining stage of the experiment – to 28.7% at the summative stage (dynamics +23.3%). There was also a significant increase in the number of teachers who demonstrated a *sufficient level* of information and communication competence: from 34.4% of people at the formative stage of the experiment to 62.8% at the summative stage (dynamics +28.4%). Positive is the fact that the number of teachers with *insufficient level* of information and communication competence decreased by 51.7%: from 60.2% at the ascertaining stage – to 8.5% at the control and generalizing stage of the experimental work. Comparative quantitative data on the levels of information andcommunication competence of teachers of experimental preschool educational institutions is shown in Table 1.

Table 1. Levels of the formation of information and communication competence of teachers of experimental educational institutions (%)

Levels	Ascertaining stage	Control stage	Dynamics
High	5.4	28.7	+23.3
Sufficient	34.4	62.8	+28.4
Insufficient	60.2	8.5	–51.7

Source: Own work T. Andriushchenko, L. Lokhvytska, O. Semenov, & N. Semenova.

DISCUSSIONS

The results of the conducted research conclusively prove the need to form information and communication competence in preschool education specialists as one of the essential ones. (Council Recommendation on Key Competences for LifeLong Learning, 2018; The Digital Competence Framework, 2020). The following definition was taken as a working one: information and communication competence involves the development of a person'sability to navigate in the information space, transform the information received and operate it in accordance with professional duties, personal needs and requirements of the modern high-tech information society. Thanks to the data of primary intelligence service on the scientific problem (Andriushchenko & Lokhvytska, 2021), an urgent need for the formation of information and communication competence among practitioners of preschool education institutions has been identified. It ensures the improvement of the quality of educational services and is relevant in accordance with the needs of the preschool education system and the realities of modern society. An important task, according to the authors, is also the preparation of future specialists in preschool education for the introduction of ICT and the formation of information and communication competence, which is reflected in a number of studies – Moiseienko et al., 2019; Mörk, 2021; S. Semchuk, Skripnik, & B. Semchuk, 2018 and others. However, the issue of the formation of information and communication competence of preschool education education institutions in in

the logical triad "teacher – preschooler – partents" has been ignored. Some results regarding the application of ICT and the formation of information and communication competence in teachers as subjects of the educationalal process are presented in scientific works (Chen et al., 2018; Masoumi, 2021; Otterborn, Schönborn, & Hultén, 2019; Roszak & Kołodziejczak, 2017), which is in the context of this study.

We believe that in the course of the scientific problem it was important to clarify the organizational and pedagogical conditions for the formation of information and communication competence in preschool education specialists, as well as the content that was reproduced in this study. Since the process of forming information and communication competence in preschool education specialists is based on optimising the interconnection of all components of of the educational process, an important task was to master ICT, which are simultaneously considered as organizational and pedagogical conditions and their active use. In particular, at the first stage (ascertaining), basic knowledge, skills and abilities were determined, which resembled preschool specialists' awareness of ICT and scienticif and methodological principles of their use in preschool education institutions. At the second (preparatory) stage of the experiment, the material and technical conditions of using ICT in professional activities were provided. Special training of teachers was also conducted, the pedagogical expediency of using ICT in preschool educational institutions was revealed. At the third (formative) stage, the gained experience was tested by specialists of preschool education. Its purpose was realized in three directions. The first was the formation of relevant competences in children of senior preschool age through the introduction of ICT in the educational process of preschool educational institutions. The second one was partnership with parents of preschoolers by means of ICT. The third stage ensured the identification of teachers' ICT competences in professional activities. At the fourth (control) stage, the levels of information and communication competence of preschool teachers were compared. The level of their readiness to use ICT in personal professional activities was analysed. Such a complex systematic process will contribute to the formation of information and communication competence in preschool education specialists.

CONCLUSION

In the course of the study the aim was achieved, the research questions were solved, the general and partial hypotheses were confirmed.

(1). The results of the completed research of the organizational and pedagogical conditions of digitalization of modern preschool education give grounds to state the significant potential of ICT for the development of information and communication competence of teachers of preschool educational institutions, organization of the educational process, provision of education to preschool children preschool age, establishment of partnership with parents of preschoolers.

(2). It has been found that the management of the process of using ICT in the work of preschool educational institutions is one of the priorities of creatiing a psychologically comfortable educational environment in preschool educational institutions and an important resource for improving the quality of modern preschool education.

(3). It has been proved that the development of information and communication competence of preschool teachers and the formation of motivation to use ICT in professional activities is facilitated by purposeful systematic training of teachers with the involvement of various digital services.
(4). It has been determined that using ICT in the organization of teaching, upbringing and development of children of senior preschool age as a didactic tool helps to increase the motivation to learn in preschoolers, the development of creative skills, their attention, imagination, memory, logical thinking, etc.
(5). It is confirmed that the use of ICT contributes to the establishment of partnership with parents of preschoolers, in particular: raising awareness of parents about the quality of education in preschool educational institutions, providing parents with the opportunity to receive information about their child's development, improving the quality of pedagogical professional education and psychological support for parents and family members of preschoolers, creating conditions for partnerships between the teaching staff and parents on all issues of preschool education.

FURTHER RESEARCH

We consider it expedient to direct further research to the development of technology for training future specialists in preschool education for the digitalization of modern preschool education in order to improve the efficiency of educational services.

REFERENCES

Al-Hassan, O.M. (2020). Exploring early childhood teacher education: implications for policy and practice. *Educational Research for Policy and Practice*, *19*, 89–104. https://doi.org/10.1007/s10671-019-09245-6.

Andriushchenko, T., & Lokhvytska, L. (2021). Use of ICT in the professional work of teacher in preschool educational establishment. *Innovative technologies in preschool education*: coll. science art. based on the materials of the IV International Scientific and Practical Conference (pp. 24–28). (Pereyaslav, April 20–21, 2021). L.O. Kalmykova (Ed.). Pereiaslav: Hryhorii Skovoroda University in Pereiaslav. https://doi.org/10.5281/zenodo.4965253.

Bazovyi komponent doshkilnoi osvity (*The Basic Component of Preschool Education).* (2021). MON Ukrainy. Nakaz № 33 vid 12.01.2021. Retrieved from https://mon.gov.ua/ua/osvita/doshkilna-osvita/bazovij-komponent-doshkilnoyi-osviti-v-ukrayini?=print [in Ukrainian].

Boiko, M., Morze, N., & Varchenko-Trotsenko, L. (2020). Communication and cooperation in distance learning. In E. Smyrnova-Trybulska (Ed.). *Innovative Educational Technologies, Tools and Methods for E-learning.* "E-learning" 12, pp. 50–64. Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2020.12.05. ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-19-3.

Bykov, V.Yu. (2019). Tsyfrova transformatsiia suspilstva i rozvytok kompiuterno-tekhnolohichnoi platformy osvity i nauky Ukrainy [Digital transformation of society and

development of computer-technological platform of education and science of Ukraine]. *Pedahohika i psykholohiia – Pedagogy and psychology*, *2*, 15–22. ISSN 2304-0629 [in Ukrainian].

Bylieva, D. & Nordmann, A. (Eds.). (2022). Technology, Innovation and Creativity in Digital Society. *XXI Professional Culture of the Specialist of the Future*. Cham: Springer. https://doi.org/10.1007/978-3-030-89708-6.

Chen, L., Chen, T.-L., Lin, C.-J., & Liu, H.-K. (2018). Preschool Teachers' Perception of the Application of Information Communication Technology (ICT) in Taiwan. *Sustainability*, *11*(1), Art. 114. https://doi.org/10.3390/su11010114.

Council Recommendation on Key Competences for LifeLong Learning. (2018). SWD, Brussels. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018SC0014&from=EN.

Eurén, J. (2018). *Digitalisering i förskolan: Betydelsen av IKT för barns lärande och utveckling* (Master's thesis). Faculty of Social Sciences, Dept. of Education, Umeå Univ., Umeå, Swedish. Retrieved from http://www.diva-portal.se/smash/get/diva2:1289243/FULLTEXT01.pdf.

Freeman, O.A.M., Luetz, J.M., Molthan-Hill, P., Ng, Th.F., Pandey, U.C., Pretorius, R., Vargas, V.R., & Özuyar, P.G. (Eds.) (2020). Quality Education. *Encyclopedia of the UN Sustainable Development Goals* (Vol. 4). Cham: Springer. https://doi.org/10.1007/978-3-319-95870-5.

Lokhvytska, L. & Martovytska, N. (2021). Psychological factors of information and communication technology competence forming in part-time students of the specialty "Preschool education". *SHS Web of Conferences*, *104*, Art. 02003. https://doi.org/10.1051/shsconf/202110402003.

Lopushinsky, I.P. (2018). "Tsyfrovizatsiia" osvity v konteksti rozvytku informatsiinoho suspilstva v Ukraini ["Digitalization" education in the context of development of information society in Ukraine]. *Pedahohichnyi almanakh – Pedagogical almanac*, *37*, 46–55. Retrieved from http://nbuv.gov.ua/UJRN/pedalm_2018_37_9 [in Ukrainian].

Masoumi, D. (2021). Situating ICT in early childhood teacher education. *Education and Information Technologies*, *26*, 3009–3026. https://doi.org/10.1007/s10639-020-10399-7.

Moiseienko, M.V., Moiseienko, N.V., Kohut, I.V., & Kiv, A.V. (2019). Digital competence of pedagogical university student: definition, structure and didactical conditions of formation. In A.E. Kiv & M.P. Shyshkina (Eds.). *Proceedings of the 7th Workshop on Cloud Technologies in Education* (CTE 2019). *CEUR Workshop Proceedings* (Kryvyi Rih, Ukraine). (Vol. 2643, pp. 60–70). Retrieved from http://ceur-ws.org/Vol-2643/paper01.pdf.

Mörk, S.B. (2021). University–preschool collaboration in pre-school teacher education in Iceland. *Learning Environments Research*. https://doi.org/10.1007/s10984-021-09350-5.

Nazarenko, H.A. & Andriushchenko, T.K. (2019). Informatsiino-komunikatsiini tekhnolohii yak instrument pidvyshchennia yakosti doshkilnoi osvity [Information and communication technologies as an instrument for preschool education quality improvement]. *Information Technologies and Learning Tools*, *69*(1), 21–36. https://doi.org/10.33407/itlt.v69i1.2688 [in Ukrainian].

Otterborn, A., Schönborn, K., & Hultén, M. (2019). Surveying preschool teachers' use of digital tablets: general and technology education related findings. *International Journal of Technology and Design Education*, *29*, 717–737. https://doi.org/10.1007/s10798-018-9469-9.

Pulak, I. (2018). Children and Smart Toys in Modern Learning Environment. In E. Smyrnova-Trybulska (Ed.). *E-learning and Smart Learning Environment for the Preparation of New Generation Specialists*. "E-learning" 10 (pp. 221–228). Katowice–Cieszyn: STUDIO NOA for University of Silesia. ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-05-6.

Rahiem, M.D.H. (2021). Storytelling in early childhood education: Time to go digital. *International Journal of Child Care and Education Policy*, *15*, Art. 4. https://doi.org/10.1186/s40723-021-00081-x.

Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu*. In Y. Punie (Ed.). Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/159770.

Roszak, M. & Kołodziejczak, B. (2017). Teachers' Skills and ICT Competencies in Blended Learning. In E. Smyrnova-Trybulska (Ed.). *Effective Development of Teachers' Skills in the Area of ICT and E-learning*. "E-learning" 9, pp. 91–104. Katowice–Cieszyn: STUDIO NOA for University of Silesia. ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-60071-96-0.

Semchuk, S.I., Skripnik, N.I., & Semchuk, B.I. (2018). Strukturno-protsesualna model formuvannia informatsiino-komunikatsiinoi kompetentnosti maibutnikh fakhivtsiv doshkilnoi osvity [Structural and procedural model of forming information and communication competency of future specialists in preschool education]. *Information Technologies and Learning Tools*, *67*(5), 13–30. https://doi.org/10.33407/itlt.v67i5.2345 [in Ukrainian].

Tatnall, A. (Ed.). (2020). *Encyclopedia of Education and Information Technologies*. Cham: Springer. https://doi.org/10.1007/978-3-030-10576-1.

The Digital Competence Framework. (2020). Retrieved from https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework.

Veličković, S. & Stošić, L. (2016). Preparedness of educators to implement modern information technologies in their work with preschool children. *International Journal of Cognitive Research in Science, Engineering and Education*, *4*(1), 23–30. https://doi.org/10.5937/IJCRSEE1601023V.

Vuorikari, R., Punie, Y., Carretero, G.S., & Van den Brande, G. (2016). DigComp 2.0: The Digital Competence Framework for Citizens. *Update Phase 1: The Conceptual Reference Model*. Luxembourg Publication Office of the European Union, Luxembourg. https://doi.org/10.2791/11517/.

Zakon Ukrainy "Pro osvitu" [Law of Ukraine "On Education"]. (2017). Retrieved from https://zakon.rada.gov.ua/laws/show/2145-19#Text [in Ukrainian].

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 63–74
https://doi.org/10.34916/el.2022.14.05

POSSIBILITIES OF THE DIGITAL LEARNING SUPPORT ENVIRONMENT IN THE INTEGRATION OF EDUCATIONAL AND EXTRACURRICULAR ACTIVITIES

Tatyana Noskova[1] **& Natalia Kozina**[2]
[1,2] Herzen State Pedagogical University of Russia
48 Moika Embankment, St. Petersburg, 191186, Russia
[1] noskovatn@gmail.com, ORCID 0000-0002-2058-626X
[2] nkozina@herzen.spb.ru, ORCID 0000-0002-6905-5873

Abstract: *In the period of digital economy development and education modernization, there is a need to expand pedagogical and methodological approaches to the organization of effective interaction of all subjects of the educational process, not only in educational but also in extracurricular activities. The article deals with the possibilities and main components of digital learning support environment, which is part of the Model of organisation of project activities of future technological education teachers. The main condition for the transformation of project activities in digital environment is the changes in the subject itself: motives, attitudes and positions. Interaction, development of digital tools, reflection of intermediate and final results in digital environment contributes to preparation for solving new professional tasks of future pedagogical activity. The authors describe the experience of using digital support environment in preparing future teachers of technological education and give general recommendations for using digital learning support environment in art and creative disciplines.*

Keywords: digital educational environment; environmental approach to learning; technological education; project activity.

INTRODUCTION

Today, Russia is implementing a number of initiatives aimed at developing a digital educational environment in general and higher education institutions. In 2018, the national project "Education" was approved, within the framework of which the federal project "Digital Educational Environment" is being implemented. This federal project aims to create and implement a digital educational environment in educational organisations and to ensure the implementation of the digital

transformation of the education system. As part of the project, work is being done to equip organisations with modern equipment and to develop digital services and content for educational activities.

For successful and effective work in the digital environment, it is necessary to take into account the modern information behaviour of young people. Therefore, in educational activities, it is important not only to transfer previous practices to a new format but also to look for new approaches that will allow the modern generation to be active and to form digital competences. The promising use of social networks in education is evidenced by the studies of contemporary authors (Al-rahmi et al., 2018; Rayens et al., 2018; Ansari et al., 2020; Morreale et al., 2020; Issa et al., 2021), which confirm that online collaborative learning helps students to be more creative, dynamic and scientifically oriented. As online tools and technology have evolved, social media has come to be seen as a key tool for supporting applied learning activities (Neelakandan et al., 2020). Social networks also have the advantage of providing a combination of tools that students can select, combine, and choose the ones that best fit their individual learning style and enhance their academic achievement (Neelakandan et al., 2020, p. 147; Langegård et al., 2021). Social networks, wikis and blogs provide the collaborative space required for the development of the activities offered in the programmes; likewise, they enable the formation of learning communities, in which students advance as a team to achieve the learning objectives and carry out collaborative work to support their learning process (Galvis & Carvajal, 2022).

BACKGROUND OF RESEARCH AND LITERATURE REVIEW

As digitalisation becomes a key concept in higher education institutions, it also largely affects quality issues (Tømte et al., 2019). Digitalisation of education involves various aspects of quality, ranging from organisational issues, technological infrastructure to pedagogical approaches (Bates, 2015; Selwyn, 2016). In the academic world, digital technologies have not been integrated into teaching practices, although students are taking advantage of their educational possibilities (Mercader & Gairín, 2020; Vázquez, 2015). Merkader and Geirin (2020), point to many barriers to teachers' use of technology, such as: excessive workload, strict curriculum, constant development (change) of technology, lack of technical support, inadequate assessment, ineffective leaders, diversified equipment, outdated software, lack of infrastructure and its poor quality, untimely and inadequate training, lack of planning, organisational culture, lack of goals, generation gap, lack of experience, pedagogical approaches, lack of time, prejudices and stereotypes, lack of motivation, denial of change, lack of confidence, need for excessive effort, technophobia, opinions and attitudes, etc. (Mercader & Gairín, 2020).

The question of transforming teacher training in a rapidly developing digital environment is particularly relevant nowadays. Many teachers today are not properly trained to use innovative technologies in the classroom (Shurygin et al., 2022). Learning about technology is a crucial point for a teacher to understand how their students are able to communicate and, on the whole, how fast communication and interaction systems are developing and improving. One of the easiest ways to address the problem

of the educator's "fear of technology" is to improve teachers' technical skills through constant practice and training and to delegate some technical issues to those students who participate in mobile learning and can do so (Batunova et al., 2021). Krutikov (2020) believes that the determining factors in the formation of digital competence of future teachers are the actualization of the concept of digital transformation in education in the process of teaching students, formation of responsibility and motivation to use digital technologies in the classroom; filling the content of lectures and practical classes with relevant information; involvement of future teachers in the process of mastering knowledge on digital pedagogical technologies (Krutikov, 2020). In addition to training teachers in aspects such as the design of their courses for virtual forms of learning, it is necessary to train them in the use of technological tools that best suit the needs of their courses. In this way, they will be able to make their own decisions about which of these tools actually enable students to learn, or even participate in the development of new ones that meet this objective (Galvis & Carvajal, 2022).

The global COVID-19 pandemic has forced all teachers to embrace the digital learning environment, looking for new methods and approaches to teaching. In Owens, J. & Hudson, A. (2021) researchers found that the quality of self-study activities during the pandemic largely depends on the level of awareness of all the actors in the educational process. Therefore, there is an urgent need to provide adequate support for students who are least prepared for distance learning (Owens & Hudson, 2021). Reliability and sufficient availability of Information Communication Technology infrastructure, learning tools, digital learning resources in the form of Massive Open Online Courses, e-books, e-notes, etc. are of utmost importance in such severe situations (Huang et al., 2020). Many tools are available today and it is up to the teacher to choose the best one and use it to teach their students (Dhawan, 2020).

Today there are different approaches to the organisation of project activities in higher education. The Abai Kazakh National Pedagogical University (Seisenbayeva et al., 2020) offers a whole system of teacher and students activities in project-based learning, noting that at each stage of project work there should be a specific project. Here the main place is occupied by such organisational forms as workshops, project developments, excluding lectures and courses in this model. When such forms are organised, it becomes possible to carry out work in targeted diploma projects. Through these, the student is already involved in professional activities at specific work sites together with the professionals working there.

Another approach related to the use of network resources in the organisation of project activities in the methodological training of future teachers is presented in the study by Barinova, Dorofeev, Zaydullina and Arslanova (2020). The authors consider the possibilities of network services, which occupy a special place in solving the problems of each stage of project activities:

- information-planning stage;
- practical stage;
- reflective-evaluative stage.

The information-planning stage involves the use of open electronic libraries; tools for analysing the popularity of search queries (Yandex, Google, Wordstat and Trends);

archive.org archive and its web service The Wayback Machine. At the practical stage, teacher and student activities are synchronized by means of online file-sharing platforms: file hosting services (Yandex Disk, Google Drive) and collaboration services (Google Docs, Microsoft OneDrive). At the reflexive-evaluative stage, students reflect on the findings and prepare a presentation of the results of their work using the resources of SlideShare (slideshare.net) or the Google Slides service, which is part of Google Docs; the PowerPoint web service; the template and stock library (https://badanovag.blogspot.com/p/web-20.html); the Supa-Online video constructor; the free hosting Wix constructor (wix.com). Thus, the project methods in the methodological training of future teachers contributes to the introduction of digital smart didactics in education.

RESEARCH METHODOLOGY AND METHODS

The methodological framework of the study is based on the activity and environmental approaches: in accordance with the theory of human development in activity, the content of project activities of future teachers of technological education is studied; based on the theory of influence of educational environment conditions on student development, the use of a specially created DLSE, aimed at the developing subject, his requests and educational needs, is studied.

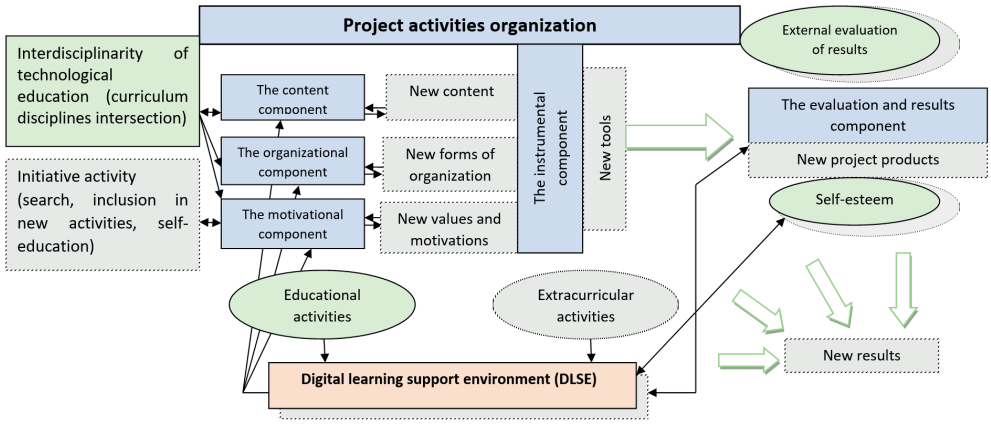
The study used modern methods of collecting and processing information: observation, questionnaires, theoretical analysis of the research problem, research of the products of the activity of future teachers of technological education; a combination of quantitative methods (methods of mathematical processing of the obtained data with subsequent analysis and generalization) and qualitative (method of digital traces network analysis) analysis of the results obtained.

PROJECT ACTIVITIES ORGANIZATION MODEL

As part of an experimental study (based at the Technological Education Department of the Herzen State Pedagogical University of Russia), the researchers developed a digital learning support environment (DLSE) for future teachers of technological education. The DLSE is an academic teacher-designed (based on social networking technologies) environment that allows the integration of combinations of educational and extracurricular (professionally directed) activities. Work in the DLSE was an obligatory part of extracurricular independent work of students in the study of the discipline “Design-project activity” (in accordance with the curriculum on the bachelor’s degree programme 44.03.01 Pedagogical Education, profile “Technology Education”). Thirty-four undergraduate students took part in the experimental work. These were students of the groups “Costume Design” and “Microsystem Technology”. The classes were held in the spring semester (February–June).

The following Model (Fig. 1) reflects the organisation of project activities of future teachers of technological education taking into account the functioning of the DLSE. The Model consists of traditional components: content, organisational, motivational, instrumental, evaluation and results. However, in order to obtain an innovative result,

the Model is supplemented by a the DLSE of future teachers of technological education. The digital environment actualizes the innovative outline of each component, resulting in: new content, new forms of organization, new values and motivations, new tools, as well as project activities going beyond the educational process, resulting in new activity products and new results.



F i g u r e 1. Project Activities Organization Model

S o u r c e: Own work.

The content component is implemented through the interdisciplinarity of technological education and through initiative activities: independent search for additional information and inclusion in new activities. The new content indicates the integration of various meaningful parts of academic disciplines.

The organisational component combines the phasing of project activities, as well as the specifics of building project interaction both in the classroom and in the digital environment, which constitutes new forms of organization. It is the inclusion of students of different courses in the project group to participate in initiatives of a professional profile (competitions, exhibitions, master classes, creative contests).

The motivational component, as well as the content component, is inseparably connected with initiative activity. Reflection on the project results plays an important role. The future teacher sees the potential of the project activity and can evaluate the project. At the same time, at the level of creativity, the cognitive interest in the designed object increases, the boundaries of spatial thinking are extended. New practices of network project interaction form new values and motivations.

The peculiarity of project activities is that the obligatory component is the instrumentality of actions. Taking into account the ongoing processes of transformation of technological education, new tools and, accordingly, new products of activity are emerging. New computer tools appear (special machines, automatic machine tools, robotic devices, etc.), which the future teacher needs to master and then introduce into the educational process, teaching computer graphics and drawing; computer-aided design (CAD) systems, robotics; electronics and electrical engineering.

The evaluation and results component combines an external professional and social evaluation of the final results of project activities by users of the digital environment, as well as self-assessment. It is not only important how the academic teacher evaluates the student, but also how the student evaluates himself, his internal motivation and activity satisfaction, which is also part of the innovative result.

An innovative element of the Model is the DLSE of project activities of future teachers of technological education. Blinov (2019) considers the digital environment as "a system of conditions and opportunities that implies the presence of an information and communication infrastructure and provides a person with a set of digital technologies and resources for self-realization, personal and professional development, solving everyday and professional problems". We believe that everything is transformed in the digital environment, from the pedagogical system, its methodological foundations to psychological positions, the attitudes of the subjects of the educational process: students, teachers, management of the educational institution (Noskova, 2020).

The study of the discipline "Design-project activity" was organised in the blended learning form: online video lectures on the Moodle platform; laboratory work in the classroom and the organisation of extracurricular independent work on the Moodle platform with access to the DLSE (remotely). The discipline "Design project activity" involves the future teacher's study of the theoretical foundations of design and creation of their own projects in the process of laboratory work. A feature of the discipline is also a combination of traditional graphic tools and techniques with digital tools. The course programme involves working with a range of digital tools, including professional graphic editors: Adobe Photoshop, Corel Draw, Adobe Illustrator, Adobe Lightroom; graphic editors focused on the intermediate level of training: Gravit Designer, Gimp, Photomaster, Paint Tool Sai 2; mobile applications for editing and working with images: PicsArt, Bazaart. Graphic composition skills for creating a collage were acquired through the digital tool Bomomo, and exercises on colour harmony through the application Color Scheme. Images could be selected and searched through the social Internet service Pinterest (Noskova et al., 2021). The intermediate results of the tasks were placed in the learning DLSE for discussion and correction with the academic teacher and group mates. Creating the author's promotional video, reflecting the stages of work on the corporate identity, involved working with professional video editors Adobe After Effects; Adobe Premiere Pro; editors for video processing editors, focused on the average level of training: Chello, Moovly, Video; as well as in mobile applications for editing and working with video: Inshot, VN Video Editor Maker.

Thus, in the DLSE there is an opportunity to choose according to the level of preparation, as well as the preferences, aspirations and position of the student. At the same time, the environment accumulates digital traces, activity products, ratings, comments, which serve as a visual representation and reflection of the student's work, his activity, interaction with group members in the learning process; allows to track and evaluate progress; motivates others to be active.

RESULTS AND DISCUSSION

The authors hypothesized the idea of introducing the DLSE, aimed at developing new aspects of universal and general professional competences through the use of digital tools, digital objects, networking, into the project activities of future teachers of technological education along with an instrumental environment that contributes to the formation of basic competences.

The levels of future teachers' involvement in the DLSE were investigated in educational and extracurricular activities. As part of extracurricular activities, the study was conducted among undergraduate students of technological education (future teachers of technological education) in the full-time and part-time departments. In the 2019/2020 academic year, the total number of full-time and part-time undergraduate students (1-4 courses) who took part in the experiment was 106 people. In the 2020/2021 academic year, full-time and part-time undergraduate students of 1–4 courses (100 people) also took part in the experiment. The work was carried out in two directions: in the initial courses (1, 2) and in the senior courses (3, 4).

As part of the educational activities, the study was carried out in the process of mastering the discipline „Design project activity" (curriculum for the undergraduate program 44.03.01 Pedagogical Education, profile "Technological Education"). In the 2019/2020 and 2020/2021 academic year, the number of focus group participants was 34 people. The students who took part in the experiment were students of the groups "Costume Design" and "Microsystem Technology". Students were given the opportunity to develop a design project, taking into account the specifics of their areas of professional activity.

To determine the absolute increase in the level of involvement of future teachers of technological education in extracurricular project activities, we selected the completed tasks of the discipline "Design-project activity", the implementation of which implied the use of the DLSE. The assessment was implemented by the level of formation of three criteria of project-creative orientation: cognitive criterion (the knowledge, ideas of future teachers about project activities, understanding the essence of project tasks; qualitative assessment of knowledge: awareness; systematic; performance); motivational criterion (the desire of the future teacher to prove himself as a creative person, interest in project activities); activity criterion (ability to plan and carry out project tasks of a creative nature, to think figuratively, in an original way, outside the box; a qualitative assessment of project activities).

Each of the criteria has a system of indicators characterizing the manifestation of the studied qualities according to this criterion. The degree of manifestation of indicators for each criterion is measured using the measurement tools and research methods described earlier.

Table 1 shows the number of students for each level of inclusion (1 – basic, 2 – advanced, 3 – high) in extracurricular project activities.

Table 1. The effectiveness of the inclusion of future technological education teachers in extracurricular project activities using the DLSE

Levels:	Criteria for the diagnosis of student involvement in the implementation of project activities					
	Motivational criterion		Cognitive criterion		Activity criterion	
	Number of students	% of the number of students	Number of students	% of the number of students	Number of students	% of the number of students
2019–2020 academic year						
1	34	100%	34	100%	34	100%
2	22	64.7%	16	47%	10	29.4%
3	4	11.7%	2	5.8%	14	41.1%
2020–2021 academic year						
1	34	100%	34	100%	34	100%
2	24	70.5%	22	64.7%	16	47%
3	10	29.4%	10	29.4%	28	82.3%

Source: Own work.

The absolute increase in the level of involvement after the introduction of the DLSE according to the increased level of the motivation criterion is 5.8%, the cognitive criterion is 17.7%, and the activity criterion is 17.6%; according to the high level of the motivation criterion, it is 17.7%, the cognitive criterion – 23.6%, the activity criterion - 41.2%.

Thus, the data obtained as a result of the experimental work confirmed the hypothesis put forward.

During the experimental study, we identified the following general approaches to ensure the transformation of project activities in art and creative training, through the use of the DLSE:

a. **willingness and readiness of the academic teacher** to work both in the classroom environment, and in the DLSE: to design, create and maintain the environment; to monitor and implement through the DLSE the correction of activities of future teachers of technological education;
b. creation of **clear and convenient** structure of the DLSE with reflection of project activity stages, which imply presentation of practical results of work: stage of practical realization and defence of the project. Supporting visualization of intermediate and final results, as well as evaluation of the implementation of these stages allows improving the process of project implementation.

By the clear and convenient structure of the DLSE we mean:

- individual thematic discussions;
- a newsfeed with useful materials;
- photo and video collections;

- recording of interim results (maintenance of activity ratings reflecting different aspects of learning and extracurricular activities in order to monitor and correct further actions, support the reflective nature of actions).

c. ensuring **the diversity of communication channels**, which allows:
- to build and develop horizontal connections;
- to carry out information and organizational pedagogical support of the future technological education teacher in choosing the object of design or inclusion in existing projects;
- to carry out collaborative activities on the basis of special network services.

The combination of work in the classroom and in the DLSE allows for strengthening:
- information component: information is transformed into the format of posts that can be saved and accessed at any time to refer to the necessary materials;
- communication component: a variety of communication channels allows to prompt feedback from the academic teacher and group mates, exchange opinions and comments, mutually evaluate the interim and final results, published news (Kuusimäki et al., 2019);
- learning management: the possibility of simultaneous distribution of information, conducting surveys, timely correction of educational activities.

CONCLUSION

To summarize, our results are close to the findings by Barinova, Dorofeev, Zaydullina and Arslanova (2020). As the colleagues point out, the most difficult part for students was the research part of the project activity, which is due to the fact that the level of skills formation was insufficient to systemise and analyse a large amount of information. But generally, most of the students are ready to organize project activities using network services. In addition to studying the levels of future teachers' involvement in the DLSE, individual reflective interviews were conducted with students who participated in the experimental study. Future teachers were asked the following questions:
- Did the work in the DLSE facilitate classroom project activities?
- Were there any deterrents to activities in the DLSE?

Analysis of the data obtained as a result of the reflective interview showed that 84% of future teachers of technological education were successful in project activities and proved themselves in the DLSE. According to the students, this was facilitated by the fact that the DLSE is a new format of work, respectively, which attracts and engages in activities, motivates to show initiative; there is a convenience of communication with both the academic teacher and the group mates; there is an opportunity to control and monitor not only their own progress, but also the progress of colleagues, which is also a motivation to get the work done. 12% of future teachers were successful in project activities, but not active in the DLSE. This was largely influenced by the fact that this group of students does not maintain social networks and they find it difficult to take the initiative in the digital environment. Such format of interaction in the DLSE limits the student more than it gives freedom and new ideas. It is worth noting that all students completed the final course work, involving the use of different graphic and video editors (of the student's choice). However, 12% of students

were not very active in the DLSE, which involves participation in the discussion of project ideas, interim and final results; publication of interim and final results of the work; evaluation of the activities of group members, self-analysis of project activities based on methodological recommendations, digital footprints and accumulated project materials. 4% of students fell into the group of those who were not successful in the implementation of the project, but were active in the DLSE. For this group, the main deterrent was the lack of artistic and design skills when creating the project.

The use of the DLSE in the disciplines of artistic and creative orientation will allow to solve professional problems in a new way, taking into account the modern information behaviour of young people, as well as stimulating students to be active, help to find personal meanings (the development of future teachers' professional qualities in the process of implementing various projects: social, artistic and creative, engineering, etc.) and to get involved in various educational initiatives.

Working in the DLSE project activities in the process of mastering the discipline "Design-project activity" made it possible to involve future teachers of technological education in extracurricular project activities, as well as conclude about the students' readiness for:

- implementation of the project "in digital form";
- change of the educational position: from an executive position to an active educational position, independently exercising self-control and self-management, as well as mutual control and mutual management of educational activities in the process of project implementation;
- development of mutually enriching cooperation (use of digital tools and educational resources, sharing);
- development of horizontal connections;
- inclusion in extracurricular project initiatives.

Nowadays, in the era of lifelong learning, we have the opportunity to improve the quality of professional qualifications through the use of the digital environment, but it is necessary to find the appropriate application.

ACKNOWLEDGEMENTS

This work was carried out within the framework of a state assignment with financial support from the Ministry of Education and Science of the Russian Federation (project No. FSZN-2020-0027).

REFERENCES

Al-Rahmi, W.M., Alias, N., Othman, M.S., Marin, V.I., & Tur G. (2018). A model of factors affecting learning performance through the use of social media in Malaysian higher education. *Computers & Education*, *121*, 59–72. https://doi:10.1016/j.compedu.2018.02.010.

Ansari, J.A.N. & Khan, N.A. (2020). Exploring the role of social media in collaborative learning the new domain of learning. *Smart Learn. Environ, 7*(1), 59–72. https://doi.org/10.1186/s40561-020-00118-7.

Barinova, N., Dorofeev, A., Zaydullina, S., & Arslanova, M. (2020). Technologies In The Implementation Of Paradigm Of The Future Teacher Training. *Humanistic Practice in Education in a Postmodern Age*, *European Proceedings of Social and Behavioural Sciences*, *93*, 116–125. https://doi.org/10.15405/epsbs.2020.11.13.

Bates, A.W. (2015). *Teaching in a Digital Age.* Retrieved from https://pressbooks.bccampus.ca/teachinginadigitalagev2 (accessed 3 July 2022).

Batunova, I., Lobyneva, E., Nikolaeva, A., & Baturina, N. (2021). Teaching IT Specialists with the Help of Online Learning. *Socio-economic Systems: Paradigms for the Future,* 1091–1098. https://doi.org/10.1007/978-3-030-56433-9_114.

Blinov, V.I. & Dulinov, M.V. (Eds.). (2019). *Didactic Specialty Vocational Education and Training Project*. „Pero".

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5–22. https://doi.org/10.1177/0047239520934018.

Galvis, Á.H., & Carvajal, D. (2022). Learning from success stories when using eLearning and bLearning modalities in higher education: a meta-analysis and lessons towards digital educational transformation. *Int J Educ Technol High Educ*. *19*(1). https://doi.org/10.1186/s41239-022-00325-x.

Huang, R.H., Liu, D.J., Tlili, A., Yang, J.F., Wang, H.H., Zhang, M., Lu, H., Gao, B., Cai, Z., Liu, M., Cheng, W., Cheng, Q., Yin, X., Zhuang, R., Berrada, K., Burgos, D., Chan, C., Chen, N.S., Cui, W., Hu, X., et al. (2020). *Handbook on facilitating flexible learning during educational disruption: The Chinese experience in maintaining undisrupted learning in COVID-19 outbreak*. Smart Learning Institute of Beijing Normal University.

Issa, T., Alqahtani, S.G., Al-Oqily, I., Goktalay, S.B., Köse, U., Issa, T., Abu Salih, B., & Almufaraj, W.K. (2021). Use of social networking in the Middle East: student perspectives in higher education. *Heliyon, 7*(4), e06676. https://doi.org/10.1016/j.heliyon.2021.e06676.

Krutikov, M. (2020). Formation of digital competence of rising teachers in the process of professional training. *Contemporary Problems of Science and Education, 6*, 92. https://doi.org/10.17513/spno.30414.

Kuusimäki, A.-M., Uusitalo-Malmivaara, L., & Tirri, K. (2019). The Role of Digital School-Home Communication in Teacher Well-Being. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.02257.

Langegård, U., Kiani, K., Nielsen, S.J., & Svensson, P. (2021). Experience nursing students in the pedagogical transition from on-campus learning to distance learning using digital tools. *BMC Nursing, 20*(1). https://doi.org/10.1186/s12912-021-00542-1.

Mercader, C. & Gairín, J. (2020). University teachers' perception of barriers to the use of digital technologies: The importance of the academic discipline. *International Journal of Educational Technology in Higher Education*, *17*(1). https://doi.org/10.1186/s41239-020-0182-x.

Morreale, S.P., Thorpe, J., & Westwick, J.N. (2020). Online Teaching: Challenge or Opportunity for Communication Education Scholars? *Communication Education, 70*(1), 117–119. https://doi.org/10.1080/03634523.2020.1811360.

Neelakandan, S., Annamalai, R., Rayen, S.J., & Arunajsmine, J. (2020). Social Media Networks Owing To Disruptions For Effective Learning. *Procedia Computer Science*, *172*, 145–151. https://doi.org/10.1016/j.procs.2020.05.022.

Noskova, T.N. & Kozina, N.D. (2021). Digital environment for supporting the project activities of undergraduate studing "Technology Education" in higher school. *Society. Communication. Education*, *3*(12), 81–92. https://doi.org/10.18721/JHSS.12307.

Noskova, T.N. (2020). *Didactics of the digital environment*: *Monograph*. St. Petersburg: Publishing house of the Herzen State Pedagogical University.

Owens, J. & Hudson, A. (2021). Prioritizing teacher emotions: Shifting teacher training to a digital environment. *Educational Technology Research and Development, 69,* 59–62. https://doi.org/10.1007/s11423-020-09921-y.

Rayens, W. & Ellis, A. (2018). Creating a Student-Centered Learning Environment Online. *Journal of Statistics Education*, *26*(2), 92–102. https://doi.org/10.1080/10691898.2018.1475205.

Seisenbayeva, Z., Nuriev, M., Rauandina, A., Osmanova, Z., & Seitkaziyev, R. (2015). The role of project activity in the formation of future specialists. *Opción*, 394–422. Retrieved from https://www.produccioncientificaluz.org/index.php/opcion/article/view/23532. ISSN 1012-1587.

Selwyn, N. (2016). Education and Technology: Key issues and debates. London, Bloomsbury.

Shurygin, V., Ryskaliyeva, R., Dolzhich, E., Dmitrichenkova, S., & Ilyin, A. (2021). Transformation of teacher training in a rapidly evolving digital environment. *Education and Information Technologies*, *27*(3), 3361–3380. https://doi.org/10.1007/s10639-021-10749-z.

Tømte, C., Fossland, T., Aamodt, P., & Degn, L. (2019). Digitalisation in higher education: Mapping institutional approaches for teaching and learning. *Quality in Higher Education, 25*(1), 98–114. https://doi.org/10.1080/13538322.2019.1603611.

Vázquez, E. (2015). Ubiquitous and mobile learning through "apps". In E. Vázquez & M.L. Sevillano (Eds.). *Mobile digital devices in education. Ubiquitous learning*, (pp. 135–154). Madrid: Narcea Ediciones. ISBN 978-84-277-2100-5.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 75–88
https://doi.org/10.34916/el.2022.14.06

EXPERIENCE IN DEVELOPMENT OF THE UNIVERSITY MOOCS ENVIRONMENT TO SUPPORT PRE-SERVICE TEACHER TRAINING

Mariia Umryk[1], **Oksana Strutynska**[2]
National Pedagogical Dragomanov University in Kyiv, Ukraine,
9 Pyrohova Str., Kyiv, Ukraine
[1] m.a.umryk@npu.edu.ua, ORCID 0000-0002-0396-0045
[2] o.v.strutynska@npu.edu.ua, ORCID 0000-0003-3555-070X

Abstract: *The paper considers some components of the digital educational environment of a modern teacher training university to support the educational process of teacher students (pre-service teachers). The relevance of such an environment in the long-term conditions of the pandemic as well as the martial law in Ukraine is indicated. It was these two factors that influenced the active development and use of the digital environment to support the academic educational process. One of the components of such digital educational environment is MOOC that is also used for informal education.*
This paper also reviews the first results of the recently completed implementation of the EDX platform in the digital educational environment to support pre-service teacher training. The article analyses the trends in MOOCs development aimed to support teacher training; discusses the results of the survey related to using MOOCs during the pandemic and the martial law; considers steps of implementation of MOOCs to support teacher training.

Keywords: MOOCs, pre-service teacher training, open EdX platform, university MOOC environment.

INTRODUCTION

The new reality that the world educational system has faced requires academic institutions all over the world to react fast and adjust to the challenges of today. The 2030 Agenda for Sustainable Development adopted at the United Nations Sustainable Development Summit in September 2015 contains 17 Sustainable Development Goals including a new global education goal (SDG 4). SDG 4 aims at 'ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all' (United Nations, 2020).

During the COVID-19 pandemic, the focus of education has shifted to the use of digital educational environments and online studying in general. In order to achieve the aforementioned sustainable development goal, it is essential to provide all students with digital educational tools and expand the opportunities of non-formal learning in particular. The question of validation of non-formal learning, such as MOOC format, remains open in educational institutions all over the world (Strutynska & Umryk, 2021; Strutynska & Umryk, 2016; Yıldırım, 2022; Zhu, Sari, & Lee, 2022).

In March 2020 the COVID-19 Global Education Coalition has been established by UNESCO. In its work the Coalition focuses on three main flagships (UNESCO, 2020):

- connectivity,
- teachers,
- gender.

As for the first factor, the issue of the Internet access remains critical all over the world. According to UNESCO, nearly 465 million children and youth, or almost 47% of all primary and secondary schools, do not have access to educational platforms because they do not have the Internet connections at home (Alhazzani, 2020; UNESCO, 2020).

15% of the Ukrainian population faces the digital divide and does not have access to broadband internet. Many social infrastructure facilities are not connected to fiber-optic networks. Among them, there are 16 040 educational institutions, or 40% of schools (Ministry and committee for digital transformation, 2020).

Another factor that significantly affected education in Ukraine is the declared martial law, which has been in effect throughout the territory of modern Ukraine since February 24, 2022 until now. It is this factor that is decisive for a clear understanding of the advantages of using the digital environment of a modern university, in conditions where physical access to the university is not only undesirable due to the pandemic, but also impossible, due to the threat of physical execution or the destruction of the university as such. It is the digital educational environment and one of its components – the *NPU MOOC Environment* (in our case) that makes it possible to continue the educational process. In this direction, it is necessary to note the work of the Ministry of Education and Science of Ukraine regarding cooperation with a number of well-known representatives of the provision of digital services for formal and informal education. The Ministry of Education and Science of Ukraine, with the help of international partners, provides free unlimited access to such leading MOOC providers as Coursera and EdX to all higher educational institutions of Ukraine. This had a positive effect on the quality of educational services of higher educational institutions and made it possible to carry out self-study and self-education of both Ukrainian teachers and students. “More than 20,000 students and teachers have already joined Coursera and are successfully mastering online courses from Google, Meta, IBM, Microsoft, Amazon Web Services, as well as such leading universities in the world as Yale University, California Institute of the Arts, Duke University, Erasmus University Rotterdam and others. Many students study several courses at once. In general, Ukrainian students have already successfully completed more than 28.000 courses and received free certificates” (Ministry of Education and Science of Ukraine, 2022).

Next critical issue that educators face throughout the world is related to teachers. On the one hand, teachers currently bear a huge burden, both from the point of view of time and emotional state; on the other hand, it has arisen the challenge of training and retraining teachers in order to develop their digital skills required for the implementation of online learning.

Having analysed various pedagogical educational institutions in Ukraine, we can state that girls constitute more than 80% of pedagogical university students and respectively, the percentage of women working in the pedagogical field is much greater than that of men. Therefore, another issue to take into account is reducing the gap in training female students of training teachers' universities in the IT field, as basic IT skills comprise digital competence, which is of a special need today. As noted earlier, the solution to these acute problems might be found in training and retraining of teachers and developing their digital skills using in particular MOOC instruments.

Paper goal. This paper reviews the first results of the recently completed implementation of the Open EDX platform in the digital educational environment of the National Pedagogical University (NPU) with regard to the implementation of MOOCs to support teacher training. It attempts to address the following questions:

- analysing the trends in MOOC development to support teacher training;
- analysing first results of the implementation of NPU MOOC Environment (based open EdX platform);
- presenting the results of the survey related to using MOOCs in NPU during the pandemic and the war state;
- considering the steps of implementation of MOOCs to support pre-service teacher training in NPU.

Research methods. Authors have used the following research methods and tools for the investigation (2021–2022):

- survey;
- interview of the Ukrainian educators;
- documents and content analysis;
- MOOC statistics analysis;
- analysis of research papers;
- updating of the model of the NPU digital educational environment;
- development of the NPU MOOCs environment.

A total of 272 Ukrainian educators took part in the present research. The Ukrainian educators from the target group (university teaching staff from the National Pedagogical Dragomanov University, Kyiv, Ukraine), were involved in this process. The survey was created during this project which aimed to gather data on the readiness level of university teachers to use MOOCs in their professional activity and for lifelong learning.

1. ANALYSIS OF TRENDS IN MOOCS DEVELOPMENT TO SUPPORT PRE-SERVICE TEACHER TRAINING

With the beginning of the pandemic and, consequently, the quarantine, the interest in MOOCs has significantly increased (Qian, Li, Zou, Feng, Xiao, & Ding, 2022;

Strutynska & Umryk, 2016; Smyrnova-Trybulska, Sekret & Morze, 2021). Figure 1 shows the growth in the number of MOOC platforms in 2021 (the statistics taken from MOOC aggregator "Class Central"), (Shah, 2021).

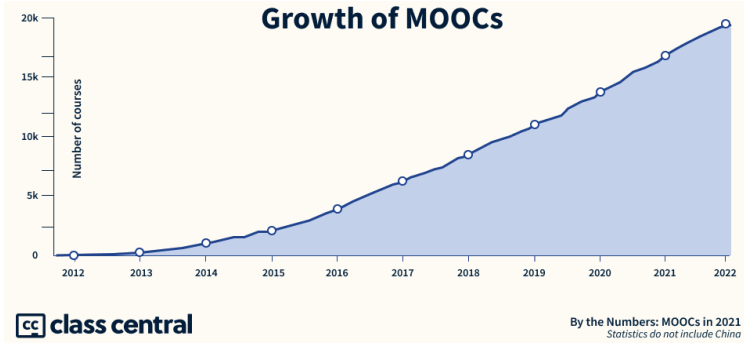


Figure 1. Growth of MOOCs in 2021

Source: Data gained from D. Shah, URL: https://www.classcentral.com/report/moocs-stats-and-trends-2021 (accessed on 25.09.2022).

At the same time, the latest trends in MOOC development include the following (Shah, 2021):

- MOOC providers focused on finding a business model, certificates and graded assignments moved behind paywalls. All the top MOOC providers also have completely paid courses;
- nowadays, more and more of the courses are created by companies every year (Google, Microsoft, Amazon, Facebook, etc.), not only by universities;
- the pandemic has also increased the adoption of online courses from Corporations and Governments around the world. This is where they are (and will be) looking for growth over the next few years.

The analysis of the courses that were the most popular in pre- and post-pandemic period (Figure 2) has shown that the following categories do not contain any courses intended to support teacher training.

At the same time, the need for high-quality training of pre-service teachers has become even more urgent due to the pandemic and the martial law and the challenges it poses: most students have no chance to visit schools for their teaching internship during the quarantine and wartime, as the schools are closed or destroyed as well. Therefore, it is necessary not only to change the approach to the professional training in their future professional field (Computer Science, Mathematics, Physics, Biology, etc.) due to the fact that Ukrainian universities mostly arrange the process of studying using blended learning technologies; but also prepare them for online working, blended and distance learning formats at schools. The ways that might help in the professional training of pre-service teachers include:

- developing and implementing courses for training the pre-service teachers to organise the educational process of online, distance and blended format and work effectively under such conditions;

- preparing pre-service teachers for the format of non-formal learning and the use of MOOCs in particular;
- finding out the readiness of pedagogical university teachers to improve their own qualifications by means of non-formal learning and to use and develop MOOCs in particular;
- preparing pedagogical university teachers (IT disciplines in particular) for training pre-service teachers in their own use and development of MOOCs.

Figure 2. Comparing the most popular MOOCs in pre- and post-pandemic period

Source: Data gained from D. Shah, URL: https://www.classcentral.com/report/the-second-year-of-the-mooc (accessed on 25.09.2022).

Therefore, the authors of the following study analysed the number and subject area of the MOOCs intended to support teacher training using MOOC aggregator "Class Central", (Figure 3).

The analysis of the courses found (about 470 courses) has shown that there are no available courses in Ukrainian language. Therefore, we found it necessary to create an environment for developing MOOCs aimed at training pre-service teachers in Ukraine.

Also, in Ukraine we have some MOOC platforms (Prometheus, EdEra, etc.). But they have only several MOOCs for teacher training (less than 10). That is why NPU as a teacher training university needs MOOCs development to support pre-service teachers.

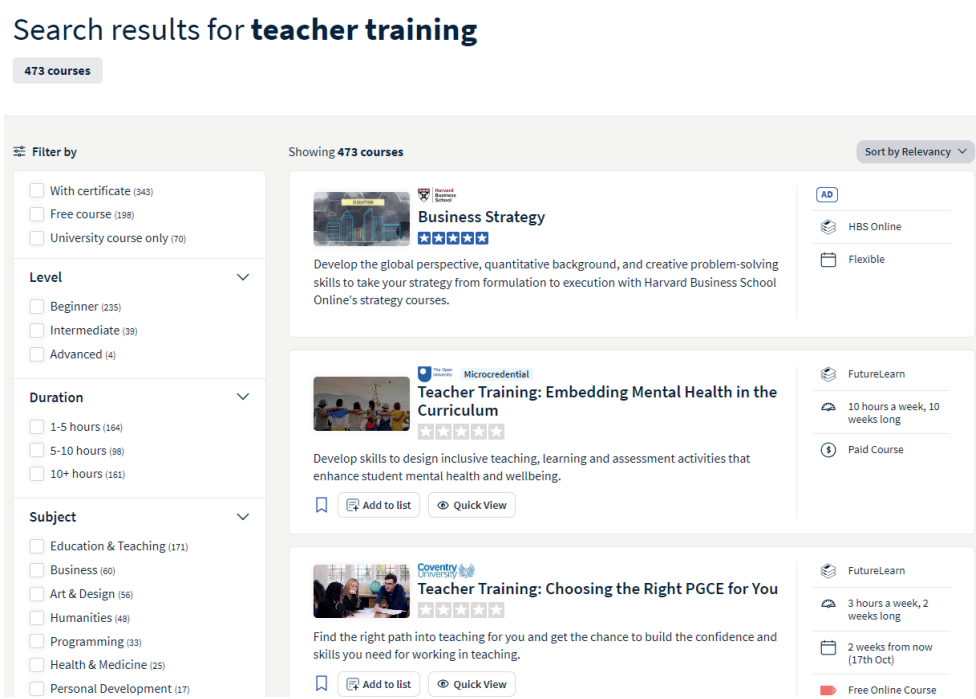


Figure 3. Search results MOOC for teacher training

Source: Own work based on data from URL: https://www.classcentral.com (accessed on 25.09.2022).

2. DEPLOYMENT OF NPU MOOCS ENVIRONMENT AS COMPONENT OF THE DIGITAL EDUCATIONAL ENVIRONMENT (BASED ON OPEN EDX PLATFORM)

Considering the importance of online learning during the pandemic and the martial law, especially in supporting teacher training at NPU we have systematically analysed opportunities for using MOOCs in higher education institutions as well as the existing MOOC development platforms.

The world statistics on the use of MOOCs have shown a rapid growth of MOOC platforms in recent years, in particular in the number of registered users. MOOCs have reached 220 million learners (excluding China). In 2021, providers launched over 3100 courses and 500 microcredentials (Shah, 2021). Table 1 shows top MOOC providers in terms of users and offerings.

As we examined in our previous research (Strutynska & Umryk, 2021) MOOCs are one of priority areas for the modern educational institutions. The conditions of the pandemic and the martial law in Ukraine encouraged leaders of educational institutions to reconsider and change approaches to the educational process. Specialists with different success rates try to model the digital environment of all structural and learning components of educational institutions. Nowadays, a lot of universities include MOOCs as part of such digital environments.

Table 1. Top MOOC providers offerings by the end of 2021

MOOC provider	Learners (in million)	Courses	Microcredentials	Degrees
Cousera	97	6.000	910	34
EdX	42	3.550	480	13
FutureLearn	17	1.400	180	22
Swayam	22	1.465	0	0

Source: Own work based on data from D. Shah, URL: https://www.classcentral.com/report/mooc-stats-2021 (accessed on 25.09.2022).

Based on our previous research (Strutynska & Umryk, 2021), the authors of this paper proposed a simplified model of the NPU digital educational environment (Figure 4):

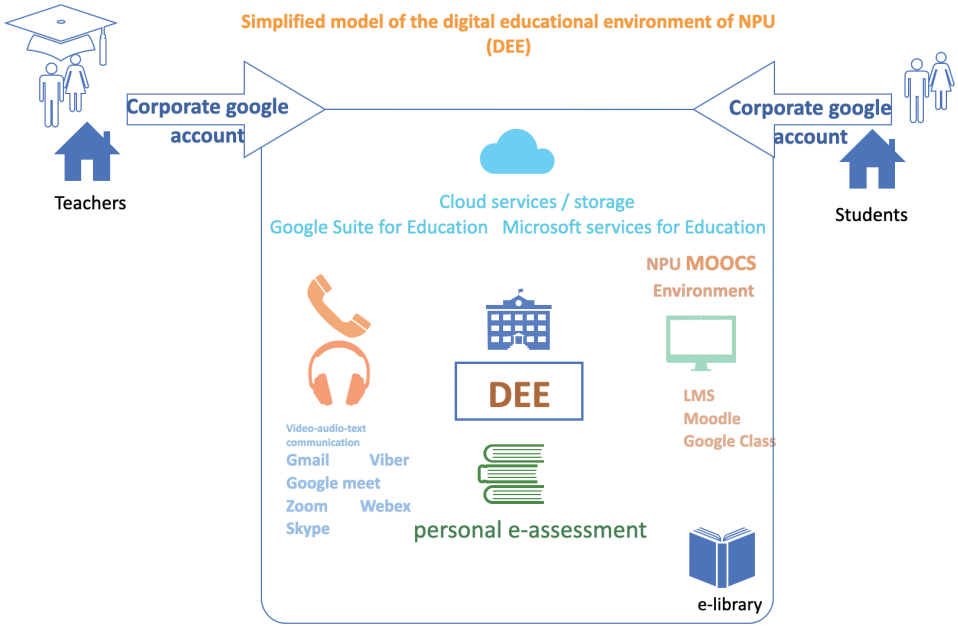


Figure 4. Simplified model of the NPU digital educational environment

Source: Own work based on Strutynska & Umryk, 2021.

As seen from Figure 4, MOOCs Environment is a component of NPU digital educational environment.

With regard to this global tendency, the use of MOOCs in the National Pedagogical University has been implemented along two main dimensions. The first one – the technical dimension involved purchasing a powerful server and transferring the main load of online learning to it. The second – software dimension was the development of all the components of the NPU digital educational environment:

- Distance learning systems (Moodle, Google Classroom etc.).
- MOOC learning systems – taking steps to recognize the results of students' work at the leading non-formal learning platforms such as Coursera, EdX, Prometheus, etc.
- Implementation of our own EdX platform to enable the development of MOOC courses for teacher training and retraining.

Work in the second dimension began with getting acquainted and analysing successful implementations of the leading MOOC platforms. NPU became a participant of Coursera for Campus Program and edX's Open Remote Access Program, which gave the students and teachers free access to the MOOCs of the platforms. With the help of these programs NPU acted as a consumer of the corresponding courses as well as administrated access to the platforms at the university level. NPU teachers began to integrate individual MOOC modules and disciplines into their own courses and use them for their own self-development and lifelong learning.

The next step was the creation and implementation of our own MOOC platform of NPU. The Open EDX platform NPU was built with (Open EdX, 2021) and consist of (Figures 5–6):

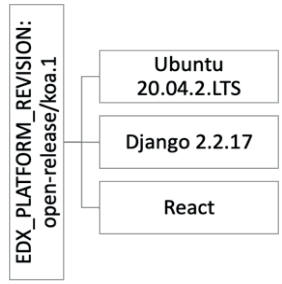


Figure 5. Installing open EdX platform NPU

Source: Own work.

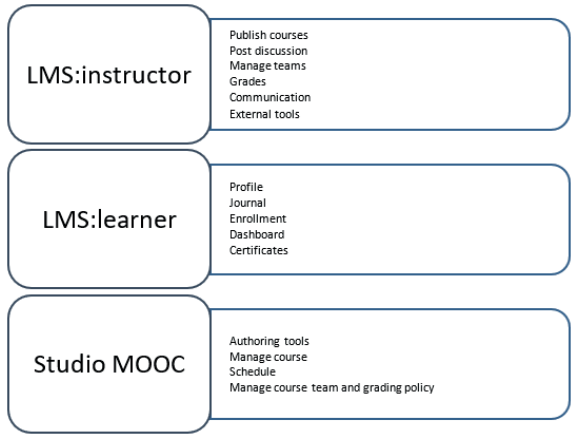


Figure 6. Administrative portal open EdX NPU

Source: Own work.

The main page of the NPU MOOCs environment is shown in Figure 7:

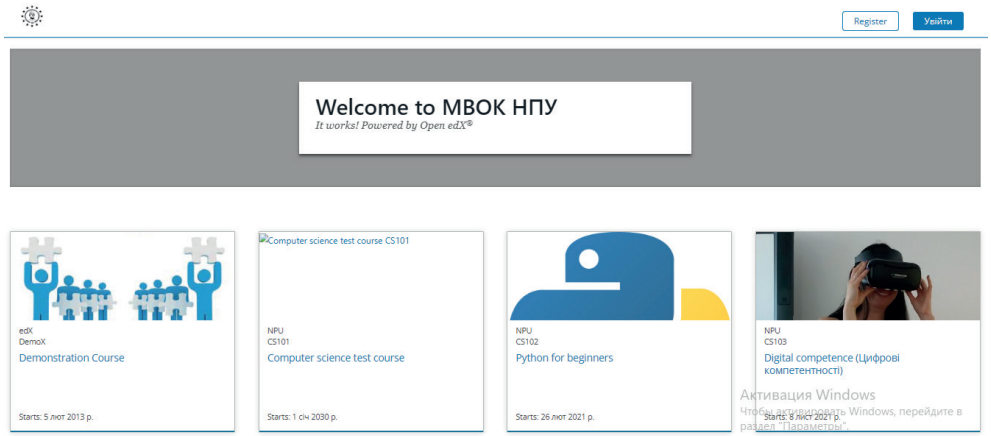


Figure 7. The main page of the NPU MOOCs environment

Source: Own work.

3. THE RESULTS OF THE DIAGNOSTIC SURVEY REGARDING THE USE OF MOOCS IN NPU DURING THE PANDEMIC AND THE MARTIAL LAW

The diagnostic survey was aimed at the target group connected with the use of MOOCs in NPU during the pandemic and the wartime. This target group consisted of 272 Ukrainian educators working at the NPU.

The online survey was developed in the Ukrainian language using Google Forms and was intended to gain the data on the Ukrainian educators' level of readiness to use MOOC in their professional activity and for lifelong learning. We guaranteed the participants that only anonymised data would be shared. The survey was conducted during the 2021–2022 academic year in the quarantine and the martial law.

The results of the survey related to using MOOCs in the NPU during the pandemic and the wartime from the target group are presented in Figures 8–10 below.

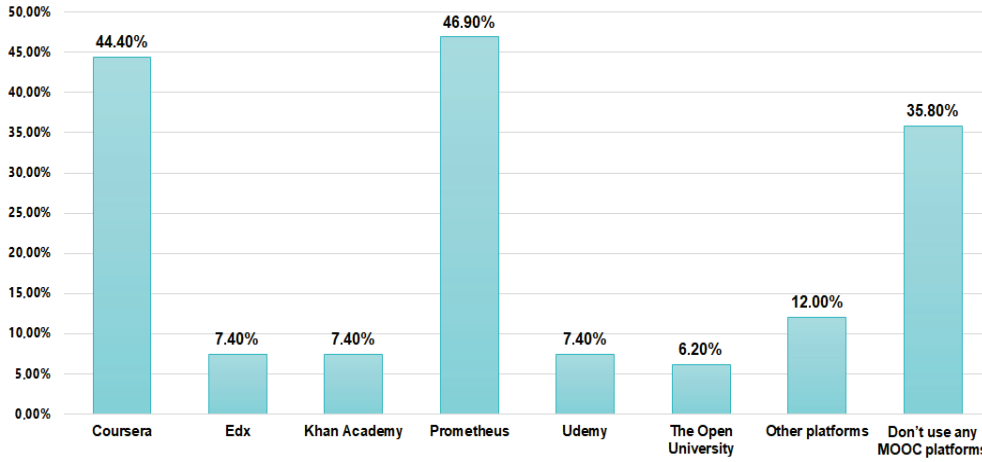
Q.: *What MOOC platforms do you use in your professional activity?*

Survey responses on using MOOC platforms in the professional activity are shown in Figure 8 (multiple answers are possible, that is why the total responses can be more than 100%).

As seen from Figure 8, a significant part of NPU teachers (35.8%) do not use MOOCs in their professional activity.

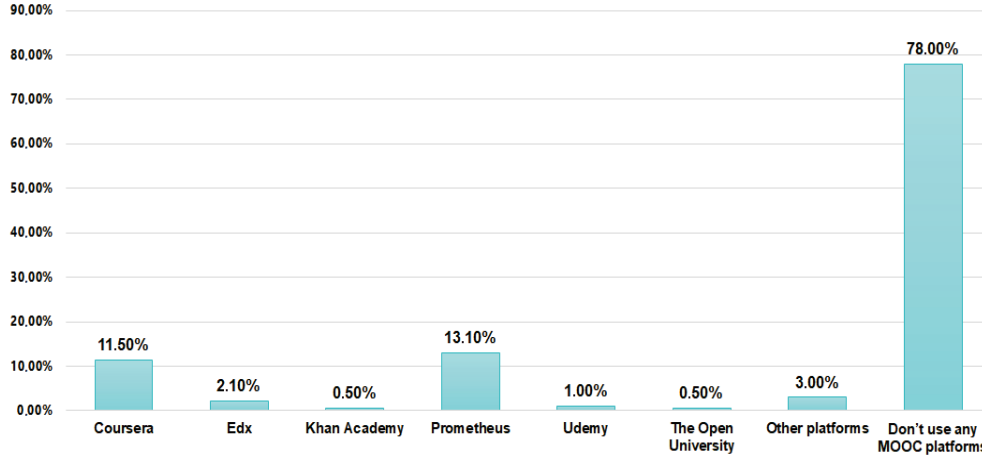
Q.: *What MOOC platforms do you use for self-learning?*

Survey responses on using MOOC platforms for self-learning are shown in Figure 9 (multiple answers are possible, that is why the total responses can be more than 100%).



F i g u r e 8. Survey responses on using MOOC platforms in the professional activity

S o u r c e: Own work.



F i g u r e 9. Survey responses on using MOOC platform for self-learning

S o u r c e: Own work.

Figure 9 demonstrates that 78% of NPU teachers do not use MOOCs for self-learning. The answers to the next question are consistent with the previous two: almost 48% of the teachers cannot recommend MOOCs to their students as they do not use the platforms themselves (Figure 9).

Q.: *Do you recommend MOOCs to your students?*
Survey responses on recommendation of MOOC for students are shown in Figure 10 (multiple answers are possible, that is why the total responses can be more than 100%):

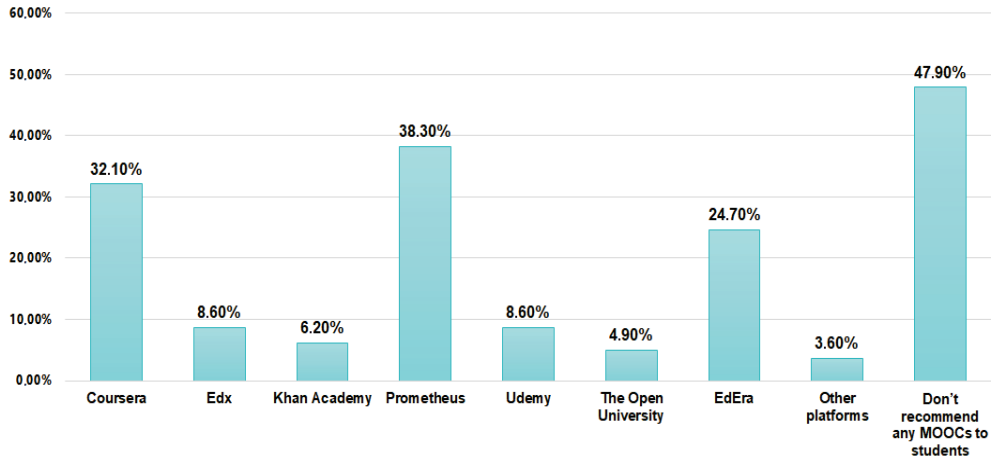


Figure 10. Survey responses on recommendation of MOOCs for students

Source: Own work.

The results of the survey have shown that there is a huge gap in the use of MOOCs to support teacher training in the NPU.

To overcome this gap, we are planning educational activities related to the use and designing of MOOCs for teachers and students in the NPU during 2022–2023 academic year.

Training NPU teaching staff in the use of MOOCs

We are provided courses for improving digital competence for NPU teaching staff under the programme "Digital Educational Technologies" (Umryk, Strutynska & Vakulenko, 2021) designed by authors of the present research. One of the modules of the programme is dedicated to NPU MOOCs Environment (see Table 2):

Table 2. The context of module "NPU MOOCs Environment" for training NPU teaching staff

No	Topic name	Lectures and trainings (in hours)
1.	Basic concepts of MOOCs. NPU MOOCs environment	8
2.	The main principles video lectures development for educational purposes	8
3.	Vlogging. Tools for keeping a video blog for educational purposes	8
4.	Technical and software tools for the development of video lectures for educational purposes	8
5.	Editing of video lectures for educational purposes	8
	Total (in hours):	**40**

Source: Own work based on Umryk, Strutynska & Vakulenko, 2021.

Training pre-service teachers (NPU students) in the use of MOOCs

The mandatory course "Digital educational technologies" is provided for NPU students/pre-service teachers (Ramskyi, Yefymenko, Strutynska, Tverdokhlib, Umryk & Yefymenko, 2022) designed by authors of the present research. One of the topics of the programme is dedicated to MOOCs.

The context of this topic is as follows:

- The concept of Lifelong learning. MOOCs. MOOC providers. Registration on MOOC. Structure of MOOC. Requirements for the development of MOOC.
- Overview of Ukrainian educational MOOC platforms: Prometheus, EdEra, etc. Overview of world popular MOOC providers: Coursera, edX, FutureLearn, etc.
- Review of digital sources for teacher self-education. The Coursera platform for the NPU. EdX platform for the NPU.
- NPU MOOCs Environment.

CONCLUSION AND DISCUSSION

The research conducted allows us to make conclusions about the following:

- with the beginning of the pandemic and, consequently, the quarantine, the interest in MOOCs has significantly increased. At the same time the pandemic has also increased the adoption of online courses from Corporations and Governments around the world;
- analysing the trends in MOOCs development to support teacher training has shown the gap in this field, especially for Ukrainian educators;
- first results of the implementation of MOOC in NPU educational process (based open EdX platform) have shown positive attitudes from university teaching staff and students to the implementation of the NPU MOOC Environment;
- the survey results have shown that there is a huge gap in the use of MOOCs to support teacher training in the NPU. To overcome this gap, we are planning educational activities related to the use and designing of MOOCs for teachers and students in the NPU during 2022–2023 academic year.

To address this issue, the authors of the present research as staff of the Center for Digital Educational Technologies of the National Pedagogical University (NPU) take the following steps:

1. Monitoring teachers to estimate their level of readiness to develop and use MOOCs in their professional activity;
2. Introducing a training module devoted to the development and use of MOOCs in digital competence courses for NPU teachers;
3. Preparing NPU teaching staff to design their own MOOCs (creating a video recording studio, establishing a unified structure for MOOCs created in NPU, developing MOOCs aimed at pre-service teacher training);
4. Implementing the use of MOOCs by students for non-formal learning;
5. Developing the mechanism of recognizing the results of students' non-formal learning.
6. Preparing pre-service teachers (NPU Master students) to design MOOC structure, MOOC content etc.

REFERENCES

Al-Rahmi, W., Aldraiweesh, A., Yahaya, N., Kamin, Y.B., & Zeki, A.M. (2019). Massive Open Online Courses (MOOCs): Data on higher education. *Data in Brief*, *22*, p. 118–125. ISSN 2352-3409. https://doi.org/10.1016/j.dib.2018.11.139.

Alhazzani, N. (2020). MOOC's impact on higher education. *Social Sciences & Humanities Open*, *2*, Issue 1, p. 100030. ISSN 2590–2911. https://doi.org/10.1016/j.ssaho.2020.100030.

Henseruk, H., Buyak, B., Kravets, V., Tereshchuk, H., & Boiko, M. (2020). Digital transformation of the learning environment at university. In E. Smyrnova-Trybulska (Ed.). *Innovative Educational Technologies, Tools and Methods for E-learning*. "E-learning" 12 (pp. 325–335). Katowice–Cieszyn: STUDIO NOA for University of Silesia. http://doi.org/10.34916/el.2020.12.20. ISSN 2451-3644. Retrieved from: http://studionoa.pl/doi/e-learning/12/el-2020-12.pdf.

Ministry and committee for digital transformation (2020, August 3). 17 tysiach naselenykh punktiv ne maiut zhodnoho optychnoho provaidera – doslidzhennia Mintsyfry *[17,000 settlements do not have a single optical provider – a study by the Ministry of Digital]*. Retrieved from: https://thedigital.gov.ua/news/17-tisyach-naselenikh-punktiv-ne-mayut-zhodnogo-optichnogo-provaydera-doslidzhennya-mintsifri (accessed 26 September 2022).

Ministry of Education and Science of Ukraine (2022, July 13). Coursera proponuie bezkoshtovni onlain-kursy dlia ukrainskykh studentiv *[Coursera offers free online courses for Ukrainian students]*. Retrieved from: https://mon.gov.ua/ua/news/coursera-proponuye-bezkoshtovni-onlajn-kursi-dlya-ukrayinskih-studentiv (accessed 26 September 2022).

Morze, N.V., Vember, V.P., & Hladun, M.A. (2019). 3D kartuvannia tsyfrovoi kompetentnosti v systemi osvity v Ukraini [*3d mapping of digital competency in Ukrainian education system*]. Informatsiini tekhnolohii i zasoby navchannia [*Information Technologies and Learning Tools*], *70*(2), 28–42. ISSN 2076-8184. https://doi.org/10.33407/itlt.v70i2.2994. Retrieved from: https://journal.iitta.gov.ua/index.php/itlt/article/view/2994 (accessed 26 September 2022) [in Ukrainian].

Open EdX (2021). Documentation for edx.org and the Open edX Community. Retrieved from: https://docs.edx.org/ (accessed 26 September 2022).

Open EdX (2021). Retrieved from: https://open.edx.org/the-platform/ (accessed 26 September 2022).

Qian, Y., Li, C.-X., Zou, X.-G., Feng, X.-B., Xiao, M.-H., & Ding, Y.-Q. (2022). Research on predicting learning achievement in a flipped classroom based on MOOCs by big data analysis. *Computer Applications in Engineering Education*, *30*(4), p. 222–234. https://doi.org/10.1002/cae.22452.

Ramskyi, Yu.S., Yefymenko, V.V., Strutynska, O.V., Tverdokhlib, I.A., Umryk, M.A., & Yefymenko, T.O. (2022). Tsyfrovi osvitni tekhnolohii: navchalna prohrama navchalnoi dystsypliny pershoho (bakalavrskoho) rivnia osvity dlia usikh pedahohichnykh spetsialnostei *[Digital Educational Technology: curriculum of the academic discipline of the first (bachelor) level of education for all pedagogical specialties]*. Kyiv: NPU imeni M.P. Drahomanova *[Kyiv: National Pedagogical Dragomanov University]*, 2022, 19 p. Retrieved from: http://enpuir.npu.edu.ua/handle/123456789/37992 (accessed 26 September 2022) [in Ukrainian].

Shah, D. (2021, December 1). By The Numbers: MOOCs in 2021. Retrieved from: https://www.classcentral.com/report/mooc-stats-2021 (accessed 26 September 2022).

Shah, D. (2021, December 14). A Decade of MOOCs: A Review of MOOC Stats and Trends in 2021. Retrieved from: https://www.classcentral.com/report/moocs-stats-and-trends-2021/ (accessed 26 September 2022).

Smyrnova-Trybulska, E., Sekret, I., & Morze, N. (2021). Preliminary analysis of the development and implementation of the MOOC project: a case study. In E. Smyrnova-Trybulska (Ed.). *E-learning in the Time of COVID-19*. "E-learning" 13 (pp. 137–150). Katowice–Cieszyn: STUDIO NOA for University of Silesia. ISSN 2451-3644. Retrieved from: https://us.edu.pl/wydzial/wsne/wp-content/uploads/sites/20/Nie przypisane/E-learning-131-17-12-2021.pdf (accessed 26 September 2022) [in English].

Strutynska, O. & Umryk, M. (2016). The Use of MOOCs for Training of the Future Computer Science Teachers in Ukraine. In E. Smyrnova-Trybulska (Ed.). *E-learning & Lifelong Learning*. "E-learning" 8 (pp. 297–320). Katowice–Cieszyn: STUDIO NOA for University of Silesia.

Strutynska, O. & Umryk, M. (2021). Distance, Online and Blended Learning as Main Educational Trends During Pandemic 2020 Conditions. *International Journal of Research in E-Learning*, 7(1), 1–25. https://doi.org/10.31261/IJREL.2021.7.1.02.

Umryk, M.A., Strutynska, O.V., & Vakulenko, I.V. (2021). Tsyfrovi osvitni tekhnolohii: prohrama kursiv pidvyshchennia rivnia tsyfrovoi kompetentnosti naukovo-pedahohichnykh pratsivnykiv universytetu *[Digital Educational Technology: program of courses to improve the level of digital competence of scientific and pedagogical staff of the university]*. Kyiv: NPU imeni M.P. Drahomanova *[Kyiv: National Pedagogical Dragomanov University]*, 2021, 18 p. Retrieved from: http://enpuir.npu.edu.ua/bitstream/handle/123456789/36367 (accessed 26 September 2022) [in Ukrainian].

UNESCO (2020, July 30). Connectivity Making universal connectivity a reality. Retrieved from: https://globaleducationcoalition.unesco.org/home/flagships/connectivity (accessed 26 September 2022).

UNESCO (2020, March 31). Global Education Coalition. Retrieved from: https://en.unesco.org/covid19/educationresponse/globalcoalition (accessed 26 September 2022).

United Nations (2020, July 13). Transforming our world: the 2030 Agenda for Sustainable Development. Retrieved from: https://sdgs.un.org/2030agenda (accessed 26 September 2022).

Yıldırım, B. (2022). MOOCs in STEM Education: Teacher Preparation and Views. *Technology, Knowledge and Learning*, *27*, p. 663–688. https://doi.org/10.1007/s10758-020-09481-3.

Zhu, M., Sari, A.R., & Lee, M.M. (2022). Trends and Issues in MOOC Learning Analytics Empirical Research: A Systematic Literature Review (2011–2021). *Education and Information Technologies*, *27*, p. 10135–10160. https://doi.org/10.1007/s10639-022-11031-6.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 89–104
https://doi.org/10.34916/el.2022.14.07

DIGITAL EDUCATIONAL CONTENT IN THE LEARNING ENVIRONMENT OF EDUCATIONAL INSTITUTIONS IN THE CONTEXT OF DISTANCE AND BLENDED LEARNING IN MATHEMATICS

Svitlana Skvortsova[1], **Anastasiia Ishchenko** [2], **Olha Halitsan** [3], **& Yana Haievets**[4]
South Ukrainian National Pedagogical University named after K. D. Ushynsky,
Staroportofrankivs'ka 26, Odesa, 65020, Ukraine
[1] skvo08@i.ua, ORCID 0000-0003-4047-1301
[2] stasi555@ukr.net, ORCID 0000-0002-8233-3858
[3] olgagalitsan@gmail.com, ORCID 0000-0003-2542-649X
[4] gaevets86@gmail.com, ORCID 0000-0003-4580-4080

Abstract: *This article deals with the use of digital educational content in mathematics teaching. The relevance of its use in distance and blended learning is important in a difficult epidemiological situation and in wartime, not only for the organisation of learning, but also for ensuring the quality of educational services. To this end, a questionnaire was developed and an online survey of 261 teachers from all regions of Ukraine was conducted. As a result of surveying teachers who teach mathematics in primary, basic, profiled schools, vocational and higher education, we found that 99.9% of them have experience in distance or blended learning, with 94.6% using digital educational content. In this regard, the question of which digital resources are the most popular among teachers, as well as at what level they use them – develop their own content or use ready-made content, is relevant. The article also explores teachers purposes for using digital content, their awareness, and their experience with such content. According to the analysis of teachers' responses, only 16.9% constantly create interactive assignments in various online services, and 70.9% do so occasionally.*

The results of the survey identified the most popular software packages for creating educational content; software for preparing presentations; tools for creating graphics and infographics; software for creating and editing videos; specialized mathematical packages and tools for studying mathematics; online services for test writing; services for creating interactive exercises, games, mental maps; online whiteboards; educational platforms. Teachers were also asked to assess their level of

ICT-competence, and 68.2% of teachers in Ukraine considered it sufficient. At the same time, there is a trend towards the development of ICT competences through mastering new services, in particular, software for working with multimedia information, and for this purpose 79.2% of teachers need seminars, webinars and trainings.

Keywords: ICT competences of mathematics teachers, teaching mathematics, digital content in education, distance and blended learning.

INTRODUCTION

Since 2020, humanity has found itself in conditions of periodic quarantines due to the pandemic, which brings the problem of using digital services, platforms for organizing schoolchildren's education in distance and blended learning up to date. In Ukraine, the problem of switching to distance learning has become even more relevant since February 2022 due to the declaration of martial law as a result of the Russian Federation's aggression. It should be noted that by this time teachers in Ukraine have gained some experience in organizing both distance and blended learning. We are therefore interested in the following *questions*: 1) to what extent do school and university teachers use the potential of digital educational resources? 2) has the dynamics of the use of digital educational resources by school and university teachers changed due to the organisation of distance and blended learning in Ukraine during the pandemic? 3) which digital learning tools are most popular in modern schools and universities? 4) how do teachers assess their level of activity in the use of digital learning tools and, specifically, their ICT competence?

1. ANALYSIS OF RESEARCH PUBLICATIONS IN THE FIELD OF DIGITAL EDUCATIONAL CONTENT

In recent years, scholarly attention has focused on the organisation of distance and blended learning in both universities and schools. The contemporary educational environment is considered by researchers to be two-component, i.e. consisting of two interrelated and mutually influencing parts: traditional classroom interaction and a digitally-based environment as an innovative complex of educational activities (Noskova & Pavlova, 2021). The study and development of a digitally based virtual classroom learning environment (VCLE) for undergraduate students in the study of STEM / STEAM disciplines in the context of gamification is the focus of Thai researchers, namely: Wannapiroon and Pimdee (2022). The study of Sun, Ruokamo, Kangas et al., (2022) shows the impact of collaborative digital game on students' behavioural, emotional, and cognitive engagement in mathematics. The experience of using ICT in educational innovation through the creation of digital content for an interactive digital board (IDB) is presented in the article of Castineira-Rodriguez, Perez-Rodriguez, & Lorenzo-Rial (2022). Thus, the creation of a digitally based environment involves the use of digital tools to create educational and gamification content.

Didactic aspects of blended learning in higher education, both traditional composition and e-learning are studied by Balyk, Shmyger, Vasylenko et al., (2021). The effectiveness of blended learning in training Greek teachers for the use of digital technologies in pedagogical work was proven by Zagouras, Egarchou, Skiniotis et al., (2022).

Obviously, the need for distance and blended learning brings the search for digital tools and their set up to date. Modern ICT tools are studied by an international team of researchers – Smyrnova-Trybulska, Sekret, and Morze (2021) – as part of the "Direction to the MOOCs" project. The aim of the project is to develop and implement the course "Contemporary ICT tools and innovative methods of creative education" in the students' training process. Thus, the problem of organising distance and blended learning is solved in two dimensions: 1) the use of digital tools by a teacher; 2) the preparation of students for the use of digital tools.

In view of the validity of organising both distance and blended learning, the issue of developing digital competences among university teachers arises. Researchers Sandi-Delgado, Sanz and Lovos (2022) address this problem through the use of serious games called AstroCodigo. The results obtained by the authors can be used to organise academic strategies for teaching digital skills in universities. It should be noted that the right set of skills is the foundation of teachers' digital well-being, as confirmed by an online survey of 336 teachers in Pakistan conducted by Yu, Mirza, Chaudhry et al. (2022).

The creation of a digitally based environment in teaching mathematics consists not only of the use of widely used digital tools, but also of specific mathematical software. The impact of implementing Inquiry-Based Learning (IBL) in mathematics teaching on the use of innovative pedagogical methods is explored by Morze, Boiko, and Smyrnova-Trybulska (2021). The authors consider theoretical and practical aspects of the development of academic teaching community for the introduction of innovative pedagogical technologies using IBL at educational institutions where staff work, carry out research and work together to improve teaching and research. Morze, Boiko and Smyrnova-Trybulska (2021) proved that community participation influences the use of innovative pedagogical methods in mathematics teaching. Ishchenko (2019) investigated the implementation of STEM education in Ukrainian schools, the selection of appropriate tools of modern pedagogical and information technologies for the organisation of STEM education in mathematics lessons, the methodological preparation of mathematics teachers for this activity, the development of innovations, the willingness to use IT technologies in the implementation of interdisciplinary links.

The issue of using various online services in teaching mathematics to primary school pupils was studied in the works of Skvortsova and Britskan (2021); Skvortsova, Britskan, and Haievets (2020); Skvortsova, Onopriienko, and Britskan (2019); Skvortsova and Britskan (2018). The authors conducted a comparative analysis of such online services as LearningApps, Google Classroom, Classtime, Classdojo; Renderforest, MS PowerPoint; Renderforest, H5P, Learnis; Padlet, Lino.it, Liveworksheets, Wizer.me. They have developed the algorithms for working in each of the templates of these services. However, in most cases, the researchers choose one or two services

for a particular idea. Thus, Khamcharoen, Kantathanawat, and Sukkamart (2022), researchers in Bangkok, used the online service Padlet to develop creative problem solving skills (CPSS) in 30 students in the Computer Education Programme, at Dhonburi Rajabhat University's Faculty of Education in Thailand.

In addition to widely used online services, specific digital tools are used in mathematics teaching. For example, in 2018 the Basic Digital Education (BDE) system was implemented in Austrian lower secondary schools (10–14 years old) to develop students' Computational Thinking (CT) as well as problem-solving skills. The system involves combining an Open Educational Resource (OER) textbook and Physical Computing with the micro:bit device. This system is planned to be introduced for pupils in grades 3 and 4 (8–10 years old) (Kastner-Hauler, Tengler, Sabitzer, & Lavicza, 2022).

The problem of formation the computational skills of primary school pupils was studied by Skvortsova, and Romanyshyn, (2020). The authors proved the effectiveness of using interactive mental arithmetic tasks created in the online services LearningApps, Liveworksheets, Wizer.me and the online platform OnlineMSchool, Pranglimine.

In order to shape the spatial abilities of preschoolers, such scientists as Lahav and Wolfson (2022) use the Osmo tactile user interface, which combines digital and physical objects, in particular the Osmo Tangram. Many mathematics teachers use spatial visualisation in their work using the GeoGebra service. It should also be noted that there are other online services for learning mathematics.

Obviously, teachers with professional experience, finding themselves in a distance or blended learning setting, are forced to master digital skills on their own through self-education or advanced training courses. Thus, researchers from the University of Los Llanos in Colombia, following a survey of teachers, came to the conclusion that teachers have a desire to develop digital skills through their professional practice, and thus acquire skills with a digital approach, understanding them as an opportunity for professional development (Torres-Florez & Diaz-Betancour, 2021).

The aim of the article is to interpret the results of an analysis of pedagogical work in Ukraine in the context of teachers' use of digital tools while organising the process of teaching mathematics in primary, middle (basic) and profiled schools; reflecting on the experience of using a digital learning environment in a distance learning setting. Achieving the aim of the study involves solving the following tasks:

1. to analyse scientific, methodological and regulatory sources in order to identify the specific characteristics of the process of creating a digital learning environment;
2. to determine the types of digital tools for creating educational content for schoolchildren in the systems of distance and blended learning in Ukraine;
3. to develop the content of a questionnaire, the answers to which will determine the experience of organizing mathematical distance and blended learning using digital tools, including specialised software packages. To organize and conduct a survey of teachers and lecturers through the social networks Facebook and Viber;

4. to identify popular application packages for creating educational content using comprehensive monitoring of teachers' use of various ICT technologies;
5. to interpret the results of monitoring the state of pedagogical practice in Ukraine on the use of digital resources in mathematics teaching in distance and blended learning settings.

2. RESEARCH METHODS

We conducted an online survey of teachers from all regions of Ukraine during the academic years 2021-2022. The aim of the survey was to investigate the issue of teachers' use of digital tools in the process of teaching mathematics, both in distance and blended format, to find out teachers' goals of using digital content, their awareness and experience of using such content, and to identify the digital resources that are most popular among teachers, and the level, on which they use them – develop their own content or use ready-made content.

The purpose of the study is to prove the hypothesis, which is as follows: 1) due to the organisation of distance and blended learning under pandemic conditions, school and university teachers have gained significant experience in the use of digital resources (digital didactic tools, virtualisation, digitalisation and gamification of the educational environment); 2) services for creating presentations for mathematics lessons, graphic editors, services for creating interactive exercises, test tasks, special software packages for teaching mathematics are widely used for the effective organisation of distance and blended learning; 3) the sustained positive dynamics of teachers' readiness for the full use of virtualisation, digitalisation and gamification of the digital educational environment is linked to the consideration of trends in contemporary educational practice and the development of further steps to improve the ICT competence of school and university teachers.

Our study used diagnostic methods of the basic level of teachers' awareness of the didactic potential of digital educational tools. For this purpose, a series of monitoring procedures was carried out using special questionnaires. This format of diagnostics made it possible to reveal the general level of teachers' awareness of special application packages and programs that provide virtualisation, digitalisation and gamification of the modern educational environment of Ukrainian educational institutions in distance and blended learning settings.

The diagnostics was carried out by processing the questionnaire material, based on the principle of teachers' "open" statements regarding the advantages and disadvantages of using digital tools in the classroom. The "open" format of the questionnaire did not provide for the development of a special scale for measuring teachers' ICT competence. In addition, during the experiment, respondents were deliberately not divided into control and experimental groups, since the use of distance learning in Ukraine has been carried out systematically for only two years and the verified data on the effectiveness of the use of digital didactic tools are absent. That is why the result of this stage of the study provides for the identification of only a generalised and average level of teachers' awareness of the advantages and disadvantages of digital educational content in the ratio.

The questionnaire was created using Google Forms and distributed through social networks such as Facebook and Viber. The survey was anonymous, the teachers were asked to answer 22 questions (21 closed type questions with a choice of answers, but at the same time each question allowed them to indicate their own answer), some of which were of a general nature: position in the education system, professional experience, experience in organizing distance and blended learning, using digital educational content, and experience in using digital technologies (https://docs.google.com/forms/d/e/1FAIpQLScKVShmqSYzwOStCIl5HiHwRzgTqZ4KYsVUzPq0aYt056pDCw/viewform).

The second set of questions provided information on the most commonly used digital educational content, the purpose of using electronic materials, the level of digital content use, the frequency of using educational content, the types of universal application packages, programs for creating presentations, graphics and infographics, video editing, types of specialized packages for mathematics teaching, services for compiling tests, interactive exercises, games, quizzes, mind maps, online boards, educational platforms. The third set of questions involved self-assessment of their own level of ICT competence, the need to master digital tools and the methods of obtaining knowledge.

Answering the questions, teachers were able to choose one or several suitable answers from the proposed ones, as well as write their own version. A total of 261 Ukrainian teachers took part in the survey: primary school teachers (41.4%; n = 108), mathematics teachers of middle school (40.2%, n = 105) and mathematics teachers of profiled schools (5.0%, n = 13), vocational school teachers (1.9%, n = 5), university teachers (7.3%, n = 19) (shown in Figure 1).

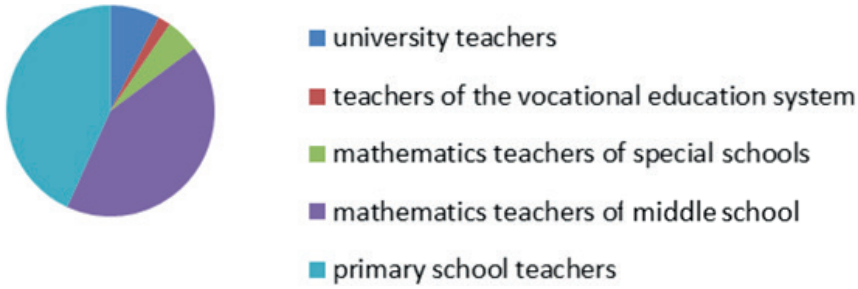


Figure 1. Distribution of teachers' answers by specialties

Source: Own work.

The others are teachers of both basic and profiled schools at the same time, students of pedagogical universities, teachers of the extended day-care groups, tutors. Depending on their professional experience, the respondents: 57.1% – have more than 20 years of teaching experience, 20.7% – 11–20 years, 11.9% of the respondents have 6–10 years professional experience and 7.3% – up to 5 years, while 1.9% claim the experience of 30–40 years and 1.1% – more than 40 (shown in Figure 2).

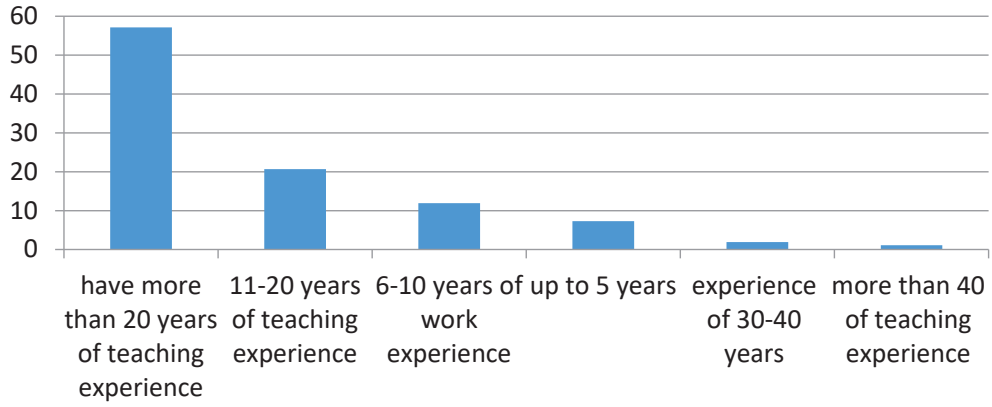


Figure 2. Distribution of teachers according to professional experience

Source: Own work.

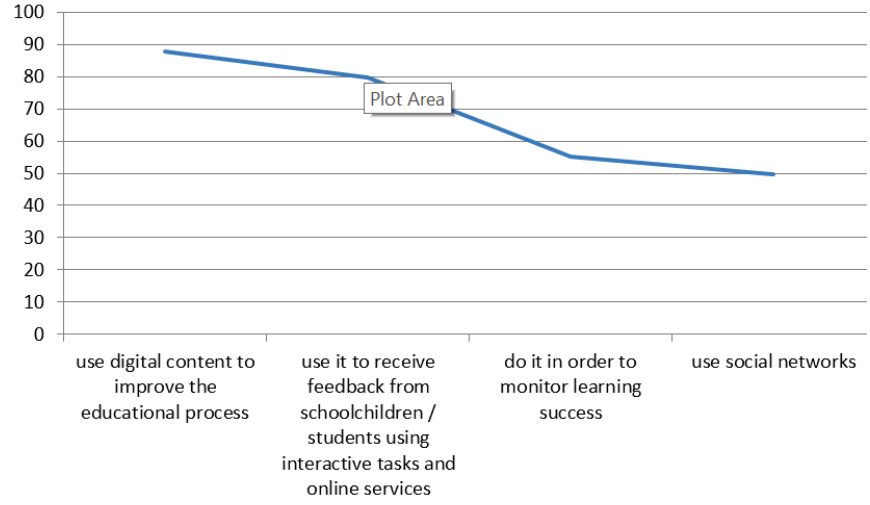
3. RESULTS AND DISCUSSION

As a result of a survey of the teachers who teach mathematics in primary, middle (basic), profiled schools, in the vocational education system and in the institutions of higher education, we have found out that 99.9% of them have experience in distance or blended learning, with 94.6% using digital educational content. Such a high percentage of teachers with distance learning experience is beyond doubt, because since March 2020, schools in Ukraine have periodically switched to distance learning. But some questions arise to 4.6% of teachers who provide distance learning but do not use digital educational content. Perhaps these teachers used only such social services as Viber, Skype, Zoom, Teams, Google Meet for online lessons, and organized videoconferences for mathematics lessons. At the same time, such a low percentage of teachers who do not use digital educational content is encouraging, taking into account the fact that 57.1% of respondents have more than 20 years of experience. This means that teachers with a long teaching experience have mastered digital skills to some extent. The data on the time spent using digital educational content is also encouraging: 25.3% use digital content in their work for more than 10 years, 31.0% – from 6 to 10 years, there are 20.3% of respondents with 3–5 years of such experience and 22.6% – up to 3 years. These data indicate the popularity of such resources in the pedagogical community. Thus, we can state that Ukrainian teachers widely use digital tools while organising mathematics education.

This raises the question of what digital resources are most popular among teachers, as well as at what level they use them – develop their own materials or use ready-made content. The majority of respondents (80.1%) use educational content posted on the Internet. Among the respondents there are those who develop and modify the necessary educational materials on their own (60.2%), and 41.4% of the respondents use ready-made educational content and their own materials. But there are those who do not use digital content in their work, but this percentage is quite low – 1.1%. It is important to note some disparity in similar data. Thus, when answering the question

about the experience of using digital educational content in distance and blended learning, 4.6% of respondents indicated its absence, and only 1.1% answered a direct question about the use of digital educational content. It can be seen that 4.6% have no experience of using it, and only 1.1% do not use digital content. Based on this data, we conclude that 3.5% use digital content, but they consider the experience of using it insufficient.

Through the survey, we investigated teachers' goals of using digital content in the organisation of mathematics teaching. The most common use of digital content by 87.7% of teachers is to improve the educational process, 79.7% use it to receive feedback from pupils / students using interactive tasks and online services, 55.2% of teachers do it to monitor learning success, for pedagogical collaboration with colleagues, 49.8% of respondents use social networks. It should be noted that a quarter of teachers use electronic learning materials, realising a whole range of goals – to monitor the learning success of pupils/students through the use of electronic journals; to receive feedback from pupils/students through interactive exercises using online services; to cooperate with colleagues using social networks. And only 17.2% of teachers chose one of the proposed goals.



F i g u r e 3. Distribution of teachers according to the purpose of using electronic educational materials

S o u r c e: Own work.

Thus, educational services help to achieve a whole range of goals, which means that the question of what digital resources teachers use is no less important. The results of the analysis of the answers to this question show that 26.4% of respondents use a whole range of tools: universal software tools, digital tools and web services, as well as the content of educational channels, platforms, portals, websites, etc. 17.2% use a narrower set: digital tools and web services, as well as content presented on educational channels, platforms, portals, websites. 24% of teachers in Ukraine use only content posted on educational channels, platforms, portals, and websites.

The next question of the questionnaire gave an opportunity to find out the level of the use of digital resources by teachers. As the analysis of teachers answers show, only 16.9% constantly create interactive tasks in various online services, and 70.9% – from time to time. 11.9% do not perform independent learning content using software. It is most likely these teachers are not digitally literate. A small percentage, only 8.0% of the respondents, have the necessary programming skills and create their own digital learning content. Almost all teachers – 82.4% use the content of educational channels, websites, etc., 60.2% – digital tools and web services, 49.8% of respondents use universal software. Presentation programs (MS PowerPoint, Prezi, SlideRocet, VoiceThread, PowerPoint, etc.) are the most popular among 92.3% of respondents; word processors (Microsoft Word, Word Perfect, ChiWriter, MultiEdit, Open Office, etc.) – among 88.5% of teachers. However, database management systems (Microsoft Access, Microsoft FoxPro, Paradox, Oracle, Informix, Sybase) are used by only 4.2% of teachers.

Teachers make sufficient use of: spreadsheet programs (Microsoft Excel, Lotus, Quattro Pro, etc.) – 48.7%; graphic editors (Paint Windows, CorelDRAW packages, Adobe PhotoShop and Adobe Illustrator, etc.) – 47.5%. Less popular among teachers in Ukraine, are: systems for automating calculations (Mathematica, Maple, MatLab, MathCad, etc.) – 21.5%; virtual sound and music programs – 24.1%; software tools for working with multimedia information (Movavi Screen Capture, Camtasia Studio, etc.) – 25.7% (shown in Figure 4).

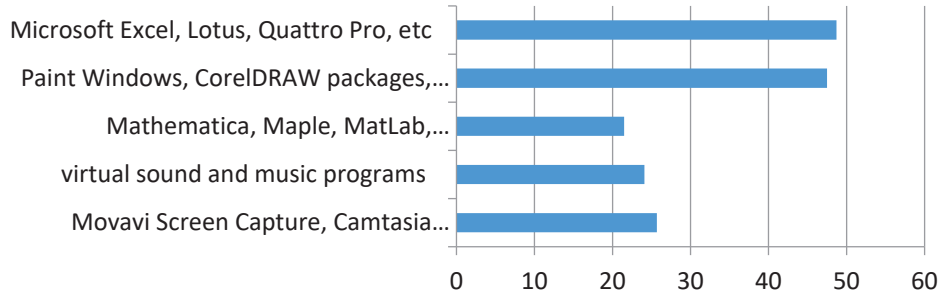


Figure 4. Types of digital resources used by teachers in their professional activities

Source: Own work.

It is important to note that only 0.7% of teachers use all the packages of educational content listed in the questionnaire (word processors, presentation programs, spreadsheet programs, graphic editors, database management systems, systems for automating calculations, virtual sound and music programs and software tools for working with multimedia information). Among them: a quarter are primary school teachers and one sixth are middle school teachers with more than 20 years of experience, 11.0% are primary school teachers with 6–10 years of experience and 11.0% of middle school teachers (6–10 years and 11–20 years of professional experience) and only 5.5% are university teachers. The majority (14.0%) only work with word processors and presentation programs.

PowerPoint turned out to be the most popular program for preparing presentations among teachers – 98.5%, they use Prezi (18.4%), ClearSlide (2.7%), Canva (1.5%) less often. As noted above, teachers had the opportunity to complete their own version; such responses included liveworksheet, Emazi, SlideShare, Google Slides, Genial.ly (shown in Figure 5).

And for creating graphics, infographics, Canva is the most popular tool, 54.0% of respondents work with it, 14.9% and 8.4%, respectively, are familiar with such programs as Piktochart and PosterMyWal. Crello is used by 0.4%, and 3.4% of teachers do not use such services (shown in Figure 6).

The results of the survey show that the majority of teachers work with programs for preparing and editing video tasks: Movavi – 46.7%, iMovie – 21.8%, Learnis – 16.9%, Camtasia – 9.6%, and 18.4% are not familiar with the above software list (shown in Figure 7).

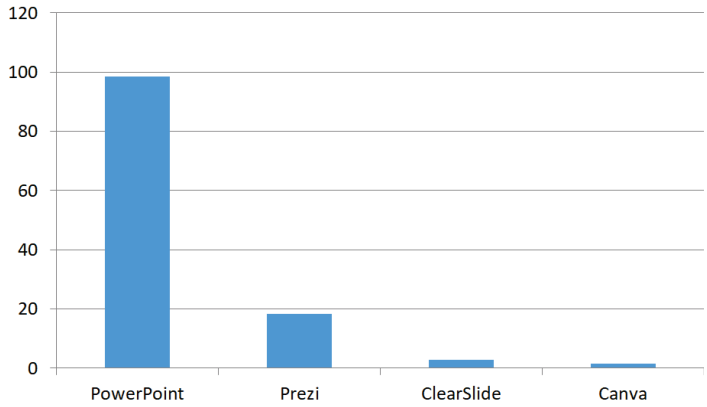


Figure 5. Types of services for creating presentations used by teachers in their professional activities

Source: Own work.

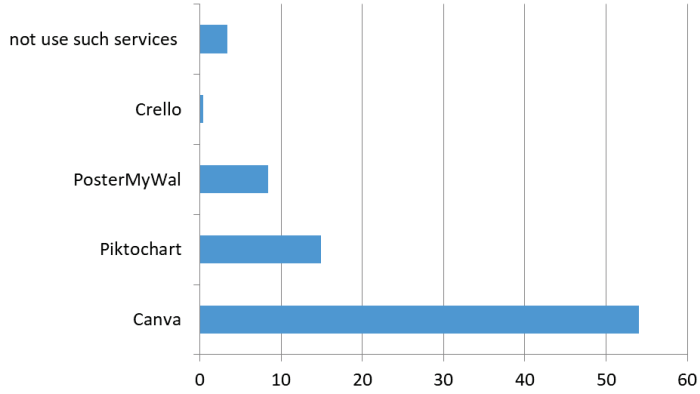
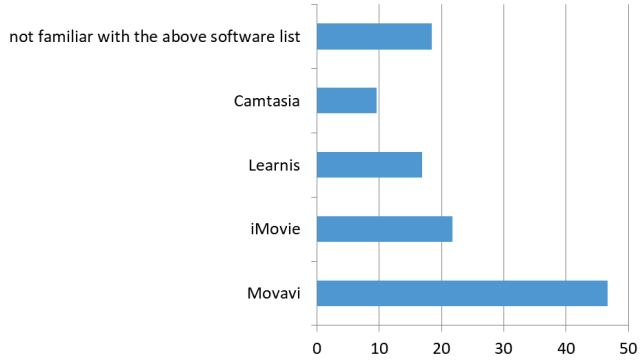


Figure 6. Types of services for creating graphics and infographics used by teachers in their professional activities

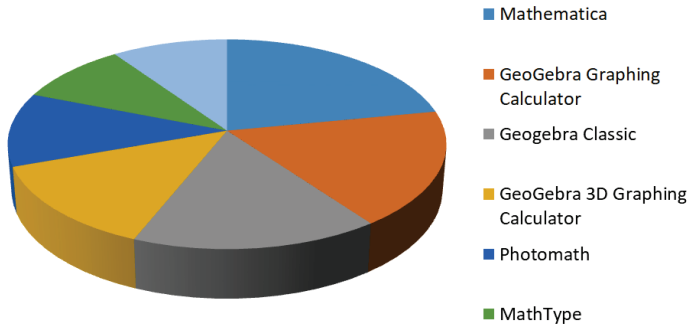
Source: Own work.



F i g u r e 7. Types of programs for preparing and editing videos used by teachers in their professional activities

S o u r c e: Own work.

Special digital tools play an important role in mathematics teaching. In this regard, we were interested in the experience of using mathematical packages, digital tools used by mathematics teachers. The most commonly used applications are Mathematica (29.5%), GeoGebra Graphing Calculator (24.1%), Geogebra Classic (21.8%), GeoGebra 3D Graphing Calculator (18.0%), Photomath (15.3%), MathType (12.6%), MathCAD (13%) (shown in Figure 8).



F i g u r e 8. Types of digital specialized mathematical tools used by teachers in their professional activities

S o u r c e: Own work.

The next rating group: Advanced Grapher, Pythagoria, LiveMath, Geometryx, Derive with a rating of 8.0%, 5.4%, 4.6%, 4.2%, 3.8%, respectively. Almost never used is Euclidea (0.4% of respondents). Unfortunately, 22.2% of teachers do not use such content in their practice.

For compiling tests teachers mainly use: Google Forms (93.1%), Classtime (28.0%), and Online Test Pad (19.2%). And only 6.9%, 1.9%, 0.4%, respectively, are familiar with Mentimeter.com, Webanketa, Simpol services. Applications Microsoft Forms, Kahoot!, tests of Ukrainian websites “Vseosvita” and “Na urok” are used by 0.4% of respondents who indicated them as “Own answer”.

93.1% of respondents try to diversify classes with the help of quizzes, games, exercises created using digital content, 74.7% of which use Learningapps for this, 33.0% – Quizizz, 25.3% – "Crossword Factory". Ukrainian teachers are less familiar with the services Learnis (14.9%), Liveworksheets (13.4%), Crosswordus (11.1%). The least used ones are Wizer me – 8.0%, CROSS – 6.1%, Flippity – 3.1%. It should be noted that 6.9% of teachers do not use this type of activity in their work.

Based on the characteristics of the cognitive processes of pupils, who are representatives of the digital generation, it is no less important to structure the educational material in teaching mathematics, the results of which can be presented in the form of a mind map. It is obvious that using services for creating mind maps is expedient. Respondents' answers to the question about the types of mind maps which they have used are shown in Figure 9.

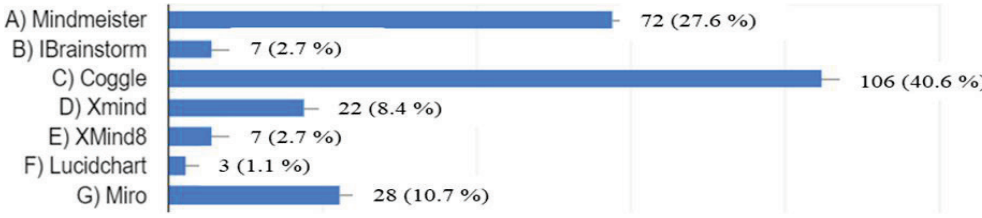


Figure 9. Mind maps in teachers' work

Source: Own work.

The percentage of those who do not use such services, unfortunately, turned out to be high – 21.5%, which is a cause for concern, as the presentation of educational material in a structured form affects the effectiveness of teaching mathematics.

To implement distance learning, 75.1% of respondents use Zoom, while 55.2% also use Padlet. Services such as Rizzoma and Scrumlr turned out to be unfamiliar to the respondents. 0.4% of teachers tried to use Google Meet, Whiteboard, Droo, Jamboard in their work.

Answers to the question "Which educational platforms did you accede?" presented in Figure 10.

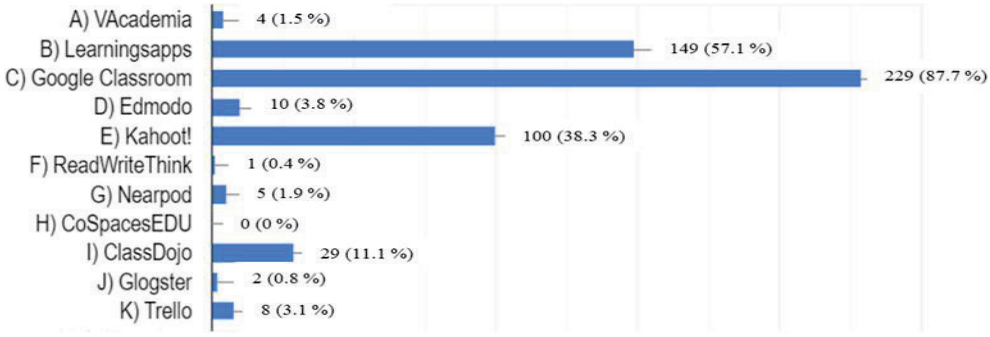


Figure 10. Use of educational platforms

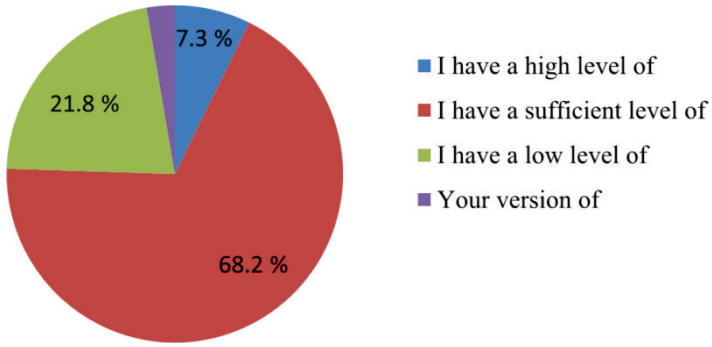
Source: Own work.

In addition to the platforms mentioned above, Microsoft Teams and "Na Urok" are used (0.4% of respondents each). We would like to note that there were no negative answers to this question.

The survey also included the teachers' self-assessment of ICT competence level (Figure 11). It is encouraging that the majority of teachers rated their level as sufficient, and 21.8% as high.

At the same time, 0.4% of teachers assessed their level as zero. And 42.2% of those who assess their ability to use digital tools at a low level want to improve it.

67.0% of teachers are ready to continue mastering software tools for working with multimedia information, 41.0% are ready to master virtual programs for working with sound and music files, 31.0% want to master new programs for preparing presentations, 39.8% – to improve their skills in using graphic editors, 22.6 and 26.1%, respectively, want to improve the skills in computing automation systems and control systems databases, 16.9% and 10.3% want to master the skills of working with spreadsheets and word processors.



F i g u r e 11. ICT competence of the respondents

S o u r c e: Own work.

At the same time, there is a noticeable trend towards the development of ICT competence through the development of new services, in particular, software tools for working with multimedia information, and for this, 79.2% of teachers need seminars, webinars and training.

Measuring respondents' awareness of the content and organisational parameters of the introduction of digital teaching tools at this stage of the study did not provide for identifying the criteria for the effectiveness of their use by teachers. The study was aimed only at identifying the general level of activity in the use of digital educational content by teachers. The experimental data obtained by means of a generalized percentage illustrate the general dynamics in the use of various application packages. This allows us to determine the prospects for further scientific research in this direction, which envisages the development of a clear criteria base and a set of features that can be used to diagnose the levels of ICT competence of contemporary Ukrainian teachers with their subsequent verification by means of mathematical statistics.

CONCLUSION

1. Based on the results of the analysis of scientific sources and methodological, statistical, informational and instructional literature, it has been established that the development of mathematical education worldwide is moving towards the creation of a digitally based learning environment. Many researchers have devoted their research to the study and development of digital tools that help students understand and assimilate educational material, provide its visualisation, create opportunities for research activities, and provide immediate feedback.
2. Among the digital tools which can be used for teaching mathematics, there are universal programs (creating presentations, educational videos, tables, tests, etc.) and specialised software packages for teaching mathematics (Geogebra, Mathematica, MathCAD, etc.).
3. Various combinations of both universal and specialised software tools can be used to organise a digital learning environment. To determine the most popular digital services among primary school teachers, mathematics teachers, vocational school teachers and university teachers in Ukraine, we included the majority of well-known digital tools in the content of the questionnaire and invited teachers to answer the questions of the anonymous online questionnaire posted on social networks. The activity of teachers should be noted – we received 261 responses.
4. Among the universal software packages, the most popular ones among Ukrainian teachers are programs for creating presentations for lessons (MS PowerPoint, Prezi, SlideRocet, VoiceThread, etc.) and text editors (Microsoft Word, Word Perfect, ChiWriter, Multi-Edit, Open Office, etc.). In particular, the most popular program for creating presentations is PowerPoint, and for creating infographics – Canva, video – Movavi. Among the specialised programs for teaching mathematics to pupils, Ukrainian teachers use Mathematica and Geogebra services the most.
5. Primary school teachers (41.2%) and mathematics teachers (41.4%) took part in the survey, and more than half of the respondents have extensive teaching experience – more than 20 years. 99.6% of respondents have the experience in distance and blended learning, while 94.6% have used digital services. It should be noted that Ukrainian teachers have a long experience of using ICT, in particular, 25.3% have been using digital technologies for more than 10 years, and 31.0% – from 5 to 10 years. However, most of them use digital content from educational channels (82.4%), and only 60.2% use digital tools and web services to create educational digital content. In fact, the use of digital resources by teachers is mostly carried out from time to time (70.9%), and only 16.9% – use digital support in lessons constantly.

Interpretation of the results of monitoring the dynamics of teachers' activity of using various ICT technologies allowed us to notice a trend towards the development of ICT competence through the development of new services, in particular, software tools for working with multimedia information, and to this end, 79.2% of teachers need seminars, webinars and training. The survey implied self-assessment of the level of

ICT competence of practising teachers. 68.2% of teachers considered the level to be «sufficient». This is the basis for the conclusion that subsequent work on increasing the level of ICT competence of teachers and lecturers can be carried out based on the existing set of skills and abilities in the use of digital educational content.

REFERENCES

Balyk, N., Shmyger, G., Vasylenko, Y., Skaskiv, A., & Oleksiuk, V. (2021). The didactic aspects of blended learning in higher educational institutions during the pandemic. In E. Smyrnova-Trybulska (Ed.). *E-learning in the Time of COVID-19*. "E-learning" 13 (pp. 65–75). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2021.13.06.

Castineira-Rodriguez, N., Perez-Rodriguez, U., & Lorenzo-Rial, M.A. (2022). Learn to create interactive digital content to teach science. *Magis, International Journal of Educational Research*, *15*, 1–24. https://doi.org/10.11144/Javeriana.m15.accd.

Ishchenko, A. (2019). STEM education: practical oriented tools for teachers of mathematics. In E. Smyrnova-Trybulska (Ed.). *E-learning and STEM Education Scientific*. "E-learning" 11 (pp. 631–642). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2019.11.39.

Kastner-Hauler, O., Tengler, K., Sabitzer, B., & Lavicza, Z. (2022). Combined Effects of Block-Based Programming and Physical Computing on Primary Students' Computational Thinking Skills. *FRONTIERS IN PSYCHOLOGY, 13,* Article Number 875382. https://www.frontiersin.org/articles/10.3389/fpsyg.2022.875382/ful.

Khamcharoen, N., Kantathanawat, T., & Sukkamart, A. (2022). Developing Student Creative Problem-Solving Skills (CPSS) Using Online Digital Storytelling: A Training Course Development Method. *International Journal of Emerging Technologies in Learning, 17*(11), 17–34. https://online-journals.org/index.php/i-jet/article/view/29931.

Lahav, O. & Wolfson, A. (2022). Enhancing spatial skills of young children with special needs using the Osmo Tangram based on tangible technology versus a Tangram card game. *VIRTUAL REALITY, 26*(2), Early Access JUN 2022. https://link.springer.com/article/10.1007/s10055-022-00665-z.

Morze, N., Boiko, M., & Smyrnova-Trybulska, E. (2021). Some theoretical and practical aspects of the organization of the community of teachers (on the example of inquirybased learning implementation). In E. Smyrnova-Trybulska (Ed.). *E-learning in the Time of COVID-19*. "E-learning" 13 (pp. 163–175). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2021.13.14.

Noskova, T. & Pavlova, T. (2021). Pedagogical goal-setting in a digital environment: problem actualization. In E. Smyrnova-Trybulska (Ed.). *E-learning in the Time of COVID*. "E-learning" 13 (pp. 125–136). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2021.13.11.

Sandi-Delgado, J.C., Sanz, C.V., & Lovos, E.N. (2022). Acceptance of Serious Games to Develop Digital Competencies in Higher Education. *Electronic journal of E-Learning, 20(3),* 351–367. https://doi.org/10.34190/ejel.20.3.2181.

Skvortsova, S. & Britskan, T. (2021). Distance mathematics lesson in primary school: servis for creating interactive exercises. In E. Smyrnova-Trybulska (Ed.). *E-learn-*

ing in the Time of COVID-19. "E-learning" 13 (pp. 225–237). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2021.13.19.

Skvortsova, S. & Britskan, T. (2018). Training for future primary school teachers in using service learning apps teaching mathematics. *International Journal of Research in E-learning*, *4*(1), 59–77. http://doi.org/10.31261/IJREL.2018.4.1.05.

Skvortsova, S., Britskan, T., & Haievets, Y. (2020). E-course "Internet resources for creating mathematical learning and game content for primary school children", In E. Smyrnova-Trybulska (Ed.) *Innovative Educational Technologies, Tools and Methods for E-Learning*. "E-learning" 12 (pp. 65–76). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2020.12.06.

Skvortsova, S., Onopriienko, O. & Britskan, T. (2019). Training for future primary school teachers in using service H5P teaching mathematics. In E. Smyrnova-Trybulska (Ed.). *E-learning and STEM Education*. "E-learning" 11 (pp. 277–294). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://us.edu.pl/wydzial/wsne/wp-content/uploads/sites/20/Nieprzypisane/E-learning-and-STEM-Education-2019-Vol.11.pdf.

Skvortsova, S. & Romanyshyn, R. (2020). Use of online simulators for the formation of primary school learners' computing skill. In E. Smyrnova-Trybulska (Ed.). *Innovative Educational Technologies, Tools and Methods for E-Learning*. "E-Learning" 12, (pp. 65–76). Katowice–Cieszyn: STUDIO NOA for University of Silesia http://doi.org/10.34916/el.2020.12.18.

Smyrnova-Trybulska, E., Sekret, I., & Morze, N. (2021). Preliminary analysis of the development and implementaition of the mooc project: a case study. In E. Smyrnova-Trybulska (Ed.). *E-learning in the Time of COVID-19*. "E-learning" 13 (pp. 137–150). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2021.13.12.

Sun, L., Ruokamo, H., Kangas, M., & Siklander, P. (2022). Effects of Collaborative Digital Gameplay on Students' Three Dimensions of Engagement in Mathematics. *International Journal of Game-Based Learning, 12*(1), 1–16. http://doi.org/10.4018/IJGBL.294012.

Torres-Florez, D. & Diaz-Betancour, D.M. (2021). The overview of university teachers in Colombia regarding their digital skills. *CLIO AMERICA, 15*(29), Article Number 4375. https://www.webofscience.com/wos/woscc/full-record/WOS:000740275900001.

Wannapiroon, N. & Pimdee, P. (2022). Thai undergraduate science, technology, engineering, arts, and math (STEAM) creative thinking and innovation skill development: a conceptual model using a digital virtual classroom learning environment. *Education and information technologies, 27*, 5689–5716. https://doi.org/10.1007/s10639-021-10849-w.

Yu, F., Mirza, F., Chaudhry, N.I., & Wu, Y.Y. (2022). Impact of Perceived Skillset and Organizational Traits on Digital Wellbeing of Teachers: Mediating Role of Resilience. *Frontiers in psychologiy, 13,* Article Number 923386. https://doi.org/10.3389/fpsyg.2022.923386.

Zagouras, C., Egarchou, D., Skiniotis, P., & Fountana, M. (2022). Face to face or blended learning? A case study: Teacher training in the pedagogical use of ICT. *Education and information technologies*. https://doi.org/10.1007/s10639-022-11144-y.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 105–119
https://doi.org/10.34916/el.2022.14.08

EDUCATION IN THE CONDITIONS OF PANDEMIC AND WAR: UKRAINIAN STUDENTS' REPRESENTATIVE OPINIONS

Nataliia Klishevych[1], Roman Pavliuk[2], Vadym Sulitskyi[3], & Tetiana Liakh[4]
Borys Grinchenko Kyiv University, Ukraine
[1] n.klishevych@kubg.edu.ua, ORCID 0000-0002-5611-6454
[2] r.pavliuk@kubg.edu.ua, ORCID 0000-0002-8957-6158
[3] v.sulitskyi@kubg.edu.ua, ORCID 0000-0001-6386-2028
[4] t.liakh@kubg.edu.ua, ORCID 0000-0002-8807-0497

Abstract: *The article deals with the results of the study of students' attitudes to distance learning in the conditions of a pandemic and martial law in Ukraine, the impact of distance learning on the quality of educational services and internships at the Institute of Human Sciences. The study helped to recognise the achievements, identify problems and improve the organization of the educational process at the Institute of Human Sciences during the pandemic and martial law; to analyse the quality of educational services and take into account their suggestions in preparation for the new academic year; to improve students' internships by providing suggestions to heads of internship bases. The main results of the study are formulated in Conclusions: the quality of education does not depend on the forms of teaching, but depends on the scientific and methodological support of educational disciplines by teachers, their use of the latest forms and methods of teaching, compliance of the content of the topics under consideration with modern trends and events taking place in the world; distance learning is perceived by students as a temporary inconvenience, to which they have successfully adapted thanks to the opportunity to work using e-learning courses and use various Internet platforms for communication with teachers and colleagues; internships in various social institutions contribute not only to the formation of students' certain practical skills and abilities, but also positively affect the formation of their general and special (professional) competences; practical orientation training and the policy of student-centeredness give positive results and make students competitive in the labour market in Ukraine; the pandemic and the state of war (martial law) in the country have made students more responsible, independent, patient, and tolerant.*

Keywords: pandemic; martial law; e-learning; quality of educational services; student; teacher; internship.

INTRODUCTION

The relevance of the study is due to the global COVID-19 pandemic and the adaptive quarantine on the territory of Ukraine, which has been in force since March 12, 2020. Due to quarantine restrictions, the education sector required correction and numerous changes in its work to ensure that the quality of educational services was at a high level. A new test for modern education was the full-scale military invasion of Russia into Ukraine on February 24, 2022. According to UNICEF (UNICEF, 2022), more than 11.3 million people left their homes in the first month of the war. More than 4.2 million people left Ukraine to seek refuge in other countries. The number of internally displaced people reached 7.1 million. On February 25, 2022, the Ministry of Education and Science of Ukraine recommended that higher education institutions suspend the educational process for security reasons. Starting from March 14, 2022, the educational process in most regions of Ukraine will be resumed in a remote format. Given the new challenges, the priority in the educational process was to improve existing and introduce new distance learning tools. In the organization of the educational process, the main task was the maximum focus on the needs and abilities of students.

Recent studies on the peculiarities of the organisation of the educational process during the pandemic confirm the effectiveness of using e-learning courses, distance technologies, taking into account the characteristics and capabilities of both students and teachers; peculiarities of communication during the distance learning format; creating conditions for maintaining mental health, reducing stress, etc.

LITERATURE REVIEW

Thus, it is important during the COVID-19 pandemic to analyse the specifics of the formation of competences of education recipients through distance learning. In particular, the research of Pavliuk and Liakh (2019) is devoted to the study of approaches to the formation of ICT competence of future social work specialists in higher education institutions; Liakh et al. (2021) studied the peculiarities of the formation and development of the professional competences of social workers in the conditions of distance learning.

The challenges and needs of education providers during the pandemic and military conflicts were studied in different countries: Morze and Varchenko-Trotsenko (2021) in Ukraine; Cuaton (2020) in Philippines; Matsuoka (2021) in Japan; Yang (2020) in China, etc.

Heasly and Iliiko (2022) emphasize the need to develop new tools for distance education, to form graduate employability skills.

According to Muzaffar et al. (2021) e-learning in higher education has grown significantly over the last decade due to its inevitable benefits in critical situations such as natural disasters (e.g., the COVID-19 pandemic, etc.) and military circumstances.

Incorporating digital citizenship into online experiences has proven to be a positive response to COVID-19 to provide a safe and flexible learning environment through advanced technology (Akcil & Bastas, 2021).
In this context, universities should be a reference point in shaping and preserving public health (Quinn et al., 2021).
Higher education is considered an important tool for the general development of any country. Researchers like Singh et al. (2021) point out that a good ecosystem in terms of political will, visionary leadership, fair budget, good infrastructure and a good teaching community are among the basic requirements for higher education to move towards new and higher horizons.
The current state of digital education and prospects for the development of digital competences are presented in the studies of such scientists as Buinytska, Kobylin, Kuzminska, Mazorchuk. They emphasize that the sustainable development of the University is ensured through the creation of a modern digital educational environment (Morze & Buinytska, 2019; Kuzminska et al., 2020).
Thus, we faced the need to study three aspects of the impact of the pandemic and the war on the distance learning of students of the Institute. We face the following questions: How did the pandemic and martial law affect the quality of student learning? How do students feel about distance learning during the pandemic and martial law? How to organize internships during distance learning? We hypothesized that distance learning affects the quality of student learning during a pandemic and martial law. We needed to find out whether this process had a positive or negative impact.

1. COMMON ACHIEVEMENTS, PROBLEMS AND WAYS TO IMPROVE THE ORGANIZATION OF THE EDUCATIONAL PROCESS AT INSTITUTE OF HUMAN SCIENCES

We have developed e-questionnaires on three main issues: a survey that will help to recognize our common achievements, identify problems and improve the organization of the educational process at the Institute of Human Sciences; a survey on the analysis and improvement of the quality of educational services provided by the Institute of Social Sciences; a survey on the students' internships.
All questionnaires were offered to students by filling out a Google form and sent to the corporate mail. The surveys were designed in such a way that the questions touched upon all aspects of the educational process and issues that can affect the quality of student learning. To test the hypothesis, we used mathematical statistics methods to process the results and compare the data.
Students were required to carefully fill out and honestly answer all items of these questionnaires. To achieve real results, the survey was anonymous. All responses were processed automatically. The study was conducted from June 2021 to June 2022.
The survey involved 97 students enrolled in the following study programmes: Psychology – 11.3%; Practical Psychology – 40.2%; Social Work – 10.3%; Social Pedagogy – 16.5%; Speech Therapy – 21.6%. Among them: 79.4% studied full-time, and 20.6% – part-time.

The gender picture of the survey is the following: women – 84.3%; men – 15.7%. This is due to the fact that in Ukraine these specialties are considered more female, and men are less willing to study in these study programmes. The obtained data correlate with the results of the admission of female and male students to the Institute of Human Sciences (mean statistical error ± 0.002).

Thus, the results of the survey represent the opinion of students of all areas of professional training carried out at the Institute of Human Sciences.

The survey, which helped to recognize common achievements, identify problems and improve the organization of the educational process at Institute of Human Sciences during distance learning, included 12 questions. We received the following data:

1. How satisfied are you with the results of your studies in the chosen educational programme (1 – dissatisfied, 5 – maximally satisfied)?

58.8% of students are maximally satisfied with the results of their studies in the chosen educational programme; 33% are satisfied; 5.2% are more satisfied than not, 3.1% are more dissatisfied than satisfied (see Figure 1).

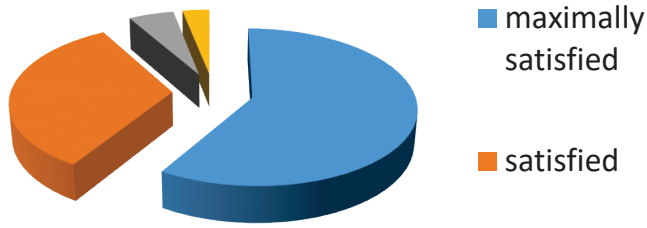
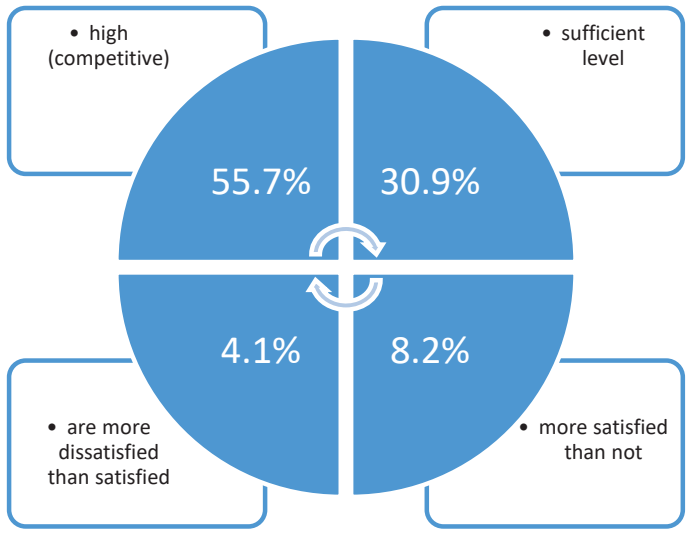


Figure 1. Distribution of respondents' answers to the question about satisfaction with studying in the chosen educational programme

Source: Own work.

Dissatisfaction with the results of studies in the chosen educational programme is explained by the large number of tasks that students need to complete; lack of "live communication"; the need to spend a lot of time at the computer. It should be noted that our university has e-learning courses in all disciplines to ensure the educational process, there are e-learning courses in all disciplines of any educational programme. They are developed in accordance with the working programmes of the academic disciplines and undergo appropriate professional certification in order to provide students with scientific and methodological materials for the courses they study. Electronic training courses include lectures, seminars, practical tasks, independent and module tests. In addition, each type of lesson has deadlines, methodical advice, a visual component, and reasonable and understandable requirements and evaluation criteria. In the e-learning course, the percentage of the workload of each student is monitored and the electronic system of evaluation and calculation of points in the register are monitored. Thus, it was e-learning courses during the pandemic and the transition to distance learning that allowed students to master the educational programme well. E-learning courses have become a tool to organize and conduct the educational process during the war, since students can work and complete tasks in the e-learning course from any corner of the world.

2. Rate the modernity and practical orientation of the educational programme (1 – does not meet modern trends, has no practical orientation, 5 – fully meets modern trends, has a practical orientation):
63.9% of students recognized the modernity of educational programmes and their orientation to practice; 26.8 – believe that most of the educational disciplines they studied have modern content and are practically oriented. At the same time, 7.2% of students said that they lack a practical component in their studies. They explain this by the lack of an opportunity to do something on their own. It should be noted that during distance learning, the following types of online classes became popular among students: webinars with leading practitioners; master classes for employees of public and state institutions on a particular type of activity in a particular sphere of life, guest lectures; webinars, etc. Thus, students had the opportunity not only to acquire certain scientific knowledge in academic disciplines, but also to see and independently practice their skills during practical activities. For example: a webinar on combating domestic violence helped students to get acquainted with methods and techniques of overcoming conflicts in the family.
3. Rate the level of mastering social skills (emotional intelligence; critical thinking; creativity; stress resistance; teamwork, etc.) in the learning process (1 – low (non-competitive) level, 5 – high (competitive) level). The results of the distribution of students' answers are presented in Figure 2.



F i g u r e 2. Distribution of respondents' answers on the level of mastery of social skills (emotional intelligence; critical thinking; creativity; stress resistance; teamwork, etc.) in the learning process

Source: Own work.

As we can see from Figure 2, 55.7% of students acknowledged that the level of their social skills is sufficient to ensure their high competitiveness in further professional activity; 30.9% – note their sufficient level in this area of training; 8.2% – believe that

they are more satisfied than not; 4.1% are more dissatisfied than satisfied. Students explain their dissatisfaction by the lack of prospects in the future, the randomness of the chosen specialization, low self-esteem. However, this can also be explained by the fact that dissatisfied students had high expectations, which, in their opinion, were not justified due to distance learning. Thus, distance learning did not significantly affect students' mastering of social skills, which significantly increase their competitiveness in further professional activities.

4. What information resources did teachers use for your online learning?

Among the most common electronic information resources recognized by students, teachers used Hangouts (Google) Meet, Moodle (72.2%), ZOOM (11.3%), SKYPE, Telegram, Viber, E-mail, etc. (from 1% to 4.4%). It should be noted that no student named such an electronic resource as YouTube. At the same time, 1% of students identified that teachers use Instagram and Facebook. Thus, it can be concluded that teachers need to expand their own digital competence in order to use a greater variety of electronic information resources to improve the educational process. This will help to make classes interesting and useful. It is also advisable to use various platforms, for example – POWTOON, for students to practice practical skills when solving situational tasks.

The results of a study by Muthuprasada et al. (2021) showed that the majority of respondents (70%) are willing to choose online classes to manage curricula during this pandemic. Most students preferred using a smartphone for online learning. Through content analysis, we found that students prefer recorded sessions with a quiz at the end of each session to improve learning efficiency.

5. As we can see, the teachers conducted most of the classes in Moodle. Therefore, our next question was: "Is the Moodle platform easy to use for distance learning?"

68% of students noted the convenience of using this platform during distance learning and its provision; 25% – recognized partial benefits. Among other students, less than one percent did not use this electronic resource and chose another way (e-mail, Viber, Telegram, etc.) to communicate with teachers. These data correlate with the results presented in point 4. Among the disadvantages of the Moodle platform, students identified: lack of a modern interface, limited technical capabilities and functionality.

6. Is it convenient to use Hangouts (Google) Meet for online classes?

Students found this communicator convenient for online classes (88.7%); 10.3% – consider it partially convenient due to an unexpected technical failure during classes. As for 1% of students, they did not use this electronic resource and chose another way (e-mail, Viber, Telegram, etc.) to communicate with teachers. This fully correlates with the results obtained in point 4 and point 5.

Thus, we can conclude that the total involvement of students in distance learning is 99%. The results of our study partially coincide with the results of other researchers (Kuzminska et al, 2020).

7. Would you like to see elements of distance education used in the future for other students?

64.9% of students admitted that they would like elements of distance learning to be used in the future for other students; 28.9% – spoke in favour of partial use of this form of work with students; 5.2% of students are strongly against distance learning;

1% – noted that distance learning (even elements) will not be as effective as face-to-face meetings and field workshops. Thus, despite the preference among students to use distance learning in the further educational process, almost a third of them have doubts about the effectiveness of this form of education.

8. What do you think are the advantages of distance education?

Among the most common answers (100%) we have: convenience. I am always in touch with teachers and can complete assignments when it is convenient for me; it was easy to combine with work; studying at home saves time that is usually spent traveling to the university; comfort; learning in a quiet environment. Intermediate evaluation of distance course students takes place in the form of online tests. Therefore, students have less reason to worry. The possibility of subjective evaluation is excluded: the electronic system that checks the correctness of the answers to the test questions will not be affected by the student's performance in other subjects, his social status and other factors; individual approach. With traditional teaching, it is quite difficult for the teacher to pay the required amount of attention to all the students in the group, to adjust to the pace of work of each student. The use of distance technologies is suitable for organising an individual approach. In addition to the fact that the student chooses his pace of learning, he/she can promptly receive answers to questions that arise from the teacher: accessibility, mobility. Everything is in an accessible format (we can say that it is at hand in the phone). You can study anywhere; all you need is an Internet connection; easy assimilation of educational material. More free time.

Thus, among the advantages of distance learning, students highlight: comfort, convenience, accessibility, cost-effectiveness, peace of mind, objectivity of evaluation, mobility, communication.

9. What difficulties did you face and how do you propose to solve them during distance learning?

Almost 92% of the surveyed students answered that there were no difficulties. Among other answers (8%), we find the following statements: it is difficult to concentrate on subjects during distance learning; during the internship, I had to work remotely, because most institutions were closed for quarantine; additional supervision, webinars, online courses; when you were asked to turn on the camera and microphone at the beginning, and you are not alone in the room; communication difficulties during study; a lot of work at the computer; the difficulty adapting to the online learning format; difficulties associated with the need to master time management.

Thus, the disadvantages of distance learning can be divided into four conditional groups: organizational, technical, communicative, methodical.

Among the proposals made by students to improve distance education, the following should be highlighted: increase the number of English language classes; to reduce the amount of workload on students, to convert quantitative indicators of successful learning into qualitative ones; to change the evaluation criteria for individual disciplines; to optimize the teaching of academic disciplines; to improve the information technology competence of both students and teachers.

10. Was it more difficult to study remotely on 3–4 courses, compared to full-time study on 1–2 courses? (see Figure 3).

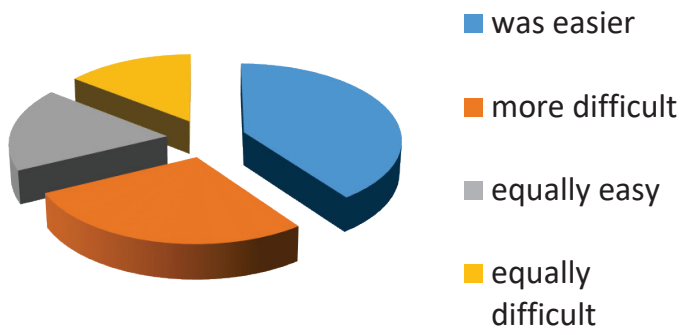


Figure 3. Distribution of students' answers to the question "Was it more difficult to study remotely on 3–4 courses, compared to full-time study on 1–2 courses"

Source: Own work.

Distance learning was easier for 37.1% of students than full-time. Among them are students who are used to constantly working and acquiring knowledge. For 25.8% of students distance learning was more difficult. This is mainly due to time management, problems with the organization of their own time. For 16.5% of students, it was equally easy to study both full-time and remotely. And for 13.4%, it was equally difficult to study both full-time and remotely. Among other answers, we see the following: at first it was difficult to adapt, but over time everything got better; it was difficult to study not because of distance learning, but because of the lack of face-to-face communication with teachers; it all depended on the number of tasks that had to be performed in academic disciplines; it was difficult emotionally.

We would like to highlight the words of gratitude from students to teachers for timely adaptation to changes and excellent organization of distance learning.

11. Has the workload increased during distance learning?

The workload increased for 46.4% of students. This is due to the need for students to independently process a large amount of information, additionally attend guest lectures, take additional training courses on various educational Internet platforms. 37.1% of students believe that the workload during distance learning remained the same as during full-time classes; 13.4% noted that the workload has decreased. Students themselves explain this by the fact that teachers quickly adapted to the changes and made timely changes to the e-learning courses.

12. Please provide your suggestions for improving the educational process in the programme you studied.

Among students' suggestions , we came across the following: to pay more attention to practical tasks of theoretical issues considered during classes; to consider more practical aspects of specialists' activities through interactive forms of learning; to apply the latest technologies and teach students their use through assignments for practical work; additional teaching of academic subjects in foreign languages; to conduct more guest lectures, master classes, webinars by leading experts in various academic disciplines; to support the development of scientific media resources of the Institute of Human Sciences on popular Internet platforms.

Thus, the survey on the achievements, problems and improvement of the organization of the educational process at the Institute of Human Sciences during distance learning showed that students are generally satisfied. They have a personal opinion on how to improve and optimize learning. All their suggestions are taken into account in the organization of student learning in the next academic year.

2. ANALYSIS AND IMPROVEMENT OF THE QUALITY OF THE EDUCATIONAL SERVICES PROVIDED BY THE INSTITUTE OF HUMAN SCIENCES

We examined the attitude of students to distance learning at the Institute of Human Sciences. The next step was to study the question: "How did distance learning affect the quality of student learning?" We conducted a survey and received the following results:

1. To what extent were your expectations met after entering this educational programme?

44.8% of students answered that their expectations were fully met; 31% – largely met; 17.2% found it difficult to answer this question; for 8% of students, their expectations were either not met or not met at all. As practice shows, students who express dissatisfaction chose a specialty following their parents' recommendations, for the sake of their friends' company, where there was enough passing score on the results of the evaluation of knowledge.

2. Among the advantages of studying at the Institute of Human Sciences, students highlight the fact that it is the best space for quality education; the availability of a real choice of educational disciplines of the elective block; taking into account the interests and needs of students; partnerships between teachers and students. The results obtained coincide with the data of the primary questionnaire, which determined the attitude of students to distance learning.

3. Among the shortcomings affecting the quality of education, students identify: too much legislation, sometimes complex legal documents; lack of distance learning in some educational programmes; distance learning format; unpopularity of certain educational programmes.

4. In your opinion, does the study programme allow you to sufficiently form or develop basic professional competences?

65.5% of students answered this question affirmatively; 27.6% – rather yes than no; 6% – rather no than yes. These data confirm and correlate with the results of points 2–4 of the previous survey, which allows us to conclude that the distance form of education does not significantly affect the quality of education, provided that the educational process is properly organized.

5. What disciplines, in your opinion, should be added to your educational programme?

Students gave the following answers to this question: development of social programmes; psychology and legal sciences; preferably more usual practice, rather than therapeutic, is desirable; management and personality psychology.

Analysing students' answers to the questions in comparison with item 3 of this survey, we see contradictions regarding the legislative and regulatory framework. On the one hand, they believe that there is too much such information, on the other hand, they believe that the educational process should be supplemented with legal disciplines. This is explained by different approaches of guarantors of educational programmes to the application of legal disciplines in the educational process of students. For example, the educational programme "Social Advocacy" requires the study of legislation regulating the provision of social services in Ukraine, and the educational programme "Speech Therapy" requires students to know the basics of legislation in the field of inclusive education and work with children with disabilities.

6. 93.1% of students recognized the educational space of the University as favourable for the success of their own studies. These students like to study under any conditions and circumstances. Communication skills in the educational space, learning and mastering new knowledge, skills, abilities and acquiring certain general and special competences that will help them to be competitive in further professional activities are important for them.

7. Almost 98% of students admit that the material and technical environment of the University has a positive effect on the success of learning and the quality of knowledge acquisition.

8. 96.3% answered the question "What exactly do you lack in the educational space and material and technical environment of the University?": "Offline mode. Because working in a group is easier than remotely." Here we observe a contradiction between the answers to this question and the results obtained in point 9 of the previous questionnaire. At the same time, students recognize the level of informational and organizational support provided to them by the guarantor of the educational programme and the administration in the process of studying a particular educational programme as sufficient (86.2%) and partially sufficient (13.8%). However, students lack the support of fellow students (90%). Thus, it can be concluded that students lack "live" communication with teachers and classmates. And this affects the "emotional background" of students' learning material, but does not significantly affect the quality of knowledge gained.

9. Students are completely or partially satisfied with the schedule of the educational process and the schedule of classes (97.3%). But there are also proposals and reflections on: changing senior students' courses to the second shift; quarantine conditions and wartime, which did not allow them to fully enjoy full-time education; increasing the duration of breaks between pairs; early transition to face-to-face education.

10. Evaluate the volume of the main types of your workload while studying in the educational programme: the volume of classroom hours is optimal (9.4 points out of 10); the amount of independent work is optimal (9.7 points out of 10); the volume of practical classes is optimal (9.34 points out of 10); the time allocated for coursework is optimal (9.12 points out of 10).

Thus, students recognized that the amount of workload is optimal for distance learning. This is different from the data obtained in point 11 of the previous survey, which indicates a positive attitude of students to learning despite the fact that during distance learning, almost half of them indicated that the study load increased. At the

same time, the students suggested that the time for coursework preparation should be freed from a large number of classroom classes.

11. From which sources do you learn about the programme learning outcomes, content, goals of the educational programme (choose all the answer options that correspond to your experience): educational programmes – 86.2%; work programmes of academic disciplines – 58.6%; at the beginning of the study of the academic discipline – 72.4%; presentation of the educational programme – 44.8%; reported by the leader or classmates in a joint conversation – 3.4%

12. It should be noted that students participate in the work of scientific circles, but wish that the work in this direction was more active (82.6%). This also applies to academic mobility programmes for students. At the same time, they acknowledge their awareness of competitions, international exchange programmes, grant offers (98%). They receive this information from teachers, the university website, electronic publications (96.3%). Among the reasons why students do not participate in academic mobility programmes, students most often mention lack of time; insufficient knowledge of foreign languages; do not want to change something in their own lives. Thus, students have the opportunity to use and participate in academic mobility programmes, but due to self-doubt or unwillingness to leave the "comfort zone", low self-esteem, they do not want to do it.

13. One of the priority activities of university teachers is the formation of students' knowledge of academic integrity during their studies. 97% of students know and use the basic principles of academic integrity in the educational process. Students are informed about the algorithm of actions in cases of sexual harassment, corruption, discrimination during studies (89%).

14. Satisfaction with the quality of education at the Institute of Human Sciences is confirmed by the fact that 93.1% of students recommended others who wish to enter bachelor's and master's programmes to study at the educational programme they are studying.

15. Students are satisfied with the level of communication with the guarantor of the educational programme (79.3%) and the counsellor of the student group (89.7%).

Thus, in general, students of the Institute of Human Sciences highly appreciated the quality of education in educational programmes. Despite the adverse circumstances (pandemic, war), the education is organized and conducted at a sufficiently high level. Students noted that their expectations regarding this specialty were met; flexible study schedule; favourable educational space; good material and technical equipment of the educational process; sufficient level of support from the guarantor of the educational programme, teachers and tutors of student groups; optimal workload from the main types of educational activities. Among the main shortcomings students indicated participation in the academic mobility of students; work of department scientific circles. Suggestions: to advertise the educational programme in social networks.

3. STUDENT INTERNSHIPS

One of the components of the educational process is the organization of student internships. In our institute, student learning is practice-oriented. Therefore, it is important for us to have feedback on the evaluation of student internships in various social institutions. Our survey gave the following results:

1. Students rated the level of theoretical preparation for practice at 9.8 points out of 10. This indicates a high professional level of the teaching staff of the Institute. At the same time, students widely used the knowledge gained during classes, for example, on social work with different types of families. However, there was a lack of certain practical skills in certain types of activities, for example, telephone counselling. This affected the students' assessment of the use of their knowledge in practical activities (9.6 points out of 10).
2. Students highly appreciated the opportiunities of the practice bases for their professional growth (9.8 points out of 10), which indicates a high level of qualification of employees of organizations that provided students with practice and good material and technical equipment. This contributed to various opportunities for students to develop professional skills and abilities, such as: working with stress; providing psychological assistance in crisis situations; drawing up psychological characteristics; assessing the needs of recipients of social services, etc. (9.8 points out of 10).
3. Students highly appreciated the impact of practice on the formation of professional competences (9.7 points out of 10) and readiness to perform professional functions (9.6 points out of 10).
4. Internships in certain social institutions influenced students' choice of employment in the relevant social institutions. According to our analysis of the employment of graduates of our institute, after graduation, 85.3% are employed in the institutions where they did their internship. 67% of them already have a permanent job.
5. The highest score (10 points out of 10) was given to the objectivity of the practice supervisors from both the institute and the practice base.
6. Internships during the pandemic and martial law in Ukraine helped students to develop such personal qualities as independence, self-organization, patience, tolerance, responsibility, efficiency, etc.

Thus, students highly appreciated the internships in social institutions. They noted that their theoretical training, which they received at the Institute of Human Sciences, allowed them to complete the tasks of the practice and prove themselves as highly qualified workers on the basis of practice. The most necessary theoretical knowledge for performing the tasks of this type of practice turned out to be knowledge of the theory of social work, social work with service recipients in territorial centres of social services, gerontology, social protection of the population. Also, all applicants noted that the practice bases offered various forms and methods of work to develop practical skills and abilities in accordance with the practice tasks. They especially noted that the most productive for improving their practical competence were familiarization with the assessment of the problems of recipients of social services, analysis of the work of the "Social assistance at home" centre and other areas;

counselling; work with documents; performing practical tasks; conducting interviews in crisis and stressful situations.

Thus, according to the answers of the respondents, it can be noted that the internships during the pandemic and martial law were organized at a high level, students were able to fully complete the tasks provided for by the internship programmes, as well as practise, improve and form practical skills and abilities.

CONCLUSION

The conducted research helped us to recognise the achievements, identify problems and improve the organization of the educational process at the Institute of Human Sciences during the pandemic and martial law; to analyse the quality of educational services provided to students, and take into account their suggestions in preparation for the new academic year; to improve the internships of students by providing suggestions to the supervisors of internship bases. In addition, we can draw the following conclusions:

1. The quality of education does not depend on the forms of instruction, but depends on the scientific and methodological support of teachers of educational disciplines, their use of the latest forms and methods of education, compliance of the content of the topics under consideration with modern trends and events taking place in the world.
2. Students perceive distance learning as a temporary inconvenience, to which they have successfully adapted thanks to the ability to work in e-learning courses and use various Internet platforms for communication with teachers and colleagues.

The practical implications of the study by Shah et al. (2021) inform policy makers in academia about the psychological needs of students in a virtual learning environments.

3. Internships in various social institutions contribute to the formation in students not only of certain practical skills and abilities, but also have a positive impact on the formation of their general and special (professional) competences.
4. Practice-oriented education and the student-centred policy give positive results and make students competitive in the labour market in Ukraine.
5. The pandemic and the state of war in Ukraine have made students more responsible, independent, patient, and tolerant.

REFERENCES

Akcil, U. & Bastas, M. (2021). Examination of university students' attitudes towards e-learning during the COVID-19 pandemic process and the relationship of digital citizenship. *Contemporary Educational Technology*, *13*(1), 291. https://doi.org/10.30935/cedtech/9341.

Cuaton, G. (2020). Philippines Higher Education Institutions in the time of COVID-19 Pandemic. *Revista Romaneasca pentru Educatie Multidimensionala*, *12*, 61–70. https://doi.org/10.18662/rrem/12.1sup2/247.

Heasly, B. & Iliiko, D. (2022). Overcoming Disruptions Caused by the Pandemic: Purposeful Leading to a More Sustainable World. *Discourse and Communication for Sustainable Education*, *13*(1), 1–4. https://doi.org/10.2478/dcse-2022-0001.

Kuzminska, O., Mazorchuk, M., Morze, N., & Kobylin, O. (2020). Digital Learning Environment of Ukrainian Universities: ‘e Main Components to Infuence the Competence of Students and Teachers. In V. Ermolayev, F. Mallet, V. Yakovyna, H. Mayr, & A. Spivakovsky (Eds.). *Information and Communication Technologies in Education, Research, and Industrial Applications*. ICTERI 2019. Communications in Computer and Information Science, *1175*, 210–230. https://doi.org/10.1007/978-3-030-39459-2_10.

Liakh, T., Spirina, T., Lekholetova, M., & Shved, O. (2021). Building professional competences of social workers through distance learning in the context of the COVID-19 pandemic. In E. Smyrnova-Trybulska. *E-learning in the Time of COVID-19*. “E-learning” 13 (pp. 151–162). Katowice–Cieszyn: STUDIO NOA for University of Silesia. ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-25-4. https://doi.org/10.34916/el.2021.13.13.

Matsuoka, I. (2021). EDITORIAL: Impact of COVID-19 pandemic on higher education in Japan: Transition to online education and challenges in experiential pharmacy practice. *Pharmacy Education*, *20*(2), 91–94. https://doi.org/10.46542/pe.2020.202.9194.

Morze, N. & Buinytska, O. (2019). Digital Competencies of University Teachers. In E. Smyrnova-Trybulska, P. Kommers, N. Morze, J. Malach (Eds.). *Universities in the Networked Society. Critical Studies of Education, 10*, (pp. 19–37). Cham: Springer. https://doi.org/10.1007/978-3-030-05026-9_2.

Morze, N., Varchenko-Trotsenko, L., Terletska, T., & Smyrnova-Trybulska, E. (2021). Implementation of adaptive learning at higher education institutions by means of Moodle LMS. *Journal of Physics: Conference Series*, *1840*. IOP Publishing Ltd. https://doi.org/10.1088/1742-6596/1840/1/012062.

Muthuprasada, T., Aiswaryab, K.S., Girish A., & Jhaa, K. (2021). Students’ perception and preference for online education in India during COVID-19 pandemic. *Social Sciences & Humanities Open*, *3*(1). https://doi.org/10.1016/j.ssaho.2020.100101.

Muzaffar, A., Tahir, M., Anwar, M., Chaudry, Q., Rasheed Mir, S., & Rasheed, Y. (2021). A Systematic Review of Online Exams Solutions in E-Learning: Techniques, Tools, and Global Adoption. *IEEE Access*, *9*, 32689–32712. https://doi.org/10.1109/ACCESS.2021.3060192.

Pavliuk, R.O. & Liakh, T.L. (2019). Approaches to the Development of the ICT Competence Standard in the System of Research-Based Training for the Future Specialist of Social Sphere in Ukraine. In E. Smyrnova-Trybulska, P. Kommers, N. Morze, J. Malach (Eds.) *Universities in the Networked Society. Critical Studies of Education*, *10*, (pp. 201–222). Cham: Springer. https://doi.org/10.1007/978-3-030-05026-9_12.

Quinn, V.J., Dhabalia, T., Roslycky, L., Wilson, V.J., Hansen, J., Hulchiy, O., Golubovskaya, O., Buriachyk, M., Vadim, K., Zauralskyy, R., Vyrva, O., Stepanskyi, D., Ivanovitch, P., Mironenko, A., Shportko, V., & McElligott, J. (2021). COVID-19 at War: The Joint Forces Operation in Ukraine. *Disaster medicine and public health preparedness*, *16*(5), 1753–1760. https://doi.org/10.1017/dmp.2021.88.

Shah, S.S., Shah, AA., Memon, F., Kemal, A.A., & Soomro, A. (2021). Aprendizaje en line durante la pandemia del COVID-19: aplicación de la teoría de la autodeterminación en la «nueva normalidad». *Revista de Psicodidáctica*, *26*, 169–178. https://doi.org/10.1016/j.psicod.2020.12.004.

Singh, B., Kaur, J., Sen, R.K., Singh, B., & Chattu, V.K. (2021). The Double Whammy of Pandemic and War: A Systematic Review of India's Education Diplomacy to Address Educational Inequities in Afghanistan. *Education Sciences*, *11*(10), 651. https://doi.org/10.3390/educsci11100651.

UNICEF. (2022, March 24). More than half of Ukraine's children displaced after one month of war. https://www.unicef.org.uk/press-releases/more-than-half-of-ukraines-children-displaced-after-one-month-of-war-unicef/.

Yang, R. (2020). China's higher education during the COVID-19 pandemic: some preliminary observations. *Higher Education Research & Development, 39*:7. 1317–1321. https://doi.org/10.1080/07294360.2020.1824212.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 120–131
https://doi.org/10.34916/el.2022.14.09

ASPECTS OF DEVELOPING STUDENTS' INDIVIDUAL EDUCATIONAL TRAJECTORY

Hennadii Karimov[1], **Marina Romaniukha**[2],
Ivan Karimov[3], **& Liudmyla Sorokina**[4]
[1,2,3,4] DSTU, Kamianske, Dniprobudivska st.2,
[1] gkarimov@ukr.net, ORCID 0000-0002-0208-2607
[2] romanuks@ukr.net, ORCID 0000-0001-7623-2690
[3] ikarimov@ukr.net, ORCID 0000-0003-4145-9726
[4] sludmila1906@gmail.com, ORCID 0000-0003-4875-2896

Abstract: *The paper examines the organisational and methodological aspects of individualization behind professional higher education through the implementation of an individual learning trajectory of higher education candidates, taking into account the forced activation of distance learning. It analyses a survey of students on the individual learning trajectory as well as the organisational and methodological approaches to its implementation in one of the typical higher educational institutions of Ukraine. The authors discuss ways of using elements of different types of training in the process of realisation of the student's individual learning trajectory. The conducted analysis allowed them to pinpoint the main organisational and methodological directions of updating the individual educational trajectory. The theoretical basis of the study became the main principles and regulations of higher education organisation. The study used historical-logical and systemic approaches, general scientific and special methods, in particular: statistical (when analysing and interpreting data from higher education students on the individual trajectory of education); monographic and abstract-logical methods (when analysing the influence of individualisation of students' set of competences on the format of higher education); methods of observation and generalization (when discussing the use of elements of various forms of education in the implementation of the students' individual learning trajectory); methods of systemic analysis and synthesis. As a result, the directions for the development of the means of implementing the individual learning trajectory of higher education students in specialty 073 "Management" were formed.*

Keywords: individual learning trajectory, implementation, organisation, students, higher education.

INTRODUCTION

The pandemic, hostilities and the overwhelming insecurity in Ukraine significantly affected all areas of society, including education, which forcibly introduced means and methods of distance learning into the traditional framework of higher education. The observed changes in the academic environment have caused changes in the educational terminology. Experts stress that this new work mode can be called emergency remote teaching (Iglesias-Pradas et al., 2021) or emergency online teaching (Lorenza & Carter, 2021), reflecting the unprecedented speed of change the COVID-19 pandemic caused in the teaching community. The terms reflect both the urgent switch from traditional classes to an online blended mode and a sense of disruption among the faculty staff and the students (Lorenza & Carter, 2021).

All the above urged educational management to reconsider the issue of obtaining programme competences and corresponding programme learning outcomes by students of higher education at all of its levels (Karimov et al., 2021). Evidently, the changes caused by the pandemic in previous years increased the instructor's workload, which posed extra effort to present the learning content equal to the one developed in traditional classrooms (Iglesias-Pradas et al., 2021) as well as the necessity to introduce new ways of teaching (Domínguez-Lloria et al., 2021). However, the war hostilities made this workload even more dramatic.

Thus, the need for continuous monitoring and adjustment of curricula arises, triggered by the lack of a reference point for an ideal situation in which "a set of goals and tasks will be completely fulfilled during the theoretical time of study" as well as by the recognition that "the theoretical time of study is not the real time that should be spent by each individual student to achieve the ultimate learning outcomes. The real time will be different for different students" (Tuning Educational Structures, 2007). On the other hand, higher education seekers are now more aware that a university degree does not guarantee employment. This prompts universities to ensure that students have the best possible chance of becoming the first choice in the labour market, increasing their "value" for employers, thus meeting the actual needs of the latter" (Rashkevych, 2014). This strife raises the need for active participation of employers in the elaboration of relevant training programmes. Whereas the implementation of the chain "specific applicant – specific conditions – specific employer" calls for the need to personalize the educational trajectory within the curriculum in order to take into account the features of all three components where possible.

1. STUDY ON THE CANDIDATES' NEED FOR THE INDIVIDUALIZATION OF THE EDUCATIONAL TRAJECTORY

1.1. General characteristics of the respondents

To find out university candidates' opinion on the individual trajectory of education a sociological survey was conducted, comprising two blocks of questions, namely, those on educational trajectory and on professional priorities and expectations of a graduate. It was held among students of a typical higher educational institution

where both engineering and humanities courses are taught – Dniprovsky State Technical University (DSTU). The Sociological Laboratory of DSTU conducted an anonymous electronic questionnaire using a specially developed toolkit for students of first (bachelor) and second (master) cycle studies in different courses. Graphically, the general description of the respondents is presented in Figures 1–3.

Most of the interviewees are holders of the first (bachelor's) level of higher education and only 15.5% – of the second (master's) level (see Figure 1), which corresponds to the general ratio of holders by education level.

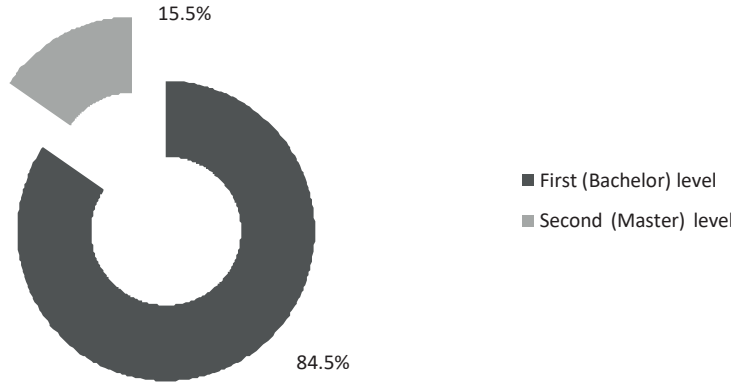


Figure 1. Educational level of respondents

Source: Own work based on http://www.dstu.dp.ua/uni/downloads/osv_traekt.pdf (accessed 14.05.2022)

The respondents participating in the survey come from humanities as well as from engineering fields. The distribution of respondents by field of study is shown in Figure 2.

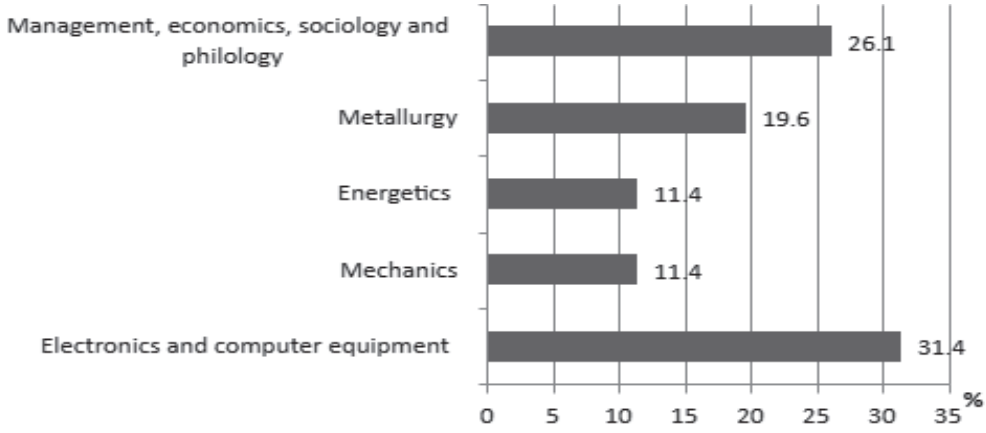


Figure 2. Faculties represented by the respondents

Source: Own work based on http://www.dstu.dp.ua/uni/downloads/osv_traekt.pdf (accessed 14.05.2022)

The maximum activity in the survey was shown by respondents who are beginning their studies at the university level and, accordingly, begin to build their own vision of the future educational trajectory. The distribution of participants by year of study is shown in Figure 3.

The final sample total was 245 people, which with a 95% probability ensures a representation error within 5%. We used random sampling relying on the simple probability sampling method, representative of the year of study and educational programme (Sociological Laboratory of DSTU, 2021).

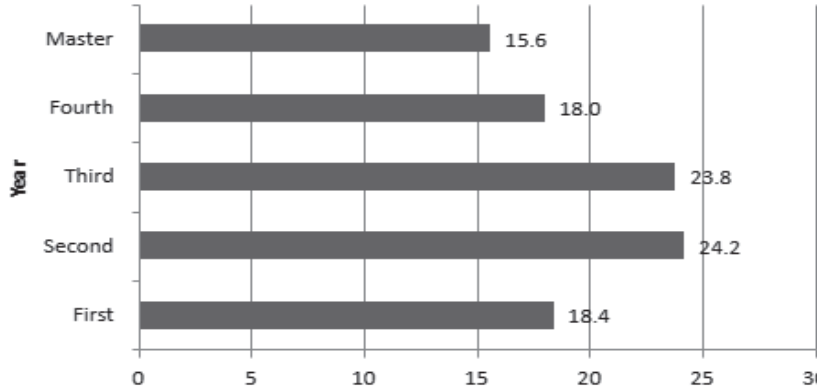


Figure 3. Respondents' term of study

Source: Own work based on http://www.dstu.dp.ua/uni/downloads/osv_traekt.pdf (accessed 14.05.2022)

1.2. Individualising educational trajectory: students' opinions

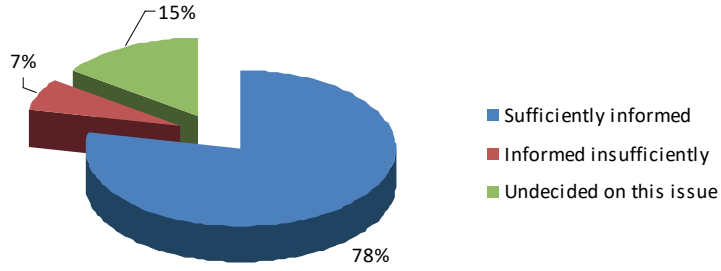
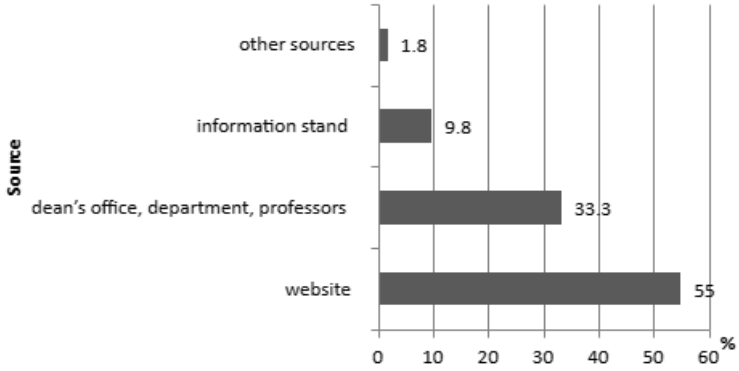


Figure 4. Opinion on the information about elective disciplines

Source: Own work based on http://www.dstu.dp.ua/uni/downloads/osv_traekt.pdf (accessed 14.05.2022)

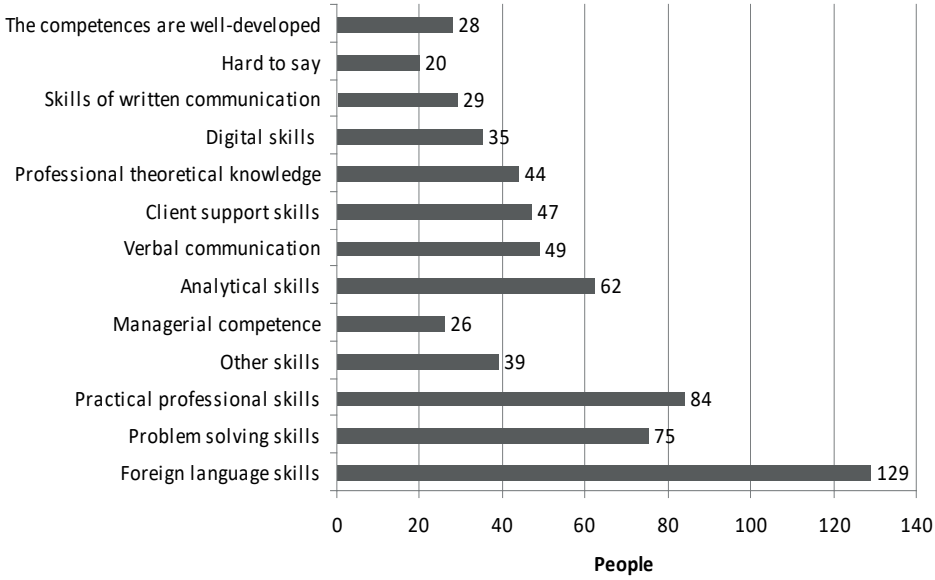
Being an average higher education institution, when it comes to selecting scientific disciplines by the students, we adopt the approach "Completely free choice", which is fixed by the Regulations behind the implementation of the students' right to free choice of educational disciplines at Dniprovsky State Technical University (DSTU). According to survey data (Sociological Laboratory of the DSTU, 2021), the vast majority (75.6%) of respondents individualize their own educational trajectory precisely

at the expense of a wide range of elective disciplines. At the same time, not all students are satisfied with the amount of information about the goals, content and expected results of completing the proposed elective disciplines, which is illustrated in Figure 4, although the students are informed by quite a variety of methods. For instance, candidate preferences regarding the source of information are presented in Figure 5. In contrast, the possibility of choosing a research direction occurs through the free choice of a supervisor with the appropriate range of scientific priorities. This meets the requirements of the majority of respondents (78.5%) with 13.6% undecided on this issue.



F i g u r e 5. Sources of information about selective disciplines

S o u r c e: Own work based on http://www.dstu.dp.ua/uni/downloads/osv_traekt.pdf (accessed 14.05.2022)

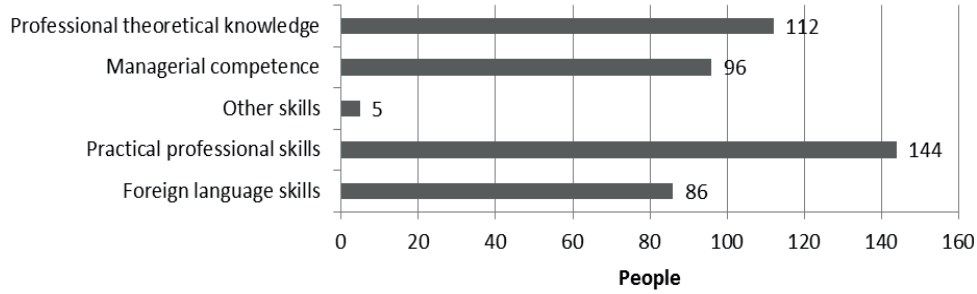


F i g u r e 6. Distribution of desired skills (abilities, skills and competences)

S o u r c e: Own work based on http://www.dstu.dp.ua/uni/downloads/osv_traekt.pdf (accessed 14.05.2022)

Thus, it is possible to draw a conclusion about the generally satisfied expectations of the applicants as for the individualization of the educational trajectory. However, simultaneously there is a desire of the students' to expand / add certain competences to the existing learning outcomes. Taking into account the general trends in the development of society (the largest number of respondents strive to master a foreign languages), the desired competences among the students are distributed as follows (see Figure 6).

When analysing the desired expansion of the competence toolkit, it should be taken into account that the "actual" assessment of graduates changes its structure (see Figure 7).



F i g u r e 7. Distribution of competences meaningful for career success (knowledge, abilities and skills)

S o u r c e: Own work based on http://www.dstu.dp.ua/uni/downloads/rezul_prof_2021.pdf (accessed 14.05.2022)

In other words, the most important resource for achieving the desired professional status and further career planning, is possessing practical professional skills, recognized as a priority by 144 respondents (Career Planning Center, 2020).

2. NORMATIVE REGULATION BEHIND THE INDIVIDUALISATION OF THE EDUCATIONAL TRAJECTORY

According to the Law of Ukraine "On Education": an individual educational trajectory is a personal way of realising the individual potential of an education seeker, which is formed taking into account their abilities, interests, needs, motivation, opportunities and experience, is based on the education seeker's choice of types, forms and pace of education, subjects of educational activity and their proposed educational programmes, educational disciplines and their level of complexity, methods and means of learning, which can be implemented through an individual curriculum (BVR, 2022). At the same time, Article 49 of the Law of Ukraine "On Higher Education" (OBVR, 2022) provides for the right to obtain higher education in one of the main forms (full-time, part-time, distance, online, dual) or a combination thereof.

In doing so, "the higher education institution may use other forms of obtaining higher education and combine forms of obtaining higher education in accordance with the provision on the organisation of the educational process in a higher education institution,

as well as establish requirements for combining forms of higher education" (OBVR, 2022). The regulation on the organisation of the educational process (Gulayev, Peremitko & Hlushchenko et al., 2017) of a higher education institution is supplemented and specified by regulations on the organisation and recognition of results obtained by other (non-institutional) forms of higher education and provisions regulating the procedure for the formation of an individual educational trajectory by education seekers. The result of the shaping of their individual educational trajectory is reflected in the candidate's individual educational plan, which contains, for example, a list of disciplines of free choice and is mandatory. From the list of selective academic disciplines, the candidate must choose any academic disciplines of at least 25% of the total number of ECTS credits.

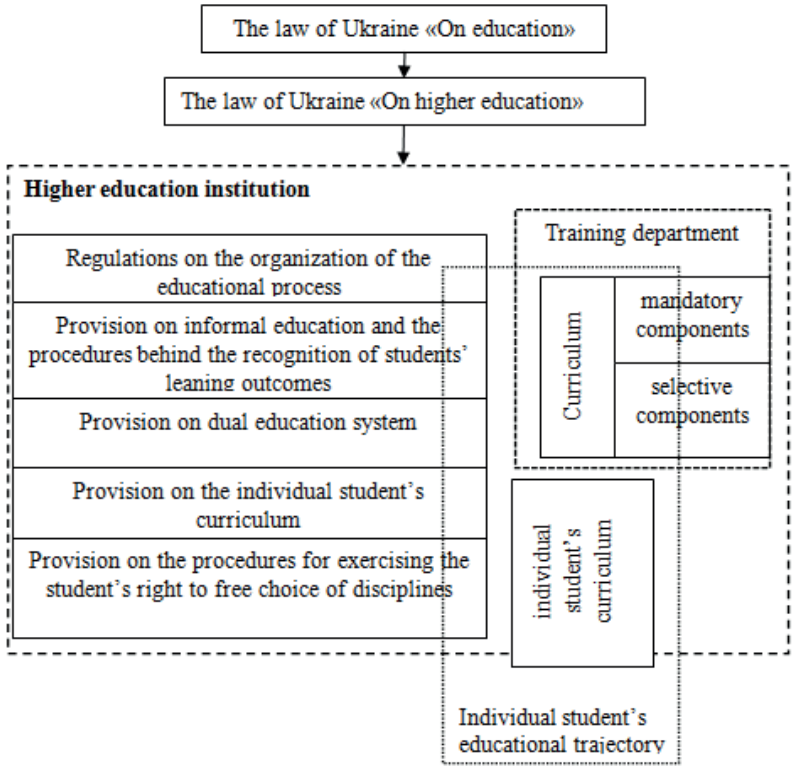


Figure 8. Regulation of the implementation of the individual learning trajectory of higher education candidates

Source: Own work.

Given that the process of implementing candidates' individual educational trajectories is closely related to individual development planning, which is defined as "an organised and guided process implemented directly by the student… the student analyses their learning process, successes and achieved results, and draws up a plan for their individual, educational and professional development" (The Quality Assurance Agency for Higher Education, 2009), the main active aspect in the shaping

of the educational trajectory is the person acquiring the education. Simultaneously, the higher education institution, actively enhanced by other (except face-to-face) forms of education or elements thereof, acts as "an administrator who takes on the functions of creating educational programmes, organising the interaction between teachers and students, and the final certification of graduates" (Nykolaev, 2022).
The final generalised scheme of regulatory support for the implementation of the individual learning trajectory of higher education candidates is shown in Figure 8.

3. DIRECTIONS FOR THE INDIVIDUALISATION OF LEARNING OUTCOMES

Based on the data in Chapter 1, it is possible to formulate the following priority directions in which students wish to individualise their learning outcomes:

- Knowledge of foreign languages;
- Practical professional skills;
- Theoretical professional knowledge;
- Computer skills (despite the low number of responses, it is included in the list, as it is a component of almost all other areas).

It is possible to meet students' existing needs to improve (individualise) their own learning outcomes by involving elements of other forms of obtaining higher education involving an institutional form of education. The possibilities of their use are illustrated in Table 1.
The list of considered areas for the use of elements of various forms of obtaining higher education is not exhaustive. The list does not include variants involving significant material and technical difficulties (for example, the creation of a simulation enterprise to practice practical processes), financial (for example, funding foreign internships), or those of an organisational nature (for example, a compulsory internship in enterprises of the region with issuing professional qualifications). All of the above-mentioned solutions can be implemented to some extent by almost any university, regardless of its current state.

Table 1. Directions for the individualisation of learning outcomes based on the use of elements of various forms of higher education

Learning outcomes	Forms of higher education			
	Institutional	**Distance**	**Online**	**Dual**
	Reasoning: 20% of applicants and students are willing to improve their skills in this area			
Foreign language competence	Widening the offer of elective language courses focused on other courses later in the curriculum		Succeeding with curriculum enhanced by content from foreign educational institution	

	Reasoning: as assessed by graduates from European universities, the decisive factor (25%) of successful employment is «experience and communication in professional environment» (Velden, 2009)			
Practical professional skills	Improving the role and professional focus of practical classes			Taking into account, that absolute majority of students (62.7%) combine study and work, which for 48.3% partially intersect with the university course, and 26.3% are employed in their study field (Career Planning Center, 2020).
	Reasoning: 78% of employers prefer to select willing applicants with «so called general skills, not belonging to the main profile of the chosen position» (Rashkevych, 2014)			
Theoretical professional skills		Relying on asynchronous study mode using ICTs	Involvement of renowned experts of the other subjects of educational process	
	Reasoning: informatisation is a key condition of training students, willing to gain a total awareness of the real world (May, 2002)			
Computer user skills	taking into account the growing popularity of online educational platforms, the most effective (from the point of view of individualisation of the educational trajectory) seems to be the recognition and accumulation of learning outcomes obtained through non-formal and informal education, an example of which can be the European system of credit accumulation and transfer (ECVET) (Cedefop, 2016)			

Source: Own work.

CONCLUSION

Thus, completely free choice, if implemented in the institution under study, gives maximum independence to candidates, but it is difficult for students to navigate the list of disciplines, as it is difficult for them to see the sequential and logical relationship between disciplines. The solutions proposed in Chapter 3 also pose a number of challenges:

- firstly, in the normative and regulatory area – for instance, "the issue of the implementation of some key European documents, for example, opening the

possibility of recognition and accumulation of learning outcomes (and corresponding credit points) is still a debatable issue" (Bakhrushyn, 2022).

- secondly, organisational challenges – when implementing combined forms of education, the responsibility and workload of coordinators of individual student curricula increases significantly due to the continuous individual coordination of prerequisites; requisites; competences to be mastered by the student, as well as programmed learning outcomes for each specific subject with the requirements of the curriculum.

It can be proposed to develop approximate fixed profiles using a combination of elements belonging to different forms of higher education. For instance, the curriculum for the course "Management" might be adapted in the following way:

- "Enterprise": includes dual training in the economic service of a metallurgical or chemical enterprise (which are profiled for the region) combined with an in-depth study of the specifics of metallurgical/chemical production in distance mode.
- "Language": success is envisaged with a part of the curriculum offered by a foreign university (online mode) as a component such selective disciplines as "Second foreign language" and "Foreign language for professional purposes" within one of the institutional forms of higher education.
- "Project Manager": maximum recognition and accumulation of learning outcomes obtained through non-formal and informal learning, in particular offered by online educational platforms.

In view of the above, the offered propositions to improve the design and implementation of the individual learning trajectory of higher education candidates in the specialty 073 "Management" are suitable for implementation, provided that a clear regulatory and organisational mechanism is developed.

REFERENCES

B a k h r u s h y n, V. (2022). Yak vidnovliuvatymut osvitu y nauku pislia viiny [*How to restore education and science after the war*]. *Zerkalo nedely,* blog post, 23 Juney. Retrieved from https://zn.ua/ukr/EDUCATION/jak-budut-vidnovljuvati-osvitu-ta-nauku-pislja-vijni.html (accessed 1.07.2022).

Bulletin of the Verkhovna Rada (BVR) (2022). Law of Ukraine «On Education» (5 September 2017 № 2145-VIII, Revision on July 5, 2022). Retrieved from https://zakon.rada.gov.ua/laws/show/2145-19?lang=en#Text (accessed 10.07.2022).

Career Planning Center DSTU (2020). Profesiini priorytety ta ochikuvannia vypusknyka-mahistra DDTU. Sotsiolohichne doslidzhennia. [*Professional priorities and expectations of a master's graduate of DSTU. Sociological Research*]. *Kamianske: Career Planning Center at Dniprovsky State Technical University.*

Cedefop (2016). *ECVET in Europe: monitoring report 2015. Cedefop research paper.* Luxembourg: Publications Office. ISSN 1831-5860, ISBN 978-92-896-2186-1. http://dx.doi.org/10.2801/946187.

Domínguez-Lloria, S., Fernández-Aguayo, S., Marín-Marín, J.-A., & Alvariñas-Villaverde, M. (2021). Effectiveness of a Collaborative Platform for the Mastery of Competencies in the Distance Learning Modality during COVID-19. *Sustainability*, *13*(11), 5854. https://doi.org/10.3390/su13115854.

Gulayev, V., Peremitko, V., Hlushchenko, O., Karavan, N., Solod, V., & Dobryk, L. (Eds.). (2017). Polozhennya pro organizaciyu osvitn'ogo procesu v Dniprovs' komu derzhavnomu tekhnichnomu universiteti. [*Regulations on the organization of the educational process at the Dniprovsky State Technical University*]. *Kamianske: Dniprovsky State Technical University.*

Iglesias-Pradas, S., Hernandez-García, A., Chaparro-Pelaez, J., & Prieto, J.L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Computers in Human Behavior*, *119* (2021). https://doi.org/10.1016/j.chb.2021.106713. Retrieved from http://www.elsevier.com/locate/comphumbeh (accessed 20 July 2022).

Karimov, G., Karimov, I., Romaniukha, M., & Sorokina, L. (2021). Programme competences for management students in the COVID-19 pandemic time. In E. Smyrnova-Trybulska (Ed.). *E-learning in the Time of COVID-19*. "E-learning" 13 (pp. 100–113). Katowice–Cieszyn: STUDIO NOA for University of Silesia. ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-25-4. https://doi.org/10.34916/el.2021.13.09.

Lorenza, L. & Carter, D. (2021). Emergency online teaching during COVID-19: A case study of Australian tertiary students in teacher education and creative arts. *International Journal of Educational Research Open*, *2–2* (2021). https://doi.org/10.1016/j.ijedro.2021.100057. Retrieved from www.elsevier.com/locate/ijedro (accessed 30 July 2022).

May, C. (2002). *The Information Society: A Sceptical View*. Oxford: Wiley. ISBN 978-0-745-62684-0.

Nykolaev, E. (2022). Chto yzmenytsia v vysshei shkole blahodaria onlain-obrazovanyiu? [*What will change in higher education thanks to online education?*]. *Zerkalo nedely,* blog post, 18 July. Retrieved from https://zn.ua/EDUCATION/chto-izmenitsja-v-vysshej-shkole-blahodarja-onlajn-obrazovaniju.html (accessed 21.07.2022).

Rashkevych, Yu. (2014). Bolonskyi protses ta nova paradyhma vyshchoi osvity [*The Bologna process and the new paradigm of higher education*]. Lviv: Lviv Polytechnic Publishing House. ISBN 978-617-607-628-5.

Sociological Laboratory of the Department of Sociology, DSTU (2021). Osvitnia traiektoriia. Rezultaty opytuvannia. Analitychnyi zvit ta infohrafika. [*Educational trajectory. Survey results. Analytical report and infographic*]. *Kamianske: Sociological Laboratory of the Department of Sociology Dniprovsky State Technical University.*

The Official Bulletin of the Verkhovna Rada (OBVR) (2022). Law of Ukraine «On Higher Education» (1 July 2014 № 1556-VII, Revision on May 12, 2022) Retrieved from https://zakon.rada.gov.ua/laws/show/1556-18?lang=en#Text (accessed 01.06.2022).

The Quality Assurance Agency for Higher Education (2009). Personal development planning: guidance for institutional policy and practice in higher education. ISBN 978-1-84482-914-9. Retrieved from https://www.qaa.ac.uk/docs/qaas/enhancement-and-development/pdp-guidance-for-institutional-policy-and-practice.pdf?sfvrsn=4145f581_8 (accessed 12.05.2022).

Tuning Educational Structures in Europe (2007). Introduction to Tuning-2. Retrieved from http://www.unideusto.org/tuningeu/images/stories/documents/General_Brochure_final_version.pdf (accessed 1 July 2022).

Velden, A. (Eds.). (2009). *Competencies and Early Labour Market Careers of Higher Education Graduates.* EU: Higher Education as a Generator of Strategic Competences (HEGESCO) project.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 132–150
https://doi.org/10.34916/el.2022.14.10

SELFIE AS A TOOL FOR MEASURING THE DIGITAL COMPETENCE OF PARTICIPANTS IN THE EDUCATIONAL PROCESS

Natalia Morze[1], Liudmyla Chernikova[2], & Viktoriia Kucherovska[3]
[1,3] Borys Grinchenko Kyiv University,
04053, Kyiv, Ukraine, 18/2, Bulvarno-Kudriavska Str.
[2] Municipal institution "Zaporizhsky Regional Institute of Postgraduate Pedagogical Education" of the Zaporizhzhia Regional Council,
69035, Zaporizhzhia, Ukraine, 57-A, Nezalezhnoi Ukrainy Str.
[1] n.morze@kubg.edu.ua, ORCID 0000-0003-3477-9254
[2] tchernikova.la@gmail.com, ORCID 0000-0002-1214-9019
[3] v.kucherovska.asp@kubg.edu.ua, ORCID 0000-0002-4064-9416

Abstract: *There are different approaches to the assessment of the level of digital competence of the population and, in particular, participants of the educational process. Digital competence is considered one of the key competences of every citizen of a modern digital society, which is why the task of developing it to a measurable level is relevant for all educational institutions.*
The article investigates the results of the pilot implementation of the SELFIE tool developed by the EU in secondary education in Ukraine. The indicators of key areas of SELFIE, the level of confidence in the use of technology by respondents, as well as the positive and negative experiences of survey participants in the implementation of digitalisation in the educational process are studied. Proposals for the future development of the project SELFIE in educational institutions of Ukraine are described. The research uses such methods as analysis of scientific works to interpret key concepts, systematization of information on the use of digital technologies in education, directions of digitalisation of education, explanation of the current state of digital transformation of education and analysis of the results of the SELFIE pilot project survey of participants in Ukraine.
The conclusions describe the possibility of increasing the efficiency of measuring digital competence using SELFIE.

Keywords: digitalisation, digital competence, educational strategies, digitalisation of education, SELFIE tool, digital skills.

INTRODUCTION

According to McKinsey (Blackburn, LaBerge, & O'Toole, 2020), our world made a 5-year leap just in eight weeks of 2020 in the implementation of digital, consumer and business solutions. Digitalisation has suddenly become an integral part of everyone's life. The all too rapid transition to online learning has, on the one hand, contributed to the renewal and emergence of new progressive and interactive learning practices. On the other hand, however, it has created additional challenges for the organization of the educational process under the new conditions. Online learning had showed that teachers and educational leaders have lack competence and confidence in the effective use of digital technologies, especially online. The painful transition to the new digital realities is primarily a consequence of the insufficient level of digital competence not only of educators, but also of society as a whole. For example, Deputy Minister of Digital Transformation for European Integration Valeriia Ionan (Ionan, 2021), mentioned in her reports that in the spring of 2020, 79% of managers of Ukrainian general secondary education institutions (GSEIs) organized additional training for teaching staff to improve the quality of distance learning in quarantine. For the digital transformation of the educational process, the main obstacle to success is the lack of understanding where to start and foreseeing the prospect of this process. Since the prospect of massive change can be difficult, it is important to understand in which direction to move or how to form a solid strategy. Building strategies for the digital development of an educational institution is only possible if one understands the level of readiness for change and the level of training of all participants in the educational process. This can be ensured through surveys and tests to determine the level of digital competence.

In this study, we consider SELFIE as a tool for measuring the digital competence of participants of the educational process, which can be offered to secondary education institutions to form a strategy for effective technology implementation.

According to the glossary of the Digital Competence Framework for Ukrainian Citizens (DigComp, 2021), digital competence is an integral personality trait that dynamically combines knowledge, skills, abilities and attitudes regarding the use of digital technologies for communication, personal development, learning, work, participation in public life, in accordance with the field of competence, in an appropriate manner (safely, creatively, critically, responsibly, ethically). Ocaña-Fernández, Valenzuela-Fernández, and Garro-Aburto, (2019) consider digital competence as a holistic picture that encompasses technological knowledge and abilities that should be developed in an integrated way. Marzal García-Quismondo & Cruz-Palacios believe that digital competence in the education of citizens will provide prospects of empowerment regarding internal social aspects such as politics, economics, employment, etc. as well as aspects of new cultural trends and entertainment of this century (Marzal García-Quismondo & Cruz-Palacios, 2018).

Nonetheless, Iordache, Mariën, and Baelden, (2017) insist that digital competence is considered to be the most practical and measurable outcome of learning processes for the new digital literacy.

Digital competence is not just the ability to read and write emails online. It is the ability to work with information, process it, apply critical thinking skills to assess the reliability of information and create new content and spread it.

FORMULATION OF THE PROBLEM

Today we are witnessing the mass distribution of digital technologies nowadays. Digital technologies accelerate economic growth and the efficiency of technological processes, contribute to productivity growth and, as a result, improve the quality of services, and also expand opportunities in education. However, the benefits of digital innovation largely depend on the technical equipment of the population, internet connectivity and level of digital skills.

The impetus for the increased pace of digitalisation was the COVID-19 pandemic and the forced displacement of people due to the war. The pandemic crisis and the war in Ukraine accelerated the transformation processes that caused many changes in all aspects of life, including education, and led to new challenges for educational authorities at both local and national levels. Technological acceleration has opened the problem of unpreparedness of citizens for the drastic changes associated with digital transformation and, at the same time, preparedness of teaching staff to improve the quality of online studying during the quarantine. This situation was created in most enterprises of all sizes. Employees of different professions suddenly found themselves in personal crises. The whole world was forced to urgently master services for network communication and interaction, switch to electronic document management and learn online communication.

According to a study of the digital literacy of the Ukrainian society in 2021 (DigSkillsUkraine, 2021), 47.8% of the citizens had knowledge of digital skills below the basic level, 52% of the survey participants said that they had tried online tools for the first time since the COVID-19 pandemic, the most common of which are online shopping apps, online news tracking and remote work. At the same time, 44.4% of respondents are interested in improving their digital skills.

According to the results of a survey KPMG (Tsymbal, 2020), 42% of Ukrainian CEOs and 69% of CEOs globally plan to reduce office space and introduce remote work for some employees and to hasten the end of the pandemic.

The obstacles to the digitalisation of the population are quite primitive: laziness, fear, self-confidence and, most importantly, lack of understanding of what digital competence is, what digital skills one should have, how to measure its level and how to protect oneself from cyber fraud.

Avast (Avast Academy Team, 2022) together with YouGov and Forsa conducted a survey in 2021. They surveyed 16 thousands users of the internet in 17 countries to learn digital citizenship trends around the world. The results of that survey showed that:

- 4.6 billion people (more than half of the world's population) have access to the Internet;
- about 700,000 people access the Internet every day;
- 60% of respondents worldwide said that the Internet has become more important in their lives because of the global pandemic;

- 30% of respondents said they have continued their professional activities online because they are already used to it;
- older generations are generally unable to learn to use technology as quickly and easily as they would like;
- although the younger generation who grew up with these technologies can easily use them, they often need additional support in understanding digital activities;
- digitalisation of all spheres of public life is a topical issue not only because of the pandemic and war in Ukraine, but also because of global trends and national policy on the vector of digital transformation of the country.

Objective: to outline the concept of digital competence, to show the possibility of increasing the efficiency of measuring digital competence using SELFIE.

RESEARCH METHODS

The research uses such methods as analysis of scientific works to interpret key concepts, systematisation of information on the use of digital technologies in education, directions of digitalisation of education, explanation of the current state of digital transformation of education and analysis of the results of the SELFIE pilot project survey (JRC & ETF, 2021).

LITERATURE REVIEW

Viberg, Mavroudi, Khalil, Bälter (2020) built a seven-factor structure of digital competence of teachers with emphasis on their readiness for digitalisation: ability to use digital learning technologies; social influence and support; intention to use; usefulness and effectiveness; awareness of limitations; pedagogical potential; awareness of assistance.

Nikou, De Reuver, Kanafi, proposed a conceptual model of information and digital literacy as a new prerequisite of the technology acceptance model. The authors insist that the role of digital literacy of employees is neglected in the modern literature (Nikou, De Reuver, & Mahboob Kanafi, 2022).

Park, Kim, & Park, write that digital literacy is a multidisciplinary field that broadly covers literacy, ICT, Internet, computer skills, science, health and language education (Park, Kim, & Park, 2020).

Our national scientists are also studying the importance of digital competence for improving the economy and the quality of services. Bykov believes that the digitalisation of society reflects the trends of the scientific and technological progress (Bykov, 2017). Thus, digital transformations allow us to ensure the mobility of users' activities in information spaces; to develop cloud technologies; to process large amounts of data in order to make informed decisions; to promote the development of the nation and electronic communications systems; to promote greater attention to data protection systems; to develop the digital services market, etc. Litvinova defines the digital transformation of the educational process as filling the educational environment with devices for learning and teaching, cloud-oriented technologies and technologies of augmented and virtual reality (Lytvynova, 2019).

Sukhonos, Garust, & Shevtsov, studied foreign experience and prospects for its implementation in the Ukrainian education system. The authors believe that the success of digitalisation of education depends on the level of state support, which entails the need to create a state programme (mechanism) of digitalisation of education (Sukhonos, Harust, & Shevtsov, 2019).

DIGITAL LITERACY OF THE POPULATION AS A NECESSARY SKILL FOR LIFE

The development of cities and their digitalisation is a multidimensional process. However, in most cases, this process focuses on the development of new technical solutions. Governments often do not pay necessary attention to human resource development. Instead, technologies generate new innovative solutions, but they are only tools, access to which is limited due to the lack of digital skills. As we live in the era of digital development, the task of local leaders is to promote the development of digital competence of citizens. We should strive for every single citizen to have the opportunity to acquire digital skills in the short and long term. In a world where technology is spreading very fast, digital competence is becoming necessary and there is no alternative to it. Cities and regions that fail to re-skill their workforce will not be able to compete globally, as they will experience a sharp economic decline.

Digital transformation is taking place in almost all spheres of human life, not leaving aside the education system. One of the key tasks of today is to ensure the digital transformation of educational institutions that will meet the requirements and opportunities, integrate with the global information open educational space, which provides free access for all participants to world digital resources, meet the educational needs of students, as well as effective interpersonal e-communication and e-collaboration.

Nowadays, educational strategies require radical changes, rethinking and comprehensive attention. Only if the right vision of digital skills is formed at the local level, it is possible to provide quality educational services that meet the requirements and challenges of digital transformation in the world. This means that an important role on the way to reformatting educational environments is played by the right content and quality curriculum for students, which will allow them to receive education remotely. Education should be considered as something that starts from childhood and has no limits, that is, it lasts throughout life.

STANDARDS FOR TEACHING AND ASSESSING DIGITAL COMPETENCES. POLICY OF THE DIGITALISATION OF EDUCATION IN UKRAINE

In order to bridge the digital divide in Ukraine, the Digital Competence Framework for Ukrainian Citizens (DigComp, 2021) was developed by the Ministry of Digital Transformation with the support of the EU4Digital initiative. The framework will serve as a so-called digital competence standard for Ukrainians and will be used to

improve the level of digital competences. It outlines the scope of knowledge, skills and practical abilities that citizens need to compete in the Ukrainian and European labour markets and to comfortably use modern digital technologies. The framework is the basis for creating state policy and planning further educational initiatives. The Ukrainian DigComp is based on the European Digital Competence Framework (Carretero Gomez, Vuorikari, & Punie, 2017), which was adapted to the national, cultural, educational and economic peculiarities of Ukraine.

One of the tasks of implementing DigComp is to make additions and changes to professional standards and job requirements, as well as to create educational programmes, training courses, educational resources, with the subsequent creation of a professional detailed Framework for improving the level of service provision.

Today, the current documents are the Professional Standard of a Teacher of a General Secondary Education Institution (ProfStandardTeacher, 2020) and the Professional Standard of a Head (Principal) (ProfStandardHead, 2021) of a General Secondary Education Institution. These documents are aimed at helping participants in the educational process to determine clear guidelines for their own professional development, in particular to develop information and digital competence. The Ministry of Digital Transformation of Ukraine, together with the Ministry of Education and Science of Ukraine, has developed a draft "Conceptual and Reference Framework for the Digital Competence of Pedagogical and Scientific and Pedagogical Workers" (DigCompEdu, 2021). It is based on the European model of the EU Digital Competence Framework for Educators (Redecker & Punie, European Framework for the Digital Competence of Educators: DigCompEdu, 2017). Thanks to the implementation of the Framework, it is possible to design individual educational trajectories for students. According to the approach described in the Framework, the teacher becomes a leader in the digital world, not a "library of knowledge", as it was before. This, accordingly, becomes an impetus to increase the level of personal competences of teachers and managers of educational institutions.

The Concept of Digital Transformation in Education (Concept, 2021) is currently being approved. This document was created to promote the development of education, namely:

- pay attention to the development of digital infrastructure;
- create opportunities for the development of digital skills of teachers and students;
- implementation of registers for automation of educational processes.

The use of the recommendations of the Concept will make it possible to narrow the gap of digital competences of participants in the educational process, update the outdated content of education in academic subjects, solve the problem of lack of computer equipment and quality Internet coverage in institutions and institutions of the education and science system, and promote the creation of high-quality digital educational content.

The strategic goals of the Concept implementation are:

1. To make the digital educational environment accessible and modern.
2. To form digital competences in education workers.
3. Update the content of ICT education to meet modern requirements.

4. Ensure transparency of services and processes in the field of education and science. Make them convenient and efficient.
5. Study and research the state of digital transformation of education and science.

The implementation of this plan should take place by 2026.

PILOT IMPLEMENTATION OF SELFIE

General information

As part of the implementation (JRC & ETF, 2021) of the course of nationwide digitalisation in Ukraine in 2021, a pilot implementation of the free online resource SELFIE was carried out, which aims to help educational institutions analyse the state and effectiveness of the use of digital technologies in the educational process. This resource is a tool that allows you to form an idea of the current state of the level of digitalisation of the educational institution and further develop a strategic action plan to improve performance. The piloting of the SELFIE tool in Ukraine was conducted to determine the effectiveness of the use of digital technologies by educational institutions and to encourage further development of the digital potential of participants of the educational process. Analysis of the results of the SELFIE pilot project makes it possible to determine whether this tool meets the needs of Ukrainian reforms and the goals of digital transformation of the economy and education.

Organization of the pilot project

The piloting of the SELFIE project was initiated by the EU and the Ministry of Education and Science of Ukraine with the active support of the Ministry of Digital Transformation, implemented in 2021. For the pilot implementation, 63 secondary schools were involved in two regions – Lviv and Zaporizhzhia regions.

When choosing institutions, the organizers also took into account such criteria as the location of the institution, the number of students, the form of ownership of the institution. Experimental institutions of the New Ukrainian School also took part. All institutions that participated in the piloting of the project were selected on a voluntary basis.

For secondary schools, all piloting coordination was carried out by two SELFIE regional coordinators. Their main role was to organize the piloting process of the SELFIE project.

An important stage in the preparation of the pilot was the task of adapting the tool to the Ukrainian education system. After the preparation of the question bank, a technical check of the instrument was carried out, followed by recommendations for changes in the questionnaire. The overall preparation process lasted 7 months.

Implementation

For the pilot educational institutions of the project, the implementation of SELFIE took place in the following stages:

- registration and adaptation of the tool to the respondent institution;
- conducting a survey of participants in the educational process;

- receiving the SELFIE report, which is generated automatically on the platform;
- analysis of the results and their discussion in the teaching staff;
- development of a plan to improve the results;
- development of a digitalisation plan for the surveyed educational institution.

Interest in the survey was due to the opportunity to obtain an objective comprehensive assessment of the state of digitalszation, which can be used for further development of the institution. The total number of pilot participants in secondary education institutions reached 12714 people (Figure 1).

Table 1. Participants of the pilot implementation of SELFIE in Ukraine

SELFIE	Participants	Supervisors	Teachers	Students
Quantity, person	12 714	368	1899	10 447
%	100	2,9	14,9	82,2

Source: Own work.

Analysis and conclusions

Key indicators in eight key areas of SELFIE (Figure 1):

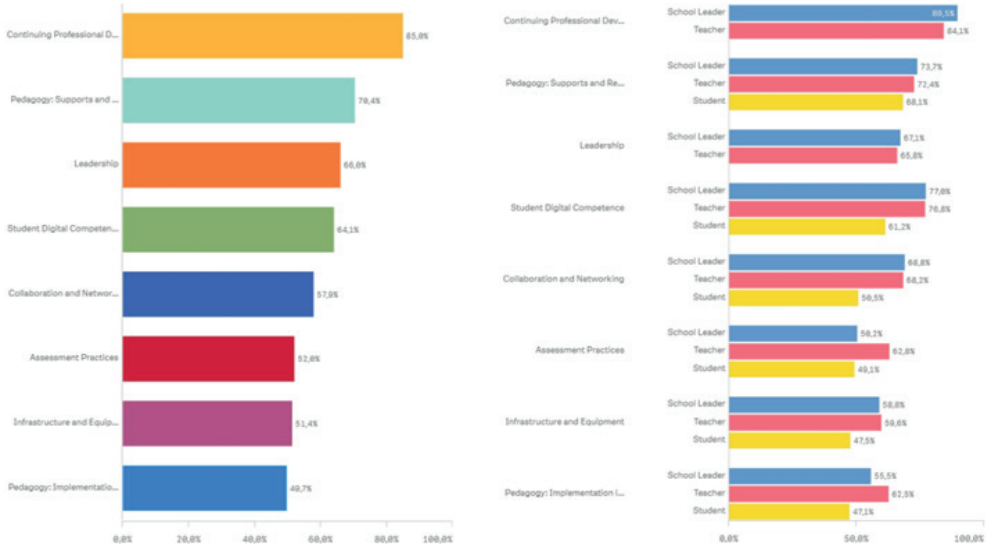


Figure 1. Overview by area. Percentage of positive responses by area

Source: SELFIE tool report.

According to the survey results, we can observe a fairly high level of measurement in the area of Continuing Professional Development in the introduction of digital technologies (85%). This indicator is expected, because during the pandemic, most teachers were required to receive training in digital skills. The result of Pedagogy:

Support and Resources (70.4%) is also predictable, as educational tools are now an integral part of the educational process. Leadership (66.0%) needs attention, this percentage can be caused by a misunderstanding of the meaning of the term and inability to develop leadership skills in students. Students' Digital Competences (64.1%) – the formation of students' digital competences of students should be cross-curricular, in turn, computer science programmes should be revised and updated.
Slightly worse results were demonstrated in the questions related to Pedagogy: Implementation in classroom (49.7%) – traditional teaching methods still prevail in classrooms, even during distance learning, teachers do not often use multimedia and interactive resources. Infrastructure and Equipment (51.4%), the obstacles are insufficient funding to update computer classes and the general infrastructure of the institution, inability and/or unwillingness to use certain technologies.
Assessment Practices (52.0%) need to be diversified, the system of student assessment should be revised to assess not only knowledge but also skills and abilities. Collaboration and networking (57.9%) is an indicator that, in the context of distance learning, needs to be rapidly increased, this can be achieved by creating a dialogue between educational institutions to identify common problems faced by institutions for further joint solutions. Thus, all these indicators require attention and refinement (Figure 2).

F i g u r e 2. Question ranking. Percentage of positive responses

S o u r c e: SELFIE tool report.

Every member of the teaching staff of a general secondary education institution in Ukraine is obliged to acquire new and improve previously acquired competences within their professional activity or field of knowledge, so the indicator of 88.2% is expected. Teachers can choose their own areas of professional development and, accordingly, through motivation, it is possible to increase the level of readiness.
The study of general data indicators shows that working with online educational resources is provided at a fairly high level in Ukraine (87.5%), experience sharing between colleagues is common (83.5%), and open educational resources are used (82.3%). The need for continuing professional development is felt by 83.2% of respondents, these data may be due to the overload of teachers (Figure 3).
Most teachers (79.5%) indicated that they have the opportunity to discuss their thoughts and issues with school leaders who support new ways of learning (77.7%). Participants in the educational process at a sufficient level (77.5%) have knowledge about the safe use of digital resources, adhere to the principles of academic integrity (72.4%) and devote time to studying the progress of their activities (70%) (Figure 4).

Another important indicator is access to the Internet (69.6%). The school should have a local network with access to the Internet from all available computers with the ability to filter out harmful content and access to wireless Internet.

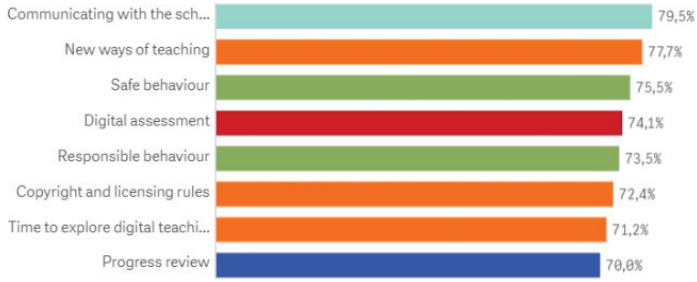


Figure 3. Question ranking. Percentage of positive responses

Source: SELFIE tool report.

According to the results, attention should be paid to measuring and preventing the digital divide (67.6%). Readiness to use the virtual digital environment (67.1%) and the use of data to improve learning is at a fairly good level (64.6%), which may also be a consequence of the conditions in which learning and teaching currently take place.

Figure 4. Question ranking. Percentage of positive responses

Source: SELFIE tool report.

In contrast, the indicator of checking the quality of information (64.1%) should be further studied and requires significant attention. Addressing the previous needs will help to reduce the digital divide in institutions (Figure 5).

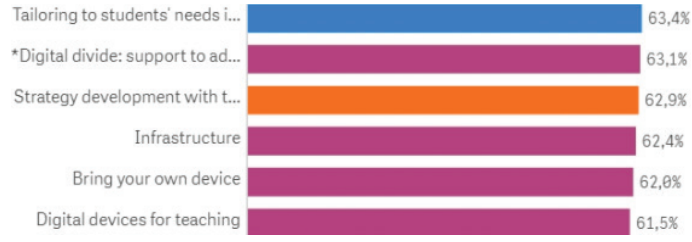
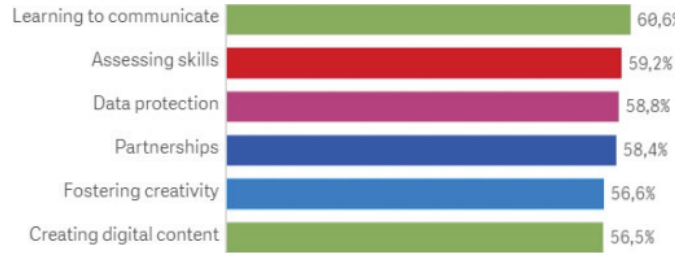


Figure 5. Question ranking. Percentage of positive responses

Source: SELFIE tool report.

Teachers often use existing teaching tools, but these do not always meet the needs of individual students, some visual, some auditory, etc. It is therefore important to adapt the tools to the needs of students (63.4%).
Slightly more than half of the institutions (62.9%) pay attention to the development of a digital strategy. This indicator should be improved by conducting master classes and creating working groups to produce changes. At the same time, schools are not ready for updated learning technologies (62%) (for example, 1:1 eLearning, Blended learning, Flipped classroom, BYOD, etc.) (Figure 6).



F i g u r e 6. Question ranking. Percentage of positive responses

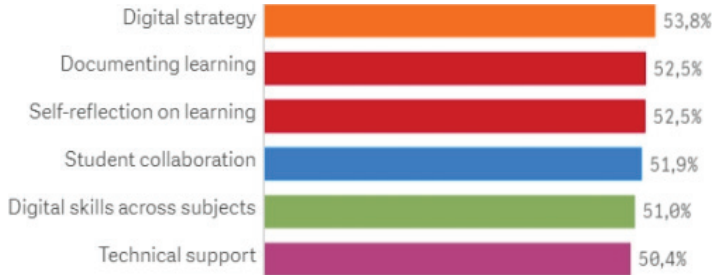
S o u r c e: SELFIE tool report.

Learning to communicate online and offline should be cross-curricular for all subjects (60.6%). Recommendations on the assessment of acquired competences should be added to the legislative documents, as currently only 59.2% of the surveyed participants of the educational process have an understanding of how to do this.
The basics of data protection and cybersecurity should become the basis of the new computer science programme (currently 58.8%).
Building partnerships among colleagues and leaders is the key to a quality organization of the educational process. Under such conditions, strong interdisciplinary ties, collaborative problem solving, creating an an effective educational environment, etc. are possible. Therefore, the indicator of 58.8% needs to be improved.
Creativity as a skill plays a significant role in personality development, so teacher creativity will encourage children's learning, spark interest and stimulate new aspirations (56.6%).
Digital content development has such a result (56.5%) due to the significant number of alternative solutions already created (Figure 7).

F i g u r e 7. Question ranking. Percentage of positive responses

S o u r c e: SELFIE tool report.

The place where education takes place can both inspire and depress. Building a quality educational space should be part of the institution's strategic plans (56.1%). Discussing technologies, sharing experiences helps to broaden opportunities and find like-minded people (55.7%). Only half of the respondents (55%) are interested in feedback from other participants in the educational process. This is a small percentage and needs to be carefully refined (Figure 8).



F i g u r e 8. Question ranking. Percentage of positive responses

S o u r c e: SELFIE tool report.

Having a vision for how an organisation uses digital learning in all its forms can be considered a digital learning strategy, and should be based on collaboration, the pursuit of immersive experiences and the use of diverse resources. There is a need to approve digital strategies both at the national and local level (53.8%).

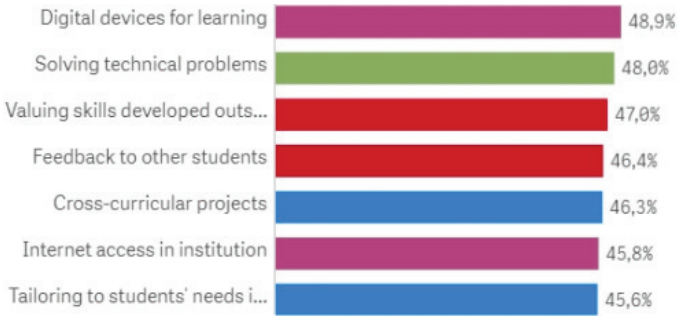
Self-reflection is extremely important for each participant in the educational process, because it is through self-knowledge, self-analysis, self-assessment and self-control that the level of acquired knowledge, skills and abilities can be assessed.

We often do not even perceive important things in everyday life as something really valuable. Thus, we pay little attention to cooperation in educational institutions (51.9%). According to the results of the PISA-2018 testing and questioning of Ukrainian teenagers PISA-2018 (Mazorchuk, Tereshchenko, & Bychko, 2020), it is proven that higher results in reading are achieved by those students who consider cooperation as a value and are inclined to interact cooperatively with their classmates.

The value of students' cooperation for achieving higher results in learning, confirmed by objective evidence, should naturally encourage domestic educators to intensify activities that would help students to form sustainable skills of teamwork, purposeful collective interaction (even in conditions of remote, i.e. distance learning). As for technical support (50.4%), schools need full-time staff to monitor and provide technical support for hardware and software. Now it is mostly the responsibility of an IT teacher, voluntary wish of children or parents (Figure 9).

Most Ukrainian secondary schools have a policy of prohibiting the use of gadgets in the classroom (48.0%). Instead, students' own devices can be useful and extend the teacher's teaching and learning opportunities.

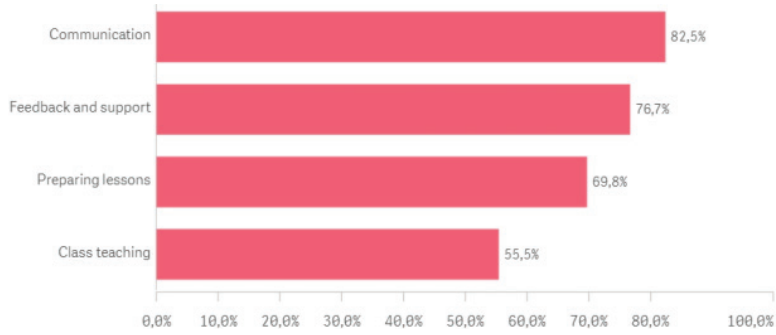
Teachers, like students, need recognition for their digital achievements. According to the survey, only 47.0% of respondents pay attention to this. This is a small percentage to motivate learners to new aspirations in this area.



F i g u r e 9. Question ranking. Percentage of positive responses

S o u r c e: SELFIE tool report.

Feedback between students is generated during collaborative activities (46.4%). It is important for teachers to pay attention to the correct formation of the ability to evaluate the actions of others, avoiding judgemental opinions and personal comments.
Cross-curricular links contribute to the activation of students' cognitive activity, improving the quality of knowledge, skills and abilities. Implementation of interdisciplinary links allows economical and at the same time intensive use of time at lessons (46.3%).
Regular surveys of students about their needs, desires, level of satisfaction with the organization of the learning process will help to understand the further trajectories of the institution. The results obtained can be used to build strategies for the digitalisation of the institution.
The SELFIE survey assessed teachers' attitudes to continuing professional development, which took place last year. Thus,, online professional learning was the most convenient for the majority of teachers – 87.1%. The most convenient ways for teachers to improve their qualifications were training through cooperation (83.0%), internal training (78.5%), and face-to-face professional training (78.3%). The least convenient for teachers was the way of in-service training through study visits – 58.5%.
The level of confidence in using technology is: (Figure 10):



F i g u r e 10. How confident do your teachers feel in using technology for the following tasks? Percentage of positive responses

S o u r c e: SELFIE tool report.

Thus, for most teachers, communication via the Internet no longer causes fear (82.5%), they are ready to receive feedback and support (76.6%). For a significant part of students, preparation for lessons has moved to the digital world from paper notes and outdated methods (69.8%). However, the organization of distance learning remains difficult for almost half of the respondents (44.5%).
Under conditions of nationwide quarantine and limited access to education, teachers used technology for teaching in 60.3% of their teaching time.
For teachers and managers, the use of technology is described as an accepting approach, with managers at 57.6% and teachers at only 34.3%.
Teachers and managers indicated factors that negatively affect teaching and learning with digital technologies (Figure 11):

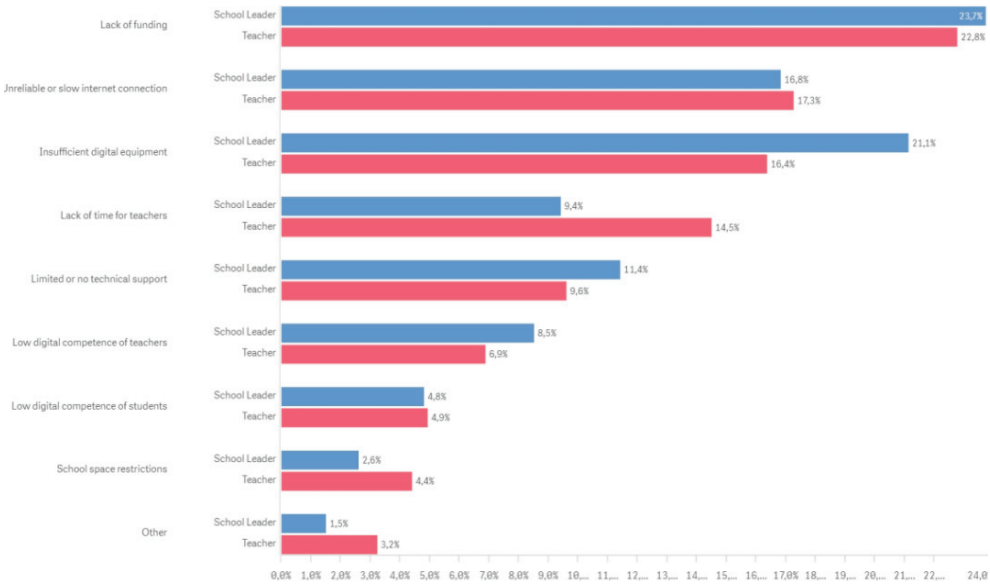


Figure 11. Is teaching and learning with digital technologies in your school negatively affected by the following factors? Percentage of each response option by user profile

Source: SELFIE tool report.

Factors that negatively affect distance learning according to teachers and managers (Figure 12).
Factors that positively influence distance learning according to teachers and managers (Figure 13).
One of the sections of the survey was to determine the conditions of technology use by students outside of school. Thus, 87.8% of respondents use technology for entertainment at home, 82.4% for studying and 45.7% of students do not use technology outside of school at all.
75.7% of the students surveyed have access to digital devices at home.

Figure 12. Is remote teaching and learning with digital technologies, negatively affected by the following factors? Percentage of each response option by user profile

Source: SELFIE tool report.

Figure 13. Is remote teaching and learning with digital technologies, positively affected by the following factors? Percentage of each response option by user profile

Source: SELFIE tool report.

Students' responses to the question on positive factors influencing distance learning with the use of digital technologies (Figure 14):

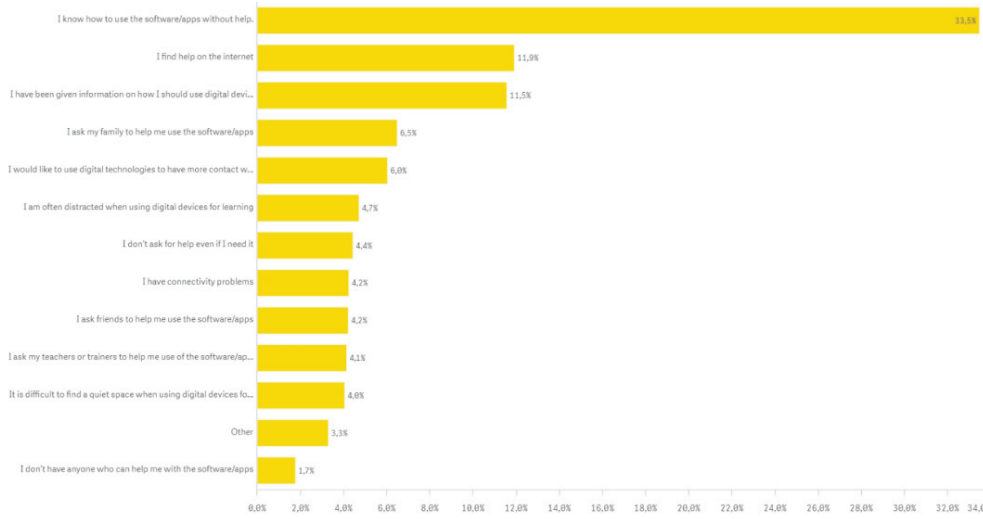


Figure 14. Is remote training with digital technologies positively affected by the following factors? Percentage of each response option by user profile

Source: SELFIE tool report.

SUGGESTIONS FOR THE FUTURE DEVELOPMENT OF THE PROJECT IN UKRAINE

In our opinion, parents are integral participants in the educational process, and their involvement in the survey will contribute to a comprehensive impact on increasing the level of digital potential of end users of educational services – students.

The survey should be conducted at school with the support of the SELFIE school coordinator (European Commission). Coverage of the results to ensure transparency and dissemination of the developed change strategy. The organization before the survey and the survey itself is not difficult. There are structured step-by-step SELFIE instructions and a SELFIE manual for school coordinators translated into Ukrainian.

It is recommended to create a network of educational institutions using SELFIE in Ukraine to share best practices, as well as for cooperation between institutions and possible support/encouragement of new institutions to join the project.

It is necessary to provide access to computer equipment for students whose parents are unable to purchase the necessary equipment for training. Address the issue of quality Internet connection in the premises of the entire educational institution. Allow the use of gadgets for educational purposes. Create structured secure repositories of digital educational resources to support distance and blended learning, with free access for all participants in the educational process. Use applications for children with special needs. Improve the processes of assessing the knowledge and competences of students using digital technologies, engaging students in self- and mutual assessment. Promote the search and use of interdisciplinary links for teaching and learning.

CONCLUSION

The COVID-19 pandemic has proved the importance and necessity of digital competence for the well-being of the population, the development of economies and the digital society. The capabilities of a digitally developed society make it possible to create more effective governance mechanisms, expand access to livelihoods, including the provision of medical and educational services, and improve the level of public services. In a global sense, digitalisation is not only the use of technology, it is a much broader concept characterised by a change in the culture of behaviour and transversal transformations.

The modern education system in Ukraine and, directly, the educational process of each individual secondary education institution, needs a digital transformation that can ensure the quality and effectiveness of learning. By focusing on promoting digital citizenship among teachers and students, making it the basis of the educational policy of the educational institution, it is possible to create a high-quality and effective educational space for the new generation. This, in turn, will help the educational institution to remain relevant, offering students a modern level of education that is necessary for future success in life and further education. Using modern digital technologies in the educational process is the right way to digital maturity of all its participants.

The first step towards the digital transformation of the educational institution should be made by conducting a survey of the participants of the educational process regarding their skills, needs, desires and determining their readiness to accept innovations. Only having an understanding of the starting point, it is possible to develop roadmaps and strategies for building a digital education policy.

Monitoring the level of digital competence and digital readiness of all participants in the educational process is crucial. The SELFIE tool helps educational institutions to analyse and assess the current state of digital competence, create a specific digital transformation plan for each educational institution, and in the future improve curricula and processes in the field of digitalisation. SELFIE is a convenient and accessible resource for secondary education institutions in Ukraine. It is advisable to recommend it for wide use in secondary education institutions to develop their digitalisation strategies and educational policies.

REFERENCES

Avast Academy Team. (2022). *Retrieved from Digital Literacy in 2022.* Avast*:* https://www.avast.com/c-digital-literacy.

Blackburn, S., LaBerge, L., & O'Toole, C. (2020, April 22). *Digital strategy in a time of crisis.* Retrieved from McKinsey & Company: https://www.mckinsey.com/business-functions/.

Bykov, V. (2017). Suspilstvo znan i osvita 4.0 [Knowledge Society and Education 4.0]. *Osvita dlia maibutnoho u svitli vyklykiv 21 stolittia (Polska edukacja w kontekście zmian cywilizacyjnych),* pp. 30–45. Retrieved from https://cutt.ly/uBybBST.

Carretero Gomez, S., Vuorikari, R., & Punie, Y. (2017). *DigComp 2.1: The Digital Competence Framework for Citizens.* Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/38842.

Concept of digital transformation of education and science. (2021). Retrieved from Ministry of Education and Science: https://mon.gov.ua/storage/app/media/news/2021/05/25/tsifrovizatsiigromadskeobgovorennya.docx.

Digital Competence Framework for Citizens. (2021). Retrieved from Ministry of Digital Transformation of Ukraine: https://thedigital.gov.ua/storage/uploads/files/news_post/2021/3/mintsifra-oprilyudnyue-ramku-tsifrovoi-kompetentnosti-dlya-gromadyan/%D0%9E%D0%A0%20%D0%A6%D0%9A.pdf.

European Commission. *Digital education.* Retrieved from European Education Area: https://education.ec.europa.eu/focus-topics/digital-education.

Ionan, V. (2021). *Digital competence. What skills should be developed during the pandemic?* Retrieved from EU4Digital: https://eufordigital.eu/uk/digital-competence-what-skills-do-you-need-to-develop-during-the-pandemic/.

Iordache, C., Mariën, I., & Baelden, D. (2017, 02). Developing Digital Skills and Competences: A Quick-Scan Analysis of 13 Digital Literacy Models. *Italian Journal of Sociology of Education*, *9*(1), pp. 6–30. https://doi.org/10.14658/pupj-ijse-2017-1-2.

JRC and ETF, N.T. (2021). *SELFIE Pilot Ukraine: Country Report, European Training Foundation.* Retrieved from Digitization of education: https://mon.gov.ua/ua/news/ponad-20-tisyach-uchasnikiv-iz-96-zakladiv-osviti-v-ukrayini-zavershili-pilotne-vprovadzhennya-selfie.

Lytvynova, S. (2019). Informatyzatsiia i tsyfrovizatsiia zahalnoi serednoi osvity: initsiatyvy y osvitnie vprovadzhennia [Informatization and digitalization of general secondary education: initiatives and educational implementation]. *Informatsiino-tsyfrovyi osvitnii prostir Ukrainy: transformatsiini protsesy i perspektyvy rozvytku. Proceedings of the methodological seminar of the National Academy of Pedagogical Sciences of Ukraine,* pp. 130–137. Retrieved from https://core.ac.uk/download/pdf/233898739.pdf.

Marzal García-Quismondo, M., & Cruz-Palacios, E. (2018). Gaming como Instrumento Educativo para una Educación en Competencias Digitales desde los Academic Skills Centres. *Revista General de Información y Documentación, 28*(2), pp. 489–506. https://doi.org/10.5209/RGID.62836.

Mazorchuk, M., Tereshchenko, V., & Bychko, H. (2020). *PISA-2018: UKRAINE IN THE CENTER OF ATTENTION. Student collaboration and sense of belonging to an educational institution: Does it contribute to academic achievement?* Ukraine. Retrieved from http://pisa.testportal.gov.ua/wp-content/uploads/2020/10/PISA-2018_UKRinFocus_5_September_2020.pdf.

Nikou, S., De Reuver, M., & Mahboob Kanafi, M. (2022, May 3). Workplace literacy skills — how information and digital literacy affect adoption of digital technology. *Journal of Documentation, 78*(7), pp. 371–391. https://doi.org/10.1108/JD-12-2021-0241.

Ocaña-Fernández, Y., Valenzuela-Fernández, L.A., & Garro-Aburto, L.L. (2019). Inteligencia artificial y sus implicaciones en la educación superior. *Propósitos Y Representaciones*, *7*(2), pp. 536–568. https://doi.org/10.20511/pyr2019.v7n2.274.

P a r k, H., K i m, H., & P a r k, H. (2020, Jul 24). A scientometric study of digital literacy, ICT literacy, information literacy, and media literacy. *Journal of Data and Information Science*, *2*, pp. 116–38. https://doi.org/10.2478/jdis-2021-0001.

Professional standard of the head (director) of the institution of general secondary education. (2021). Retrieved from Ministry of Economic Development, Trade and Agriculture: https://mon.gov.ua/storage/app/media/news/2021/09/22/Nakaz-568-zatverdzh.standartu.keriv.22.09.pdf.

Professional standard of the primary class teacher, general secondary education teacher and primary education teacher. (2020). Retrieved from Ministry of Economic Development, Trade and Agriculture: https://www.me.gov.ua/Files/GetFile?lang=uk-UA&fileId=22daac6a-f0db-4de0-8d49-47aa6b2ecb99.

R e d e c k e r, C. & P u n i e, Y. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu*. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/159770.

Study of digital skills of Ukrainians. (2021). Retrieved from Ministry of Digital Transformation of Ukraine: https://osvita.diia.gov.ua/uploads/0/2623-research_eng_2021.pdf.

S u k h o n o s, V., H a r u s t, Y., & S h e v t s o v, Y. (2019). Digitization of education in Ukraine: foreign experience and domestic perspective of implementation. *Legal horizons*, *19*(32), pp. 79–86. Retrieved from https://essuir.sumdu.edu.ua/handle/123456789/78482.

The conceptual-referential framework of digital competence of pedagogical and scientific-pedagogical workers. (2021). Retrieved from Ministry of Education and Science: https://osvita.diia.gov.ua/uploads/0/2900-2629_frame_pedagogical.pdf.

T s y m b a l, A. (2020). *How Ukrainian business has changed after COVID-19*. Retrieved from The page: https://thepage.ua/ua/experts/yak-zminivsya-ukrayinskij-biznes-pislya-covid-19.

V i b e r g, O., M a v r o u d i, A., K h a l i l, M., & B ä l t e r, O. (2020, 04). Validating an Instrument to Measure Teachers' Preparedness to Use Digital Technology in their Teaching. *Nordic Journal of Digital Literacy*, *1*, 38–54. https://doi.org/10.18261/issn.1891-943x-2020-01-04.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 151–162
https://doi.org/10.34916/el.2022.14.11

CREATIVITY AS AN INTERDISCIPLINARY COMPETENCE OF THE INDIVIDUAL AND OF THE ARTIFICIAL INTELLIGENCE

Jolanta Szulc
Institute of Culture Studies / University of Silesia in Katowice
40-007 Katowice, ul. Uniwersytecka 4
jolanta.szulc@us.edu.pl, ORCID 0000-0002-8926-3098

Abstract: *Creativity is a desirable feature of everyone, both in the professional and private spheres, and is increasingly recognised one of the core competences in the 21st century. An individual's creativity can also be enhanced by various forms of artificial intelligence. The aim of the article is to present and examine the common characteristics of human creativity and artificial creativity (Computational, 2022). The study is based on the analysis of the literature on the subject registered in selected databases: ERIC and Web of Science. The article is divided into three parts. The first part discusses the concept and presents current research results on creativity competences. The second part characterises individual creativity and artificial creativity (Computational, 2022) and presents selected examples. In the third part, the competences of an individual are compared with artificial creativity (Computational, 2022). In particular, the following issues are addressed: (1) to what extent man and his creativity become models for the creators of AI solutions and (2) how these solutions can be used in modern education. The results of the research are presented at the end of the article.*

Keywords: creativity, creativity competences, individual creativity, artificial creativity, computational creativity.

INTRODUCTION

In line with the Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning (2006/962 / EC), developing key competences, both in school education and in the lifelong learning strategy has become one of the top priorities. The issues applicable to all eight key competences include: critical thinking, creativity, initiative, problem solving, risk assessment, decision taking, and constructive management of feelings (Recommendation, 2006). On the other hand, creativity is associated with the cultural and

creatine sectors, created by entities conducting economic activities related to culture and technology and combining artistic activities with entrepreneurship (Regulation (EU) 2021/818). Creativity is understood in a similar way in other European documents, such as:

- Decision (EU) 2021/820 of the European Parliament and of the Council of 20 May 2021 on the Strategic Innovation Agenda of the European Institute of Innovation and Technology (EIT) 2021–2027: Boosting the Innovation Talent and Capacity of Europe and repealing Decision No 1312/2013/EU;
- Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013;
- Regulation (EU) 2021/523 of the European Parliament and of the Council of 24 March 2021 establishing the InvestEU Programme and amending Regulation (EU) 2015/1017.

Creativity in such different ways will be considered in the next chapter.

1. CONCEPT AND RESULTS OF RESEARCH ON CREATIVITY

1.1. Creativity and creativity competences

The concept of creativity, derived from the Latin word creatus, in the common understanding means a mental process that leads to the creation of "something" new, original (Słownik, 2022).

A general description of the concept of creativity is provided in Decision No 1350/2008/EC of the European Parliament and of the Council of 16 December 2008 concerning the European Year of Creativity and Innovation (2009). It reads: "creativity as a personal attribute, and to be harnessed to full advantage it needs to be widely disseminated throughout the population. This requires an approach based on lifelong learning" (Decision No 1350/2008/EC, 2009).

Creativity is also understood as being "a phenomenon whereby something new and valuable is formed. The created item may be intangible (such as an idea, a scientific theory, a musical composition, or a joke) or a physical object (such as an invention, a printed literary work, or a painting)" (Creativity, 2022). Meusburger estimates that there are over a hundred different definitions in the literature, usually developing the context (domain, organization, environment, etc.) that determines the originality and / or appropriateness of the created object and the processes that resulted in it (Meusburger, 2007). For example, we talk about computational creativity, organisational creativity, malevolent creativity (Creativity, 2022).

Competence as an important component of the creative sphere was included in the "Four C" model proposed by Kaufman and Beghetto. This model distinguishes four types of creativity: mini-c ("transformative learning" involving "personally meaningful interpretations of experiences, actions, and insights"), little-c (everyday problem solving and creative expression), Pro-C (exhibited by people who are professionally or vocationally creative though not necessarily eminent) and Big-C

(creativity considered great in the given field) (Kaufman and Beghetto, 2009). Terms taken from this concept are widely used. For example: Kozbelt, Beghetto, and Runco use a little-c/Big-C model to review major theories of creativity (Kozbelt, Beghetto, Runco, 2010). Boden distinguishes between h-creativity (historical) and p-creativity (personal) (Boden, 2004). Robinson (Robinson, 1999) and Craft focus on creativity in the general population, particularly with regard to education, with Craft distinguishing "high" and "little c" creativity and citing Robinson as relating to "high" and "democratic" creativity (Craft, 2001). Csikszentmihalyi defined creativity in terms of those who made significant creative contributions, perhaps changing the field (Csikszentmihalyi, 2013). Simonton analysed career trajectories of outstanding creative people in order to map patterns and predictors of creative productivity (Simonton, 1997; Creativity, 2022).

The concept of creativity competences is related to the concept of creative thinking competence. Creative thinking means „discovering new opportunities and solutions for problems by looking beyond current practices and using innovative thinking" (Creative, 2022). This discovery can be accomplished through activities such as:

- learning when a new approach is required,
- taking over the solution from outside the current work environment,
- modifying the solution from outside the current work environment
- creating a new solution.

In practice, creative thinking competence can be implemented in the form of various activities, which include:

advanced event planning, business writing for impact and influence, creativity and innovation for the workplace, critical thinking and problem solving for effective decision, financial planning for retirement, finding creative solutions to workplace challenges, improving your memory, increasing your self-confidence, life planning for retirement, mindfulness and leadership, practical facilitation skills, strategic thinking, using positive influencing skills in the workplace, writing in plain language (Creative, 2022). Both creativity and creativity competences are the subject of research, the selected results of which will be presented in the next chapter.

1.2. Results of research on creativity and creativity competences

Scientific interest in creativity occurs in many disciplines, primarily in psychology, business and cognitive science. Research on creativity is also developed in education, humanities, technology, engineering, philosophy (especially philosophy of science), theology, sociology, linguistics, art, economics and mathematics. The subject of these studies includes such issues as: the relationship between creativity and general intelligence, personality type, mental and nervous processes, mental health, artificial intelligence. Some of this research concerns fostering creativity through education and training, fostering creativity for the benefit of the national economy, and applying creative resources to improve teaching and learning efficiency (Creativity, 2022). The literature on the subject includes reviews of research on creativity and creativity competences. Detailed information on the literature found is provided in Table 1.

Table 1. Results of searches for search terms, *creativity* and *creativity competences* in ERIC and Web of Science databases (as on 12 September 2022)

Database name	Search term	Number of records found	Including: review article/ reports
ERIC	Creativity (all fields)	22 590	14 928
Web of Science	Creativity (all fields)	79 824	51
ERIC	Creativity competences (all fields)	104	77
Web of Science	Creativity competences (all fields)	2 334	1 957
Total		**104 852**	**17 013**

Source: Own work based on ERIC and the Web of Science databases.

Additionally, Figure 1 and Figure 2 present the percentage analysis of the results of searches for the terms *creativity* and *creativity competences* in the Web of Science database.

Figure 1. Search results for the term *creativity* in the Web of Science database (as on 12 September 2022)

Source: Own work based on the Web of Science database.

Figure 2. Search results for the term *creativity competences* in Web of Science database (status on 12 September 2022)

Source: Own work based on the Web of Science database.

The following research topics were already distinguished in the report from 1966, including 92 publications from 1906–1966: defining creativity, measuring creativity, creativity and intelligence, characteristics of the creative individual, teaching and creativity, and inhibitors of creativity (Hahn, 1968). Works on the topic appear today: unstructured, interactive, or spontaneous motions, including gestures, dance, shifting body postures, physical object-manipulation, drawing, etc. to favourably impact creative performance. As a result of a review of works registered in the PubMed, PsychInfo, Sports Discus and Google Scholar databases, it was found that embodied movement robustly enhanced creativity across nearly all studies (90%), with no studies showing a detrimental effect (Frith, Miller and Loprinzi, 2020).

The second group of reports containing research results concerns creativity competences. A 1997 report found that a common way to teach creative thinking is to use creative problem solving. The stages of problem solving were mentioned, i.e. problem exploration, idea development, implementation and selected activities developing the competence of creative problem solving. The role of attitude, experience and motivation is emphasized. It seems interesting to conclude that creativity training is more a matter of removing internal and external blockages than of learning skills (Henry, 1992).

The research mission was examined in review on the issue of developing teaching competences of novice faculty members. The mission of scientists has changed in recent years. Academics face a strong social demand for graduates to access employment and are increasingly required to possess a range of competences beyond their discipline knowledge. Research is being carried out in the field of developing competences of novice university academics based on the concept of situated competence (Kiffer & Tchibozo, 2013).

Another systematic literature review provided an overview of STEM (science, technology, engineering and mathematics) and STEAM (STEM + Arts) – based empirical educational interventions to determine their potential to develop students' creativity. Publications published in 2010–2020 and registered in the Web of Science and Scopus databases were selected for analysis as part of the review process. Analysis suggests that: (1) the interventions based both on STEM and STEAM have multiple and even contradictory forms, both in theory and in practice; (2) there appears to be a preference among researchers for the Likert-type test to evaluate creativity; and (3) both educational approaches show evidence of positive effects on student creativity (Aguilera and Ortiz-Revilla, 2021).

2. INDIVIDUAL CREATIVITY AND ARTIFICIAL CREATIVITY (COMPUTATIONAL CREATIVITY)

2.1. Individual creativity

Each individual has three components of creativity: knowledge, creative thinking and motivation. Knowledge includes technical knowledge, intellectual qualifications and knowledge of procedures. The ability to think creatively is defined by the ways of approaching problems. On the other hand, motivation is divided into two types: external and internal. External incentives can be cash in the form of bonuses

and promotions. In contrast, internal motivation is driven by individual passion and interest, which has a greater impact on creativity than external motivation (Luecke & Łuczkiewicz, 2005).

What are the qualities of a creative person? Having selected features often enables individuals to generate innovative solutions to their problems. Most often a creative person is characterized by: imagination, openness to experience, inquisitiveness or curiosity, intuition, idea finding, tolerance for ambiguity, independence, innovation (Montgomery, Bull and Baloche, 1993). Creativity is developed through practical activities, which promote features such as: (1) curious – creative people like to learn new things, so their free time may include reading books or watching films on topics of interest to them; (2) playful – people are happy to play with ideas until they find the right one; (3) open-minded – a person with an open mind is willing to listen and try new ideas; (4) flexible – this trait supports their willingness to try out new ideas and experiences; (5) sensitive – increases awareness of the surrounding problems, which may sometimes make people even more concerned with solving them; (6) independent – independent work allows creative people to exercise personal freedom and make their own decisions; (7) risk-taking – creative people are willing to take the risk of trying new ideas; (8) intuitive – people trust themselves to follow their heart instead of feeling constrained by more logical demands; it is a helpful tool for brainstorming and generating ideas; (9) thorough – creative people often put a lot of thought and care into their work, pay attention to details that others seem to be of little importance; (10) ambitious – creative people are often aware of how much effort they put into their work; breakdown of large tasks into smaller, more achievable parts can facilitate the management of complex processes; (11) objective – creative people are often passionate about what they do, but also understand the need to be objective; this often requires constant practice and editing; (12) energetic – creative people are often energetic – this does not mean that they seem hyperactive, but they put a lot of energy into their work (12 Traits, 2022).

The psychology of the development of human creative potential, which is part of the psychology of development, proposes the concept of creative potential and its development. Researching the category of "creative personality potential" requires continuous research of the current and potential characteristics of the examined person. The realization of the creative potential are effective creative activities, initiated by the internal creative activities of the subject and the creative processes taking place in humans on a conscious and unconscious level. Creative potential considered as a category of personality is dominant, multifunctional and passes through various stages of maturity. In this way, it is possible to specify potential creativity on the level of self-reflection, communicative and updated creativity (Wiszniakowa-Zelinskiy, 2016).

The subject of the latest research on individual creativity indicates current research areas. In 2021, 12 publications were registered in the ERIC database (as on 12 September 2022), which were assigned the following subjects, respectively: creativity (10), correlation (5), foreign countries (5), higher education (4), postsecondary education (4) . On the other hand, 541 publications were registered in the Web of Science database in 2022 (status on 12 September 2022), most of which were assigned to such

Web of Science categories as: management (101), psychology multidisciplinary (78), education educational research (60), business (56), psychology experimental (45). Further analysis of the publications assigned to the management category allows us to specify further research areas: business economics, psychology, engineering, information science library science, operations research management science and others. In the group of publications assigned to the management category, there were, inter alia, topics such as: managing creativity in organizations, the relationship between the creativity of members and the creativity of the team, proactive behaviour in the field of information security, the effects of mentor's creativity, the impact of the workplace status on the creativity of employees.

2.2. Artificial creativity (computational creativity)

Computational creativity (also known as artificial computational creativity, mechanical creativity, creative computing or creative computation) is understood as a multidisciplinary enterprise that is at the intersection of the fields of artificial intelligence, cognitive psychology, philosophy and art (Computational, 2022). The purpose of thus understood computational creativity is to model, simulate or create creativity with the use of a computer. The specific goals are:

- constructing a program or computer capable of creativity at the human level;
- better understanding of human creativity and formulation of an algorithmic perspective of creative human behaviour;
- designing programs that can enhance human creativity without necessarily being creative (Jordanous, 2022).

The field of computational creativity deals with theoretical and practical issues in the study of creativity. Theoretical work is carried out on nature and the proper definition of creativity and combined with practical work on the implementation of systems showing creativity, with one thread of work influencing the other. This form of computational creativity is called a media synthesis (Vales, 2019; Computational, 2022). Creative design is about expanding the space of possible projects with new knowledge. This happens as a result of creative design mechanisms such as emergence, analogy, and creative evolution. These mechanisms are also the subject of research on visual perception (Grabska, 2014). The concept of computational creativity also applies to art, mathematical models and engineering projects, and innovative scientific theories. One such theory is that creativity and curiosity are the by-products of a simple computational principle to measure and optimize learning progress. This is the formal theory of Schmidhuber (2006; 2010). If we imagine an agent capable of manipulating its surroundings, and thus its own sensory stimuli, then it can be motivated for continuous, open, active and creative exploration. An agent can use a black box optimization method, such as reinforcement learning, to learn (through conscious trial and error) a sequence of actions that maximize the expected sum of future reward signals. There are external reward signals for achieving externally defined goals, but the goal function to be maximized also includes an additional, inherent term for wow-effect modelling. This non-standard term motivates purely creative agent behaviour even when there are no external targets. Schmidhuber argues that this objective function explains the activities of scientists, artists and comedians. For example, physicists

are motivated to create experiments that lead to observations according to previously unpublished physical laws that allow for better data compression. Composers receive an inherent reward for creating non-arbitrary melodies with unexpected but regular harmonies that produce a wow effect by improving data compression. Likewise, the comedian receives an inherent award for "inventing a novel joke with an unexpected punch line, related to the beginning of the story in an initially unexpected but quickly learnable way that also allows for better compression of the perceived data" (Schmidhuber, 2010).

Computational creativity is a complex phenomenon whose study is further complicated by the plasticity of the language we use to describe it. Therefore, some researchers believe that it is impossible to develop a general theory of creativity (Computational, 2022). However, some generative principles are more general than others, leading to the claim that some computational approaches are "general theories". For example, Stephen Thaler suggests that certain neural network modalities are generative enough and general enough to manifest a high degree of creative ability (Thaler, 2013). Many authors such as Boden (2009), Wiggins (2012) and Ritchie (2001; 2005), have introduced formalisms that help us more accurately define software creativity.

The subject of the latest research on computational creativity indicates current research areas. In the period 1976–2021, 17 publications were registered in the ERIC database (as on 12 September 2022), which were assigned the following subjects, respectively: creativity (12), foreign countries (9), computation (7), computer science education (6), creative thinking (6). On the other hand, 83 publications were registered in the Web of Science database in 2022 (as on 12 September 2022), most of which were assigned to such Web of Science categories as: computer science artificial intelligence (8), computer science information systems (8), education educational research (8), neurosciences (8), mathematical computational biology (7). Further analysis of publications assigned to the category of computer science artificial intelligence management allows to specify further research areas: computer science, engineering, instruments instrumentation, mathematics, operations research management science, robotics. In the group of publications assigned to the computer science management category, there were, inter alia, topics such as: deep learning creativity, creating analogies between human and artificial intelligence as the basis of creativity, the problem of creative writing supported by Large language models (LLMs), automatic game creation using computational processes, algorithmic music generation by harmony recombination with genetic algorithm, CycleGAN algorithm to achieve the sketch recognition process in sketch-based modelling, automate the evaluation of design exams.

In the next chapter, we will look for the similarities and differences in the perception of human and artificial creativity.

3. INDIVIDUAL CREATIVITY VS. ARTIFICIAL CREATIVITY (COMPUTATIONAL CREATIVITY)

When analysing the results of research on creativity, we can ask ourselves the question: to what extent do humans and their creativity become a model for the creators

of AI solutions? In response to these questions, we will present the latest research results concerning selected concepts. They include:

- creative thinking – is one of the characteristics of competences at the human level. It is now believed that speculative ideas about the brain processes involved in creative thinking can be implemented in computational models. Two factors are important for creativity: imagination and selection or filtering. Imagination should be limited by experience, while filtering in the case of creative use of words may be based on semantic and phonological associations. Analysing the brain processes involved in coming up with new words leads to practical algorithms that create many interesting and novel names associated with a set of keywords (Duch, 2006).
- computational thinking competences – assumes the openness of short tasks as an indicator of whether creativity is necessary to successfully solve a task. When designing a task, you can make it more open and thus require more creativity and different competences in the field of computational thinking (Datzko, 2019).
- evaluation as a key element of creativity, both human and artificial – internal evaluation mechanisms drive the creative process and influence the competence of the creative agent. External evaluation works through certainty and requires interaction with users who express both opinions and some subjective quantification of the final work of art. This approach was used in the Psi model, which uses natural language processing techniques to infer satisfaction and emotional impact of the end product obtained by the creative agent (Augello, Infantino, Pilato, Rizzo and Vella, 2015).

Many of these solutions are used in modern education and research. Issues are addressed:

- developing competences of the 21st century through computational thinking and active learning;
- computational thinking perceived as one of the basic conditions for the development of students' problem-solving skills in primary school (including first programming with Ozobots, learning scenarios with robots);
- a methodical approach to teaching STEM skills through educational robotics for school teachers;
- the use of programming tools in teaching and educational materials by teachers of primary and secondary schools;
- virtual environment for creative and team learning;
- learning visual creative programming in the gaming environment;
- implementation and use of learning and collaboration technologies that shape competences in empowerment and creativity;
- designing informatics curriculum for K-12 education.

CONCLUSION

Our statements confirm that creativity as an interdisciplinary competence is attributed to both the individual and artificial intelligence. The analysis of the literature

on the subject allowed us to specify and examine the common characteristics of human creativity and artificial creativity (computational creativity). These are: creative thinking, computational thinking competences, evaluation as a key element of creativity, both human and artificial.

Man and his creativity become a model for the creators of AI solutions, and these solutions can be used in modern education. The subject of research is creativity in the general population, especially with regard to education. Distinctions between "high" and "little c" creativity and "democratic" creativity can be helpful. Moreover, creativity is defined in terms of those people who have made a significant creative contribution, possibly changing the field. Career trajectories of outstanding creative people are drawn up in order to reflect patterns and determinants of creative productivity.

REFERENCES

Aguilera, D. & Ortiz-Revilla, J. (2021). STEM vs. STEAM Education and Student Creativity: A Systematic Literature Review. *Education Sciences*, *11*(7), Article Number 331. https://doi.org/10.3390/educsci11070331.

Augello, A., Infantino, I., Pilato, G., Rizzo, R., & Vella, F. (2015). Creativity evaluation in a cognitive architecture. *Biologically Inspired Cognitive Atchitectures*, *11*, 29–37. https://doi.org/10.1016/j.bica.2014.11.013.

Boden, M.A. (2004). *The Creative Mind: Myths And Mechanisms*. London: Routledge. https://doi.org/10.4324/9780203508527.

Boden, M.A. (2009). Computer models of creativity. *AI Magazine, 30*(3), 23–34. https://doi.org/10.1609/aimag.v30i3.2254.

Computational creativity. In *Wikipedia. The Free Encyclopedia*. Retrieved September 12, 2022 from https://en.wikipedia.org/wiki/Computational_creativity.

Craft, A. (2001). 'Little C' creativity. In A. Craft, B. Jeffrey, & M. Leibling (Eds.). *Creativity in education*. London: Continuum International.

Creative Thinking Competency. In *PCM Training. Performance Management Consultant*. Retrieved September 12, 2022 from https://pmctraining.com/site/develop-your-core-competencies/creative-thinking-competency/.

Creativity. In *Wikipedia. The Free Encyclopedia*. Retrieved September 12, 2022 from https://en.wikipedia.org/wiki/Creativity.

Csíkszentmihályi, M. (2013). *Creativity: Flow and the Psychology of Discovery and Invention*. Harper Perennial.

Datzko, C. (2019). Openness and Creativity in Solving Short Tasks for Learning Computational Thinking. *Constructivist Foudations*, *14*(3), 407–410.

Decision (EU) 2021/820 of the European Parliament and of the Council of 20 May 2021 on the Strategic Innovation Agenda of the European Institute of Innovation and Technology (EIT) 2021–2027: Boosting the Innovation Talent and Capacity of Europe and repealing Decision No 1312/2013/EU. Retrieved September 12, 2022 from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021D0820&qid=1662907284808.

Decision No 1350/2008/EC of the European Parliament and of the Council of 16 December 2008 concerning the European Year of Creativity and Innovation (2009) (Text with EEA

relevance). Retrieved September 12, 2022 from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008D1350&qid=1663151617120.

Duch, W. (2006). Computational creativity. In *2006 IEEE International Joint Conference on Neural Network Proceedings*, *Vols 1–10* (pp. 435–442). Retrieved September 12, 2022 from http://fizyka.umk.pl/publications/kmk/11-Computational-Creativity.pdf.

Frith, E., Miller, S., & Loprinzi, P.D. (2020). A Review of Experimental Research on Embodied Creativity: Revisiting the Mind-Body Connection. *Journal of Creativity Behaviour, 54*(4), 767–798. https://doi.org/10.1002/jocb.406.

Grabska, E. (2014). The Theoretical Framework for Creative Visual Thinking *Studying Visual and Spatial Reasoning for Design Creativity.* Retrieved September 12, 2022 from https://link.springer.com/chapter/10.1007/978-94-017-9297-43.

Hahn, M. (1968). Minnesota Research Coordinating Unit for Vocational Education, Minneapolis: Review of Research on Creativity. Spons Agency-Office of Education (DHEW).

Henry, J. (1992). Creative Competences. Aspects of Educational and Training Technology Series, *25*, 139–144.

Jordanous, A. (2014). What is Computational Creativity? In *Thecreativitypost*. Retrieved September 12, 2022 from https://www.creativitypost.com/science/what_is_computational_creativity.

Kaufman, J.C. & Beghetto, R.A. (2009). Beyond Big and Little: The Four C Model of Creativity. *Review of General Psychology*, *13*(1), 1–12. https://doi.org/10.1037/a0013688.

Kiffer, S. & Tchibozo, G. (2013). Developing the Teaching Competences of Novice Faculty Members: A Review of International Literature. *Policy Futures in Education*, *11*(3), 277–289. https://doi.org/10.2304/pfie.2013.11.3.277.

Kozbelt, A., Beghetto, R.A., & Runco, M.A. (2010). Theories of Creativity. In J.C. Kaufman, R.J. Sternberg (Eds.). *The Cambridge Handbook of Creativity* (pp. 20–47). Cambridge University Press.

Luecke, R. & Łuczkiewicz, G. (transl.) (2005). Zarządzanie kreatywnością i innowacyjnością. *[Managing creativity and innovation].* Wydawnictwo MT Biznes.

Meusburger, P. (2009). Milieus of Creativity: The Role of Places, Environments and Spatial Contexts. In P. Meusburger, J. Funke, & E. Wunder (Eds.). *Milieus of Creativity: An Interdisciplinary Approach to Spatiality of Creativity*, (pp. 97–153). Cham: Springer.

Montgomery, D., Bull, K.S., & Baloche, L. (1993). Characteristics of the Creative Person: Perceptions of University Teachers in Relation to the Professional Literature. *American Behavioral Scientist*, *37*(1), 68–78. https://doi.org/10.1177/0002764293037001007.

Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning (2006/962/EC). Retrieved September 12, 2022 from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006H0962.

Regulation (EU) 2021/523 of the European Parliament and of the Council of 24 March 2021 establishing the InvestEU Programme and amending Regulation (EU) 2015/1017. Retrieved September 12, 2022 from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R0523&qid=1663147833984.

Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regula-

tions (EU) No 1290/2013 and (EU) No 1291/2013. Retrieved September 12, 2022 from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R0695&qid=1662942787748.

Regulation (EU) 2021/818 of the European Parliament and of the Council of 20 May 2021 establishing the Creative Europe Programme (2021 to 2027) and repealing Regulation (EU) No 1295/2013 (Text with EEA relevance). Retrieved September 12, 2022 from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R0818&qid=1663147833984.

Ritchie, G. (2001). Assessing Creativity. In *Proceedings of the AISB*. Retrieved September 12, 2022 from https://homepages.abdn.ac.uk/g.ritchie/pages/papers/aisb01.pdf.

Ritchie, G. (2005). Experiments With Assessment of Creative Systems: An Application of Ritchie's Criteria. In *Conference: Second Computational Creativity Workshop, IJCAI2005*. Retrieved September 12, 2022 from https://www.researchgate.net/publication/261511218_Experiments_With_Assessment_of_Creative_Systems_An_Application_of_Ritchie's_Criteria.

Robinson, K. (1999). *All our futures: Creativity, culture, education*. National Advisory Committee on Creative and Cultural Education. eBook, English.

Schmidhuber, J. (2006). Developmental Robotics, Optimal Artificial Curiosity, Creativity, Music, and the Fine Arts. *Connection Science*, *18*(2), 173–187. https://doi.org/10.1080/09540090600768658.

Schmidhuber, J. (2010). Formal Theory of Creativity, Fun, and Intrinsic Motivation (1990–2010). *IEEE Transactions on Autonomous Mental Development*, *2*(3), 230–247. 10.1109/TAMD.2010.2056368.

Schmidhuber, J. (2012). When creative machines overtake man: Jürgen Schmidhuber at TEDxLausanne. Retrieved September 12, 2022 from https://youtu.be/KQ35zNlyG-o.

Simonton, D.K. (1997). Creative Productivity: A Predictive and Explanatory Model of Career Trajectories and Landmarks. *Psychological Review, 104*(1), 66–89. https://doi.org/10.1037/0033-295X.104.1.66.

Słownik Języka Polskiego PWN. *[PWN Polish Language Dictionary]*. Retrieved September 12, 2022 from https://sjp.pwn.pl/szukaj/kreatywność.html.

Thaler, S. (2013). Creativity Machine® Paradigm. In E.G. Carayannis (Eds.). *Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship* (pp. 447–456). Springer.

Vales, A. (2019). An introduction to synthetic media and journalism. Retrieved September 12, 2022 from https://medium.com/the-wall-street-journal/an-introduction-to-synthetic-media-and-journalism-cbbd70d915cd (accessed 12 September 2022).

Wiggins, G.A. (2012). The mind's chorus: Creativity before consciousness, Cognitive Computation. Special issue on Computational Creativity, *Intelligence and Autonomy*, *4*, 306–319. https://doi.org/10.1007/s12559-012-9151-6.

Wiszniakowa-Zelinskiy, N. (2016). Psychologia rozwoju kreatywnego potencjału człowieka. [*Psychology of the development of human creative potential*]. Oficyna Wydawnicza AFM.

12 Traits of Creative People: By Indeed Editorial Team. In *Indeed. Carier Guide*. Retrieved September 12, 2022 from https://www.indeed.com/career-advice/finding-a-job/traits-of-creative-people.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 163–177
https://doi.org/10.34916/el.2022.14.12

ONLINE EDUCATION AT A MODERN UNIVERSITY: TOOLS FOR INTERACTIVE LEARNING

Liudmyla Khoruzha[1], Liliya Hrynevych[2], Dmytro Bodnenko[3], Iryna Vakulova[4], & Volodymyr Proshkin[5]
[1, 2, 3, 4, 5] Borys Grinchenko Kyiv University
Bulvarno-Kudriavska St. 18/2, Kyiv, Ukraine
[1] l.khoruzha@kubg.edu.ua, ORCID 0000-0003-4405-4847
[2] l.hrynevych@kubg.edu.ua, ORCID 0000-0002-5818-8259
[3] d.bodnenko@kubg.edu.ua, ORCID 0000-0001-9303-6587
[4] i.vakulova.asp@kubg.edu.ua, ORCID 0000-0002-7123-5646
[5] v.proshkin@kubg.edu.ua, ORCID 0000-0002-9785-0612

Abstract: *The article substantiates the utility of digital tools and services in interactive learning in the context of distance education. It analyses the capabilities of technical equipment enabling interactive learning (interactive response and assessment systems, interactive panels, testing and voting systems, touch tables, interactive sandbox and interactive floor) and discusses the didactic side of digital tools and services application in learning (online demonstration, simulation, experiment; webinars; visualization tools; testing tools; mind maps and knowledge maps; timelines, word clouds; virtual digital boards, etc.). Finally, the article presents the findings from faculty and student surveys exploring advantages and downsides of the use of digital tools and services for interactive learning.*

Keywords: digital tools, informatization of education, interactive learning, distance education, modern university, specialist training.

INTRODUCTION

The present day global situation of the pandemic and its aftermath has transformed the ways various aspects and dimensions of human life operate. The most noticeable changes have taken place in education, including higher education. Within a very short time we have witnessed the transition from the phase of getting accustomed to distance learning to the phase when distance mode is a major form of students' learning. Faculty teaching online classes using various video conferencing services (Google Meet, Zoom, Jitsi, Duo and others) has become the new normal. So, it appears to bear out the claim made by American scholars that "the future and

education in the future will be digital…" (Bonn, 2021). It should be noted that online learning belongs to the synchronous mode of interaction between various actors when participants are simultaneously present in the electronic educational environment. The synchronous mode is complemented by the asynchronous mode when the interaction between actors in distance learning takes place with a time lag, utilizing interactive education platforms, e-mails, forums, social networks, etc.

The synchronous mode of online classes can last from 1.5 to 3 hours but in such settings the students' focus in terms of active listening and processing of material often drops since the typical ability to concentrate lasts for 45–60 minutes, thus diminishing the effectiveness of cognitive performance. In this context, an important question is how to maintain students' focus and engage them in active learning while taking into consideration their needs and demands? The answer can be found through analysis of application possibilities and didactic value of interactive methods and technologies of distance learning with related multimedia resources.

The purpose of this article is to discuss a rationale for the application of digital tools and digital services for implementation of interactive learning within the context of distance education and to analyse their didactic specificity in learning.

1. ANALYSIS OF CURRENT RESEARCH

The problem of interactivity and interactive learning methods is not new in pedagogy. The areas of relevant scientific research touch upon general pedagogical aspects of exploration and implementation of interactive learning methods (Moreno & Mayer, 2007; Cairncross & Mannion, 2001; Sysoieva, 2011), discovery of possibilities to mainstream digital tools and resources in the educational process (Kumawat, 2020; Hurlbut, 2018), conceptualization of the phenomenon of a new pedagogy – digital humanistic pedagogy (Bykov, 2016), a didactic model of sustainability commitment (Öhman, 2021), and other. The research by Yürüm, & Yıldırım (2022) on the influence of interactive video on learning outcome and learner satisfaction in e-learning environments, deserves attention. Development of digital pedagogical tools in learning is widely featured in the works of scholars, such as Pacheco (2022), Insorio (2021), Tsai (2020) and other. Thus, theoretical and methodological principles of using interactive whiteboards have been revealed in the works Dudaitė & Prakapas (2019), Samsonova (2021), Bajtoš & Kašaiová (2016), Bodnenko, Kuchakovska, Proshkin, & Lytvyn (2020). The study of the higher school is in the research of Khoruzha, Bratko, Kotenko, Melnychenko, & Proshkin (2019) and organisation of the educational process in Ukrainian schools under the lockdown conditions Hrynevych, Ilyich, Morze, Proshkin, Shemelynets, Lyniov, & Riy (2020). In addition, the theoretical and practical principles of using digital technologies for the organization of interactive learning are given in some studies (Subhash & Cudney, 2018; Estriegana, Medina-Merodio, & Barchino, 2019; Valverde-Berrocoso, del Carmen Garrido-Arroyo, Burgos-Videla, & Morales-Cevallos, 2020; Makransky & Petersen, 2019; Liao, Chen, & Shih, 2019).

Consolidation of scholarship on this subject matter allows us to maintain that interactivity in learning is a way of organising students' cognitive activity based on active

communication, information exchange, performance of assignments in an electronic educational setting that helps boost learning motivation and create an emotionally conductive climate.

The aim of this study is to find out the peculiarities of the implementation of the templates method in the process of e-learning of higher mathematics for automated generation and visualization of tasks using cloud services. The **research and problem questions** are the following: to analyse the methodological aspects of using the templates method as a real and affordable method of creating and using packages of practical mathematical tasks for students; to reveal the possibilities of cloud-based learning technologies for the implementation of the method of templates in the process of learning higher mathematics.

The research hypothesis is that the use of digital tools and services for interactive learning could improve its quality. We do not intend to reveal the effectiveness of digital tools and services. It more important for us to diagnose the real state of their use in the educational process now.

2. MATERIALS AND METHODS

The research employed a set of methods that included both theoretical methods, such as analysis, synthesis, comparison, generalization to study scientific literature and identify various tools of interactive online learning; and empirical methods, in particular testing of teachers and students to determine their awareness and degree of utilization of interactive tools of online learning. We also used statistical methods, in particular, the ranking, to interpret the results of the research. We did not use special statistical criteria because our task was to establish the real state of implementation of interactive learning in the conditions of distance education. At the same time, the given recommendations require statistical proof of their significance in the future.

3. MAIN RESULTS

Exploring the concept of interactivity for a distance-learning system, scholars identify four main types of interactivity. The classification is based on the definition of message sender and message recipient in the process of learning interaction:

- learner – learner;
- learner – teacher;
- learner – learning material;
- learner – multimedia presentation management tools (Sysoieva, 2011).

Utilization of interactive tools in online learning stipulates a clear definition of didactic goals and objectives; actualization of underlying knowledge and skills; grasping of the essence of concepts and performance methods; assimilation of received knowledge; problem solving; control and assessment of knowledge, overall satisfaction level, etc. Using interactive tools of online learning in achieving identified didactic objectives helps foster creativity in learning and cognition; introduce the elements of competition and play; organise student interaction within and across groups; carry out continuous monitoring of satisfaction, emotional comfort level, etc.

Thus, interactivity promotes collaboration, mutual understanding, tolerance and friendliness, and enables person-oriented learning. Given that interactivity predominately takes place in cooperative learning when each student contributes to a common success, attention should be paid to the availability of necessary technical equipment, digital tools and services.

3.1. Technical equipment for interactive learning

According to the expert survey involving faculty of Borys Grinchenko Kyiv University (35 respondents), equipment that is most frequently used in university education includes interactive sets (board and projector), tablet, designer sets for robotics and programming, etc.

Equipment that is still uncommon in the educational process because of its high cost but that has a significant potential for the realization of interactivity can include:

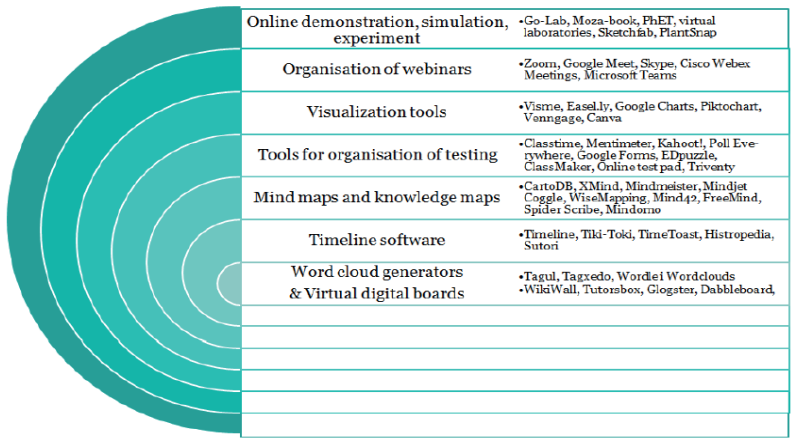
- *digital measurement computer sets* (Vernier, NEULOG, Einstein) enabling to conduct laboratory experiments, practical assignment and demonstration of phenomena in mathematics, physics, chemistry, biology, geography and other subjects. The device has a built-in memory, can run on various operating systems. This allows the collection of information, its prompt processing with playback on the built-in display or projector screen;
- *interactive panels* (Promethean, EdPro Touch, Intboard) enabling to create digital interactive classrooms with the possibility to connect more than 30 users. It enables to check knowledge by polling, create and edit office documents (tables, documents, presentations), etc., operates as a multimedia presenter, and offers toolkits for mathematics, physics, chemistry, biology, etc. It also enables the use of interactive stylus. As practice shows, the most common in-teractive panels have a 65”, 75” or 86” diagonal. Typically, all modern inter-active panels have a resolution of 4K Ultra HD, which ensures a clear picture with rich, bright colours, which attracts students’ attention. It is important that modern models do not have a visible pixilation of the image;
- *interactive response and assessment systems* (SunVote, XPRESS, SMART RESPONSE) enabling surveys and polls, collecting generalized and individual responses, as well as conducting seminars, conferences, etc. It enables teachers to receive quick responses from audiences and allows students to participate in joint activities and group work. In the process of interactive interaction, it is possible to distribute consoles into teams among students, receive information about the current and final voting, etc. Most often, for interactive voting, participants are given consoles, but an option is possible with the help of other means, such as mobile applications;
- *interactive touch tables* (Elpix, Intboard Dotyk) with screen and in-built computer that utilize multi-touch technology (simultaneous work of several users) to enable teamwork and enhance interaction between participants of the learning process;
- *interactive sandbox* (iSandBox, Briolight, SandBox) is a piece of equipment based on the concept of augmented reality which creates a movement sensitive projection on real sand. By moving and building sand, user can create

mountains, volcanoes, rivers and other virtual landscapes, working with their own imaginary world that can be changed. It is used for teaching geography, natural sciences as well as therapeutic counselling and psycho-correction. For students of pedagogical specialties it is necessary to master the method of working with interactive sandbox, because it promotes the development of pupils' speech, communication skills, stimulates the visual, tactile system, as well as develops general motility and coordination of movements. In addition, the device is used in sand, sensory and game therapy, is an effective tool for training with a speech therapist, psychologist, teacher and other professionals who work with children. It is used in schools, kindergartens, rehabilitation and play centres, treatment rooms;

- *interactive floor* (Briolight, OMG Interactive, FunFloor) is a system containing displays with projected images and sensors that enable interaction with projected images on the floor. It is used in inclusive and rehabilitation facilities, schools, pre-schools, sports schools and facilities. Future teachers should understand that interactive floor can be used for school development or recovery of motor, intellectual, emotional and volitional students. Content in the form of a game makes the execution of tasks a relaxed and exciting process. The interactive floor can be used both individually and for a small group, with a corrective or entertaining purpose, as a stand-alone tool or as part of a general program depending on individual needs.

The analysis of actual practice suggests that the above-mentioned technical means enabling interactivity allow students to better adapt in a group, build personal contacts, share information, take responsibility for group activity, put forward ideas, create projects, take calculated risk and out-of-the-box solutions, avoid repeating mistakes, convincingly present ideas, anticipate work outcomes, effectively manage their performance and time, etc.

3.2. Digital tools and services



F i g u r e 1. Classification of digital tools and services

S o u r c e: Own work.

The selection of digital tools and services has been guided by the following requirements for students' interactive engagement (see Figure 1):

1. understanding that the collective organisation of learning and joint learning is an effective form of education process;
2. creating conditions for group interaction;
3. activation of autonomous learning in an actor-actor dialogue;
4. processing of learning information in different forms and at different levels of complexity;
5. mandatory reflection in the process of group work.

Therefore, we identify the following digital tools and services for interactive engagement between students and teachers in distance learning settings:

- *Online demonstration, simulation, experiment* (for example, Go-Lab, Mozabook, PhET, virtual laboratories, Sketchfab, PlantSnap, etc.). The software solutions imitate performance of laboratory assignments, simulate experiments, and visually demonstrate the principles of device operation. They allow observation of processes that are difficult to see in real life without auxiliary technical means, for example, due to small size of observed objects or short interval of time. It enables to implement interactive case study that envisages decision-making and utilization of existing advantages to resolve problems. It is advisable to use imitation learning, enabling students to acquire knowledge, skills and abilities through imitation of certain ways of performance and precise reproduction. One of the most common is the PhET project of the University of Colorado (https://phet.colorado.edu), which has developed more than 100 interactive models for teaching and studying science. These simulations provide animated interactive and game environments that allow students and pupils to explore. The experience of the authors of the article on the use of digital tools and services allows us to identify problematic issues that will be promising for further research: whether simulations can completely replace experiments with real laboratory equipment; how not to turn educational simulations into entertainment; how best to use simulations during distance learning.
- *Organisation of webinars* (Zoom, Google Meet, Skype, Cisco Webex Meetings, Microsoft Teams, etc.). Apart from conventional functions, some software solutions enable to pose questions and conduct polls, use interactive boards, vote, form mini-groups, etc. They enable different types of interactive communication such as conversation, dialogue, debate as well as role play. The possibility of maintaining several rooms simultaneously enables such an interaction method as interview.
- *Visualization tools* (Visme, Easel.ly, Google Charts, Piktochart, Venngage, Canva, etc.) enable generation of graphs, diagrams, presentations and other visual educational content and offer templates for organisation of remote classes. These tools include the possibility of organising work in mini-groups. The use of images enables brainstorming that stimulates search for new ways to look at a problem to be addressed. Building associations between solutions and images is a useful tool to solicit new ideas and develop creative thinking.

- *Tools for organisation of testing* (Classtime, Mentimeter, Kahoot!, Poll Everywhere, Google Forms, EDpuzzle, ClassMaker, Online test pad, Triventy, etc.) enable the generation of various multiple-choice surveys, quizzes and learning games. As a rule, modern resources allow you to create tests with single and multiple choice questions, entering a number or text, giving an answer in free form, setting the sequence, filling in the blanks (number, text, list), sequential removal of redundant information and more.
- *Mind maps and knowledge maps* (CartoDB, XMind, Mindmeister, Mindjet Coggle, WiseMapping, Mind42, FreeMind, Spider Scribe, Mindomo, etc.) enable information visualization and structuring through diagrams reflecting words, ideas, tasks, etc. with other elements around a core word or idea. They enable brainstorming as type of interactive discussion. The advantages of digital tools include the following: intuitive controls (many graphic design options, elements can be added to any part of the workspace, draw lines of any shape and size and sign them, view the map in different planes, attach files, folders and links, create a catalogue of images: when you hover over the attached icon, the image increases to its true size, etc.); ability to save the map in different formats (jpeg, pdf, html, etc.).
- *Timeline software* (Timeline, Tiki-Toki, TimeToast, Histropedia, Sutori, etc.), apart from traditional functions, enable diagnostic and forecasting of task performance by revealing inter-connectedness between events, their analysis at micro-, macro- and mega-levels, separation of details, etc. They enable the use of 'solution trees' when each student provides input about a certain problem in a chronological order and teacher summarizes students' thoughts. They also enable to use a 'microphone' method, giving each student a possibility of providing answers or comments in a particular order or sporadically.
- *Word cloud generators* (Tagul, Tagxedo, Wordle i Wordclouds, etc.) enable visualized cataloguing and are used in teamwork to describe key concepts. The importance of words is reflected in font size or colour. These generators help implement the 'snowball' method as collective search for joint solution or view. Each participating student has the possibility of presenting their vision of problems. Highlighting the main characteristics of Word cloud generators the following should be mentioned: the ability to change fonts; the ability to choose different colours in which the text and background will be displayed; the ability to display certain words exclusively in the selected colour; the presence of the function of selecting the page orientation and aspect ratio of the image; the presence of a button of random settings, thanks to which you can generate different options for displaying text; free access to download your own cloud or distribute it via a link.
- *Virtual digital boards* (WikiWall, Tutorsbox, Glogster, Dabbleboard, Twiddla, Scribblar, Padlet, Educreations, Popplet, Realtimeboard, Twiddla, etc.) enable collaboration among students and teachers through chat function and demonstration of texts, illustrations, videos, etc. The experience of the authors of the article on the use of virtual digital boards shows that they are an

> effective means of implementing various forms of educational process: web contests, interactive games, quizzes, also allow students to organize and reflect, expand opportunities for research, counselling. It should be noted that the use of virtual digital boards in the educational process contributes to the formation of students' ability to work independently with different sources of information, allow them to immediately see the results and evaluation of their work through the ability to respond quickly to one board or provide access to their own board. Virtual digital boards provide a great opportunity to visualize information, working in groups, even at a distance from each other, but under the control of a teacher who acts as an administrator, coordinator. He/She remotely regulates, adjusts the flow of information. The administrator receives notifications of changes on the board. After the required information is collected, students, together with the teacher begin to systematize the information and compile a single project (Bodnenko, 2020).

The variability of application of digital tools and services for implementation of interactive learning in the context of distance education, and their didactic specificity in application for learning purposes solicited exploration of the actual situation with their practical application in university education. A survey of 35 faculty members and 238 students of Borys Grinchenko Kyiv University, conducted in March 2022, has revealed mixed perceptions and awareness among students and faculty as regards digital tools and services for implementation of interactive learning in the context of distance education. In the process of developing the questionnaire, experts were involved, namely, 6 university teachers who take care of the problems of organizing and implementing distance learning. Their comments and wishes were taken into account in the process of developing the questionnaire.

The vast majority of faculty members (94.3%) believe that the use of digital tools and services for implementation of interactive learning is important in the context of distance education; however, a considerably lower percentage of students (66.4%) share this opinion. Such high percentage of faculty members is likely to suggest that they may to a certain degree equalize distance education with interactive learning or insufficiently understand the concept of interactive learning itself.

Students are more pragmatic in this regard, predominantly focusing on distance education outcomes rather than the process. 71.4% have stated that they have experience of using digital tools and services for implementation of interactive learning in the context of distance education; and 62.2% of students confirm that teachers use these digital tools and services. At the same time, Graph 1 suggests that this experience is not far-reaching: only 8.6% of faculty members use digital tools and services for demonstration, simulation, experiment and timeline activities; 11.4% use word cloud generators; and about 20% use visualization tools and virtual boards (see Figure 2). Interestingly, students appear to be more confident users of digital tools versus teachers. In some categories, students outperform teachers in 1.5 – 2 times, for example, in the use of software for demonstration, simulation and experiment (students – 26.9%, teachers – 8.6%), word cloud generators (students – 25.2%, teachers – 11.4%), timeline generators – (students – 19.3%, teachers – 8.6%), etc.

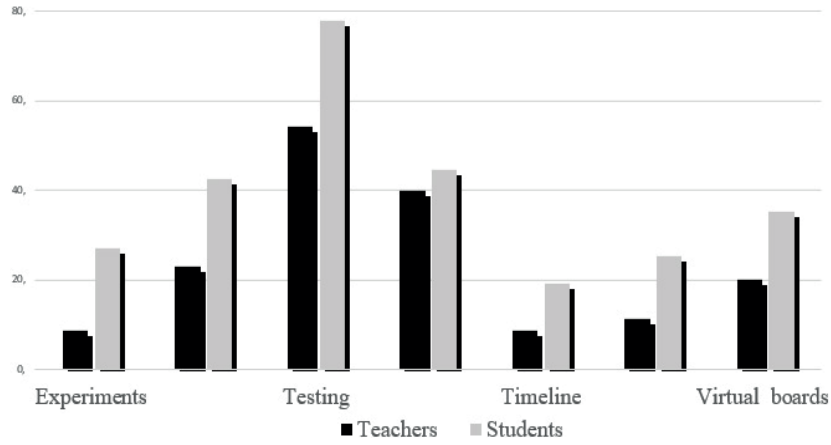


Figure 2. The use of digital tools and services in distance learning

Source: Own work.

In light of these findings, it was important to find out teachers' opinions about factors that hamper effective use of digital tools and services. The rank-ordered factors are presented below (Table 1).

Table 1. Ranking of factors hampering the use of digital tools and services (from smallest to largest contributors)

Rank order	Factor	Responses, %
1	Students' insufficient knowledge of computer software (or Moodle) enabling interactive learning	31.4
	Overloaded thematic plan in the curricula	
2	Lack of willingness, passivity of students	42.9
3	Lack of willingness, passivity of teachers	48.6
4	Inadequate technical capabilities (weak internet connection, limited availability computers or mobile devices)	54.3
5	Teachers' insufficient knowledge of computer software (or Moodle) enabling interactive learning	65.7
	Teachers' lacking time to prepare for classes involving interactive learning	

Source: Own work.

3.3. Use of interactive services in teaching of the natural sciences

Here are fragments of the use of interactive services in the educational process. At the stage of submission of new material, through the use of deductive method, we carry out the disclosure of material from general to partial. The use of frames or Mind maps helps to implement this method (for example Mind Map). MIt is possible

to use an inductive method (from partial to general) when creating a roadmap for studying the discipline. In particular, through the use of reflection from school material and through brainstorming, the general mental structure of the thematic plan of the academic discipline is formed. During the compilation of the Mind Map, students in small groups in an online resource must form thematic components of the discipline by content modules (each team is engaged in one of the five content modules of the discipline "Physics"). Having created the components (by modules), students together with the teacher build a roadmap for studying the discipline "Physics" in a shared cloud service. Figure 3 shows the result of the road map formation for studying the discipline "Physics" in the introductory lecture.

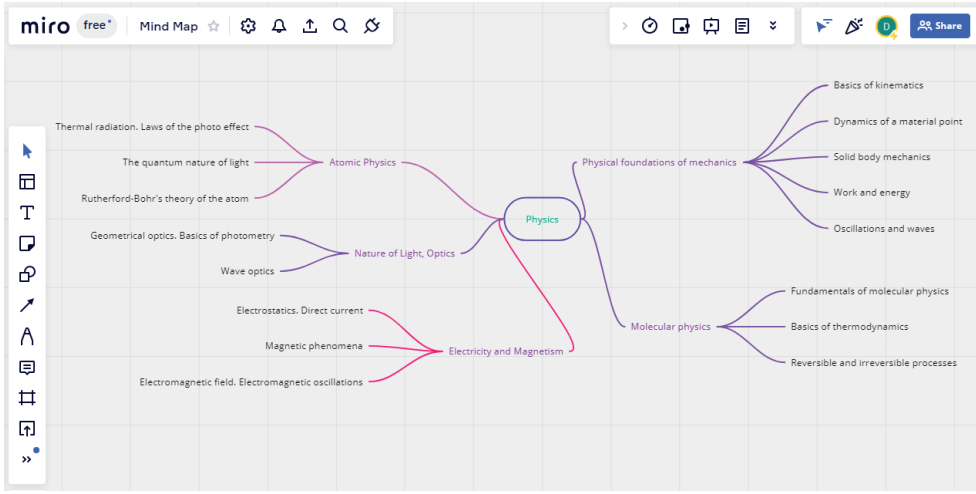


Figure 3. Using Mind Map mental maps to create a roadmap for studying the discipline "Physics"

Source: Own work.

At the stage of reflection (it can be both the beginning of a class (practical, seminar or lecture) and the end of a class, that is summing up what has been learned) it has already become a tradition to use online testing with the help of Testing Tools. The authors of the study propose to conduct a "team briefing" – blitz of control works, which contain questions of both theoretical and practical nature. Interactive team briefing is carried out, for example, when studying the discipline "Physics" for students of the educational program "Security of information and communication systems", using virtual digital jamboard (miro, Padlet, Realtimeboard, Twiddla, etc.). To implement the blitz of interactive control, the lecturer develops the template of the team briefing in advance. The template is positioned according to the environment. The briefing template is located on the virtual digital board, the necessary number of templates is replicated in the same board (according to the contingent of students of the group/subgroup) (Figure 4).

F i g u r e 4. Use of virtual digital boards (Jamboard, Miro) for conducting team briefing (blitz control works)

S o u r c e: Own work.

The recommendation to arrange the templates in pairs (horizontally or vertically, conventionally it is possible to name the first and the second, or the first-fourth option), which is freely formed in a digital resource (using the zoom tool, both the teacher (can see by reducing the scale as much as possible) the activity of whole group, and the student (can work with maximum zoom) in his template, respectively). Students are given access to an online whiteboard where they sign each of their templates (selected randomly by the students, or by the sequence number in the group list). Next, the questions are announced in the established order: part of the questions are the same for everyone (for example, write a formula for the average path speed); the second part is different for each versions (for example, version I – write a formula for the law of energy conservation, and version II should write a formula for maintaining the momentum); the third part is arbitrary formula(s) by subject, with a mandatory indication of the formula's name; a separate task can be to indicate the dimensions in the formulas given in the briefing. The number of questions varies depending on the value of the score assigned to this type of work in the current lesson. Upon completion of the briefing writing, students of odd variants check the work and give points to students of even variants (and vice versa). The entire process can be freely coordinated by the discipline lecturer by observing the activities of students both through webinar organisation tools (Zoom, Google Meet) and by observing their activities in a virtual digital whiteboard (Jamboard, Miro). Note that, according to a survey of expert teachers, it is advisable and convenient (when organising distance learning) to use two means of outputting video data (for example, one gadget (monitor) demonstrates a window (for example, Google Meet) with a digital audience

of students, the second – allows for visual control over the activities of students in a virtual digital board (for example, Miro)).

To check the work, students are recommended to use the "first" part of rainbow colours (red, orange, yellow), and to write the work, conventionally can be used black (or the "second" part of rainbow colours (green, azure, blue, purple). The distribution into the variant zones, the icons of each student's movement and the different colours of the work (writing/checking) does not give students the opportunity to correct their own ("someone else's") work or write it off.

Tools for online demonstration and simulation of experiments are of particular importance to ensure interactive interaction. Here is an example of using phet.colorado.edu (Interactive Simulations for Science and Maths – https://phet.colorado.edu/), which gives students the opportunity to understand the nature and essence of physical (as well as chemical, biological) phenomena and the laws of mathematics. In particular, solving the problem of Coulomb law with the help of a virtual digital board, students, together with the teacher, can get acquainted with the virtual model of this law demonstration, the dependence of the strength of the interaction of point charges on the module of their magnitude and distance between them and form an appropriate explanatory drawing-demonstration in PHET to solve typical problems (Figure 5).

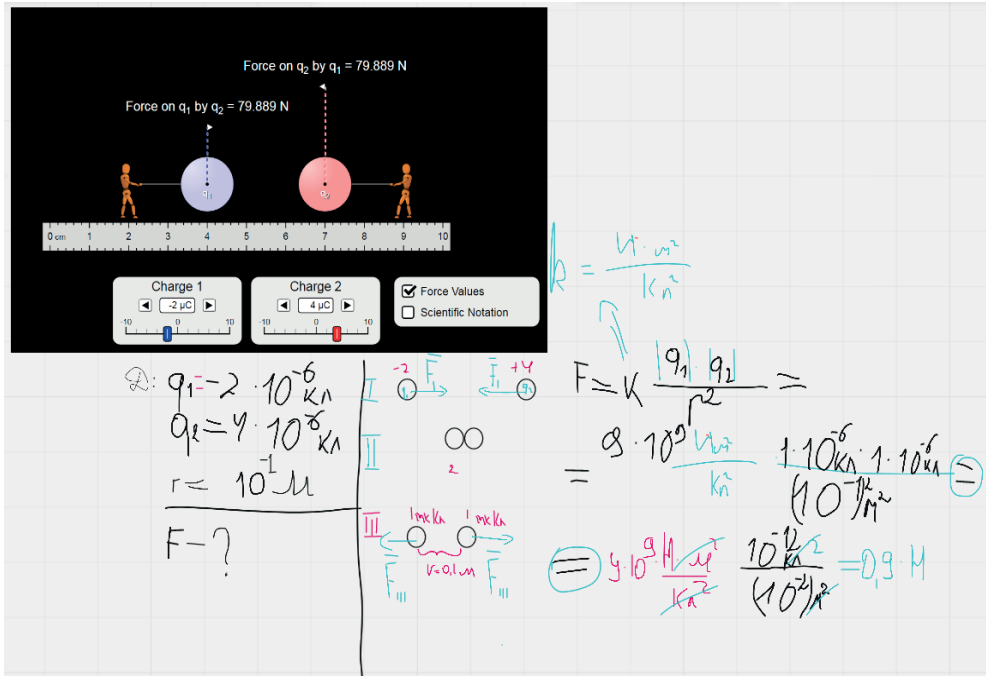


Figure 5. Using Interactive Simulations for Science and Maths phet.colorado.edu to build a physical model for solving a typical Coulomb Law problem

Source: Own work.

CONCLUSION

The problem of the use of digital tools and services for implementation of inter-active learning in the context of distance education is of relevance for the improvement of higher education quality and cognitive activity of students.

The variability of digital tools and services allows for their extensive use in the education process, in line with respective didactic goals and objectives. Their didactic specificity in application for learning purposes have been analysed.

The diagnostic of awareness and perceptions among teachers regarding the use of digital tools and services for implementation of interactive learning in the con-text of distance education has shown that teachers make only limited use of such digital tools and services in class. However, students appeared to be more knowledgeable. This highlights the issue of raising teachers' information and communication competence to master relevant tools and services and understand their didactic value in education process. To this end, the content of diverse programs and courses in post-diploma education requires updating and relevant training should be offered to teachers.

Thus, the use of mental maps and knowledge maps (brainstorming, deductive and inductive method), virtual digital boards (writing briefings, checking them and solving physical problems), online demonstrations, simulations, experiments (solving problems using the construction of a physical model), etc.: contributes to the practical introduction of interactive teamwork between participants in the educational process; enhances the level of consolidation of material by topic (content module, discipline); contributes to the formation of critical thinking and analytical competencies in students.

Therefore, the organisation of interactive learning in the context of distance education should ensure two aspects: utilization of digital tools and services, and interpersonal interaction between teachers and students and between students.

REFERENCES

Bajtoš, J. & Kašaiová, M. (2016). Use of interactive whiteboards in the work of teachers of vocational subjects with an emphasis on the effectiveness of teaching. *The New Educational Review*, *46*(4), 119–129. https://doi.org/10.15804/tner.2016.46.4.10.

Bodnenko, D.M., Kuchakovska, H.A., Proshkin, V.V., & Lytvyn, O.S. (2020). Using a Virtual Digital Board to organize student's cooperative learning. https://doi.org/10.31812/123456789/4419.

Bonn, M., Green, H., Courtney, A., & Senseney, M. (2021). Innovation Through Colaboration in Humanities Research. *Digital Humanities Quarterly*, *15*(4).

Bykov, V. & Leshchenko, M. (2016). Digital humanistic pedagogy: Relevant problems of scientific research in the field of using ICT in Education. Information Technologies and Learning Tools, *53*(3), 1. https://doi.org/10.33407/itlt.v53i3.1417.

Cairncross, S. & Mannion, M. (2001). Interactive Multimedia and Learning: Realizing the benefits. Innovations in Education and Teaching International, *38*(2), 156–164. https://doi.org/10.1080/14703290110035428.

Dudaitė, J. & Prakapas, R. (2019). Influence of use of Activinspire interactive whiteboards in classroom on students' learning. *Digital Education Review*, 299–308. https://doi.org/10.1344/der.2019.35.299-308.

Estriegana, R., Medina-Merodio, J.-A., Barchino, R. (2019). Student acceptance of Virtual Laboratory and practical work: An extension of the Technology Acceptance Model. *Computers & Education*, *135*, 1–14. https://doi.org/10.1016/j.compedu.2019.02.010.

Hrynevych, L., Ilyich, N., Morze, N., Proshkin, V., Shemelynets, I., Lyniov, K., & Riy, H. (2020). Organizatsiya osvitnogo protsesu v shkolah Ukrayini v umovah karantinu: analitichna zapiska [Organization of the educational process in Ukrainian schools under quarantine: an analytical note]. *Kyiv: Kyiv University im. Borysa Hrinchenka, 76*.

Hurlbut, A. (2018). Online vs. traditional learning in teacher education: a comparison of student progress. *American Journal of Distance Education*, *32*(4), 248–266. https://doi.org/10.1080/08923647.2018.1509265.

Insorio, A. (2021). Technological and Operational Mobile Learning Readiness of Secondary Teachers. *International Journal of Pedagogical Development and Lifelong Learning*, *2*(1). https://doi.org/10.30935/ijpdll/9362.

Khoruzha, L., Bratko, M., Kotenko, O., Melnychenko, O., & Proshkin, V. (2019). The study of the Higher School Lecturer's competence in Ukraine: Diagnostics and analytics. *The New Educational Review*, *55*(1), 233–246. https://doi.org/10.15804/tner.2019.55.1.19.

Kumawat, D. (2020). E-Learning in times of COVID-19 Crisis. *Delhi Journal of Ophthalmology*, *31*(2). http://dx.doi.org/10.7869/djo.583.

Liao, C.-W., Chen, C.-H., & Shih, S.-J. (2019). The interactivity of video and collaboration for learning achievement, intrinsic motivation, cognitive load, and behavior patterns in a digital game-based learning environment. *Computers & Education*, *133*, 43–55. https://doi.org/10.1016/j.compedu.2019.01.013.

Makransky, G. & Petersen, G.B. (2019). Investigating the process of learning with Desktop Virtual Reality: A structural equation modeling approach. *Computers & Education*, *134*, 15–30. https://doi.org/10.1016/j.compedu.2019.02.002.

Moreno, R. & Mayer, R. (2007). Interactive multimodal learning environments. Educational Psychology Review, *19*(3), 309–326. https://doi.org/10.1007/s10648-007-9047-2.

Öhman, J. & Sund, L. (2021). A didactic model of sustainability commitment. *Sustainability*, *13*(6), 3083. https://doi.org/10.3390/su13063083.

Pacheco, A. (2022). Digital Humanities or Humanities in Digital: Revisiting Scholarly primitives. *Digital Scholarship in the* Humanities, *37*(4), 1128–1140. https://doi.org/10.1093/llc/fqac012.

Samsonova, O. (2021). Educational Technology in Abu Dhabi Public Schools: Teaching with Interactive Whiteboards (iwbs). *International Journal of Technology Enhanced Learning*, *13*(1), 60. https://doi.org/10.1504/ijtel.2021.10032781.

Subhash, S. & Cudney, E.A. (2018). Gamified learning in Higher Education: A systematic review of the literature. *Computers in Human Behavior*, *87*, 192–206. https://doi.org/10.1016/j.chb.2018.05.028.

Sysoieva, S. (2011). Interaktyvni tekhnolohii navchannia doroslykh: navch.-metod. posib. [Interactive adult learning technologies: tutorial manual]. *National Akademy of Educa-*

tional Sciences of Ukraine, Institute of Pedagogical Education and Adult Education. Kyiv: VD "EKMO".

Tsai, Y. (2020). Collaborative translation in the Digital age. *Research in Language*, *18*(2), 119–135. https://doi.org/10.18778/1731-7533.18.2.01.

Valverde-Berrocoso, J., del Carmen Garrido-Arroyo, M., Burgos-Videla, C., & Morales-Cevallos, M.B. (2020). Trends in educational research about e-learning: A systematic literature review (2009–2018). *Sustainability*, *12*(12), 5153. https://doi.org/10.3390/su12125153.

Yürüm, O., Yıldırım, S., & Taşkaya-Temizel, T. (2022). An intervention framework for developing interactive video lectures based on video clickstream behavior: A quasi-experimental evaluation. *Interactive Learning Environments,* 1–16. https://doi.org/10.1080/10494820.2022.2042312.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 178–190
https://doi.org/10.34916/el.2022.14.13

PROFESSIONAL SELF-IMPROVEMENT OF SOCIAL WORKERS IN WORKING WITH FEMALE COMBATANTS: THE POTENTIAL OF THE MOOC

Olena Faidiuk[1], **Maryna Lekholetova**[2], **& Tetiana Liakh**[3]
Borys Grinchenko Kyiv University, Ukraine
[1] o.faidiuk@kubg.edu.ua, ORCID 0000-0003-3778-6986
[2] m.lekholetova@kubg.edu.ua, ORCID 0000-0003-4055-991X
[3] t.liakh@kubg.edu.ua, ORCID 0000-0002-8807-0497

Abstract: *The processes of digital transformation of all spheres of life in modern Ukrainian society and the introduction of emergency distance learning in wartimein Ukraine have led to the emergence of new challenges in the professional self-improvement of social workers in order to provide quality social services to a new target group of clients – participants in combat operations in conditions of uncertainties and threats of wartime.*
The authors of the article investigated ICT used by social workers of Kyiv (Ukraine) working with combatants in state and non-governmental organisations. The study showed a satisfactory level of ICT use in professional activities with this target group and the need to improve the professional competence of workers providing services to this target group.
The problems of combatants, which are addressed by social workers, were explored. A theoretical analysis of the content and structure of open online courses that can be used for professional self-improvement of social workers related to improving their digital and methodological competence in working with combatants was carried out. To achieve the goal a wide range of theoretical research methods (analysis, synthesis, comparison, generalization, etc.) were used. Based on the analysis of MOOC platforms available on the domestic and international Internet market of educational services, it was found that Coursera, EdEra, and Prometheus are the most popular among social workers. It was found that all courses on MOOC platforms have a similar structure, which includes interactive video lectures, educational resources, online tests of various types, and a forum for discussing issues and organising a discussion.

Keywords: MOOC (Massive open online course); professional competences; information and communication technologies; participants in hostilities, female combatants; professional improvement and self-improvement; social work; wartime.

INTRODUCTION

The relevance of the study is determined by the adaptive conditions of distance work, and, to a certain extent, the risky face-to-face work of specialists during the period of quarantine restrictions and the current state of war in Ukraine due to the full-scale invasion of Russian troops. Currently, the population of Ukraine, in particular, groups in difficult life circumstances, or categories with special needs and requirements, need the protection of their rights and interests, as well as quality social services. However, they have limited access to services. Moreover, specialists providing social assistance and support to the population must also adapt to new, changed working conditions during wartime. These circumstances caused the emergence of new challenges in the professional self-improvement of social workers in order to provide high-quality social services to a new group of social work clients – combatants in the conditions of uncertainty and threats of wartime.

Currently, more than 38,000 women are serving in the Ukrainian army, including civilian positions. In total, there are more than 50,000 women in the army now (Women's war: how many women are now defending Ukraine in the army, 2022). Since the beginning of the war, more than 16,700 service woman have received the combatant status. Three hundred two servicewomen have been given state awards, and over 4,500 have received departmental and other awards since 2014 (How many female military personnel serve in the Armed Forces of Ukraine, 2021). These statistics indicate an increase in the number of female combatants whose requests must be granted now and who will have their specific needs in the future.

Social workers and other specialists who work with combatants should be provided with all the necessary resources and means to provide quality assistance to this target category. In wartime, specialists in extreme and changed conditions requires new abilities and skills in mastering the necessary techniques, technologies, and working methods, which they need to provide to the target audience in person and remotely.

The main challenge for social workers today is mastering and using new methods and forms of interaction with clients and colleagues in professional activities. Providing qualified social services to clients requires specialists to improve their skills in using digital technologies, to master the norms and rules of behaviour in the digital environment, which determines the content of the professional development of social workers, especially in remote work conditions and wartime. The availability of MOOC platforms in the modern market of educational services provides specialists with more opportunities to choose online courses according to their professional needs, including those that are important and useful in working with female combatants.

LITERATURE REVIEW

MOOCs (massive open online courses) are quite widely advertised in the mass media, and both paid and free courses are available. Today, even more scholars are focusing their research on the history of MOOCs, the evolution of educational technologies, and open/distance learning (Daniel, 2012; Daniel & Uvalić-Trumbić, 2012a; Lambert, 2019; Guest & Wainwright et al., 2021). They are exploring the results of

using mLearning and MOOCs to understand chaos and complexity in education (de Waard & Abajian et al., 2011; Henderikx & Kreijns et al., 2018), studying deforming and motivating factors that direct students not only to enroll in certain courses, but also to request their own space, the opportunity to create MOOCs (Gil Quintana & Martínez Pérez, 2017).

Researchers do not ignore the social aspects of MOOCs, including the interaction between course participants and the support of learning processes (Castaño Garrido, & Maiz Olazabalaga et al., 2015), social media tools that can contribute to productive social learning processes (Anderson & Gifford et al., 2020), the usage of MOOC courses for health promotion (Gómez Gómez & Munuera Gómez, 2021).

Some MOOCs replicate traditional learning pedagogy by adding multimedia elements such as video lectures. Other MOOCs go above the limits by involving a large number of participants, facilitating discussion, and relying on their input into the course. MOOC platforms usually provide some built-in social tools for this purpose (Facebook, Twitter, and MentorMob) in educational technology MOOCs (Alario-Hoyos & Pérez-Sanagustín et al., 2013; Borrás-Gené & Martínez-Núñez et al., 2019). The researchers indicate that the OpenEdX forum's design faces various issues preventing effective support of participants and, as a result, affecting their experience. Therefore, there are demands for a redesign of MOOC platform forums, more efficient and effective technical assistance interventions, and ultimately, improved learning (Ntourmas & Avouris et al., 2019).

It should be noted that MOOCs are used not only in universities but also are of great interest to practitioners in the social sphere, who need to improve their qualifications and timely respond to social challenges when new knowledge is promptly needed. MOOCs serve as an effective tool for social work professionals to gain knowledge. Therefore, Universities must focus on the needs of professionals when developing open courses. It is particularly true for meeting requests to support parenting skills in preventing the repetition of violent patterns between generations, and strengthening communication processes in the family system (Phayal & Khadka et al., 2015; Giovanni & Durán et al., 2021); to overcome obstacles in providing effective social reintegration and unemployment among female combatants (Ruiz & Díaz, 2019; Asal & Jadoon, 2020), to overcome the consequences of armed violence for rural communities, as well as for their life trajectories and careers (Manrique Rueda, 2021), to restore access to social attitudes, identity, promoting the strengthening of the public benefit of former military personnel (Mcmullin, 2013; Hernández & Morales et al., 2021), and others. MOOCs have two positive outcomes: improving learning and encouraging institutions to develop specific missions, such as those of social workers. This scientific study indicates various points of view on this topic. The scholars study the issue of the impact of ICT on the development of higher education; features and dynamics and expansion of MOOC in the international educational space, measure the use of MOOC in the conditions of transnational education, and analyse the function of MOOC in Ukrainian educational realities (Avshenyuk & Berezan et al., 2018). In particular, these are opportunities for the openness of learning, individualization, interactivity, as well as enrichment of learning content. Scholars also emphasize the need to bring the MOOC phenomenon into educational research and to direct this

research to new social and educational problems (Vázquez Cano et al., 2018, Calvo Salvador & Braga Blanco et al., 2019).
Studying the Characteristics of MOOCs completers, they found that practitioners with the purpose of self-improvement have a greater possibility of completing the course, as they have more previous learning experience (Li & Wan, 2016).
The study by Sharov, Filatova, Biliatska, & Yankova (2021) reveals that MOOCs are effective for learning and self-development. Such training plays an important role in the personal development of the future specialist, as it promotes the development of social competence, communication culture, and leadership skills, as well as skills of conflict avoidance, teamwork, and others.
It is important to emphasise the role of MOOCs in the self-improvement of social workers in providing quality services. For example, in their work with a specific category of social services recipients – female participants in hostilities in Ukraine.
The analysis of the mentioned studies, the modern challenges social workers face in the conditions of military operations in Ukraine, and the increase in the number of female combatants due to the Russian-Ukrainian war require a detailed assessment of combatants' needs when they come to social workers. It is important to analyse the content and structure of mass open online courses that can be used for social workers' professional self-improvement, related to the improvement of their digital and methodological competence in working with combatants. These challenges formed the basis of our scientific search.

1. ANALYSIS OF REQUESTS OF COMBATANTS TO SOCIAL SERVICES AND NON-GOVERNMENTAL ORGANISATIONS IN KYIV (UKRAINE)

To fulfil the research task, the research group conducted a survey of social work specialists in Kyiv (Ukraine) who provide social assistance and social services to female combatants.
The purpose of the survey was to determine the main problems and needs of combatants approaching state services and NGOs. The tools used by specialists for working with female military personnel, including those lacking in effective work with this target group, have been studied.
Respondents were invited to participate in the survey by distributing the questionnaire in the online group of the network of social service centres and among non-governmental organizations.
This stage of the research was based on using open and closed questions of the questionnaire, which was designed to study the provision of social support to this category of persons.
The list of the survey included such topics:

- The specifics of the requests and needs of the participants applying for help from state services and NGOs;
- Types and range of services provided by specialists to this target audience;
- Information and communication technologies used by specialists in their professional activities.

The study was conducted in compliance with all confidentiality rules. The responses of participants have been analysed with some minor changes.

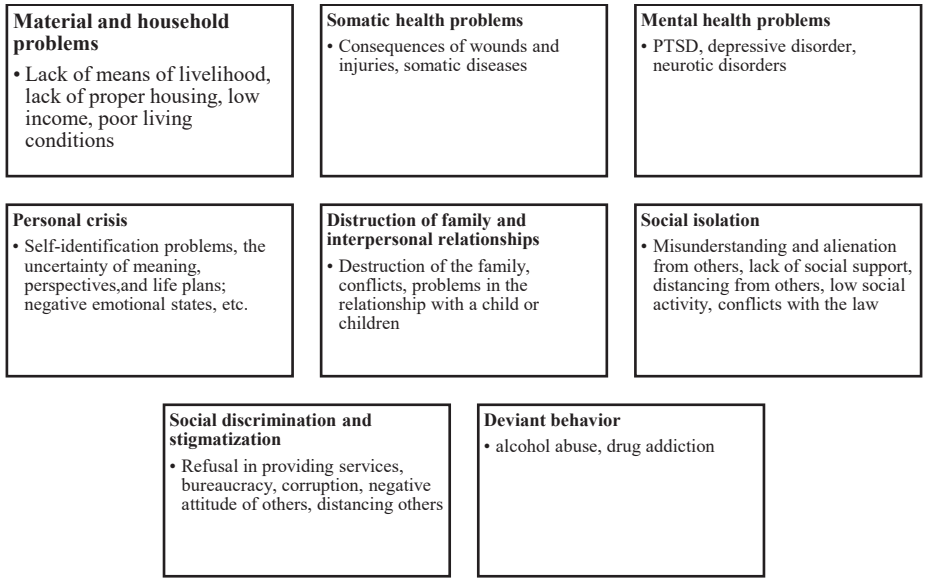
The study sample consisted of specialists from the district centres of Social services in Kyiv, specialists from the Departments of Social Protection of the Population, and representatives of NGOs that provide social services to participants in hostilities. The number of interviewed respondents was 70, among those, 85.7% were specialists working in state organisations, and 14.3% were NGO workers.

The main requests combatants address to specialists are receiving information consultation (100%), psychological support (90%), assistance in registering the status, obtaining documents, registering benefits, receiving legal aid; assistance in receiving treatment, medical rehabilitation, and recovery; solving household problems (57.1%); employment promotion; assistance in childcare, child education (42.8%). Other requests addressed by specialists from combatants are the following: receiving humanitarian aid; organisation of children's cultural and recreational activities and rehabilitation of children; obtaining personal hygiene products; consultations of psychotherapists; assistance in carrying out psychological rehabilitation; professional and social adaptation; provision of technical and other means of rehabilitation, and others. These and other needs of combatants are also determined by the state of war in the country. Therefore, female combatants constantly need humanitarian aid. They also need help in taking care of a child or children, being forced to leave their children with other relatives, or put them under the temporary care of the state. Women's participation in hostilities negatively impacts their psychological state, which was indicated by all respondents (100%). Female combatants have various personal problems, such as conflicts in their family, conflicts or breakup of relations with a husband or partner (71.4%). Also, female combatants have difficulties in raising children, conflicts with the environment outside the family; issues with drinking alcohol, drug addiction, and addictive behaviour; personal uncertainty, lack of life prospects, and self-doubt (57.1%). Respondents also noted that female combatants have significant problems with physical health, social isolation, and loneliness.

All 100% of respondents confirmed that female combatants need psychological help. Getting information about rights, opportunities, benefits, etc. is also important (71.4%). The woman soldiers need sufficient material resources; development of resilience, activity support; participation in social initiatives, social action groups, and socially beneficial activities (57.1%). Protection of rights, representation of interests, acquisition or restoration of professional skills, and retraining (42.8%) are among other requests of female service members.

71.4% of respondents answered positively to the question, "Have the needs and requests of combatants changed during the period of martial law?" stating they have changed. The urgent needs and current requests of this target audience are the aggravated psychological state of combatants (anxiety, uncertainty, fears); satisfaction of basic needs; receiving psychological support; the need for humanitarian aid; financial support, including state payments provided for by the current legislation of Ukraine; concerns about physical health, the possibility of receiving medical assistance, and other.

Specialists provide advisory services to all combatants (100%). Other vital services are social support (85.7%), representation of the interests of this target audience (71.4%), social adaptation services (57.1%), crisis intervention services (42.8%), and others. Therefore, the analysis of the results of the study made it possible to highlight the main problems and needs faced by female participants in hostilities (Figure 1).



F i g u r e 1. Problems and needs of female combatants addressed to the social workers

Source: Own work.

At this stage of the study, it was found that most often, female combatants apply for such types of social support:

- Medical assistance – receiving quality medical services;
- Legal support – obtaining assistance in providing social benefits, and quarantines such as material aid, land plot, and status registration;
- Material support – receiving targeted material aid, funeral assistance; treatment and rehabilitation of combatants; rehabilitation of children; benefits for housing and communal services; obtaining a plot of land; providing housing, and improving living conditions;
- Socio-pedagogical support – organisation of recreation and leisure for children and other family members; help with child care;
- Psychological support is provided in the form of psychological diagnostics to determine the psycho-emotional state of combatants. The need to receive psychological counselling to reduce psychological stress, and overcome fear and worries about life and health; psychological therapy, psychotherapeutic groups, and self-help groups that help to overcome negative experiences, fear, and psychological exhaustion.

Assessments of the needs and requests of combatants seeking assistance, and analysis of respondents' responses about their professional experience with this target audience lead to the conclusion that social workers, faced with the various needs and requests of combatants, also have their own needs to increase their professional competence. According to the survey results, the following knowledge and skills are important for social workers in working with this target audience: how to recognise anxiety states; how to provide psychological first aid to a person in emergency situations; how to provide pre-medical aid in war conditions; how to carry out career guidance activities in case a person wants to change occupation; how to work with victims of sexual violence or rape; peculiarities of conducting social mediation, and others. These new challenges require social workers to have up-to-date knowledge and skills for effective work with this target audience under martial law in the country.

In addition, it is not always possible to provide services face-to-face under martial law conditions, and remote work with this target audience requires specialists to organise the work process using modern ICT. However, social workers recognize the need for additional training and mastery of relevant technologies to work remotely with female combatants.

2. ANALYSIS OF ICT USED BY SOCIAL WORKERS OF THE CITY OF KYIV (UKRAINE) IN THEIR WORK WITH FEMALE

In the second stage of the research, we obtained the following results by analysing the respondents' answers regarding the information and communication technologies they use in their professional activities in working with female combatants.

Specialists use the following ICT in their professional activities: Google presentation (42.8%), Google search (28.5%), YouTube (28.5%), and Google Doc (14.2%). The following ICT are not used or used very rarely: Cloud (28.5%), Google Classroom (28.5%), Evernote (28.5%), Writing.com (28.5%), Trello (28.5%), Mind Meister (28.5%), Scribbler (28.5%), Red Pen (14.2%) and others.

Specialists use specific models, technologies and methods to provide services to combatants: consultations using information and communication systems, counselling under the SETA program, Telegram, and Viber.

All specialists (100%) working with female combatants have the opportunity to engage specialists who have special training for working with female combatants and also have the opportunity to engage other qualified specialists (psychologists, lawyers, doctors, teachers, and others). Specialists also have at their disposal the premises and equipment necessary for individual and group work (85.7%). However, some specialists do not have experience working with the category of clients with traumatic experiences or in crisis (14.2%), and also do not have experience in implementing social projects (14.2%).

Specialists indicate the following needs in working with combatants as field training for providing services to hostilities participants (85.7%), training on professional burnout (85.7%), professional qualification improvement courses (42.9%), and self-education (28.6%).

The obtained results give us the basis to conclude that female combatants (especially in wartime) have specific needs and requests that state institutions and public organisations must guarantee. Specialists working in these institutions must be ready to provide quality services to this category of clients. Both professional qualities and ICT skills are important for the effective organisation of the workflow.
Based on the present study, it was found that specialists use individual information and communication technologies in their professional activities. The most frequently used ICTs are Google presentation, Google search, and YouTube. Specialists do not know or rarely use other ICTs in their professional activities. Respondents indicated they need special field training for providing services to the target audience; they require training on professional burnout, and courses to improve their professional qualifications. Based on the results of the obtained data, we can conclude that social workers need to improve their ICT skills in order to organise effective remote work with this target audience. The main requests of social workers are as follows: the creation and designing of presentations; the creation of their own websites according to the needs of the target audience; basics of digital literacy; how to spot misinformation and fake news.

3. MOOCS FOR PROFESSIONAL SELF-IMPROVEMENT OF DIGITAL AND METHODOLOGICAL COMPETENCE OF SOCIAL WORKERS WORKING WITH FEMALE COMBATANTS

Focusing on the results of the analysis of combatants' requests to social services and NGOs in Kyiv and the exploration of ICT Kyiv social workers used for working with combatants, the authors selected electronic (open) courses that may be essential and useful for social workers to provide quality social services and ensure readiness to work with combatants and their family members in wartime (Figure 2).

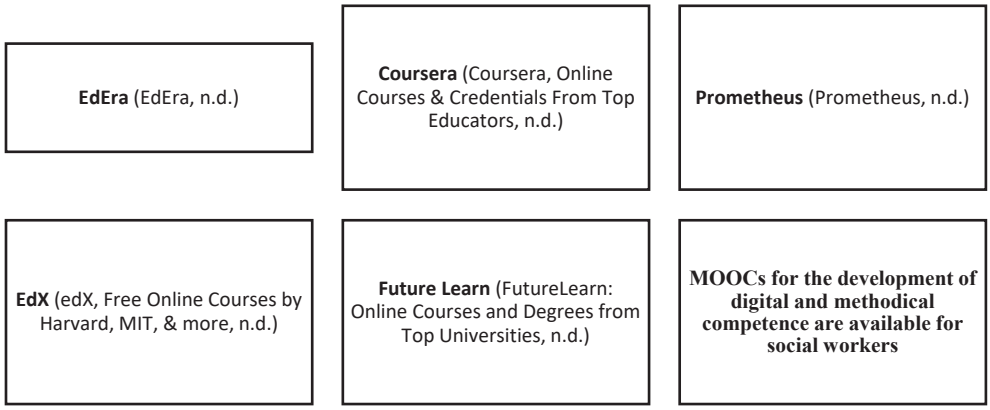


Figure 2. Electronic (open) courses for social workers to provide quality social services and ensure readiness to work with combatants and their family members in wartime

Source: Own work.

The present report provides an analysis of the most accessible educational platforms and interesting, open online courses that specialists can take for free to improve their professional knowledge, skills, and abilities in working with this target audience and for their professional self-development.

The list of recommended courses for professional self-improvement (professional knowledge, skills, and abilities) of social workers working with women participants in hostilities:

1. Dialogues without anxiety (https://study.ed-era.com/uk/courses/course/265). Purpose: To recognise anxiety states, reduce the level of anxiety, cope with difficult situations, and overcome work-related fears.
2. House of (NON)SAFETY (http://nonviolence.ed-era.com). Purpose: To recognise violence and its types, understand its causes and consequences, and learn how to avoid domestic violence.
3. From place to career (http://ican.ed-era.com). Purpose: To prepare for the development of your own business, manage career plans and career assessment
4. Dialogue and mediation skills for public service needs (https://courses.ed-era.com/courses/course-v1:OSCE_EDERA+Med_101+2020/about). Purpose: To master the skills of social mediation.
5. Pre-medical care (https://courses.ed-era.com/courses/course-v1:EdEra-SmartOsvita+Med+1/about). Purpose: To master the skills of providing pre-medical care.
6. Social Work: Practice, Policy and Research (https://cutt.ly/2ZzL51b). Purpose: To develop skills to empower individuals, families, communities, and organisations to meet their needs and create positive change.
7. Psychological First Aid (https://www.coursera.org/learn/psychological-first-aid?action=enroll). Purpose: To learn how to provide psychological first aid to people in emergencies using the RAPID model.
8. Basic psychological assistance in conditions of war (https://courses.prometheus.org.ua/courses/course-v1:Prometheus+BPA101+2022_T2/about). Purpose: To learn how to provide basic psychological assistance in wartime conditions.
9. How do employment centre specialists work with veterans and understand their military experience (https://courses.prometheus.org.ua/courses/course-v1:VETERAN_HUB+VH101+2022_T2/about). Purpose: To master the specifics and skills of working with veterans on career and employment issues
10. First aid in wartime (https://courses.prometheus.org.ua/courses/course-v1:Prometheus+FAW+2022_T2/about). Purpose: To create an idea of pre-medical care in war conditions and to master the MARCHE algorithm.
11. Gender equality and combating sexual harassment in the military sphere (https://courses.prometheus.org.ua/courses/course-v1:Prometheus+GE101+2021_T2/about). Purpose: To master the basic ideas of gender equality; learn how to detect, counter and prevent sexual harassment; find out what to do if you have suffered or witnessed sexual harassment.
12. Find Your Calling: Career Transition Principles for Returning Veterans (https://www.edx.org/course/find-your-calling-career-transition-principles-for?in

dex=product&queryID=1acc19585e24eac d430c1926a08ba08c&position=3). Purpose: To develop practical skills for making a successful military-to-civilian career transition.

13. University Studies for Student Veterans (https://www.edx.org/course/university-studies-for-student-veterans?index=product&query ID=46462f15f9a459f54 dd7e5dd9d7d354c& position=2). Purpose: To assist students – future military personnel who intend to start or return to education soon, as well as to equip higher education professionals who work to support student-veterans.
14. Field Ready! Planning for Success in a Conflict Zone (https://www.futurelearn.com/experttracks/planning-for-success-in-conflict-affected-regions). Purpose: To master the skills of working in a complex conflict zone.

The list of courses for the development of digital and methodological competence of social workers according to the requests of specialists:

1. Pro PowerPoint (https://propowerpoint.com/ua?utm_source=ed era&utm_medium=site&utm_campaign). Purpose: To master the skills of designing presentations in PowerPoint.
2. Basics of web development (HTML, CSS, JAVASCRIPT) (https://courses.ed-era.com/courses/course-v1:EDERA_BBF+WEB+2019/about). Purpose: To get acquainted with the theoretical and practical aspects of front-end development, creating your own websites according to the needs of target groups
3. Key skills for the 21st century (https://courses.ed-era.com/courses/course-v1:British_Council+BC1+2020/about). Purpose: To master the key skills such as critical thinking; communication and cooperation; creativity; digital literacy
4. VERY VERIFIED: online media literacy course (https://verified.ed-era.com/ua). Purpose: To learn how to navigate the information and how to recognise misinformation and propaganda.
5. Hours of media literacy (https://study.ed-era.com/uk/courses/course/824). Purpose: to master the basics of media literacy about the work of the media, fakes news and verification of information.

CONCLUSION

The results of the study provide key insights into the main problems and needs of combatants when they apply for state services, and NGOs are receiving humanitarian aid, psychological, legal, and material support, medical assistance, and also help with childcare.

Taking into account the analysis of scientific and pedagogical sources and the analysis of the content and structure of mass open online courses on various electronic platforms, we can conclude that MOOC courses provide ample opportunities for improving methodological and digital competences. The advantages of using MOOC courses as a modern trend in the field of providing online services are accessibility, openness, broad involvement of digital technologies, narrow content orientation to the needs of the target audience, and the creation of a national and international professional community.

Prospects for further research include conducting an empirical study on the effectiveness of using the proposed MOOC courses in the context of forming the digital culture of social workers, expanding their knowledge and skills in working with female combatants, and testing its effectiveness experimentally.

ACKNOWLEDGMENTS

The study was conducted in the framework of the scientific theme of the Institute of Human Sciences, Borys Grinchenko Kyiv University "Socialization of vulnerable population groups in the context of territorial community development in Ukraine", registration number: 0121U112043, term of realization 06.2021–06.2026.

REFERENCES

Alario-Hoyos, C., Pérez-Sanagustín, M., Delgado-Kloos, C., Parada, G., H.A., Muñoz-Organero, M., & Rodríguez-de-las-Heras, A. (2013). Analyzing the Impact of Built-In and External Social Tools in a MOOC on Educational Technologies. In Hernández-Leo, D., Ley, T., Klamma, R., Harrer, A. (Eds.). *Scaling up Learning for Sustained Impact*. EC-TEL 2013. Lecture Notes in Computer Science, vol. 8095. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-40814-4_2.

Anderson, V., Gifford, J., & Wildman, J. (2020). An evaluation of social learning and learner outcomes in a massive open online course (MOOC): a healthcare sector case study. *Human Resource Development International*, *23*:*3*, 208–237. https://doi.org/10.1080/13678868.2020.1721982.

Asal, V. & Jadoon, A. (2020). When women fight: unemployment, territorial control and the prevalence of female combatants in insurgent organizations. *Dynamics of Asymmetric Conflict*, *13*:*3*, 258–281. https://doi.org/10.1080/17467586.2019.1700542.

Avshenyuk, N., Berezan, V., Bidyuk, N., & Leshchenko, M. (2018). Foreign experience and Ukrainian realities of mass open online courses use in international education area. *Information Technologies and Learning Tools*, *68*, 262. https://doi.org/10.33407/itlt.v68i6.2407.

Borrás-Gené, Martínez-Núñez, & Martín-Fernández. (2019). Enhancing Fun Through Gamification to Improve Engagement in MOOCs. *Informatics*, *6*(3), 28. MDPI AG. http://dx.doi.org/10.3390/informatics6030028.

Calvo Salvador, M.A., Braga Blanco, G.M., & Fueyo Gutiérrez, M.A. (2019). Abriendo la formation de los profesionales de la educación al campo de los MOOC. Results of a research project at the universities of Cantabria and Oviedo. *Profesorado, Revista De Currículum Y Formación Del Profesorado*, *23*(2), 259–276. https://doi.org/10.30827/profesorado.v23i2.9684.

Castaño Garrido, C., Maiz Olazabalaga, I., & Garay Ruiz, U. (2015). Social networks and cooperative learning in a MOOC. *Revista Complutense de Educación*, *26*, 119–139. https://doi.org/10.5209/rev_RCED.2015.v26.46328.

Coursera | Online Courses & Credentials From Top Educators. Join for Free. (b. d.). Coursera. https://www.coursera.org/.

Daniel, J. (2012). Making sense of MOOCs: musings in a maze of myth, paradox and possibility. *J. Interact. Media Educ*. 2012(3), Art. 18 (2012). https://doi.org/10.5334/2012-18.

Daniel, J.S. & Uvalić-Trumbić, S. (2012a). Open Educational Resources (OER): The Coming of Age of ICT in Education? Speech to eLearning Korea 2012, 12 September. http://sirjohn.ca/wordpress/?page_id=29.

de Waard, I., Abajian, S., Gallagher, M.S., Hogue, R., Keskin, N., Koutropoulos, A., & Rodriguez, O.C. (2011). Using mLearning and MOOCs to understand chaos, emergence, and complexity in education. *The International Review of Research in Open and Distributed Learning*, *12*(7), 94–115. https://doi.org/10.19173/irrodl.v12i7.1046.

EdEra. (b. d.). EdEra. https://www.ed-era.com/.

edX | Free Online Courses by Harvard, MIT, & more. (b. d.). edX. https://www.edx.org/.

FutureLearn: Online Courses and Degrees from Top Universities. (b. d.). FutureLearn. https://www.futurelearn.com/.

Gil Quintana, J. & Martínez Pérez, J. (2017). El empoderamiento del alumnado en los sMOOC. *Revista Complutense de Educación*, *29*(1), 43–60. https://doi.org/10.5209/RCED.51932.

Giovanni, I., Durán, A. del S., Aponte, D.M., & Laverde, D.J. (2021). Factors that facilitate and hinder the processes of reintegration of ex-combatients and their families. *Universitas Psychologica*, *19*, 1–17. https://doi.org/10.11144/Javeriana.upsy19.ffdp.

Gómez Gómez, F. & Munuera Gómez, P. (2021). Use of MOOCs in Health Care Training: A Descriptive-Exploratory Case Study in the Setting of the COVID-19 Pandemic. *Sustainability*, *13*(19), 10657. MDPI AG. http://dx.doi.org/10.3390/su131910657.

Guest, C., Wainwright, P., Herbert, M., & Smith, I.M. (2021). Driving quality improvement with a massive open online course (MOOC). *BMJ open quality*, *10*(1), e000781. https://doi.org/10.1136/bmjoq-2019-000781.

Henderikx, M., Kreijns, K., & Kalz, M. (2018). A Classification of Barriers that Influence Intention Achievement in MOOCs: 13th European Conference on Technology Enhanced Learning, EC-TEL 2018, Leeds, UK, September 3–5, 2018, Proceedings. https://doi.org/10.1007/978-3-319-98572-51.

Hernández, E.A., Morales, M.D., & Vivares, D.V. (2021). Discursos del trabajo en excombatientes de las FARC. Barreras sociolaborales en la reintegration. *América Latina Hoy*, *88*, 3–21. https://doi.org/10.14201/alh.24083.

How many female military personnel serving in the Armed Forces of Ukraine – new data from the Personnel Center. (2021). *ArmiyaInform – ArmiyaInform information agency*. https://armyinform.com.ua/2021/12/04/skilky-zhinok-vijskovosluzhbovcziv-sluzhat-u-zbrojnyh-sylah-ukrayiny-novi-dani-kadrovogo-czentru/.

Lambert, S.R. (2019). Six critical dimensions: A model for widening participation in open, online and blended programs. *Australasian Journal of Educational Technology*, *35*(6), 161–182. https://doi.org/10.14742/ajet.5683.

Li, Q. & Wan, F. (2016). A case study of the characteristics of MOOCs completers: Taking an online professional training MOOC for example. In *2016 IEEE 16th International Conference on Advanced Learning Technologies (ICALT),* 503–505. IEEE. https://doi: 10.1109/ICALT.2016.2.

Manrique Rueda, G. (2021). Travailler dans la violence : récits d'anciens combattants du groupe paramilitaire Héros de Montes de Maria en Colombie. *Criminology*, *54*(2), 221–244. https://doi.org/10.7202/1084295ar.

McMullin, J. (2013). Integration or separation? The stigmatization of ex-combatants after war. *Review of International Studies*, *39*. https://doi.org/10.1017/S0260210512000228.

Ntourmas, A., Avouris, N., Daskalaki, S., & Dimitriadis, Y. (2019). Evaluation of a Massive Online Course Forum: Design Issues and Their Impact on Learners' Support. In Lamas, D., Loizides, F., Nacke, L., Petrie, H., Winckler, M., Zaphiris, P. (Eds.). Human-Computer Interaction – INTERACT 2019. INTERACT 2019. *Lecture Notes in Computer Science*, vol. 11747. Cham: Springer. https://doi.org/10.1007/978-3-030-29384-0_12.

Phayal, A., Khadka, P., & Thyne, C. (2015). What Makes an Ex-Combatant Happy? A Micro-Analysis of Disarmament, Demobilization, and Reintegration in South Sudan. *International Studies Quarterly*, *59*. https://doi.org/10.1111/isqu.12186.

Prometheus. (b. d.). Prometheus – The best online courses in Ukraine and the world. https://prometheus.org.ua/.

Ruiz, A. & Díaz, O. (2019). En búsqueda de visibilization: experiences and needs of women ex-combatants of the FARC-EP in the peace building scenario. *Reflexion Política*, *21*, 9–28. https://doi.org/10.29375/01240781.3595.

Sharov, S., Filatova, O., Biliatska, V., & Yankova, N. (2021). Analysis of the MOOC Capabilities for Student Training in the Humanities. *International Journal of Emerging Technologies in Learning (iJET)*, *16*(22), 113–128. https://doi.org/10.3991/ijet.v16i22.25071.

Vázquez Cano, E., López Meneses, E., Fernández Márquez, E., & Ballesteros Regaña, C. (2018). The new virtual environments of permanent learning (MOOC) and their educational possibilities in social and educational environments. *Pixel-Bit: revista de Medios y Educación*, *53*, 179–192. https://hdl.handle.net/11441/85413.

Women's war: how many women are now defending Ukraine in the army. (2022). Vikna. https://vikna.tv/video/ukrayina/skilky-zhinok-sluzhyt-v-ukrayinskij-armiyi-zaraz/.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 191–204
https://doi.org/10.34916/el.2022.14.14

GRADUATE STUDENTS' ATTITUDES TO THE DEVELOPMENT OF DIGITAL OPPORTUNITIES AT THE LEVEL OF INDIVIDUALS AND EDUCATIONAL ORGANISATIONS

Olena Kuzminska[1], Mariia Mazorchuk[2], Nataliia Morze[3], Eugenia Smyrnova-Trybulska[4], Maria Stec[5], & Prudencia Gutiérrez-Esteban[6]
[1] National University of Life and Environmental Sciences of Ukraine,
16a Heroev Oborony St., Kyiv, Ukraine 03041
[2] V. N. Karazin Kharkiv National University, Kharkiv, Ukraine
4, Svobody sq., Kharkiv, Ukraine
[3] Borys Grinchenko Kyiv University, Kyiv, Ukraine,
Bulvarno-Kudriavska St, 18/2, Kyiv, Ukraina, 04053
[4,5] University of Silesia in Katowice, Faculty of Arts and Sciences of Education,
Bielska 62, 43-440 Cieszyn, Poland
[6] Extramadure University, Spain
[1] o.kuzminska@nubip.edu.ua, ORCID 0000-0002-8849-9648
[2] mazorchuk.mary@gmail.com, ORCID 0000-0002-4416-8361
[3] n.morze@kubg.edu.ua, ORCID 0000-0003-3477-9254
[4] esmyrnova@us.edu.pl, ORCID 0000-0003-1227-014X
[5] maria.stec@us.edu.pl, ORCID 0000-0002-0735-2004
[6] pruden@unex.es, ORCID 0000-0001-5328-5319

Abstract: *The digital transformation of education requires the development of both individual digital capabilities, in particular, researchers, and the digital capabilities of higher education institutions. The article presents the design and results of a study of Ph.D. students' attitudes from Borys Grinchenko Kyiv University (Ukraine), University of Silesia (Poland), and Extremadura University (Spain) to digital opportunities at the individual level and the level of educational organisations. Following the self-assessment of postgraduate students, which was based on the relevant models and descriptors of the Jisc digital capabilities structure, the main factors influencing the development of the researcher's digital capabilities were determined. The major factor was the degree of influence of the organisational digital maturity of the universities where young researchers are trained. It was determined that graduate students, regardless of affiliation, the factors which have the greatest influence on the*

development of the researcher's digital capabilities include: the digital environment of the educational institution where graduate students study; competent teachers who have a high level of digital competence and successfully use it in teaching; collaboration with fellow graduate students or other researchers. The need for the development of Communications and Digital infrastructure as the elements of organisational digital capability has been identified. The obtained results can be used in the scaling of the proposed methodology, as well as in the design of digital environments of higher education institutions and the methodology of their application in the process of training specialists at a high level of digital capabilities.

Keywords: digital capabilities, organisational digital capabilities, higher education institution, Ph.D. students, survey.

INTRODUCTION

Due to the rapid pace of digital changes in various industries, organisations are forced to increase the pace of their digital transformations to create new or modify (digitalise) existing business processes, cultures and experiences to meet the demands of the labour market (Mhlungu et al., 2019). And, if for businesses the need and adoption of digital transformation is more a matter of survival, for educational organisations the implementation of digital technologies can help institutions become more competitive (Mohamed Hashim et al., 2022).

The report entitled "Driving Digital Transformation in Higher Education" (Brooks & McCormack, 2020) states that the digital transformation of an educational institution should be preceded by the digitization of existing information (1), which includes the digitisation and organisation of analogue materials, and the digitisation of processes (2), which involves their automation and optimisation. For this, digital capabilities should be taken into account and developed both at the individual level and the level of the institution (organization). Moreover, the digital capabilities of professionals are related not only to disciplinary or organisational innovations but also to economic competitiveness (Orlik, 2018).

We agree (Bartlett-Bragg, 2017) that the concept of "digital capabilities" is broader than the concept of digital competence, as it exists at the intersection of people and technology, work and learning. These are digital practices that people and organizations need for successful implementation in a digital society (Jisc 2017a). At the same time, modern studies focus on the formation of students' and teachers' individual digital capabilities (Limniou et al., 2021; Varga-Atkins, 2020; Balyk et al., 2020) as subjects of the educational process of higher education institutions. Somewhat less research interest has been shown in developing the digital capabilities of early career researchers and research teams (Kuzminska et al., 2021; Wolski et al., 2020), although the research potential of a higher education institution is important both for training specialists in modern digital society and the implementation of digital transformation. The developing of digital capabilities was discovered by some researchers from different countries. The professional development of digital competences as standardized frameworks supporting evolving digital badging practices

was researched by Kullaslahti, Ruhalahti, & Brauer (2019). The development of students' digital competence in teacher training studies as a Polish case was analysed by Nowak (2019) The experts from Mexico concluded that "based on the results, Ph.D. students do not exhibit a higher level of digital competencies simply because they are in this academic level, and their gender is not a determining factor either. Moreover, partial evidence was found in several dimensions (statistically significant relationships), which suggests that distance education programs foster digital competencies as opposed to blended learning (b-learning) programs." (Sanchez-Macias & Veytia-Bucheli, 2019). Simultaneously, there are only a few such types of research. Touching upon the lack of research devoted to studying the organisational digital capability of modern universities for the development of individual digital capabilities of their students, teachers, scientists and representatives of the administration (Jisc, 2017a), there is a need to determine the relationship between the individual digital capabilities of the subjects and the general level of digital transformation of an educational institution.

The purpose of this study is to investigate the attitude of young researchers, in particular Ph.D. students from different countries, to their digital capabilities and to determine influencing factors that will contribute to their development both at the individual level and at the level of digital transformation of an educational institution. The obtained results can be useful both to researchers in the field of educational sciences and to representatives of structural subdivisions of higher education institutions to take into account factors that, according to applicants of the third level of higher education, have a significant impact on the development of researchers' individual digital capabilities and the creation of conditions for their acquisition by graduate students. This target audience has been selected because graduate students are modern young researchers who belong to the digital generation. They need to use digital services and tools in various spheres of life, particularly in research and have a clear vision of the prospects for their development. They are interested in future career development. They are aware of self-improvement and lifelong learning.

To achieve the goals of our research, we formulated the following tasks:

1. Select groups of graduate students with a high level of readiness to develop their digital capabilities as researchers (experts) from three higher education institutions in Ukraine and EU countries; limit the factors that regulate the development of their digital competence and prove the homogeneity of these groups;
2. To determine graduate students' attitude regarding the conditions offered for organisational digital maturity at their universities, developing individual digital capabilities, and compare the opinions of young researchers in a few countries.

RESEARCH DESIGN

In our study, a selective statistical survey was used as one of the methods for monitoring and evaluating the effectiveness of the implementation of educational projects. The idea is to conduct an expert assessment to determine the factors affecting the

development of the researcher's digital capabilities in general and the components of organisational digital capability in particular. To formulate the questions in the questionnaire, we introduced the following basis:

- self-assessment of the level reflecting graduate students' digital capabilities – a researcher's profile as an element of the Jisc individual digital capabilities structure (https://digitalcapability.jisc.ac.uk/what-is-digital-capability), which focuses on the digital capabilities of the Jisc Researcher (Jisc, 2017b), relevant for young and experienced researchers of higher education;
- to determine the level of graduate students' satisfaction with the existing digital capability of the educational institution where the training is carried out – (see a model of the digitally capable organization by Jisc (Jisc, 2017c) and Jisc's organisational digital capabilities maturity model (Figure 1).

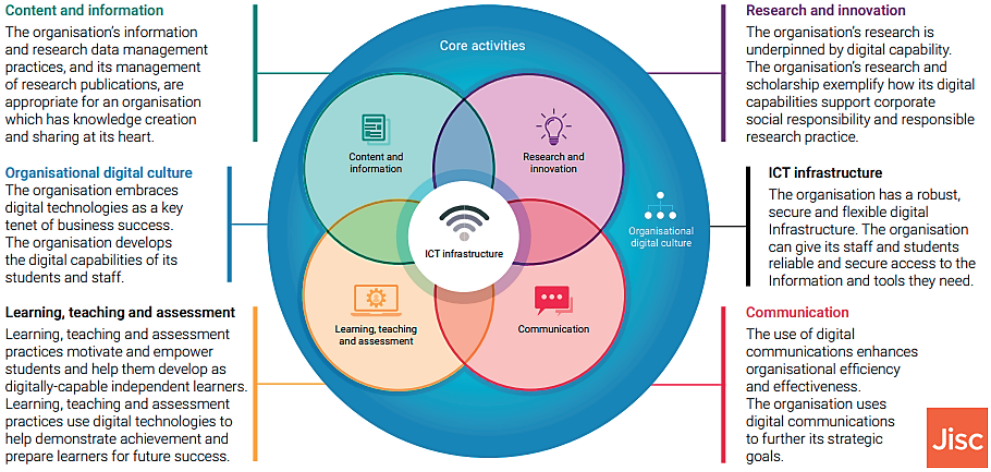


Figure 1. Jisc's organisational digital capabilities maturity model (Jisc 2017a, https://bdcdei-prod-media.s3.eu-west-1.amazonaws.com/documents/32755h2_JISC_BDC_OrganisationalMaturityModel_Inforgraphic.pdf)

Source: The figure is available on the CC BY-NC-SA Creative Commons License (https://digitalcapability.jisc.ac.uk/what-is-digital-capability/organisational-digital-capability/, https://bdcdei-prod-media.s3.eu-west-1.amazonaws.com/documents/32755h2_JISC_BDC_OrganisationalMaturityModel_Inforgraphic.pdf).

This study was conducted for the first time, we used the descriptors of the official profiles of researchers' digital capabilities and organisational digital capabilities of universities from the Jisc organisation. However, additional questions were used in the questionnaire, a further check was carried out and its reliability was confirmed: the internal consistency of the questionnaire was evaluated by Cronbach's alpha coefficient and the split-half method (Cronbach, 1951; Finch et al., 2016). Cronbach's alpha coefficient was 0.93, and Spearman-Brown coefficient is 0.82, which confirms the reliability of the research tool and the stability of the studied features. The correlation between the items of the questionnaire was evaluated in separate areas of the studied features using the non-parametric coefficient of Spearman's rank correla-

tion. The results showed a high degree of correlation (at the level of 0.7–0.8), which indicates a high degree of the construct validity of the questionnaire.

To survey a sample of Ph.D. students, a Google form was developed in three languages: Ukrainian, Polish and English (https://docs.google.com/forms/d/e/1FAIpQLSeVTEoPyK4KmpgacLF59GIqOOiTIbGA08Ypenx3u4tP9XPyBg/viewform). It is based on the Likert scale (On a scale of 1 to 5. rate the level of satisfaction (1 means complete dissatisfaction and 5 means the maximum level of satisfaction) and consists of 3 main sections:

- the first section covers the questions to fill in with the personal profile of the respondent (considering the country of affiliation, year of postgraduate study, the field of research; access level of IT and scientometric databases; self-assessment of the level of digital competences of citizens (Carretero Gomez et al., 2017) and researchers (Jisc, 2017b), motivation to develop their digital capabilities); based on the results of the answers to these questions, homogeneous expert groups were formed (the 1st task of the research);
- the second section consists of questions for self-assessment of the level of researchers' digital capabilities according to the Jisc Researcher profile (Jisc, 2017b); the received answers serve as the basis for an additional comparison of the digital capabilities of researchers across countries (I research task);
- the last section includes groups of questions (27 items) related to the main purpose of the research: assessing the importance of the main factors that influence the development of Ph.D. students' researcher's digital capabilities, in particular organisational digital capability (Jisc, 2017c) of universities where graduate students are trained (II objectives of the study).

Postgraduate students from three universities participated in the survey, where it was possible to organise the survey by considering the respondents' trust and their level of qualification: Borys Grinchenko Kyiv University (Ukraine), University of Silesia (Poland), and Extremadura University (Spain). These universities geographically represent Eastern, Central, and Western Europe; two of them are situated in the EU countries, and the third one is located outside with the perspective of joining the EU. All three universities participated in the European project entitled IRNet (www.irnet.us.edu.pl) in 2014–2017. The selected universities have developed scientific, methodological, and technological support sufficiently, the level of digitalisation of the educational process, and also the conditions for the training of graduate students – infrastructure, the competence of teachers, opportunities for academic mobility, etc.

In the course of data analysis, a set of methods and models was used, allowing to calculate all descriptive statistics and reveal the influence of individual studied characteristics on other characteristics. The choice of certain indicators was determined by the type of data, the rating scale, and the limitations of the methods. SPSS statistical data processing software (Levesque, 2005) was used for calculations.

To assess the degree of influence and importance of various factors on the young scientists' development of digital capabilities (postgraduate students) including the organisational digital capabilities of their educational institutions, we chose a 5-point Likert scale (Rate on a 5-point scale: 1-no effect, 5-defining effect). Since the sample consisted of only 50 respondents, it allowed us to choose non-parametric methods of

data analysis without taking into account the requirements for the normal distribution of characteristics and the size of the sample, as it is the case when using parametric methods of analysis. Thus, median scores and criteria based on the assessment of rank features were used to assess the homogeneity of responses for different groups of respondents. Independent-Samples Mann-Whitney U Test (Mann & Whitney, 1947; Neuhäuser, 2011) was used to compare survey results of two groups, and in the case of three or more groups – the Independent-Samples Kruskal-Wallis Test (Kruskal, 1952; Richardson, 2018). Further conclusions were made by respondents based on the analysis of survey results using graphic data visualization methods.

When testing statistical hypotheses at all stages of the analysis, the decision was based on the p-value, which reflects the probability of an error when rejecting the null hypothesis (errors of the first kind). The p-value for rejecting the null hypothesis was taken as 0.05.

Young researchers' attitude to organisational digital capability was a factor in the development of their digital capabilities in a comparison with others (the second research task), as well as connections between groups of respondents, who differ in affiliation of the university, where graduate students are trained in EU countries (in this case, it is Poland and Spain) and third countries (Ukraine), the following hypotheses are formulated:

H1: According to the respondents, the development of individual digital capabilities of researchers is equally determined by the activity of the graduate student himself/herself; the activity of the scientific supervisor; the competence of the teachers who provide the training; the level of digitisation of the educational institution; modern educational programmes; availability of a system of assistance support, mobility programmes; cooperation with scientists and other graduate students; the possibility of disseminating research results (graduate students, regardless of the country and educational institution, equally determine the impact of the specified factors on the development of their digital capabilities).

H2: All components of the university's digital capabilities (ICT infrastructure, Content and information, Research and innovation, Communication, Learning, teaching and assessment, and Organizational digital culture) are equally important for the development of graduate students' digital competence (graduate students, regardless of country and educational institution, equally define the conditionality of the development of own digital capabilities by the specified factors).

FINDINGS

For the creation of expert groups (the first research task) based on the results of the answers to the first questionnaire group from 126 graduate students, respondents with a sufficient level of digital competence and digital capabilities of the researcher (Kuzminska et al., 2021), a high level of motivation for its development and individual opportunities for its acquisition were selected (Table 1). No significant difference was found between the distributions of respondents from different countries (the analysis was conducted using the Independent-Samples Mann-Whitney U Test at the p-value = 0.05 level). To ensure the homogeneity of the expert groups, post-graduate students

in the field of social sciences in the 2nd year of study were also selected. An additional analysis of the formation of individual elements of the digital capabilities of graduate students from different universities based on the results of the answers to the second group of questions of the questionnaire confirmed the homogeneity of the identified groups in terms of these characteristics as well.

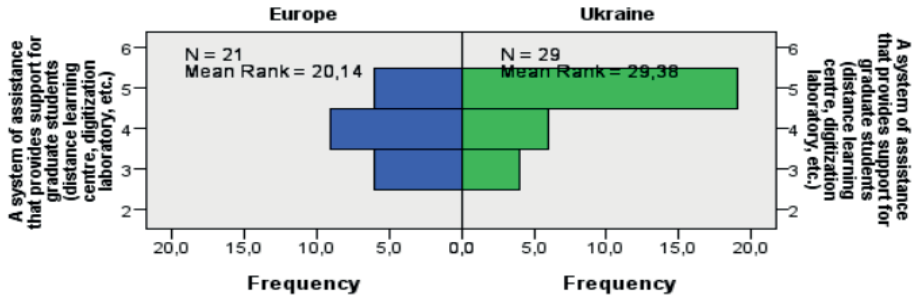
Table 1. The distribution of respondents' answers to the first group of questions, confirms the homogeneity of the studied groups

Where are you from?		Europe		Ukraine	
		Count	Column N %	Count	Column N %
Do you always have Internet access to computers and mobile devices when you need to find some information? *	Yes, I always have	18	85.70%	22	75.90%
	I have, but not always	3	14.30%	7	24.10%
	Access is very limited, I can rarely use digital devices	0	0.00%	0	0.00%
Do you have access to international databases of scientific journals and scientific publications? *	Yes, I always have	8	38.10%	8	27.60%
	I have, but not always	11	52.40%	16	55.20%
	Access is very limited, I can rarely use digital devices	2	9.50%	5	17.20%
Do you have your profile in science metric databases, such as Google Scholar, WOS, and Scopus?	Yes, and I have publications that are integrated into the relevant database	6	28.60%	12	41.40%
	Yes, I have, but I hardly use it	5	23.80%	6	20.70%
	No, I don't have one, but I plan to create one	10	47.60%	11	37.90%
Do you have your profile on the ResearchGate social network? *	Yes, I have, I am an active participant	6	28.60%	6	20.70%
	Yes, I have, but I hardly use it	9	42.90%	9	31.00%
	No, I don't have one, but I plan to create one	6	28.60%	14	48.30%
Do you think it is necessary to develop the researcher's digital competence in the process of Ph.D. study *	Yes	21	100.00%	29	100.00%
	No	0	0.00%	0	0.00%

Source: Own work.

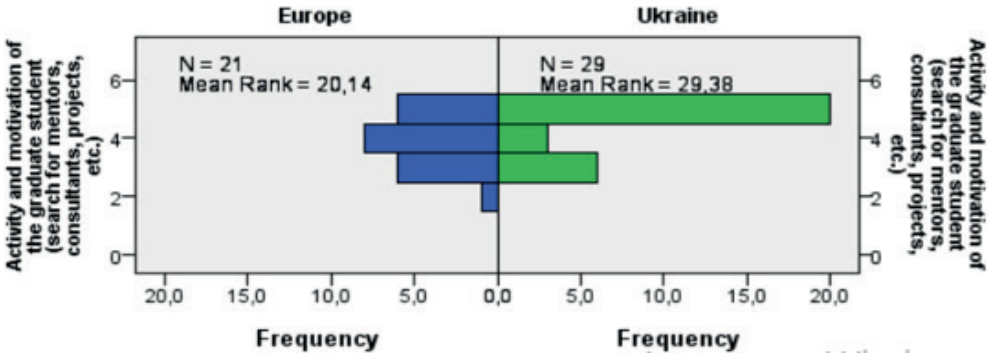
As a result, two groups of experts have formed: 29 postgraduate students from Ukrainian universities and 21 from European universities (7 from Spanish, 14 from Polish). Since the sample is small, non-parametric data analysis methods were used to assess and compare the main characteristics of the distributions. It should be noted that the small number of participants in each group in a certain way limits the audience of respondents, but still allows us to draw certain conclusions about existing trends and patterns and can be scaled, both at the level of the methodology of conducting and expanding the pedagogical experiment.

As a result of the analysis of the frequency distributions of the respondents' scores for each question of the third questionnaire group, which identified the factors with the highest level of determinants of the development of the graduate student's digital competence in the educational process at the university (the difference between the distributions was estimated using Kruskal-Wallis Independent-Samples Test) it was found that graduates, regardless of the university (country) where they study, among the factors with the greatest influence on the development of researcher's digital capabilities (the second research task) are: the digital environment of the educational institution where the graduate student studies; competent teachers who have a high level of digital competence and successfully use it in teaching classes; collaboration with fellow graduate students or other researchers (median = 5). However, a significant difference was found in the attitude of graduate students from European and Ukrainian universities regarding the influence of a system of assistance that provides support for graduate students (Figure 2) and Activity and motivation of the graduate student (Figure 3). The level of satisfaction is estimated on a scale of 1 to 5 (1 means complete dissatisfaction and 5 means the maximum level of satisfaction). The difference is significant at the p-value = 0.05. Hypothesis H1 can be considered partially confirmed. Moreover, it should be noted that postgraduate students of Ukrainian universities consider these factors to be the most influential (median = 5). The determined difference may indicate that Ukrainian graduate students take more responsibility for their development as scientists. Another reason may be some isolation of Ukrainian science from a single scientific space, therefore, more perseverance and initiative are needed for successful integration.



F i g u r e 2. Distribution of answers to the question "A system of assistance that provides support for graduate students (distance learning centre, digitisation laboratory, etc.)" by country

S o u r c e: Own work.

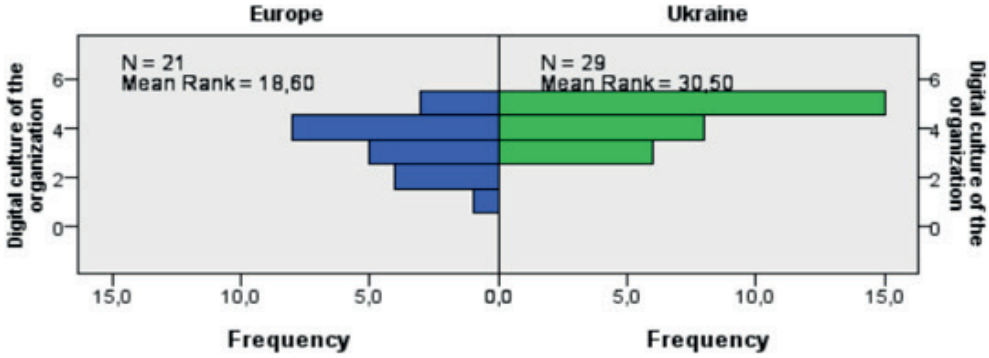


F i g u r e 3. Distribution of answers to the question "The distribution of Activity and motivation of the graduate student (search for mentors, consultants, projects, etc.)" by country

S o u r c e: Own work.

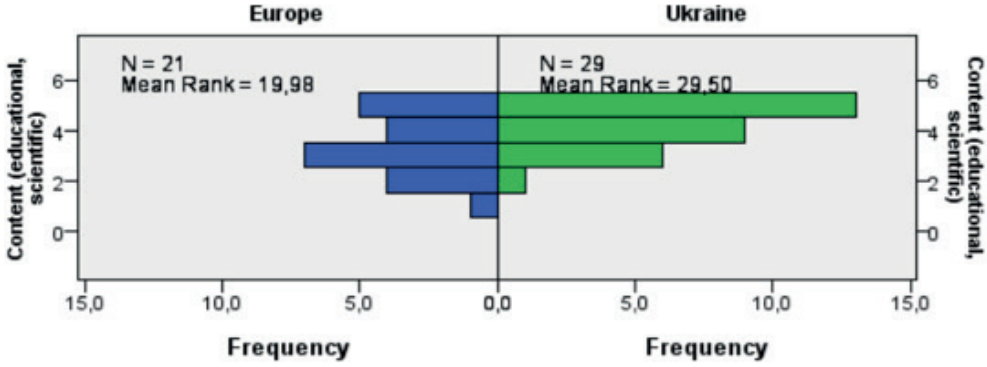
The analysis of the expert evaluation of organisational digital capability is the basis for rejecting hypothesis H2. In spite of the determination of the importance in all components of organisational digital capability for the development of the researcher's digital capabilities in both groups, a significant difference in the evaluation of 4 out of 6 components of the existing organisational digital capability in Ukrainian and European universities was determined. Thus, all respondents rated 5 out of 6 components of the existing organisational digital capability below the need; only Training, learning, and assessment meet their expectations. The biggest discrepancy was found in the attitude of European graduate students toward Communications and Digital infrastructure (in each case, the medians of expectations and realities are equal to 5 and 3, respectively). As for the analysis of responses by country, the representatives, regardless of the country, equally evaluated the distribution of Research and Innovation and Training, learning, and assessment as components of organizational digital capability. At the same time, Ukrainian graduate students generally rated the organizational digital capability of their university higher (Figure 4a–4d). The level of satisfaction is estimated on a scale of 1 to 5 (1 means complete dissatisfaction and 5 means the maximum level of satisfaction). The difference is significant at the p-value = 0.05. The latter can testify both to the sufficient level of digital capabilities of the university, and to the need for additional research related to the analysis of compliance with the requirements of Ukrainian graduate students to organisational digital capability to ensure the development of their digital capabilities.

As for the dissatisfaction with the development of the institutional Communications and Digital infrastructure, which, as a result of testing hypothesis H1, turned out to be important for the development of the researcher's digital capabilities in both groups, administrators of higher education institutions should take into account the need of graduate students to modernise the institutional IT infrastructure, in particular, to support open science and scientific communication.



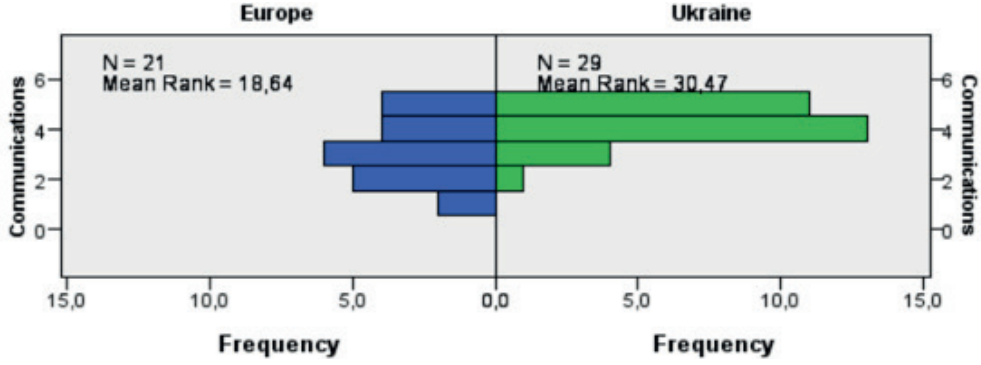
F i g u r e 4a. The answers to the question "Digital culture of the organisation" are distributed by country

S o u r c e: Own work.



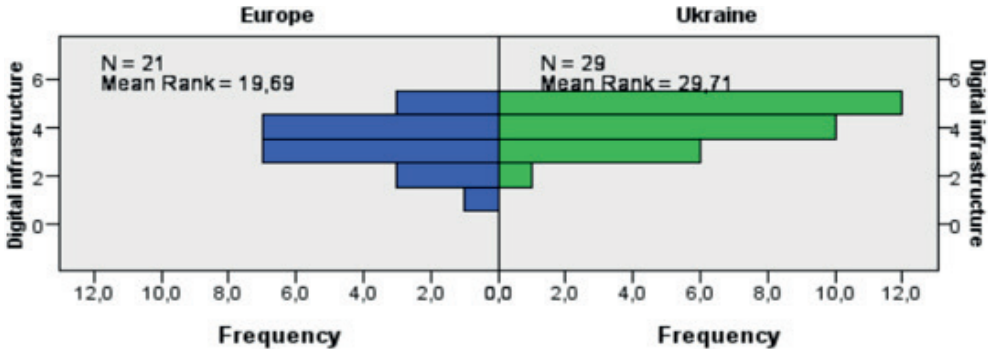
F i g u r e 4b. Distribution of answers to the question "The distribution of Content (educational, scientific)" by country

S o u r c e: Own work.



F i g u r e 4c. Distribution of answers to the "Communications" question by country

S o u r c e: Own work.



F i g u r e 4d. Distribution of answers to the question "Digital infrastructure" by country

S o u r c e: Own work.

Establishing effective communication at both vertical and horizontal levels, in particular, specialized training of research and teaching staff (Morze et al., 2017), who provide training for graduate students, will help.

CONCLUSION

The development of modern digital technologies and knowledge-intensive industries actualizes the need to train specialists with advanced digital capabilities.

The experience of the Jisc organisation, which provides digital solutions for education and research in Great Britain, is the basis for conducting additional studies related to the scaling of individual digital capabilities models, in particular, the researcher's digital capabilities, and organisational digital capability in the context of digital transformation of universities in different countries.

Based on the results of an empirical study conducted to determine the attitude of Ph.D. students of Borys Grinchenko Kyiv University (Ukraine), University of Silesia (Poland), and Extremadura University (Spain) to digital opportunities at the individual level and the level of educational organisations:

1. It was confirmed (according to the results of an online survey of selected homogeneous experimental groups of postgraduate students of Ukrainian universities – 1 group, and universities of EU countries – 2 groups) that they show a high level of readiness to develop the researcher's digital capabilities;
2. The factors that have the greatest influence on the development of the researcher's digital capabilities include the following: the digital environment of the educational institution where graduate students study; competent teachers who have a high level of digital competence and successfully use it in conducting classes; collaboration with fellow graduate students or other scientists;
3. A sufficient level of the existing distribution of Research and Innovation and Training, learning, and assessment as components of the organisational digital capability of universities, where graduate students are trained, and the need to

improve institutional Digital infrastructure and Communications have been identified.

4. Although, in general, no significant difference was found in the attitude towards the development of digital capabilities of graduate students from different countries, graduate students from Ukraine rated the organisational digital capability of their university higher, while graduate students from EU countries need more powerful Digital infrastructure and Communications (in each in this case, the medians of expectations and realities are equal to 5 and 3, respectively).

Taking into account the small number of participants in each group (related to the limitations of this study), we consider the obtained results as a basis for expanding the pedagogical experiment both by expanding the audience of respondents (both quantitatively and qualitatively, for example, involving representatives of various categories of educators as experts), and higher education institutions from different countries. We attribute the latter to the prospects of further research.

At the same time, since the available results reflect certain trends, they can already be useful to representatives of higher education institutions for monitoring and developing (if necessary) existing organisational digital capabilities for improving individual digital capabilities of subjects of the educational process and digitalisation of education.

REFERENCES

Balyk, N., Vasylenko, Ya., Shmyger, G., Oleksiuk, V., & Barna, O. (2020). The Digital Capabilities Model of University Teachers in the Educational Activities Context In O. Sokolov (Ed.). ICT in Education, Research and Industrial Applications: Proceedings of the 16th International Conference, ICTERI 2020. Volume II: Workshops (Kharkiv, Ukraine, October 06–10). CEUR-WS, 2020, 2732 (pp. 1097–1112). http://ceur-ws.org/Vol-2732/20201097.pdf.

Bartlett-Bragg, A. (2017). Digital Capabilities: Where people and technology intersect. *9th International Conference on Education and New Learning Technologies*, 3–5 July, Barcelona, Spain (pp. 14–21). P10.21125/edulearn.2017.1004.

Brooks, D.C. & McCormack, M. (2020). Driving Digital Transformation in Higher Education. ECAR research report. Louisville, CO: ECAR, June 2020. https://library.educause.edu/-/media/files/library/2020/6/dx2020.pdf?la=en&hash=28FB8C377B59AFB1855C225BBA8E3CFBB0A271DA (accessed 15 July 2022).

Carretero Gomez, S., Vuorikari, R., & Punie, Y. (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use, EUR 28558 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-68006-9 (pdf), 978-92-79-68005-2 (print), 978-92-79-74173-9 (ePub). http://doi.org/10.2760/38842.

Cronbach, L.J. (1951). Coefficient Alpha and the Internal Structure of Tests. Psychometrika, *16*(3) Sept. 297–334. http://dx.doi.org/10.1007/BF02310555.

Finch, H., French, B.F., & Immekus, J.C. (2016). *Applied psychometrics using SPSS and AMOS*. IAP. ISBN 978-16-81-23526-4.

Jisc (2017a). What is digital capability? Guide (Website), Joint Information Systems Committee, Bristol https://digitalcapability.jisc.ac.uk/what-is-digital-capability/ (accessed 15 July 2022).

Jisc (2017b). Researcher profile Jisc. [Online]. https://repository.jisc.ac.uk/7386/1/BDCP-Researcher-Profile-300419.pdf (accessed 15 July 2022).

Jisc (2017c). Developing digital capability: an organizational framework. [Online]. https://repository.jisc.ac.uk/6610/1/JFL0066F_DIGICAP_MOD_ORG_FRAME.PDF (accessed 15 July 2022).

Kruskal, W.H. & Wallis, W.A. (1952). Use of ranks in one-criterion variance analysis. *Journal of the American Statistical Association, 47*(260), 583–621. http://doi.org/10.1080/01621459.1952.10483441.

Kullaslahti, J., Ruhalahti, S., & Brauer, S. (2019). Professional Development of Digital Competences: Standardised Frameworks Supporting Evolving Digital Badging Practices. *Journal of Siberian Federal University. Humanities & Social Sciences, 12*(2), 175–186. http://doi.org/10.17516/1997-1370-0387.

Kuzminska, O., Morze, N., Varchenko-Trotsenko, L., Boiko, M., & Prokopchuk, M. (2021, December). Digital Competence of Future Researchers: Empirical Research of Ph.D. Students of Ukrainian University. In *Digital Humanities Workshop* (pp. 177–184). https://doi.org/10.1145/3526242.3526258.

Levesque, R. (2005). *SPSS Programming and Data Management,* 2nd Edition. A Guide for SPSS and SAS Users. Chicago: SPSS Inc.

Limniou, M., Varga-Atkins, T., Hands, C., & Elshamaa, M. (2021). Learning, Student Digital Capabilities, and Academic Performance over the COVID-19 Pandemic. *Education Sciences*, *11*(7), 361. MDPI AG. Retrieved from http://dx.doi.org/10.3390/educsci11070361.

Mann, H.B. & Whitney, D.R. (1947). "On a Test of Whether one of Two Random Variables is Stochastically Larger than the Other". Annals of Mathematical Statistics, *18*(1), 50–60. http://doi.org/10.1214/arms/1177730491.

Mhlungu, N.S., Chen, J.Y., & Alkema, P. (2019). The underlying factors of a successful organizational digital transformation. *South African Journal of Information Management*, *21*(1), 1–10, https://doi.org/10.4102/sajim.v21i1.995.

Mohamed Hashim, M., Tlemsani, I., & Duncan, M.R. (2022). A sustainable University: Digital Transformation and Beyond. *Education and Information Technologies*. https://doi.org/10.1007/s10639-022-10968-y.

Morze, N., Liakh, T., & Kuzminska, O. (2017). Development of educational, scientific collaboration, and project management with IC tools in universities. In E. Smyrnova-Trybulska (Ed.). "E-learning" 9, *Effective Development of Teachers' Skills in the Area of ICT and E-learning* (pp. 347–364), 2017. https://depot.ceon.pl/handle/123456789/15502.

Neuhäuser, M. (2011). Wilcoxon–Mann–Whitney Test. In M. Lovric (Eds.). International Encyclopedia of Statistical Science. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-04898-2_615.

Nowak, B.M. (2019). The Development of Digital Competence of Students of Teacher Training Studies-Polish Cases. *International Journal of Higher Education*, *8*(6), 262–266. https://doi.org/10.5430/ijhe.v8n6p262. ISSN 1927-6044, E-ISSN 1927-6052.

Orlik, J. (2018). Delivering digital skills: a guide to preparing the workforce for an inclusive digital economy. London: Nesta, 47 p. https://www.nesta.org.uk/report/delivering-digital-skills/ (accessed 15 July 2022).

Richardson, J.T.E. (2018). Kruskal–Wallis Test. In B.B. Frey (Ed.). *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*. SAGE Publications, (pp. 937–939). https://doi.org/10.4135/9781506326139.n377.

Sanchez-Macias, A. & Veytia-Bucheli, M.G. (2019). Digital competencies in Ph.D. students. A study in two Mexican universities ACADEMIA Y VIRTUALIDAD, *12*(1). ISSN 2011-0731. https://doi.org/10.18359/ravi.3618.

Varga-Atkins, T. (2020). Beyond description: in search of disciplinary digital capabilities through signature pedagogies. *Research in Learning Technology*, *28*. https://doi.org/10.25304/rlt.v28.2467.

Wolski, M., Krahe, M., & Richardson, J. (2020). A model for librarians to assess the digital capability of research teams. *Journal of the Australian Library and Information Association*, *69*(1), 47–69. http://doi.org/10.1080/24750158.2020.1712882.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 205–214
https://doi.org/10.34916/el.2022.14.15

BLOCKCHAIN BASED SERVICES IN SCHOOL EDUCATIONAL SPACE

Irina Krasteva[1] **& Todorka Glushkova**[2]
[1,2] Plovdiv University "Paisii Hilendarski",
4000 Plovdiv, 24 "Tzar Asen" str., Bulgaria
[1] irina_krasteva@uni-plovdiv.bg, ORCID 0000-0003-0842-8143
[2] glushkova@uni-plovdiv.bg, ORCID 0000-0002-6243-9364

Abstract: *The global pandemic COVID-19 has changed the stereotypes of learning and transferred much of the learning process from the physical world to the virtual space. Education platforms such as Moodle, Microsoft Teams, Google Classroom, etc. have rapidly entered school education. Regardless of the opportunities that these platforms provided, many problems were also identified, mostly related to security when working with critical information, such as when working with an electronic diary, as well as when issuing documents with factory numbering. Blockchain technologies provide opportunities to largely solve these problems, as they ensure and maintain shared, programmable, cryptographically secure and reliable information. The article examines one possibility for the application of Blockchain technologies for the implementation of some services in a school educational platform. The goal is preliminary modelling and prototyping of these services, before their real implementation in the educational platform.*

Keywords: Blockchain technology, Cyber-Physical-Social Space, Educational platform for school education.

INTRODUCTION

The rapidly changing conditions in the digital society determine the need for dynamic changes in the field of education (Schwab, 2017). In the last three years, educational platforms such as Moodle, Microsoft Teams, Google Classroom, etc. have been widely used in the school education system. and each one of them provides both access to learning resources and services such as a test system, electronic diary, game-based learning, etc. Despite the advantages of these platforms, there are also many problems, mostly related to security in online-based work with critical information. These problems are most visible when managing an electronic diary, as

well as when issuing documents with factory numbering such as diplomas, certificates of completion of an educational degree, etc.
Blockchain technologies provide opportunities to solve these problems. The main advantages of this technology are related to the fact that it maintains a shared, programmable, cryptographically secure and therefore trust-proof ledger.
The purpose of the presented research is to create a conceptual model for the use of blockchain technologies in the implementation of some services in a school educational space and to present a partial prototype implementation of two such services related to an electronic diary and work with documents with factory numbering.

1. MOTIVATION AND RELATED WORKS

1.1. Blockchain technologies

Blockchain technologies manage to achieve integrity and trust in a pure peer-to-peer (P2P) system that consists of an unknown number of nodes (peers) with unknown trustworthiness. The blockchain is based on Distributed Ledger Technology (DLT), with each ledger contained in the nodes maintaining the ownership information and storing the entire history of transaction data on the chain. Through fast and secure transactions, participants exchange information and assets with each other, without the intervention of intermediaries. Nodes cooperate together using a communication medium to achieve a certain goal without having a central element for coordination and control. A key role in building and maintaining the blockchain is the use of cryptographic and security technologies to achieve integrity.
Blockchain consensus mechanisms (Alsunaidi, 2019) allow distributed networks of computers to work together and agree on the state of the network. They ensure that public ledgers are fair, reliable, efficient, and that transactions and activities on the network reflect the truth.

1.1.1. Smart contract

Smart contracts provide the business logic of a given decentralized application deployed on Blockchain. Provide an opportunity for participants to enter into various agreements with each other. Transactions will be executed exactly as they agreed. Each user can track the execution of their smart contracts at any time (Dwivedi, 2021). Smart contracts include logic, data, properties and events. They are event-driven, meaning they can be activated when certain conditions are met.
Smart contracts can only work with resources available inside the blockchain network and cannot interact with external data.

1.1.2. Blockchain Oracle (BO)

The Smart contract receives information from an external agent program called an oracle about the occurrence of an event in the physical world. Oracles are essentially a form of communication between the outside world and the Blockchain world. Because Blockchain and Smart contracts are closed systems, oracles represent a way to securely provide data off-chain to the Blockchain network (Mammadzada, 2020).

Smart contracts are often required to have relevant and correct information from the outside world to fulfill the agreement made between network participants. An Oracle is an external data agent that observes real-world events and reports them to the Blockchain for use by Smart contracts.

1.2. Some learning platforms used in Bulgarian schools

The coronavirus is having a negative impact on education systems (Tadesse and Muluye, 2020). According to the Strategic Framework for the Development of Education, Training and Learning in the Republic of Bulgaria (2020–2030) of the Ministry of Education and Science, the focus is placed on the development of students' digital competences and the use of appropriate learning platforms with opportunities for adaptive and personalized learning. The use of an electronic diary in all Bulgarian schools from the spring of 2020, on the other hand, is a prerequisite for the search for solutions for integration with the relevant educational platform. We will analyze some of the most widely used learning platforms in secondary school in Bulgaria in terms of knowledge verification services and their integration with an electronic diary.

Microsoft Teams is provided free of charge to all teachers and students in Bulgaria, according to a national agreement with Microsoft. It supports a communication environment and a platform for storing and structuring digital learning content (AlAdwani, 2022). Feedback is provided through the creation and assessment of assignments and online tests. There is no built-in interface to an electronic school diary in the platform.

Google Classroom is a free and very widely used learning environment worldwide (Safitri et al., 2022). In Bulgaria it is used by over 60% of schools. It has all the advantages of a standard virtual classroom – uploading material files, tests, homework and independent work. Tests are developed through the Google Forms module, and although a record of student results is generated, there is no built-in interface to an electronic journal. The security of the information is not at a high enough level – it is ensured only by the users' Google accounts.

Only about 4% of schools in Bulgaria use specialized learning LMS (Learning Management System) platforms such as **Moodle** or **Blackboard**. Moodle (Yugo et al. 2022) is a modular, dynamic, object-oriented and free learning platform. Although the system has a built-in module that provides some services from a virtual diary, transferring the information to an external electronic diary is not trivial. Despite the many advantages of these platforms, they are rarely used due to the higher degree of complexity and the need for constant training of teachers and administrators.

The considered learning platforms have different advantages and disadvantages. With them, the learning process largely transfers the traditional learning methodology from the real to the virtual classroom. The generation of reports of student results and their analysis is also difficult, and integration with an electronic diary is difficult to implement. These spaces operate entirely in virtual space and do not take into account the features, conditions and changes in the physical world that are essential to users.

The cyber-physical-social system (CPSS) is a fusion of physical space, cyberspace and social space (Pasandideh et al., 2022). The creation of CPSS learning spaces

enables educators and learners to interact in person or through their personal assistants. The learning content and learning process in these environments are adapted to the background knowledge and personal characteristics, characteristics and goals of individual students.

In recent years, a team of PU "P. Hilendarski" Bulgaria developed a reference architecture called Virtual Physical Space (ViPS) (Stoyanov et al., 2021). This space can be adapted to various application domains such as tourism, healthcare, education, agriculture and others. In the field of school education, the developed environment is called BLISS. BLISS extend the base ViPS architecture by adding specific components and services based on Blockchain technologies, such as an electronic school diary and a system for working with documents with factory numbering.

2. BLISS LEARNING SCHOOL SYSTEM

BLISS is an adaptation of the ViPS reference architecture to support the learning process in secondary school. BLISS (Figure1.) is implemented as a multi-agent system. The core of the system is built by personal assistants that interact with each other. The environment of the agents consists of two parts – BLISS server, driven by events and school diary, realized through blockchain technology.

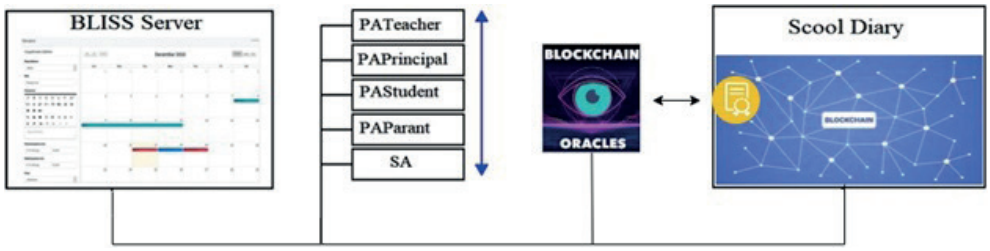


Figure 1. BLISS main components

Source: Own work.

At BLISS, specific personal assistants were developed as an instance of the genetic personal assistant of ViPS.

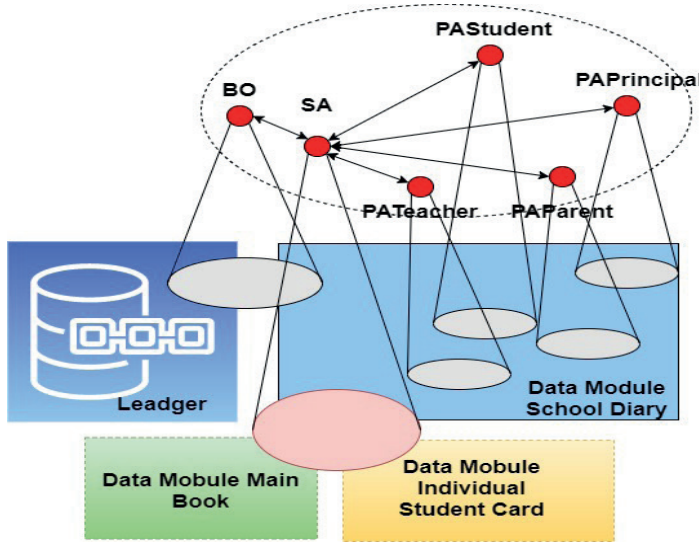
- **PAStudent.** A personal assistant assisting students in carrying out their daily duties in accordance with an established curriculum.
- **PATeacher.** This assistant is designed for teachers by reminding them of upcoming events and necessary preparation. Its main function, however, is to help teachers track and analyze the participation and progress in the learning process, as well as the results of their students.
- **PAParent.** The assistant provides information to parents about their child's participation and progress in school. A parent can see information about grades, events their child must attend, and notes made by teachers.
- **PAPrincipal.** The purpose of this assistant is to assist the principal of the school in effective management. The assistant is mainly intended to help in planning, conducting, and controlling the learning process.

The environment of the personal assistants consists of a BLISS server and a school diary, which is implemented using the Hyperledger Fabric Blockchain technology.

3. BLOCKCHAIN BASED SCHOOL E-DIARY

In its essence, the "E-Diary" service is a multi-agent system in which the personal assistants described in BLISS and other specialized intelligent agents interact.
We use a private blockchain to build the system. Joining the chain takes place with the special permission of the school principal. After access is allowed, the system provides a public and private key to the respective teacher, and the public key will also be recorded as a unique identifier of his/her personal assistant, and the private key will be contained in it as a corresponding pair.
As mentioned earlier, since Blockchain and Smart Contracts are closed systems, Blockchain Oracles (BOs) present a way to securely provide data off-chain to the Blockchain network. To write the ratings in the blockchain so that they remain immutable over time, we use BO. An Oracle is an external data agent that observes real-world events and reports them to the Blockchain for use by smart contracts. It will invoke a Smart Contract upon the occurrence of a „Valuation Entered and Confirmed" event. Through the Smart Contract, transaction data is created in the blockchain. After transactions are created and signed, the blockchain checks them for formal and semantic correctness and authorization. Only correct transactions are completed in a block and validated in the block chain. Once a block is validated, all ledgers in the system are updated with the new data.
We distinguish four types of grades that are recorded in the electronic diary: current, term, annual and grades from state exams. Each grade contains the following variables: the date it was entered, the subject for which it was set, the student who received it, the value of the grade, status (entered and confirmed), as well as the hash value of the transaction itself, which was validated in the blockchain.
To link the Blockchain Oracle, the data module and the various PA groups, we create a Specialist Assistant (SA), which is an intelligent agent and aims to respond to a change in the E-diary environment. Upon approval of transactions in the chain, i.e. their entry into the server's ledger, the Blockchain Oracle extracts this data and informs the SA that a change has occurred in its environment. The SA reacts and informs all assistants who are interested in this change. The BO writes the information (the hash value of the rating transaction) into the data module, which is accessed by all personal assistants and SA.
The SA environment consists of three modules – the Data Module of Electronic Diary (DMSD), the school's Data Module of Main Book (DMMB), and the DM of Individual Student Cards (DMISC).
The environment of the Blockchain oracle is the DMSD, the Blockchain ledger and the Blockchain itself, calling the Smart Contract. The environment of all personal assistants is DMSD and event-driven BLISS server. Examples of such events are teacher consultations, exams, online content discussion, meetings, etc.
A very important part in building a multi-agent system is communication between assistants. By definition, based on these messages, they can change their view of the

world and, in the next stage of deliberation, they choose another plan to achieve a given goal or subgoal. The communication between them would look like in Figure 2, and for clarity we have included only the communication of the SA with the other assistants in the system. Another important clarification is that the environment they observe may overlap.

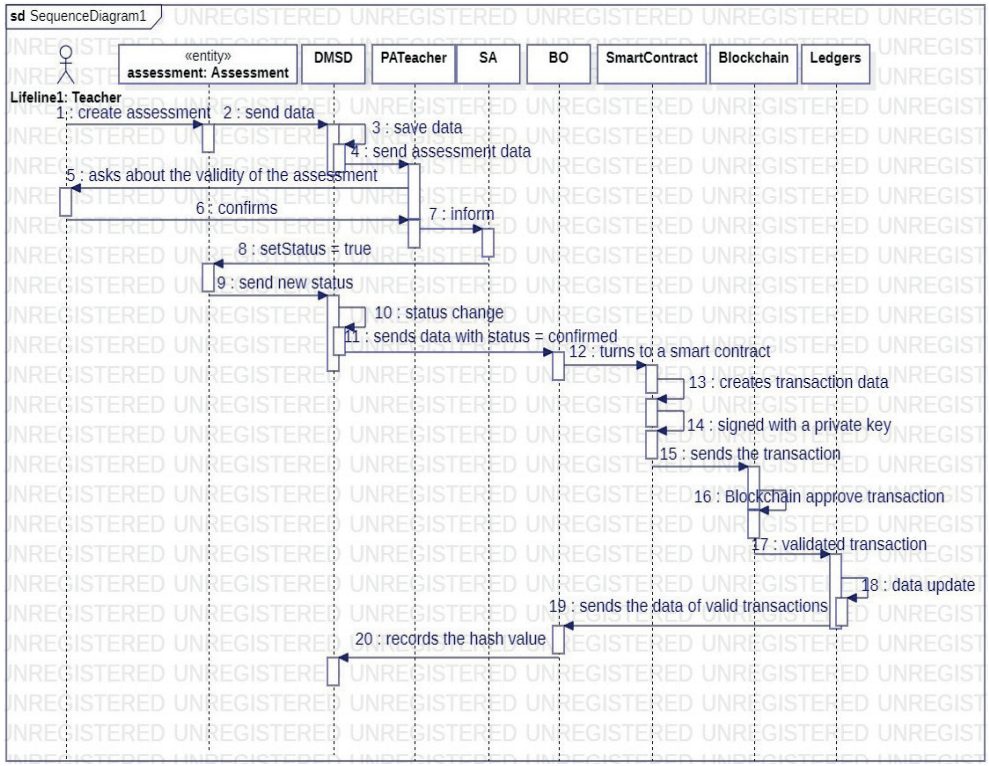


F i g u r e 2. Communication between agents in the E-Diary system

Source: Own work.

When an assessment is entered in DMSD by the teacher, it receives an automatic „entered" status. PATeacher's environment, in DMSD, is changing. It reacts to this change by sending a query to the teacher about whether the grade is valid. PATeacher checks the average assessment of the student in the given subject and if it detects a serious deviation, it sends this information to the teacher. If the teacher made a mistake during the entry, he can change it or delete it from the log before confirming the validity of the grade. If the teacher confirms the assessment, PATeacher sends the confirmation to the SA, which changes the status of that grade from „entered" to „confirmed".

The Oracle monitors the DMSD mainly for the change in the status of the assessment, when it changes to „confirmed", it calls the Smart Contract, which completes the transaction data and broadcasts it to the blockchain. After the data is checked for formal, semantic correctness and authorization, the transaction is validated in a block and recorded in all the ledgers in the Blockchain nodes. The Oracle also observes the change in the BLISS server's registry, knowing which values it submitted for execution from the Smart Contract, it expects them to be written, after validation, to the ledger. Upon the occurrence of this data, the BO records the hash value of the transaction from the registry in DMSD in the field hashValueOfTheTransaction. Figure 3 describes this process.



F i g u r e 3. UML Sequence diagram of the „Assessment Validation“ process

Source: Own work.

After applying a value to hashValueOfTheTransaction in DMSD, the SA distributes the assessments to the students‘ electronic notebooks and notifies all PAs affected by this change of a new event in their environment. Personal assistants inform users (students and parents) and record assessments in their knowledge base. Every personal assistant remembers how it was created. It stores the received information in its knowledge base and monitors the student‘s progress.

Upon receipt of an annual grade or grade from state exams, for each student, the SA transfers these grades and their blockchain-derived hash values to the school‘s Main Book (DMMB) or electronic Individual Student‘s Cards (DMISC). SA monitors data changes in DMMB and DMISC. Only SA can write information about assessments in them. If a data change occurs, during a manipulation attempt, it reacts, synchronizes the data with the Blockchain Oracle, and records the correct values. Thus, we guarantee that the ratings recorded in these documents guarantee the truth and cannot be manipulated.

On the basis of the information from the School Main Book or the Individual Student‘s Cards, documents with factory numbering are issued for the completed class and educational stage of training.

4. BLOCKCHAIN-BASED MODEL FOR DOCUMENT PROCESSING WITH FACTORY NUMBERING IN BULGARIAN SCHOOLS

Another important service is tracking the movement of documents with factory numbering (DFN). According to the regulations of the Ministry of Education and Science (MES), schools declare the necessary DFN for each school year. Applications are submitted by the schools to the Regional Departament of Education (RDE), then from the RDE to the Printing office and to the MES. RDE is an organization at the local level of the Ministry of Education and Science, which supervises the process of preparing a complete independent expert assessment of the quality of education of individual educational institutions in the given area. We will consider the functionalities of RUO-Plovdiv in the modeling of the service.

School documentation can be with or without factory numbering. According to Ordinance No. 8/11,08,2016 of the MES, documents in which a factory-printed series and number are called DFN. Each acceptance and transmission of DFN is carried out with a bilaterally signed acceptance-transmission protocol.

In the education system, the problem of security and verification of the authenticity of issued diplomas and certificates is becoming more and more serious. The use of Blockchain technologies is a reasonable choice when building this system. These technologies allow us to transfer and track factory-numbered documents, which we'll call assets, between organizations in a secure, reliable and integrity manner.

Our idea for the realization of this service is to build a private Blockchain between the MES, the National Printing House for the DFN, the RDE-Plovdiv and all schools in the Plovdiv region. All participants are known in advance and will be separate nodes in the system. They will have the following basic rights in the system:

- *MES*:
  - Receives requests for DFN from RDE-Plovdiv;
  - Sends a request to the DFN Printing House for the required number of DFN;
  - Monitors the process of using each individual DFN in the system.
- *DFN Printing House:*
  - receives a request from the Ministry of Education and Science for the necessary DFN to be printed;
  - prints and registers every DFN in the system as an asset;
  - sends the necessary DFN to RDE-Plovdiv.
- *Regional Department of Education-Plovdiv:*
  - allows access to the system of individual schools;
  - receives and processes applications for DFN from all schools in the Plovdiv region;
  - sends a request for the total number of DFNs in the Plovdiv region to the MES;
  - sends the necessary DFNs, through transactions, to each school.
- *School* (only the school director will have access to the system):
  - sends a request for the necessary DFN for the school year to RDE-Plovdiv;
  - receives the necessary DFNs in his wallet;
  - sends DFN to another school in case of excess;

- makes a request to another school if there is a shortage of DFN;
- marks and removes the used DFNs from the wallet.

Description of the process of distribution of DFN among blockchain network participants.

Step 1. Each school sends a request to become a node in the system to RDE-Plovdiv. Once access is granted, the system provides a public and private key to the respective school principal, through which he/she can verify and sign transactions for receiving and sending DFN.

Step 2. Each school principal sends a request to RDE-Plovdiv, for the required number of DFN for the relevant school year.

Step 3. RDE-Plovdiv collects the necessary number of DFN, which will be needed by all schools in the Plovdiv district, and sends this request to MES.

Step 4. MES makes a request to the DFN Printing House.

Step 5. The DFN Printing House creates the printed documents as assets in the Blockchain. Sends a physical DFN, with the necessary documents, through a courier company of RDE-Plovdiv. Creates a transaction in the system, including all assets sent, as well as the bill of lading number to RDE-Plovdiv.

Step 6. RDE-Plovdiv accepts a physical DFN and, after verification, signs the transaction in the system, which validates the request. After the transaction is accepted and approved in the blockchain, the necessary documents are transferred to the wallet of RDE-Plovdiv.

Step 7. In a similar way, RDE sends physical DFN to the respective schools, as well as creates transactions with the sent assets in the blockchain. After verifying the documents, they validate the transactions with their private keys.

Once documents become assets in a school's wallet, they are written off the blockchain network when they are used. Unused documents can be transferred to another school upon request, by a similar blockchain mechanism.

In the described E-Diary system, upon issuance of each DFN, its number is recorded in Scool's Data Module of Main Book (DMMB), and the DM of Individual Student Cards (DMISC) for the respective student who received the document – diploma or certificate.

CONCLUSION

The educational environments used in school education have indisputable advantages, but also disadvantages, mainly related to guaranteeing credibility and trust. From the results obtained so far when testing the prototypes of the presented blockchain-based services in the BLISS system, we can claim that the application of this technology largely satisfies the security and reliability requirements. The team's future plans are to realize the integration between the two blockchains – of E-Diary and DFN and to explore the co-dependency and applicability of these two services.

ACKNOWLEDGEMENTS

The results published in this article are part of a study conducted with the financial support of project FP21-FMI-002 "Intelligent Innovative ICT in Research in Mathematics, Informatics and Pedagogy of Education" of the Scientific Fund of PU "P. Hilendarski" in Bulgaria.

REFERENCES

Al Adwani, A. & Al Fadley, A. (2022). Online Learning via Microsoft TEAMS During the COVID-19 Pandemic as Perceived by Kuwaiti EFL Learners. *Journal of Education and Learning, 11*(1), 132–146. http://doi.org/10.5539/jel.v11n1p132.

Alsunaidi, S.J., Alhaidari, F.A. (2019). A Survey of Consensus Algorithms for Blockchain Technology. *2019 International Conference on Computer and Information Sciences (ICCIS)*, 1–6. http://doi.org/10.1109/ICCISci.2019.8716424.

Dwivedi, V., Pattanaik, V., Deval, V., Dixit, A., Norta, A., & Draheim, D. (2021). Legally Enforceable Smart-Contract Languages: A Systematic Literature Review, *ACM Computing Surveys, 54*(5), 1–34. https://doi.org/10.1145/3453475.

Mammadzada, K., Iqbal, M., Milani, F., García-Bañuelos, L., & Matulevičius, R. (2020). Blockchain Oracles: A Framework for Blockchain-Based Applications. *Business Process Management: Blockchain and Robotic Process Automation Forum*, *393*, 19–34. ISBN 978-3-030-58778-9. https://doi.org/10.1007/978-3-030-58779-6_2.

Okmawati, M. (2020). The Use of Google Classroom during Pandemic, *Journal of English Language Teaching, 9*(2), 438–443. https://doi.org/10.24036/jelt.v9i2.109293.

Pasandideh, S., Pereira, P., & Gomes, L. (2022). Cyber-Physical-Social Systems: Taxonomy, Challenges, and Opportunities, *IEEE Access*, vol. 10, 42404–42419. https://doi.org/10.1109/ACCESS.2022.3167441.

Safitri, M. & Aziz, M.R. (2022). Google Education for Distance Learning During the COVID-19 Pandemic. In H. Wihana (Eds.). *International Conference on Elementary Education, 4*(1), 442–448. UPI Press, Indonesia, e-ISSN 2808-8263. Retrieved from http://proceedings2.upi.edu/index.php/icee/article/view/2016.

Schwab, K. (2017). *The Fourth Industrial Revolution*. Crown Business, USA.

Stoyanov, S., Glushkova, T., & Doychev, E. (2019). *Cyber-Physical-Social Systems and Applications – Part 1*. LAP LAMBERT Academic Publishing. ISBN 978-620-0-31825-1.

Tadesse, S. & Muluye, W. (2020). The Impact of COVID-19 Pandemic on Education System in Developing Countries: A Review. *Open Journal of Social Sciences*, *8*, 159–170. http://doi.org/10.4236/jss.2020.810011.

Yugo, F.K., Hendriana, H., & Afrilianto, M. (2022). The impact of Moodle-based learning management systems (LMS) on learning achievement in the COVID-19 pandemic. *Empowerment: Jurnal Ilmiah Program Studi Pendidikan Luar Sekolah, 11*(1), 35–42. https://doi.org/10.22460/empowerment.v11i1p35-42.2854.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 215–228
https://doi.org/10.34916/el.2022.14.16

TRAINING OF PRE-SERVICE TEACHERS OF COMPUTER SCIENCE IN COMPUTER GRAPHICS

Nataliia Morze[1] **& Tetiana Yefymenko**[2]
[1] Borys Grinchenko Kyiv University, 18/2 Vorovskogo Str., Ukraine
[2] National Pedagogical Dragomanov University, 9 Pyrohova Str., Kyiv, Ukraine
[1] n.morze@kubg.edu.ua, ORCID 0000-0003-3477-9254
[2] t.o.efimenko@npu.edu.ua, ORCID 0000-0002-9012-9857

Abstract: *The article is devoted to the issue of teaching computer graphics to students of computer science at pedagogical universities, which is related to the development of information and communication technologies and modern trends in education. Based on a survey conducted with the participation of the authors of more than 250 representatives of IT companies and computer science teachers, it has been determined what life competences should be formed by teachers in students within computer science classes according to the requirements of the labour market, which sections of computer graphics are promising for student learning and therefore important for training of pre-service teachers of computer science.*
The content of computer graphics training for pre-service teachers of computer science at five pedagogical universities of Ukraine is analysed, the system of computer graphics training for pre-service teachers of computer science at the National Pedagogical Dragomanov University is described. Besides, the structure is presented and the need for the introduction of a specially developed electronic training course for distance learning of pre-service teachers of computer science is defined. It is determined which components of the information and digital competence of pre-service teachers of computer science the course in computer graphics should be aimed at. It is noted that this course contributes to the formation of important information-digital and professional competences, which are necessary for a modern specialist in the field of computer graphics as well as for a pre-service computer science teacher. The teachers who took part in the survey emphasised that they lacked qualification in dealing with such methodological issues as active methods of teaching computer science (51.1%), the cognitive-research method (44.8%), the educational project method (41.6%) etc.

Keywords: computer graphics, preparation of pre-service teachers of computer science, competence approach, digital competences.

INTRODUCTION

The globalization processes taking place around the world, technological and demographic changes, as well as digital transformation, are increasing the demand for high-level skills of graduates and, at the same time, require new, broader skill sets that will contribute to the digital transformation of the economy in society on the one hand and, on the other another, expand digital, entrepreneurial and other skills of the 21st century.

There is an ongoing modernisation of education in Ukraine. A key reform of Ukrainian education is related to the concept of the New Ukrainian School. To this end, work is constantly being carried at the legislative level and through practical, psychological and methodological assistance to teachers who work in the conditions of the implementation of this Concept.

In line with the changes taking place in today's digital society, the standards of education are changing in different countries, and the content and importance of some educational subjects are often changing. This is particularly true for the subject of computer science (Webb, Davis, & Bell, 2017).

Digital competence is becoming a basic competence and a component of 21st century literacy not only for pupils and students, but for every citizen, because the digital society technologies permeate all fields of human activity.

The ICILS 2018 International Survey of Computer and Information Literacy concludes that young people do not acquire developed digital skills through the simple use of digital devices. Simply providing students or teachers with equipment is also not sufficient to develop their digital competences (IEA Releases, 2018).

Many EU Member States are reviewing educational standards and integrating digital literacy into primary school, as well as new components such as artificial intelligence, digital citizenship and computer science (Digital Education Plan 2021–2027) In particular, this EU action plan indicates the need to increase digital skills and competences, which requires:

- Development of basic digital skills and competences from an early age;
- Digital literacy, including anti-disinformation measures;
- Digital education;
- In-depth knowledge and understanding of data-intensive technologies such as artificial intelligence (AI);
- Advanced digital skills to train more digital professionals;
- Ensuring equal representation of girls and young women in research and digital careers.

Educational standards are also changing in Ukraine. A new strategy for studying computer science is being discussed. The State Standards of Primary and Secondary Education (2018, 2020) define the following 4 learning outcomes for computer science:

1. Searching, presentation, transformation, analysis, generalization & systematisation of data, and critical evaluation of information to solve life problems.
2. Creation of information products and programmes to effectively solve tasks/problems effectively, creative self-expression (individually and in cooperation) with and without the help of digital devices.

3. To use of information & communication technologies and digital devices consciously to access information, communicate and cooperate as a creator and/or a consumer.
4. Awareness of the effects of the use of information technologies for oneself, society, the environment and sustainable development of society, compliance with ethical and legal norms of information interaction.

Research goal. The article examines the results of a study on determining the level of readiness of Ukrainian educators to use computer graphics tools. It attempts to answer the following questions:

- analysis of the theoretical basis of the research;
- analysis of digital competence of modern computer science teachers;
- analysis of the level of readiness of Ukrainian educators (target group) to use computer graphics tools based on the survey data.

Hypothesis: taking into account the rapid development of digital technologies, the authors believe that the efficiency of education in general will increase by raising the level of their Digital Competences, especially skills in using computer graphic tools.

Research methods. The authors used the following research methods and tools in the study:

- survey;
- interview with Ukrainian educators;
- document and content analysis;
- analysis of research papers.

The present study involved 221 Ukrainian educators and 16 heads of IT companies.

1. THE THEORETICAL BACKGROUND OF THE RESEARCH

In order to determine the opinions of IT specialists and computer science teachers on the status and updating of the goals and content of computer science education, in accordance with new educational standards, 16 heads of IT companies and 221 teachers of computer science were interviewed as part of the "Computer Science – New Generation" project. They noted that the school computer science course should form soft skills, which are very important in life and work (Table 1, Figure 1, Figure 2):

Table 1.

Skills	Opinion of IT specialists	Opinion of Computer Science Teachers
Critical thinking	93.8%	82.4%
Ability to work with data and information (search, analysis, transformation, generalization, systematization and submission of data)	75%	84.6%
Problem solving	100%	53.8%
Communication, collaboration and teamwork	87.5%	63.8%
Self-mastery of new technologies	43.8%	64.3%

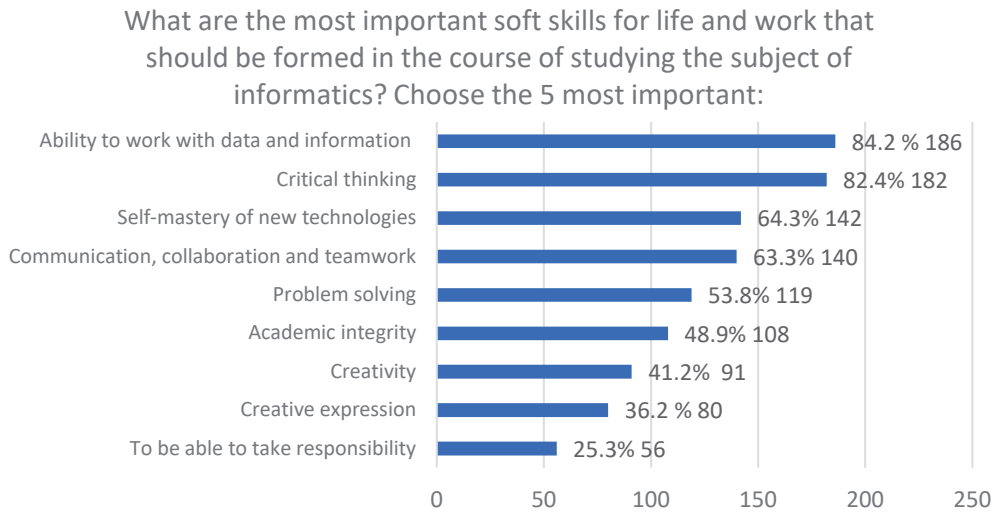


Figure 1. Teachers' answers

Source: Own work.

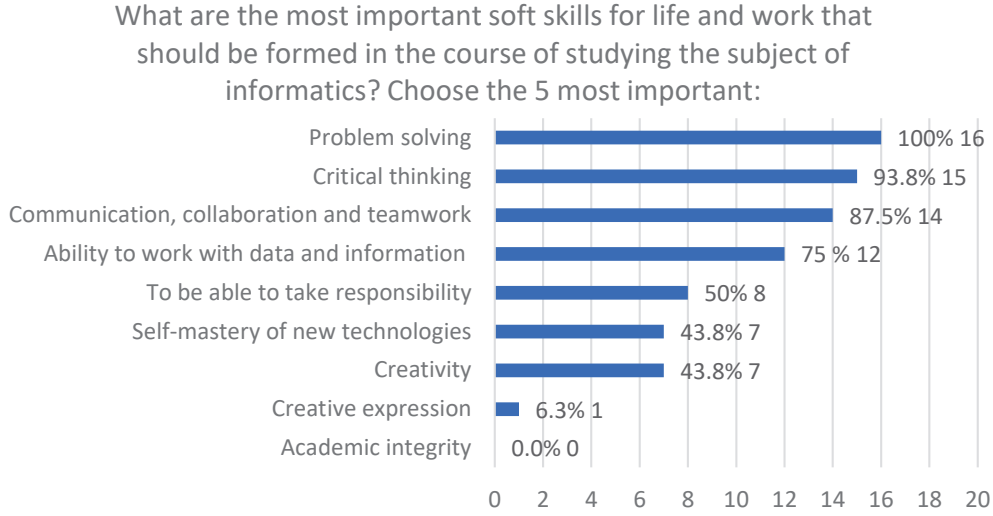


Figure 2. IT specialist's answers

Source: Own work.

The analysis of the answers of the respondents shows that significant changes should be made not only in the content, but also in the methods of training pre-service teachers of computer science in order to meet the needs of the labour market regarding the skills and competencies of graduates of secondary education institutions. Apart from information and digital competence formed at a sufficient level, pre-service teachers must have key competences necessary for successful self-realization and lifelong learning, which requires the content of the subject of computer science. It is required by the content of the subject of computer science. The content is constantly and rap-

idly changing due to the corresponding changes in digital technologies. The information and digital competence of the re-service computer science teachers includes:

A3.1. Ability to navigate in the information space, search and critically evaluate information and to use this information in professional activities.

A3.2. Ability to effectively use existing electronic (digital) educational resources new ones, if necessary.

A3.3. Ability to use digital technologies in the educational process (Standard for the professions, 2020).

Digital literacy is one of the key competences of future teaching staff. The discussion on digital literacy and how it is measured is part of the reflection on the shape of the future school and educational programmes at pedagogical universities. Understanding the state of *preparation* of new pedagogical cohorts in the intensively developing information society requires the organization of those conclusions reached so far by relevant research. For this purpose, a systematic analysis of the literature (peer-reviewed articles) indexed in repositories and scientific databases such as Google Scholar, EBSCO, Scopus and Web of Science was used. Based on data from 2001 to 2021 on Polish students, these being future educators, it was noted that:

1. Measurement of digital literacy is rare, theoretical analyses are preferred.
2. The research is dominated by quantitative techniques and tools mostly deprived of theoretical framework and psychometric properties based on a number of inconsistent indicators.
3. Occasionally DigCompEdu, TPACK, Eurostat typologies are used for measurement.
4. Digital literacy measurement is mostly based on students' self-declarations.
5. Surveys are conducted in different centres without representative samples, and the samples used are usually small.
6. The level of digital literacy is most often described as average or good.
7. Students of pedagogical faculties prefer to rely on common software and services of the information society.
8. Attitudes towards new media in education vary within this group.
9. There is a need to develop new, standardized research tools measuring digital literacy, which might nullify the Dunning–Kruger effect. (Tomczyk, 2022).

When training pre-service teachers, the pedagogical university must focus on the challenges of the times and change the educational programmes for the training of specialists in accordance with the current legislation of Ukraine. Therefore, educational programmes for teacher training are constantly analysed, modernised and improved. Computer science teachers are trained according to the educational programme of training in the specialty 014.09 Secondary education (Computer Science), the curriculum of which was updated in 2021. Graduates receive the qualification "Bachelor of Education (Computer Science)", teacher of computer science in a general secondary school.

The purpose of the computer science course is to develop the personality of a student who is able to use digital tools and technologies to solve problems, develop, creatively express themselves, ensure their own and social wellbeing, think critically, act safely and responsibly in the information society.

This means that the university must train a specialist who possesses these competences and will be able to teach them to his/her students as well.
One of the important modules that respondents pay attention to is working with graphic objects (Table 2 and Figure 3). Thus, 221 teachers rated the importance of blocks related to computer graphics according to the needs of the labour market in the following way:

Table 2.

The name of the block related to the graphics	0 not important at all	1 partially important	2 not very important	3 important	4 very important
Processing of multimedia objects	0	11	38	66	106
Computer Graphics	0	6	48	94	73
Computer animation	3	19	53	90	56
3D-graphics	0	18	58	90	54

Source: Own work.

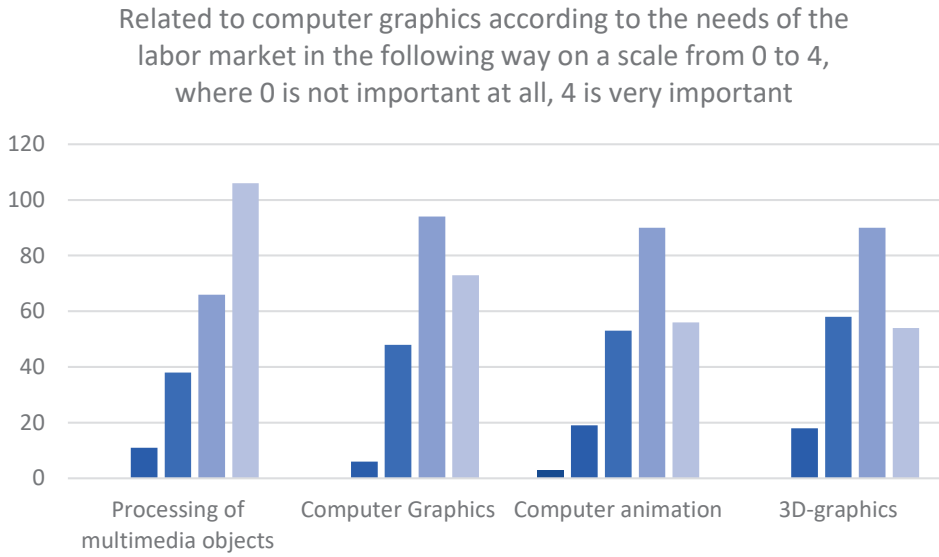


Figure 3. Distribution of answers regarding blocks of the computer science course by importance of priority according to market needs

Source: Own work.

That is why the purpose of the article is to analyze issues related to the training on computer graphics for pre-service teachers of computer science in accordance with the new conditions of the labor market and taking into account the skills of graduates of secondary education institutions, and determination of ways to modernize the system of the training.

Computer graphics and design includes the technology of creating and processing graphic images with aesthetic and functional properties, using computer equipment. A graphic designer works on the visual appeal of a product when creating a website, logo, company brand or print design. Specialists in the field of Graphic Design are constantly learning new design methods, software technologies and work methods. This field is dynamically developing and is in high demand both in the service and private employment markets. The US Bureau of Labor Statistics predicts that graphic designers will have 35% more online design job opportunities by 2026. At the same time, traditional print publishers and mass media will cut the number of designers in the printing industry by 22% (US Bureau, 2021).

Among all creative specialties, it is difficult to find a more popular one than graphic design. Such a specialty as "Graphics and multimedia in IT", for example, is currently one of the most popular in all countries.

Computer graphics and computer design is one of the content-determining disciplines that should form an individual's modern digital competence, which is included in the list of key competences and cross-cutting skills in accordance with the State Educational Standards of Ukraine and which is emphasised in the Recommendations of the European Parliament and the Council of the European Union on the formation of key competences of lifelong education. This competence allows one to organically exist in society at the level of a developer of computer products or their user.

Computer-aided design is the main means of visual communication. When training pre-service teachers, they (teachers) must develop basic digital competences for working with graphic data:

- ability to use specialized effects for animation processing and video design;
- ability to use digital technologies to process graphic images, animations and videos;
- ability to find, process, analyse and evaluate information related to professional activity;
- ability to use existing computer technologies to solve the problems of planning the educational process;
- ability to use specialised software and modern means of information storing and processing;
- ability to choose and use computer technologies to solve various pedagogical problems;
- ability to create simple computer pedagogical software tools to introduce new computer technologies into the educational process;
- ability to create and edit vector graphic images of varying complexity.

The State Standard provides basic knowledge that can be attributed to computer design issues. Issues of computer graphics are most closely related to design: raster and vector images, their objects and properties; construction and processing of graphic

images in various software environments; three-dimensional graphics; animation; concepts of 3D modelling programs and 3D printing.
The study of the topic "Computer presentations" is closely related to computer graphics: visualization of messages, computer presentations, their objects and properties; stages of creating a presentation and requirements for its design; presentation objects and means of managing its demonstration; animation effects, movement of objects in presentations; planning a presentation and speaking in front of an audience.
In the process of studying the topic of "Web resources", automated means of creating and publishing web resources are considered; the language of hypertext markup and ergonomic placement of information on the web page should be also considered.
As regards the topic of "Multimedia", it covers the problems of processing multimedia objects, construction of audio and video sequence and publishing multimedia (State standard of basic secondary education, 2020).

2. ANALYSIS OF TEACHING COMPUTER GRAPHICS DISCIPLINES IN PEDAGOGICAL UNIVERSITIES OF UKRAINE

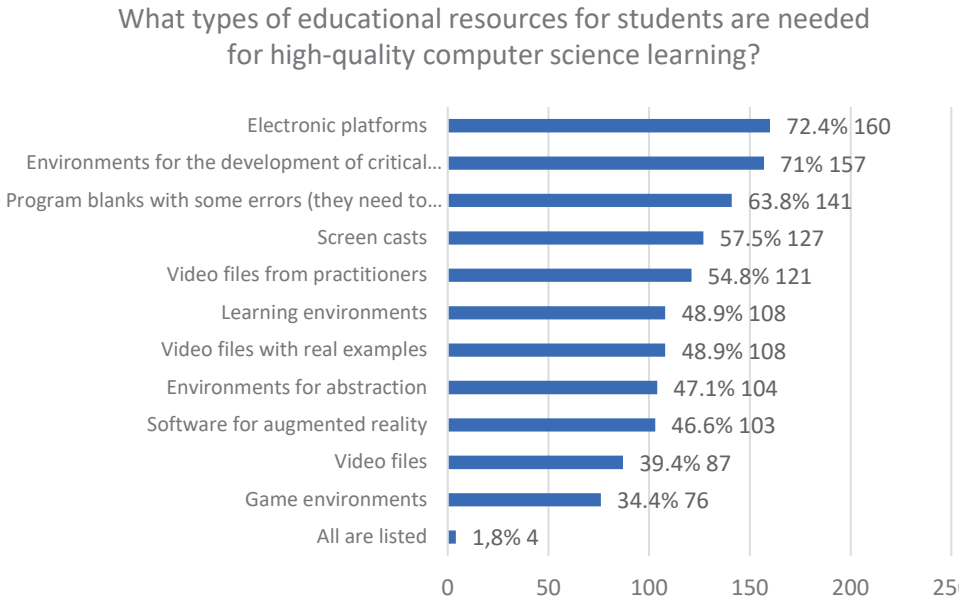
All these questions are considered in a computer science course in primary school and may be of interest to those who wish to build their future careers in the field of computer graphic design.
The analysis of research and publications shows that the pedagogical literature considers methodological issues related to the teaching of computer graphics concepts to students (Horobets, 2014), methodological principles of teaching are investigated by Hevko (Hevko, 2017) and others. Some studies consider the training of a specialist in computer graphics just from the standpoint of the formation of appropriate graphic and design competences (Cherniakova, 2010) but methodological approaches to teaching computer graphics to pre-service computer science teachers are not sufficiently covered in the literature.
Pedagogical universities provide education according to educational programmes in which issues of computer graphics and computer design are included. Some study programmes combine computer graphic design with other fields such as interactive media. In the course of the research, the curricula of pedagogical universities of Ukraine were analysed in order to determine which branches of computer graphics disciplines are studied during the training of specialists. As it turned out, these disciplines are included in the bachelor degree educational programmes 014.09 Secondary education (Computer Science).
The Volodymyr Vynnychenko Central Ukrainian State Pedagogical University trains such specialists at the Faculty of Mathematics, Natural Sciences and Technologies. The discipline "Computer graphics" (3.5 credits) is included in the block of bachelor degree professional training 014.09 Secondary education (Computer Science) with a specialisation "Secondary education" (Computer Science and Mathematics). The Faculty also offers a related discipline "Professional work with graphic packages" in the university-wide list of elective disciplines.

Ternopil's Volodymyr Hnatiuk National Pedagogical University (to be precise, its Faculty of Physics and Mathematics) offers the discipline of "Computer Graphics". This discipline is in the elective block 014.09 Secondary Education (Computer Science); the second subject specialisation is 014.04 Secondary Education (Mathematics) of the educational programme 014 Secondary Education.
The South Ukrainian K. D. Ushynsky National Pedagogical University (to be precise, its Faculty of Physics and Mathematics, Department of Applied Mathematics and Computer Science) offers bachelor degree studies in Computer Science. "Computer design" is included in the list of disciplines of the bachelor degree professional training block. "Computer graphics" is also among the disciplines of this department.
For 2022, Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University offers "Digital technologies for processing graphic images, animation and video". It is in the list of elective educational disciplines for full-time and part-time forms of bachelor degree studies. The course covers raster, vector and 3D graphics editors.
The National Pedagogical Dragomanov University (Faculty of Mathematics, Computer Science and Physics) plans to start the course "Fundamentals of Computer Design". It is part of the bachelor degree educational and professional training programme in the specialty 014.09 Secondary Education (Computer Science). According to the curriculum, which was updated and approved in 2021, 90 study hours are planned for the study of the discipline, of which 34 hours are taught (16 hours – lectures, 18 hours – laboratory work) and 56 hours – students' independent work. The course plans to study topics that will be propaedeutic for the disciplines "Fundamentals of web technologies and web design" and "Fundamentals of 3D technologies", which are offered to students in the 1st and 2nd courses of training. Students of the 3rd year have the opportunity to choose the specialization of "Computer design" and can continue to study computer design issues in the courses "Web technologies and web programming", "Computer graphics and animation", "Virtual and augmented systems reality", "Multimedia systems and technologies", "Methodology of teaching computer design", and "3D technologies and 3D modelling".
Students gain technical skills using many different types of technology, including graphic design software, sound devices, cameras and printers. They also gain additional skills such as attention to detail, analytical skills and creativity. A very important experience is when students have the opportunity to create their own portfolio to demonstrate their abilities to potential employers. This could be, for example, coursework (course paper) that would include graphic design, typography, web design, advertising design, digital photography, and interactive design techniques. This can prepare students for careers in a variety of fields including animation, visual marketing, advertising, logos, and visual media.

3. WAYS OF IMPROVING DIGITAL COMPETENCES OF UKRAINIAN EDUCATORS

Respondents emphasized that teachers need the following types of educational resources for quality teaching, (Figure 4), which indicates that when training pre-service teachers, they should be taught not only to create resources, but also to use them effectively.

These include electronic platforms (72.4%), environments for the development of critical thinking (71%), examples of programs with some errors (they need to be found and fixed (63.8%), screen casts (57.5%), video files from practitioners (54.8%), etc.).



F i g u r e 4. Types of educational resources for high-quality education of students

S o u r c e: Own work.

At the same time, almost 100% of the interviewed teachers indicated a lack of competence tasks. Therefore, it is advisable to use competence tasks when choosing the tasks of the course of "Fundamentals of Computer Design". The technological functions of computer graphics are considered as tools for solving project tasks used in print advertising, business presentations, casual games, identity development, 3D modelling and the creation of animated plots/stories. To master computer graphics tools, students are offered to complete projects that they could face in real life:

- creating the identity of your own software development company, design bureau, group by interests (fans of fantastic fictions, cakes, music, etc.);
- organization of a public event: alumni meeting, computer science olympiad, science week.

In order to prepare projects, it is necessary to create instructions, which describe the requirements for the portfolio to be prepared. Students are encouraged to form groups of 2–3 people, but due to the fact that classes have been held online for the last 3 years, this has become problematic. Students do not know each other very well, they have little time for personal communication, and such relationships have proved unproductive. Therefore, projects are mostly individual.

An electronic training course was created to train students in computer graphics using innovative pedagogical methods (https://moodigital literacye.fmif.npu.edu.ua/course/view.php?id=800).

The course is structured thematically:

1. General information about design and computer graphics
2. Copyright of programs and images. Different types of licenses
3. Raster graphics
4. Vector graphics
5. Infographics and business graphics
6. Animation
7. 3D graphics and modelling
8. Web design, website image optimisation

Each topic contains theoretical material, tasks to be performed and test questions. The teachers who took part in the survey emphasised that they lacked consideration of such methodological issues in their qualification improvement (Figure 5): active methods of teaching computer science (51.1%), cognitive-research method (44.8%), the educational project method (41.6%), etc. This emphasises the relevance of the created electronic course for teaching computer graphics, in which the mentioned techniques are implemented.

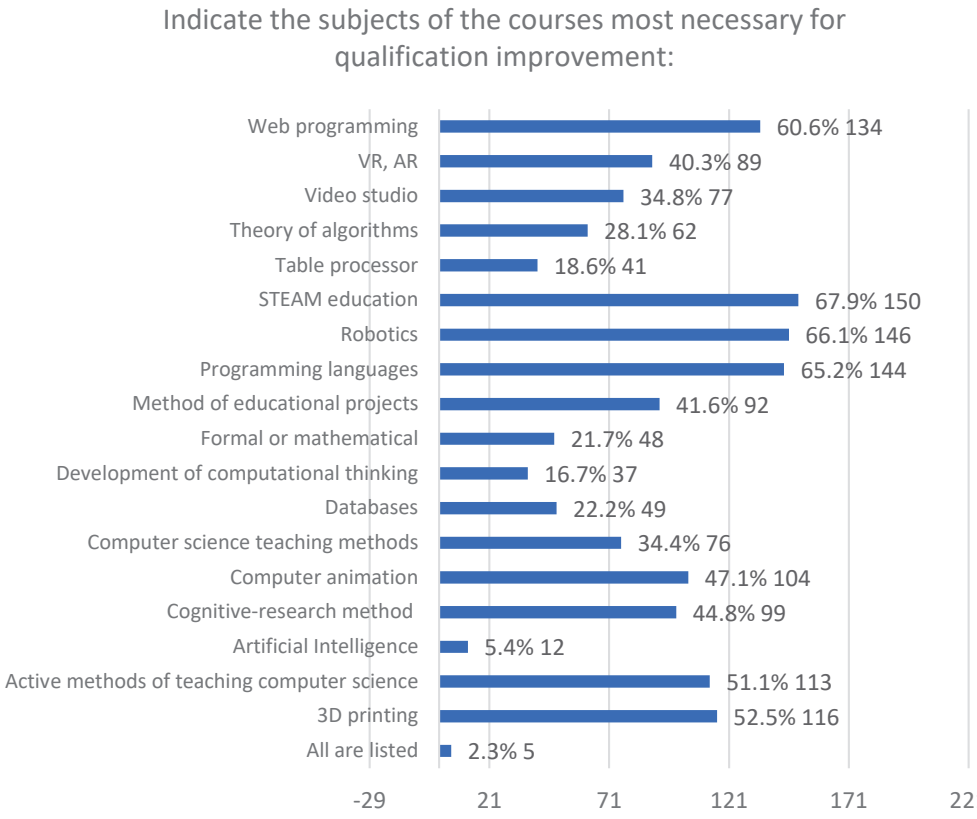


Figure 5. Distribution of answers regarding the subjects of the courses that are most necessary for improving the qualifications of computer science teachers

Source: Own work.

CONCLUSION

Pre-service teacher training should ensure the formation of key competences necessary for successful self-efficacy and lifelong learning. It is about general competences as well as information and digital competences. Only complete and comprehensive knowledge of the subject will help the teacher correctly answer the questions posed by the inquisitive mind of the pupil/student.

As practice shows, many teachers lack modern technologies and teaching methods. There are many reasons for this, but the most important one is that pedagogical universities train specialists who do not meet the needs of the current labour market. The higher education system of Ukraine in its activities is oriented to the population's demand for educational services without taking into account the requirements of the labour market. The Ukrainian education market and the labour market share common features, such as the lack of analysis and forecasting of the number and qualifications of workers needed by the economy, the lack of a flexible system for determining the qualifications of a specialist, as well as the weak connection between higher education institutions and potential employers. The current reality requires different competences from a specialist than 30 years ago. In 2022, Ukraine ranked 85th in the World Competitiveness Rankings. The main reason is the war in the country, but even before that in 2021, we Ukraine came only 54th. As the survey results show (Figure 2), employers want to see the kind of modern specialist who can solve problem situations independently (100%), has highly developed critical thinking (93%), is ready to communicate and cooperate (87.5%), knows how to work with data and programs (75%) and is creative and able to learn independently (43.8%).

Therefore, a pedagogical university should change the content and methods of teaching teachers and students in accordance with the needs of the labour market, and teachers should respond adequately to social orders, contribute to the formation of the creative personality of specialists in various branches of the national economy, and activate the educational and creative activities of students. For the effective assimilation of educational disciplines and the formation of creatively gifted pre-service teachers of computer science, professors and trainers need to build an educational process based on active learning methods using didactic laws, principles, methods and forms. One of the most promising ways of improving the training of pre-service specialists is the introduction of forms and methods of active learning. Active learning methods combine forms of individual and collective acquisition of professional knowledge, abilities and skills. The most effective of these are situational methods: seminars, discussions, practical classes, project activities.

There is a growing need in information, technological and visual literacy of school leavers and an understanding that students have changed and educational practices have not. This requires the presence of a significant number of teachers who have practical skills in the use of information and communication technologies, as defined by international educational communities and organisations.

Preparing pre-service teachers of computer science to use various teaching methods, demonstrating work output created with the help of graphic editors and tools for working with graphic resources will also contribute to increasing students' motiva-

tion to study, which, in turn, will contribute to the determination of the future profession and the formation of self-study skills.

"Universities will rely less and less upon their reputation of 'centers of excellence'; universities will become laboratories / ateliers for developing youngsters' talents through special design- and problem solving tasks, revealing real solutions for real problems. Master students will undertake assignments, experiments, designs and theses, compared to what PhD students achieve nowadays. PhD students will shift towards unique boundary-cutting research instead of performing research that has been prompted by the professor" (Kommers, Smyrnova-Trybulska, & Morze, 2018).

REFERENCES

Cherniakova, T.V. (2010) Metodika obucheniia kompiuternoi grafike studentov VUZa [Method of Training of the Computer Graphics of the University Students] avtoref. diss. na soiskaniie uch. stepeni kand. ped. nauk: spets. [PhD Theses] 13.00.02. "Teoriia i metodika obucheniia i vospitaniia". Yekaterinburg: Rossiiskii gosudarstvennyi professional'no-pedagogicheskii universitet, 2010, 18 p.

Digital Education Action Plan (2021–2027). Retrieved from https://education.ec.europa.eu/focus-topics/digital/education-action-plan.

Hevko, I.V. (2017). Formuvannia i rozvytok profesionalizmu vchytelia tekhnolohii: teoriia i metodyka [Formation and development of the professionalism of the teacher of technologies: theory and methodology]. Kamyanets-Podilsky: Axiom, 392 p. [in Ukrainian].

Horobets, S.M. Osnovy kompiuternoi hrafiky [The Fundamentals of Computer Graphics]: [navch. pos.] / S.M. Horobets. Zhytomyr: Vydavnytstvo Zhytomyrskij Derzhavny Universytet im. Ivana Franka, 2014, 168 p.

IEA Releases International Results of the International Computer and Information Literacy Study, 2018. Retrieved from https://www.iea.nl/sites/default/files/2019-11/ICILS%20Results%20 Press%20Release.pdf.

Kommers, P., Smyrnova-Trybulska, E., & Morze, N. (2019). Editorial. In E. Smyrnova-Trybulska, P. Kommers, N. Morze, J. Malach (Eds.). *Universities in the Networked Society. Cultural Diversity and Digital Competences in Learning Communities*. Cham: Springer. ISBN 978-3-030-05025-2. https://www.springer.com/gp/book/9783030050252.

Law of Ukraine "On Education". Retrieved from https://zakon.rada.gov.ua/laws/show/2145-19#Text.

Morze, N.V. & Protsenko, G.O. (2012). The concept of teaching computer science in 5–9 grades of general educational institutions. *Computer science and information technologies in educational institutions*, 8–23.

New Ukrainian school. Retrieved from https://mon.gov.ua/ua/tag/nova-ukrainska-shkola.

Standard for the professions "Teacher of primary classes of a general secondary education institution". "Teacher of a general secondary education institution". "Teacher of primary education (with a diploma of a junior specialist)". Retrieved from https://zakon.rada.gov.ua/rada/show/v2736915-20#Text.

State standard of basic secondary education. September 30, 2020, #898. Retrieved from https://www.kmu.gov.ua/npas/pro-deyaki-pitannya-derzhavnih-standartiv-povnoyi-zagalnoyi-serednoyi-osviti-i300920-898.

State standard of primary education. Government Resolution of February 21, 2018, #87. Retrieved from https://www.kmu.gov.ua/npas/pro-zatverdzhennya-derzhavnogo-standartu-pochatkovoyi-osviti.

The Bologna Declaration of 19 June 1999. Retrieved from http://www.ehea.info/page-ministerial-declarations-and-communiques.

Tomczyk, Ł. (2022). Digital Literacy Among Students of Pedagogical Faculties in Poland—A Systematic Literature Analysis. In Ł. Tomczyk, L. Fedeli (Eds.). *Digital Literacy for Teachers. Lecture Notes in Educational Technology.* Springer, Singapore. https://doi.org/10.1007/978-981-19-1738-7_20.

US Bureau of Labor Statistics. Retrieved from https://www.bls.gov/oes/current/oes151255.htm.

Webb, M., Davis, N., & Bell, T. et al. (2017). Computer science in K-12 school curricula of the 2l[st] century: Why, what and when? *Education and Information Technologies, 22*, 445–468. https://doi.org/10.1007/s10639-016-9493-x.

World Competitiveness Center Rankings. Retrieved from https://www.imd.org/centers/world-competitiveness-center/rankings/.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 229–241
https://doi.org/10.34916/el.2022.14.17

METHODOLOGY FOR THE USE OF DIGITAL SERVICES IN THE ORGANISATION OF ONLINE AND OFFLINE EDUCATION OF PRIMARY SCHOOL CHILDREN

Svitlana Skvortsova[1], **Tetiana Symonenko**[2], **& Tetiana Britskan**[3]
[1] South Ukrainian National Pedagogical University named after K. Ushynsky, Staroportofrankivs'ka 26, Odesa, 65020, Ukraine
[2] Bohdan Khmelnytsky National University at Cherkasy, Shevchenko Boulevard 81, Cherkasy, 18000, Ukraine
[3] Izmail State University of Humanities, Riepina12, Izmail, 68600, Ukraine
[1] skvo08@i.ua, ORCID 0000-0003-4047-1301
[2] simonenkotetana9@gmail.com, ORCID 0000-0001-5963-0451
[3] britskan1994@gmail.com, ORCID 0000-0001-7277-4169

Abstract: *The article presents the results of a study on the problem of training future teachers in the use of a selection of online services in mathematics lessons during online and offline learning. The research was conducted in two stages: theoretical and experimental. At the theoretical stage, as a result of a comparative analysis of the possibilities of online services for organising the education of primary school children and based on the features of the structure of the combined lesson and types of educational activities, we developed a selection of online services and created appropriate recommendations for the use of individual templates in each of them for particular types of tasks. The study of the possibilities of online services for the organisation of online and offline training took place according to the developed plan. As a result of the conducted research, in accordance with the structure of the combined lesson, combinations of online services were selected, with the help of which you can implement all stages of the lesson and make certain types of mathematical tasks interactive.*

At the experimental stage, the developed selection was introduced into the methodological training of students of the Ushynsky University and Izmail University. As a result of mastering the selected set, students demonstrated creative tasks for organising a combined primary school mathematics lesson with the possible use of online services.

Keywords: ICT, online services, teaching mathematics, combined lesson, primary school children.

INTRODUCTION

In recent years, the problem of organising learning with the use of ICT, caused by the COVID-19 pandemic, has become topical. In Ukraine, as of 24 February 2022, this problem has become even more acute as schools have switched to distance learning under martial law. And therefore, based on today's challenges, it has become impossible to train students without the use of digital tools. Therefore, future teacher training should also be aimed at forming students' ICT competences.

1. ORGANISATION OF PRIMARY SCHOOL MATHEMATICS TEACHING WITH THE HELP OF ICT

The problem of using ICT in teaching primary school pupils is quite relevant in the research space (Tuparova, Kaseva, 2016; Borysenko, Bykonia, Rembach, Shumna, Oliinyk, Anishchenko, 2020; Dukic, Petrinsak, Pinjusic, 2020). In teaching mathematics, teachers use a variety of ICT tools – web services that can be used to create their own interactive/non-interactive learning content.

The results of the study of the most popular online services that can be used in teaching primary school children online are reflected in the work of researchers such as (Aleksieva, 2021; Urrutia, 2021; Dziabenko & Budnyk, 2019; Skvortsova, Britskan, & Haievets, 2020; Skvortsova & Britskan, 2021; Skvortsova, Britskan, Symonenko, & Haievets, 2022; Haitan, 2022); and the offline learning context studied by (Vanderlinde, Aesaert, & van Braak, 2015; Skvortsova & Britskan, 2018; Skvortsova & Britskan, 2019; Skvortsova, Onopriienko, & Britskan, 2019). We define offline learning as traditional learning that takes place within a classroom or school auditorium with the direct presence of teachers and students. Features of mathematical content creation using web services are explored by (Dziabenko & Budnyk, 2019; Aleksieva, 2021; Skvortsova & Britskan, 2021 and others). However, the question of developing a set of online services to help organise mathematics teaching is still open and requires further research.

The aim of the article is to prepare future primary school teachers to use a set of web services in the process of for the organisation of online and offline mathematics learning for primary school pupils.

The study of the set of web services for the organisation of online and offline learning of primary school children was carried out in two stages: theoretical and experimental. The tasks of the first stage were: 1) to conduct a comparative analysis of the possibilities of web services for organising learning for primary school children, taking into account the peculiarities of the structure of combined mathematics lessons and types of educational activities; 2) to develop a set of web services; 3) to provide appropriate recommendations for the use of individual templates in each service for specific types of mathematical tasks.

The purpose of the article is to prepare future primary school teachers to use a selection of online services for the organisation of online and offline learning in the process of teaching mathematics students.

In the process of work, we used a set of research methods: theoretical (analysis of scientific, scientific and methodical literature, synthesis, systematization, generalization and comparison) and empirical (confirmatory and formative experiment for diagnosis and verification of the effectiveness of the developed selection and its implementation in the methodological training of students, methods of mathematical statistics for the purpose of processing and summarising the obtained data).

The study of a selection of online services for the organisation of online and offline education of primary school children was carried out in two stages: theoretical and experimental. The first stage tasks: 1) to carry out a comparative analysis of the possibilities of online services for organising the education of primary school children, taking into account the peculiarities of the structure of the combined mathematics lesson and types of educational activities; 2) develop a selection of online services; 3) provide appropriate recommendations for the use of individual templates in each service for individual types of mathematical tasks; 4) introduce the developed selection into the methodological training of future primary school specialists.

We started the first stage of the research back in 2018. For 5 years, we conducted a survey of teachers in order to find out the relevance of the problem of using digital tools by primary school teachers and to determine the online services that are most used by teachers (Skvortsova, Britskan, Symonenko, & Haievets, 2022). Based on the needs of teachers, the list of online services was supplemented every subsequent year.

1.1. Comparative analysis of services according to the structure of the mathematics lesson

The main form of teaching mathematics is a lesson. Each lesson is designed according to the goal, and its content is subject to a number of tasks that ensure the achievement of the goal. Based on the goal of learning mathematics outlined by the standard, the general goal of each section is determined, which is specified for a separate series of lessons. Depending on the educational content of the section and programme requirements for its mastery, a series of lessons can realise the goal. The goal can be related, for example, to the formation of the concept of number, calculation skills, the concept of a problem, the ability to solve problems, etc. (Skvortsova & Onoprienko, 2019).

In primary school, mathematics lessons of the combined type prevail, in which several didactic goals are solved, and various methods of teaching organisation are used. According to the structure of the combined lesson, 5 stages are distinguished. Based on the types of work at each stage of the combined mathematics lesson, we selected a set of online services that will help the teacher organise the work of students in the lesson in online and offline learning conditions.

It should be noted that the comparative analysis of online services and work algorithms in each of the services are presented in the works (Skvortsova & Britskan, 2021; Skvortsova, Britskan, Symonenko, & Haievets, 2022).

The first and important stage of an online and offline mathematics lesson is the motivation of students' educational and cognitive activities. Based on the characteristics of primary school children – representatives of the digital generation (Skvortsova & Onopriienko, 2019), this stage of the lesson should be made clear, one that sets students up for activity and arouses their interest. During distance learning, without live communication in real time, the teacher must set the students to work, explain the purpose and tasks of the lesson. The teacher must tell which online services will be used and give specific instructions for using these services.

Organisation of the motivation of students' educational and cognitive activities usually takes place in the form of a conversation. The content of this conversation, based on the topic of the lesson, contains interesting facts, historical information about the emergence or discovery of a mathematical concept, law, action, etc. or situations from the life of a modern person, which requires students to apply new knowledge or a method of action. It is advisable to illustrate this information with visual content, in particular video. In the format of both offline and online learning, a small video can be prepared using MS PowerPoint, Renderforest and Canva services to illustrate the need to learn a new concept or method of action.

The next stage of the mathematics lesson is the actualisation of basic knowledge and methods of action, which involves the revision of knowledge and skills that are the basis for perceiving, understanding and realising new educational material or a method of performing a new action.

Usually, a mathematics lesson in primary school starts with a "Geometric Minute" that allows students to focus and tune in to work. During the geometric moment, the students' attention is focused on determining essential and non-essential, common and distinctive features of geometric shapes, finding out the regularity in the location of a series of geometric shapes and its continuation, on a detailed examination of spatial shapes, their sweeps and methods of obtaining them, etc. To spend a geometric moment in both online and offline learning conditions, it is advisable to use interactive exercises that give the learner instant feedback. Interactive lessons with the above content can be created using the LearningApps and Wizer.me services.

Also, at the beginning of the lesson, mathematicians often use a type of work such as oral numbers. It is obvious that for oral arithmetic it is advisable to use interactive exercises that involve automatic checking of correctness. Such exercises can be created with the help of online services LearningApps, H5P, Liveworksheets and Wizer.me.

One of the types of tasks offered to pupils at the stage of actualisation of basic knowledge and methods of action is mathematical dictation. Mathematical dictation is a special type of task, when tasks of mathematical content are offered in oral form, using mathematical terminology. Although the tasks offered during mathematical dictation are not difficult, but taking them by ear and at the pace set by the teacher causes certain stressful conditions in pupils. In order to avoid such situations, under the conditions of distance learning, it is possible to present the task of mathematical dictation in the form of a video or audio file, which the learner can listen to at a pace convenient for him. Also, tasks for mathematical dictation can be submitted in the format of interactive exercises created in the LearningApps, H5P, Wizer.me services.

At the stage of actualization of basic knowledge and methods of action, an oral survey of students is also conducted, the purpose of which is to revise the meanings of mathematical concepts, rules, laws of arithmetic operations, etc. To organise an oral survey on theoretical questions, in the conditions of distance or online learning, it will be appropriate to use the services ClassDojo, Padlet, H5P.

In addition, an individual survey is also conducted at this stage of the lesson. To this end, it is advisable to use interactive exercises created in the services LerningApps, Liveworksheets, Wizer.me, Classtime, H5P.

The third stage of the lesson is the formation of new knowledge and methods of action. Implementation of this stage in the conditions of distance learning can be carried out with the help of creating an interactive video (H5P) and performing tasks under the guidance of the teacher (LearningApps, Liveworksheets, Wizer.me, Classtime, H5P).

The next stage of the mathematics lesson is consolidation and formation of abilities and skills. At this stage, you can widely use interactive tasks created in the services LearningApps, Liveworksheets, Wizer.me, Classtime, H5P.

At the end of the lesson, there is a reflection and summary of the lesson. In the conditions of distance or online learning, reflection of educational and cognitive activity, as well as motivation, is implemented in the format: audio/video recording (MS PowerPoint, Renderforest, Canva, Padlet), offering students to continue the following sentences: “I know , what...”; “I can explain...”; “I understand...”; “I can do...”; “I’m checking...”; “I’m trying...”; “I feel that I need...” and others.

As a result of the conducted research, in accordance with the structure of the combined mathematics lesson, we have developed a selected set of online services, with the help of which you can implement all stages of the lesson and make certain types of mathematical tasks interactive.

2. EXPERIMENTAL TRAINING OF FUTURE PRIMARY SCHOOL TEACHERS IN THE APPLICATION OF THE SELECTION OF ONLINE SERVICES

2.1. The purpose, tasks and tools of the research

The second stage of the research involved the introduction of the developed selection into the methodological training of students majoring in Primary Education of the State Institution “Southern Ukrainian K.D. Ushynsky National Pedagogical University” (Ushynsky University) and Izmail State University of Humanities (Izmail University).

During the research, the reliability of the obtained results was checked using the K. Pearson agreement criterion ($\chi 2$ chi-square). For this purpose, two hypotheses were put forward: the first is the null hypothesis (H0), which states that teacher preparation for the use of ICT in teaching mathematics using a selected set of online services does not have any advantages – the differences between the developed selection and the standard use of ICT tools are declared equal to zero. In the second, alternative hypothesis (H1), an assumption is made about the advantages of training

future primary school teachers for the use of ICT in teaching mathematics using the developed set of services.

At the stage of the ascertainment experiment for the selection of the experimental and control groups, an entrance test was conducted, which made it possible to determine the state of success in the use of ICT in the process of teaching mathematics to primary school children. For this purpose, testing of third and fourth year students of three universities – Ushynsky University, Izmail University and Vasyl Stefanyk Precarpathian National University, total of 70 subjects was conducted. The questions of the test related to the students' awareness of various online platforms and services and the skills of working in them. Each correct answer was valued at 1 point. For each student, the test performance coefficient was calculated – the ratio of the number of points scored by the student to the maximum number of points under the conditions of correct completion of all test tasks. Next, the average coefficient of performance of the test for each university was calculated. So, as a result of the analysis of the entrance test at the ascertainment stage of the research, it was found that students of Ushynsky, Izmail and Precarpathian universities have approximately the same level of competence in the field of ICT (Table 1).

Table 1. Results of entrance testing of students

Levels of ownership of ICT tools	Low		Average		Sufficient		High	
	Number of students	%	Number of students	%	Number of students	%	Number of students	%
Ushynsky University	2	8.3	9	37.5	10	41.7	3	12.5
Izmail University	1	6.25	6	37.5	7	43.75	2	12.5
Precarpathian University	3	10	12	40	12	40	3	10

Source: Own work.

The study participants were conditionally divided into experimental (40 students of Izmail and Ushynsky universities) and control groups (30 students of Precarpathian University). Experimental training was conducted for 5 months in the II semester of the 2021/2022 academic year. EG students mastered the selection developed while studying at the Ushynsky University a separate module "Using information technologies in teaching problem solving" as part of the chosen discipline "Methodology of teaching problem solving", at Izmail University – "ICT in teaching mathematics of primary school children" within the scope of teaching the normative discipline "Methodology of teaching mathematics in primary school". CG students considered the use of ICT in teaching mathematics to primary school children from time to time, completing tasks in separate online services, without studying the developed complex.

2.2. Research progress

At the formative stage of the research, the following tasks were solved in the process of working with EG students:

1. exploration of the possibilities of online services for the organisation of online and offline training.
2. demonstration of the system of organising primary school mathematics lessons with a possible combination of online services, including in a distance learning setting;
3. implementation of individual creative projects: creation of tasks for a remote mathematics lesson in accordance with its structure and the possibility of combining online services; analysis of the quality of interactive student exercises created in specific services, the levels of interactive content development and the correctness of their combination;
4. determination of the level of formation of students' knowledge of the possibilities of online services and the ability to combine them;
5. analysis of the results of the student survey of the module students regarding their motivation to use the developed selected set of online services and regarding the reflection of the acquired competences for further work.

In lectures, students received general theoretical information about using services. In the seminar and laboratory classes, students mastered practical material aimed at highlighting the features of creating educational content with the use of various templates of individual services; they considered the templates to be used at each stage of the mathematics lesson and the algorithm for creating tasks in each of them; they received methodological recommendations on the specifics of using the created content in mathematics teaching; they became acquainted with teachers' experiences of using a separate service.

After a detailed introduction to the features of using the services, the students were shown a system for organising primary school mathematics lessons with a possible combination of services. By mastering the developed system, the students gained knowledge of the technical and methodological features of combining services in accordance with the structure of the combined mathematics lesson and acquired practical skills.

For the organisation of the first stage of the lesson – motivation of the educational and cognitive activity of primary school children, students learned how to create an educational video using MS PowerPoint, Renderforest and Canva services. They were given algorithms of several ways to create an educational video using the studied services: 1) create a presentation in MS PowerPoint with subsequent conversion in video format with audio background; 2) create a presentation in the Canva online service. Moreover, it can be downloaded in various formats, in particular in MP4 video format. When downloading a presentation in video format, it is possible to select only individual slides that will be presented in the video. It is convenient if the teacher uses the presentation not only of a separate stage of the lesson, but of the entire lesson. 3) create a 3-minute educational video using images and audio background for each animated scene in the Renderforest online service.

For real-time online lessons using Zoom, Google Meet, and other services, the prepared presentation and video can also be used at this stage of the lesson, voiced directly, and provide "live" communication with students. And when teaching at a distance, the created videos can be placed in virtual classrooms / virtual whiteboard.
Traditionally, the second stage of a mathematics lesson includes various types of learning activities for students, one of which is the "Geometric Minute". To organise it, students created interactive exercises on LearningApps and Wizer.me. These services allow the use of images with pre-prepared geometric shapes. In the LearningApps and Wizer.me services, such exercises can be created using the "Quiz" templates, choosing the correct answer from the ones proposed, and "Match the pair", combining elements according to a certain feature. Note that in the LearningApps service, this template allows you to create pairs of elements of different formats, and in Wizer.me, creating pairs involves connecting their elements using a curved line. The only difference between such exercises in these services is that in LearningApps all elements are arranged randomly, while in Wizer.me all elements are divided into two groups and it is impossible to connect elements of one group. Also, when creating such an exercise, a setting must be used so that correctly formed pairs do not automatically disappear, and the number of elements for selecting a pair does not decrease.
In a traditional education setting, the teacher can offer the students to scan the QR code of an interactive task with the help of a gadget, or go to its link and do the exercise. Students receive immediate feedback – they get to know the results of their own work. In the case of distance learning, links to tasks of this type will be posted by the teacher in a virtual environment in which the entire class works. In a real-time online lesson, the student needs another digital device to complete the interactive tasks. This is due to the inconvenience of opening a new browser tab to do the exercise.
Also, at the second stage of a mathematics lesson, students are offered oral numeracy exercises. Oral arithmetic exercises were created by EG students in the LearningApps, H5P, Liveworksheets and Wizer.me services. To create interactive exercises for oral counting, we recommend using the "Omissions" template, which involves typing in answers. In these services, the templates for entering the answer have corresponding names: LearningApps – "Cloze text", Liveworksheets – "Textboxes", Wizer.me – "Blanks", H5P – "Fill in the Blanks" and "Flashcards". Note that the exercises created with the help of such templates have certain variations: the student fills in the blank by typing in the answer, or chooses the correct option from the drop-down list. The exception is the tasks created using the Textboxes template in the Liveworksheets service, which only requires writing the correct text answer without a choice. If in the LearningApps, H5P services the teacher must independently type in tasks for oral numeracy, then in the Liveworksheets and Wizer.me services you can use photos or screenshots of fragments of pages of textbooks or textbooks, where oral numeracy tasks are given. Note that a slightly different presentation of the task for filling in the blanks – in the form of a card with a picture, under which the answer should be written in the text field, can be presented in LearningApps services using the "Freetext input" template and in H5P using "Flashcards".

Oral numeracy tasks can also be created in all of the above services using the "Quiz" template. This template allows you to submit tasks for oral counting in the form of images – excerpts of textbooks or study books. The "Quiz" template in each service has its own name, in particular: LearningApps – "Matching Pairs of Images", Liveworksheets – "Multiple-Choice exercise", Wizer.me – "Fill in an Images", H5P – "Find the Hotpot or Multiple Choice ".

Obviously, it is advisable to use interactive tasks for oral numeracy both in the conditions of traditional education and during distance education.

Also, one of the types of learning activity at the second stage of the lesson is the students' performance of mathematical dictation. EG students learned to create interactive mathematical dictations using PowerPoint, Renderforest, and Canva. The created materials were then uploaded to the Padlet virtual whiteboard, or to a virtual classroom.

It is no less appropriate to use interactive exercises for mathematical dictations, the condition of which is presented in the form of video or audio: LearningApps – "Freetext input" template, Wizer.me – "Fill in an image", H5P – "interactive video". In our opinion, the most interesting form of submitting mathematical dictation is an interactive video in the H5P service – a video with stops for performing interactive exercises. An interactive video is created on the basis of a previously prepared video (PowerPoint, Renderforest, Canva) and contains interactive tasks. The student watches the video and performs the exercises independently. The student can perform interactive exercises sequentially or in random order; the service can either enable the student to complete the next task without answering the previous one, or require the sequential execution of all tasks, depending on the teacher's settings. Note that the possibility of creating an interactive video is provided only in the paid version of the H5P service.

EG students learned to use the ClassDojo service to organise an oral survey), in which the teacher can create a task with a video-answer format. During the performance of such a task, the pupil's device camera is instantly turned on and video recording begins. A similar task can be created on the Padlet virtual whiteboard, specifying in the task description that there should be a video or audio response. Giving permission to students – participants of the virtual board, to create their posts, the student clicks on the "Create a post" mark and chooses an audio or video format. So, instantly on the same device, the microphone and/or camera is turned on and the recording starts. It is also possible to record audio answers to tasks in the H5P service.

Another form of work at this stage of the lesson is an individual survey, which can be organised with the help of interactive exercises, created in the services, which contain templates for choosing the correct answer from a drop-down list and dragging and dropping (LearningApps, Liveworksheets, Wizer.me, H5P).

EG students learned to organise the stage of formation of new knowledge and methods of action in two formats: 1) execution of an interactive video in the H5P service; 2) performing tasks under the guidance of the teacher, created with the help of services, LearningApps, Liveworksheets, Wizer.me, Classtime, H5P. It should be noted that the use of online services at this stage of the lesson is somewhat limited, as it requires feedback from students, which to some extent only interactive video can

provide. At the same time, recently more and more researchers, developing mobile applications for learning mathematics, create short educational videos to explain new material, and the knowledge gained after watching the video is consolidated during the game.

EG students gained experience in organising the next stage of the mathematics lesson – consolidation and formation of abilities and skills by creating interactive exercises. Such tasks can involve step-by-step commentary and are performed under the guidance of the teacher (H5P, Canva services), or offered as independent work by students (LearningApps, Liveworksheets, Wizer.me, Classtime, H5P).

To implement the reflection and summary of the lesson, EG students created videos using MS PowerPoint, Canva, Renderforest, and Padlet services. The created video was then placed in a virtual classroom or on a virtual Padlet board, where students watch it and give audio or video responses. At the same time, students can give audio and video responses, continuing the specified statements, which are presented in text format either on the Padlet virtual board or on the ClassDojo service bulletin board.

Thus, in the process of experimental training, EG students explored the possibilities of using online services at different stages of the primary school mathematics lesson. They have gained experience in delivering a remote mathematics lesson in Google Classroom / ClassDojo or on Padlet / Lino.it virtual board. It should be noted that the acquired knowledge regarding the organisation of distance and mixed learning using a selected set of online services was applied by EG students during the simulation of future professional activities in practical classes.

Meanwhile, practice shows that over the past two years, teachers mostly use distance learning in real time, conducting online lessons. Google Meet, Zoom, MS Teams, Skype are the most common services for conducting an online mathematics lesson. These lessons also involve the performance of interactive exercises that can be placed in the above-mentioned services, and therefore the option of reverse communication with the teacher can be the same.

As a result of mastering the specified module, EG students completed creative projects – creating tasks with the help of online services in accordance with the structure of the combined mathematics lesson in elementary school. While completing the task, students demonstrated awareness of using online services and templates for creating interactive exercises of these services, understanding the features of selecting appropriate service templates for the implementation of a certain task; the possibility of combining online services when organising a distance lesson, compensating the disadvantages of certain services with the advantages of others. It should be noted that CG students also performed projects that involved creating interactive exercises in mathematics, but without special training in the use of the specified set of online services.

2.3. Research results

The creative projects created by students were evaluated according to the following criteria: content-related, practical, methodological, technical, aesthetic, and systemic. According to these criteria, the students' levels of mastery of the ability to apply the

developed complex in the educational process were determined: low, average, sufficient and high (Figure 1).

Only 10% of CG students demonstrated a low level of mastery of the ability to use online services to implement the stages of the mathematics lesson. An average level was demonstrated by 25% of EG students and 50% of CG students. 60% of EG students and 40% of CG students achieved a sufficient level. Only 15% of EG students achieved a high level.

At the end of the experiment, we find that χ^2 emp = 18.67. Given that $\chi^2 0.05 = 7.815$ for this case as well, we get $\chi 2emp > \chi 20.05$. In summary, the characteristics of the compared samples in EG and CG after the experiment differ with 95% confidence. Therefore, the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted.

The analysis of the conducted research therefore leads to the conclusion that the developed and theoretically justified selected set of online services, which formed the basis of the experimental training, produces higher results than during traditional training.

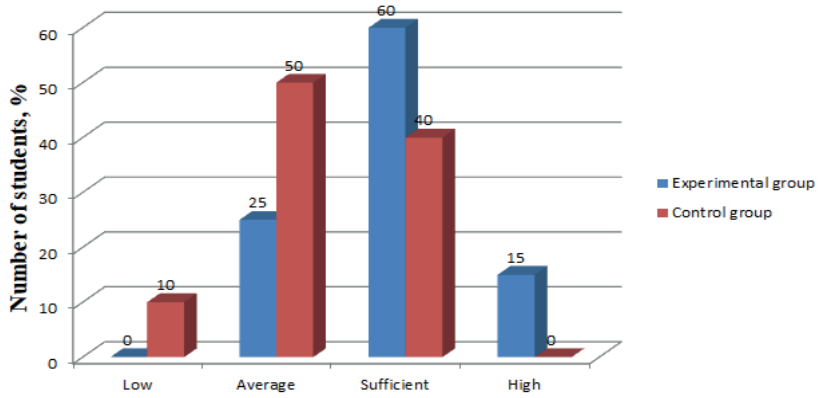


Figure 1. Results of evaluation of individual projects of EG and CG students

Source: Own work.

CONCLUSION

We investigated a selected set of web services for the organisation of online and offline mathematics education for primary school children, which includes such popular services as LearningApps, Classtime, Liveworksheets. Wizer.me, H5P, Google Classroom, ClassDojo, Padlet, Lino.it, MS PowerPoint, Renderforest and Canva. It was found that in traditional and distance learning settings, the main form of mathematics teaching is a lesson. In primary school, the predominant form is the combined-type mathematics lessons, in which several learning objectives are solved and various methods of teaching organisation are used. According to the structure of the combined lesson and based on the types of work at the different stages of the combined mathematics lesson, we selected a set of online services to help the teacher organise students' work in the lesson.

To organise the motivation of the students' learning activities, we propose the use of an educational video, which can be created using MS PowerPoint, Renderforest, and Canva.

At the stage of updating the basic knowledge and methods of the activity, we recommend using such services as LearningApps, Liveworksheets, Wizer.me, H5P, Renderforest, ClassDojo, Padlet.

For the third stage of the lesson, in a distance learning setting, we propose the creation of an interactive video (H5P), and while learning online or offline, along with the communication with the teacher, the completion of tasks under the teacher's guidance. The consolidation and formation of skills and abilities, in an online or offline learning environment, can be achieved through teacher-guided tasks (H5P, Canva) and self-directed interactive exercises (LearningApps, Liveworksheets, Wizer.me, Classtime, H5P).

In distance or online learning settings, the reflection of the learning and cognitive activity is realised in audio/video recording (Padlet, Renderforest, Canva, H5P) or in text format (Padlet, ClassDojo).

The second stage of the research involved the introduction of the results of the work into the system of training future teachers of the "Primary Education" specialty – at the Ushynsky and Izmail universities. Students were shown a system for organising primary school mathematics lessons with a possible combination of online services, including distance learning.

The results of the experimental training testify to the effectiveness of the introduction of the developed selected set of online services in the process of training future teachers with a view to applying the acquired skills and abilities in further professional activities in teaching mathematics to primary school children. The training of future primary school teachers using the developed set of online services proved to be more effective, compared to the traditional one.

Further research may involve expanding the range of online services for creating educational content in mathematics, including a complex of research environments, in particular Phet.

REFERENCES

Aleksieva, L. (2021). Electronic resources for online mathematics primary education – specifics, types, quality. *Mathematics and informatics, 64*(1), 62–83. https://doi.org/10.53656/math2021-1-5-ele.

Basogain Urrutia, J.X. (2021). The management of e-learning platforms and online assessment in primary education through the prism of school engagement and school culture. In E. Smyrnova-Trybulska (Ed.). *E-Learning in the Time of COVID-19*. "E-Learning" 13 (pp. 89–99). https://doi.org/10.34916/el.2021.13.08.

Borysenko, I., Bykonia, O., Rembach, O., Shumna, L., Oliinyk, O., & Anishchenko, V. (2020). Experience of ICT implementation in primary curriculum in Ukraine and the United Kingdom of Great Britain and Northern Ireland. *Information technologies and learning tools*, *75(*1), 42–55. ISSN 2076-8184.

Dukic, D., Petrinsak, S., & Pinjusic, P. (2020). ICT in the Primary school: Practise and Attitudes of Informatics Teachers. *Tehnicki Glasnik-Technical Journal, 14*(3), 257–264. https://doi.org/10.31803/tg-20200403052511.

Dziabenko, O. & Budnyk, O. (2019). Go-lab ecosystem: using online laboratories in a primary school. In L.G. Chova, A.L. Martinez, I.C. Torres (Eds.). *EDULEARN19 Proceedings* (pp. 9276–9285). Spain: IATED Academy. https://doi.org/10.21125/edulearn.2019.

Haitan, O. (2022). Comparative analysis of possibilities of using the toolkit of webinar-based platforms Zoom, Google Meet and MS Teams in online-learning. *Information Technologies and Learning Tools, 87*(1), 33–67. https://doi.org/10.33407/itlt.v87i1.4441.

Skvortsova, S. & Britskan, T. (2021). Distance mathematics lessons in primary school: services for creating interactive exercises. In E. Smyrnova-Trybulska (Ed.). *E-Learning in the Time of COVID-19*. "E-Learning" 13 (pp. 225–237). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2021.13.19.

Skvortsova, S. & Onopriienko, O. (2019). *Nova ukrainska shkola: metodyka navchannia matematyky u 1–2 klasakh zakladiv zahalnoi serednoi osvity na zasadakh intehratyvnoho i kompetentnisnoho pidkhodiv*. Kharkiv: Ranok. ISBN 978-617-09-6042-9.

Skvortsova, S. & Britskan, T. (2018). Training for future primary school teachers in using service learning apps teaching mathematics. *International Journal of Research in E-learning, 4*(1), 59–77. https://doi.org/10.31261/IJREL.2018.4.1.05.

Skvortsova, S. & Britskan, T. (2019). Training for primary school teachers in using service Plickers teaching mathematics. *Mathematics, information technologies and applied science (post-conference proceedings of extended versions of selected papers),* June 20–21, 2019. Brno, 74–87. ISBN 978-80-7582-123-2.

Skvortsova, S., Britskan, T., & Haievets, Y. (2020). E-course "Internet resources for creating mathematical learning and game content for primary school children". In E. Smyrnova-Trybulska (Ed.). *E-learning. Innovative Educational Technologies, Tools and Methods for E-learning.* "E-learning" 12 (pp. 65–76). Katowice–Cieszyn: STUDIO NOA for University of Silesia. https://doi.org/10.34916/el.2020.12.06.

Skvortsova, S., Britskan, T., Symonenko, T., & Haievets, Y. (2022). Interactive tools for creating educational content for primary school students. In L.G. Chova, A.L. Martinez, I.C. Torres (Eds.). *INTED2022 Proceedings* (pp. 9005–9014). Spain: IATED Academy. https://doi.org/10.21125/inted.2022.

Skvortsova, S., Onopriienko, O., & Britskan, T. (2019). Training for future primary school teachers in using service H5P teaching mathematics. In E. Smyrnova-Trybulska (Ed.). *E-learning and STEM Education*. "E-learning" 11 (pp. 277–294). Katowice–Cieszyn: STUDIO NOA for University of Silesia, https://doi.org/10.34916/el.2019.11.18.

Tuparova, D. & Kaseva, M. (2016). Information technologies in primary school-state and perspectives. *PEDAGOGIKA-PEDAGOGY*, *88*(3), 320–337.

Vanderlinde, R., Aesaert, K., & van Braak, J. (2015). Measuring ICT and contributing conditions in primary schools. *British Journal of Educational Technology, 46*(5), 1056–1063. https://doi.org/10.1111/bjet.12282.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 242–256
https://doi.org/10.34916/el.2022.14.18

PREPARATION OF FUTURE HUMANITIES TEACHERS FOR THE USE OF STEM TECHNOLOGIES IN PROFESSIONAL ACTIVITIES

Halyna Henseruk[1], **Bogdan Buyak**[2], **Mariya Boyko**[3], **Serhii Martyniuk**[4], **& Yuliia Henseruk**[5]
Ternopil Volodymyr Hnatiuk National Pedagogical University
2 Maxyma Kryvonosa str, Ternopil, Ukraine
[1] genseruk@tnpu.edu.ua, ORCID 0000-0002-5156-7280
[2] Buyak.Bogdan@tnpu.edu.ua, ORCID 0000-0003-1496-7573
[3] maryboyko@tnpu.edu.ua, ORCID 0000-0002-3864-1044
[4] sergmart65@tnpu.edu.ua, ORCID 0000-0002-5611-3317
[5] julia.genseruk@tnpu.edu.ua, ORCID 0000-0002-3573-8975

Abstract: *The study analyses the modern views on STEM education and features of the introduction of project activities as one of its directions in the educational process. The influence of the use of STEM technologies on students' motivation is studied; the necessity of preparing students for the implementation of STEM technologies in future professional activities is demonstrated, the results of a survey conducted among future humanities teachers on the mastering of STEM technologies are presented. It was found that STEM education involves the integration of knowledge from different fields, so STEM education can be used in project activities. STEM education allows students to be involved in conscious activities, thus ensuring the success of future adults in the world of digital technology, which is constantly improving. The necessity of including the content module "STEM technologies in foreign languages" in the course "Modern information technologies in the educational process" is substantiated. The tested methodology of training future humanities teachers to use STEM technologies in professional activities is described. It includes independent research of students using STEM technologies and their own creative STEM projects. An example of a STEM project created by students has been given.*

Keywords: STEM education; digital competence; digital technologies; STEM project; teacher.

INTRODUCTION

At the present stage of education development, STEM education is a progressive direction. STEM education allows to develop the personality of pupils and students, their intelligence, research abilities, creative thinking based on scientific methods, mathematical modelling, engineering design. The basis of STEM education is the integration of knowledge from different fields, which allows future professionals to be successful in different fields. Almost all experts note that advanced technologies increase motivation to learn and expand basic knowledge in a particular field.

STEAM education differs from the traditional educational process model. The whole process is centred around the problem, phenomenon or situation, which is being investigated, not around the teacher. The teacher acts as a mentor who helps to find a solution. The main goal of the STEAM approach is to overcome the detachment from solving practical problems. The STEAM approach provides a guide for project activities and a practical orientation, creates conditions for the development and improvement of analytical and creative abilities of an individual, gives an opportunity to try oneself in teamwork, develops independence in acquiring new knowledge. An important concept related to STEM education is interdisciplinarity, which is considered in education as a pedagogical innovation (Morze et al., 2018).

STEM education is traditionally associated with robotics, design, computer modelling and other areas related to engineering rather than the humanities. However, the potential of STEM education as a means of developing the speech competence huge. This is a joint scientific and technical creativity, in the process of which it is necessary to agree, communicate, formulate new ideas; protection of creative projects and research works.

In the period of digital transformation of education, the following main challenges of STEM education can be identified: the need to use innovative STEM methods and STEAM pedagogical approach; the training of specialists in STEM education; the development of methodology of professional self-development of teachers regarding the introduction of STEM technologies.

The main problem in the implementation of STEM education in the educational process is the lack of professional STEM teachers. Of particular interest is the application of the STEM education model in the training of future teachers. Educational programmes for the preparation of future teachers should include courses and modules on STEM studies.

The development and implementation of the methodology for training future teachers for the use of STEM technologies in professional activities will positively affect the quality of the organization of education in the period of digital transformation of education, will contribute to the development of personalised, adaptive and project-based learning, critical thinking and problem-solving skills. Based on our methodology, future teachers will be able to plan, develop, implement and popularize educational STEM projects.

Methods

The study was conducted using the methods of theoretical and empirical research: analysis and synthesis of scientific literature on the research problem to clarify the basic concepts and categories of STEM education; conceptual and comparative analysis of traditional and STEM oriented approaches, curricula and educational programmes, innovative pedagogical experience; identification of patterns and formulation of conclusions on the problem under study; survey of humanities students; analysis of research results.

1. BACKGROUND RESEARCH

The concept of "STEM education" appeared in the United States in 2009 in the programme "Educate to Innovate" (Department, 2009). Official documents from the US Department of Education outline that STEM is an education for global leadership that is designed to shape the critical thinking, research, and engagement with the world that is needed on the way of changes.

STEM education improves divergent and critical thinking, develops students' metacognitive skills, using project-based learning (McAuliffe, 2016; Mutakinati et al., 2018). Schmidt & Fulton show that although aspects of the STEM world can be implemented in existing curricula, the implementation and testing of these innovations requires significant efforts to meet the needs of educational institutions and their full successful implementation (Schmidt, 2019). C. Kim and other authors describe a research project aimed at helping teachers learn to develop and conduct lessons using STEM technologies (Kim, 2019).

According to the Concept of STEM-education, high-quality professional training of future specialists requires the development of educational programmes of educational institutions taking into account the latest pedagogical methods of STEM education, the application of modern network forms of educational communication, the establishing of the interdisciplinary connections, organization of educational process as pedagogical interaction, aimed at personal development, their readiness for solving life problems of varying complexity (Concept of STEM education, 2020). The structure of STEM education in Ukraine is determined by the State standard of general secondary, out-of-school, preschool, higher education and specialized standards of STEM education. Among the main sections in the implementation of STEM education in Ukraine are: higher/professional – training of specialists in various STEM professions on the basis of higher education institutions; and pedagogical – training of teachers to teach STEM educational courses, to implementation, to realization of STEM projects; formation of STEM competences.

According to Strizhak et al., the development of STEM education requires new research, didactic developments, trained, literate and managed professionals who could significantly influence this process. Therefore, it is important to implement initiatives for the training of STEM teachers (Strizhak et al., 2017). Balyk, Barna, Shmyger, & Oleksiuk developed a model of STEM competences for teacher professional training and lifelong learning, which includes four components: problem solving, working

with people, working with technology, and working with an organizational system (Balyk et al., 2018). Andrievska explores a multidisciplinary approach to the study of natural and mathematical disciplines. She considers the project method as the most promising means of implementing STEAM education in the modern primary school (Andrievska, 2017). Possibilities of using elements of STEM education in teaching physics are considered in the research of Atamanchuk & Forkun (Atamanchuk & Forkun, 2019).

The use of certain aspects of IBL is important in STEM education. The authors analyse the advantages and some aspects of STEM education and trends in modern professions with examples (Morze, Smyrnova-Trybulska, & Gladun, 2018).

Morze, Gladun and Dzyuba have analysed modern views on STEM education and features of the implementation of robotics as one of its branches in the educational process, its impact on student motivation (Morze et al., 2018). The authors have demonstrated the need to prepare students for the skills of the twenty-first century through the implementation of STEM education, starting from primary school and have investigated the problem of preparing teachers to conduct classes using robots, integrating them into subjects and selection of robotic designers.

Young people and students should be prepared in the fields of STEM education for successful functioning in digital society as well as for careers in contemporary and future professions which require adequate competences (Basogain, et al., 2020).

The need to prepare students for 21st century skills through STEM education is strong, especially at the elementary level. A modern form of interdisciplinary education for children and youth is projects and master classes, in particular, using kits for designing and programming robots (Smyrnova-Trybulska et al., 2017).

The results of a survey of teachers in Poland and Ukraine show that more than 50% of respondents understand the important role of STEM education and the need to introduce STEM technologies into the educational process.

91 primary school teachers and future teachers of the Silesian Voivodeship and the Silesian University of Poland and Ukraine and the Borys Grinchenko University of Kyiv took part in the study (Smyrnova-Trybulska et al., 2016).

The analysis of research allows us to conclude that there is a lack of scientific works that would reflect the peculiarities of the training of future teachers of the humanities to the use of STEM technologies in professional activities.

2. STEM EDUCATION: THEORETICAL BACKGROUND

Theoretical analysis of sources on STEM education has identified three key features of STEM education that distinguish it from the traditional education system:

- increasing the time and opportunities for independent preparation, the ability to identify problems and find ways to solve them in an autonomous independent manner through active purposeful and conscious activities;
- the opportunity to share one's analytical, creative findings and mistakes with other team members through participation in teamwork;
- mutual support and mutual assistance in solving educational tasks.

One of the key differences between STEM education and traditional learning is the development of learning skills as opposed to learning the material. Independent work, the ability to produce new ideas, teamwork, solving cognitive tasks are also important and necessary. STEM education creates a guarantee of successful further study and development of many areas in professional activities.

A key feature of STEM education, which has already been mentioned, but which should be emphasized, is the interaction during teamwork. Teamwork is especially relevant during the activities in the mode of creation, implementation and protection of projects. Thanks to project activities, the opportunity to activate the creative, emotional and creative component of your personality is realized. Modern education on a global scale is aimed at attracting STEM education in the direction of traditional education. This is due to the fact that STEM education allows you to include the individual in a conscious intense activity, thus ensuring success in the world of information technology, which is constantly improving. All this is possible due to the interdisciplinary applied nature of STEM education. Thus, STEM education is one of the brightest innovations of the 21st century, and it combines elements of innovation pedagogy, art pedagogy, modern pedagogical technologies. The effectiveness of this approach is associated with the practical implementation of the synergy of different fields of knowledge in the process of educating young people.

The main goal of STEM education is to educate a person who is able to independently study large amounts of information, use new technologies and be creative in finding solutions. In this way, the teachers can use the classic formats of work listed above, and can create and come up with their own. Feedback is especially important when introducing STEM education methods into the learning process.

The process of learning a foreign language involves the formation of speech competencies. Therefore, the use of STEM education methods in foreign language classes is very important. This can be the use of language learning applications, such as Quizlet, as well as creating projects and presentations.

STEM education involves the use of digital technologies in the process of learning foreign languages. The advantages of their use are: receiving a large amount of authentic information; influence on all channels of perception due to the use of multimedia technologies (text, graphics, sound, animation, video); game activity.

STEM education is an integral part of the concept of the New Ukrainian School (Ghrynevych, 2016). In the process of research, we have identified the competences of NUS, which have much in common with the goals of STEM:

- development of logical and mathematical thinking;
- understanding of nature and technology from the standpoint of exact sciences;
- ability to use information and communication technologies; ability to think creatively and form one's own opinion.

Combining different sciences and views on reality, STEM education prepares students for life in a rapidly evolving world; easily and quickly adapt to new technologies and trends.

STEM education allows teachers to clearly transfer knowledge and skills, promote student independence, use extraordinary approaches to learning, to form more motivated and interested students. STEM principles can also be implemented in humani-

ties lessons, as STEM tools will diversify the learning process and make the process of acquiring knowledge clearer.

3. RESEARCH

It is important to prepare future teachers in higher education institutions for the introduction of STEM technologies in professional activities.

STEM technologies are STEM education technologies that diversify the activities of the teacher and involve initiating and motivating students for integrated, personally oriented, problem-based, creative and reflective educational activities.

When designing the content and technologies for the implementation of disciplines of the module aimed at the development of STEM technologies, we have identified the main competences that need to be formed in teachers in the process of studying the proposed module:

- ability to acquire new knowledge using modern educational and information technologies;
- ability to independently formulate goals, set specific objectives for research in basic and applied fields of science and solve them using modern research methods using the latest domestic and foreign experience and using digital technologies;
- ability to implement an interdisciplinary approach and implementation of innovative educational technologies; ability to master new theories, models, research methods, skills of developing new methodological approaches taking into account the goals and objectives of the study.

These requirements for the competences of teachers in the field of STEM should be formed during their professional training in higher education, continuing professional development and training.

Preparation of future teachers for the introduction of STEM technologies in professional activities in the context of the development of their digital competence is one of the tasks during the design of digital educational environment of Ternopil Volodymyr Hnatiuk National Pedagogical University (Henseruk, 2020). To implement this task, a strategy for the development of digital competence of future teachers has been developed.

In the context of the purpose of the study, it is important to prepare future humanities teachers for the implementation of STEM technologies in professional activities. Content on the development of digital competence of future specialists of the educational programme "Secondary education. English language" training of the first level of education is built on a structural and logical scheme: Modern information technologies in the educational process → Computer practice → Vocational subjects → Vocational subjects teaching methods → Teaching internship → Course/Bachelor's Project → Elective disciplines in digital literacy.

In this regard, in our opinion, integrated learning is important, which presupposes the readiness of future teachers of the humanities to solve problems related to innovative practical professional activities.

At the first stage of the research, we conducted a survey of students on their understanding and opportunities for the implementation of STEM technologies in professional activities. The survey involved 96 first-year students of the Faculty of Foreign Languages of Ternopil Volodymyr Hnatiuk National Pedagogical University. The questionnaire consisted of 10 questions. The questions involved determining the students' motivation to work with the use of STEM technologies and the level of mastery of STEM technologies. According to the results of testing, 74.8 per cent of students have a low level and 11.7 per cent of students have an average level of motivation to work with the use of STEM technologies. The reason for the low motivation in most of the students' answers was non-acquaintance in the field of STEM technologies. Based on the analysis of questionnaires, we found low and average levels of mastery of STEM technologies.

4. CONTENT MODULE "STEM TECHNOLOGIES IN FOREIGN LANGUAGES"

The next stage of the study was the development of methods for training future teachers to use STEM technologies in professional activities. During the review of the educational program at the meeting of the program council and the quality commission of the Faculty of Foreign Languages, teachers of the course "Modern Information Technologies in Education" were asked to include a content module "STEM technologies in foreign languages" in the curriculum. Based on the analysis of disciplines of this educational program, professionally-oriented disciplines have been singled out, in the process of which STEM technologies will be introduced in cooperation with teachers of the course "Modern information technologies in the educational process". Among the main ones are the following: "Methods of teaching foreign languages", "Practical course of a foreign language", "Lexicology", "Practical grammar and phonetics".

In our study we will dwell in more detail on the rationale for the proven method of training future teachers of the humanities to use STEM technologies in professional activities.

The main tasks of the content module "STEM technologies in the studying of foreign languages" are:

- acquaintance with the peculiarities of the development of STEM education in Ukraine;
- study and generalization of domestic and foreign experience in the field of STEM education;
- study and generalization of domestic and foreign experience in the field of STEM education;
- organization of practical activities of students on the basis of synthesis of artistic and technical creativity;
- implementation of research projects.

In the structure of the educational programme, the module provides general professional training of students. The study is focused on the formation of a system of general pedagogical and special knowledge, which is the basis for the development of

professional competences and the acquisition in the practical training of experience in using STEM technologies in professional activities by future teachers.
When mastering STEM technologies, critical thinking skills and interest in technical disciplines are developed.
Skills of the 21st century is a special area that is now being actively discussed at various levels. Reading, writing, and arithmetic were key skills that determined literacy in the industrial age. In the 21st century, the emphasis is shifted towards the ability to think critically, to interact and communicate, and a creative approach to solving problems. We have combined the basic skills of the future in 4C (Figure 1).
Applying STEM technologies in the educational process, the teacher prepares children for technological innovations of life, teaches them to find creative and innovative approaches in solving various problematic situations.
Project learning is important in the implementation of STEM technologies in the educational process. Its advantages are close connection with the real world, the existence of the problem, a high share of motivation and encouragement to cooperate. The project method forms universal educational skills, gives the chance of independent successful mastering of knowledge, teaches to select, classify, generalize material; to improve public speaking, to see the result of their activities.

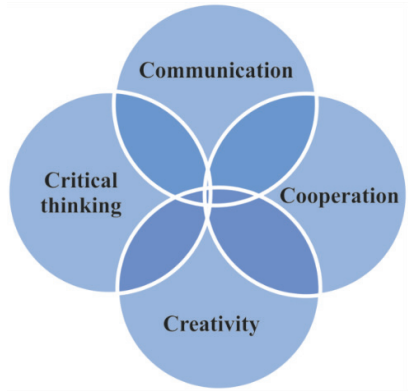


Figure 1. Basic skills 4C
Source: Own work.

Formulation of problematic issues of the educational topic requires work with different sources of information, allows you to express your own opinion with the justification of your own position. All this contributes to the enrichment of the vocabulary and grammar of the language, the development of creative abilities necessary for the modern personality.

4.1. Organisation and content of computer practice

The study of the content module "STEM technologies in foreign languages" took place during a computer practice conducted as part of the course "Modern information technology in the educational process." The curriculum devotes 30 hours of classroom work to computer practice.

The purpose of computer practice is to create STEM projects for learning foreign languages in the context of the development of digital competence of future humanities teachers. Teacher's digital competence is the teacher's mastery in applying digital technologies in their professional activities.

Digital competence includes five dimensions:

- Dimension 1. Information and ability to work with data.
- Dimension 2. Communication and cooperation.
- Dimension 3. Creating digital content.
- Dimension 4. Security. Protection of personal data and confidentiality.
- Dimension 5. Problem solving.

According to the curriculum, computer practice was held during the week (three classes a day), which contributed to the immersion of students in project activities. During the week, students worked in teams and performed both individual and group tasks.

The theme of the projects was the creation of STEM learning projects.

The tasks of computer practice involved forming certain dimensions of digital competence in the context of using STEM technologies, which were prescribed for each day.

As the training took place in a mixed form, we used the Zoom platform during our work. All possible features of the platform were used to organise project activities. During each lesson, group work took place in the Zoom virtual rooms.

The tasks were published in the course "Modern information technologies in the educational process", located in the e-learning system of TNPU. For each task, methodological recommendations and presentations on the use of a specific digital tool were published. Students uploaded all completed tasks to the shared folder on Google Drive (Figure 2):

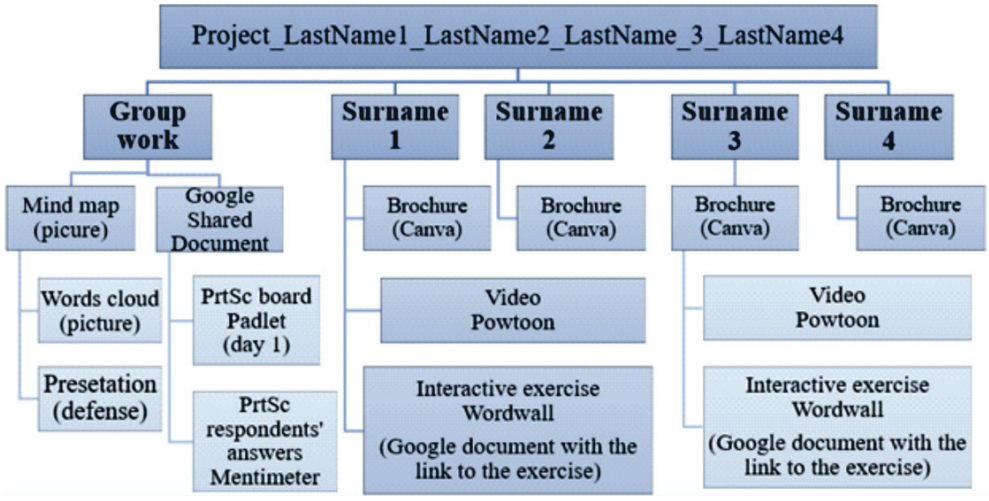


Figure 2. Structural components of the folder

Source: Own work.

Day 1. Choosing a project topic. Search for materials for the project
During the first day, the following dimensions of digital competence were formed in the context of the use of STEM technologies:
Dimension 1. Information and ability to work with data Dimension 2. Communication and cooperation
At the beginning of the project, students had to split into groups (of 4–5 students) and choose the topic of the project in the context of the use of STEM technologies. The next step was to discuss the topic of the project using the interactive whiteboard Padlet (group work). The students had to divide the project topic into four or five subtopics (depending on the number of students in the research group), which covered the whole project topic.
The task of the group work was to create a mind map of their project, which should contain the main topic and four subtopics. Students created a mind map using the digital tool https://www.mindomo.com or https://coggle.it/. Using https://wordart.com/, students created word clouds that represented their project (group work).
During all the following days, all five dimensions of digital competence were formed in the context of the use of STEM technologies.
Day 2–3. Creating digital content.
The tasks of the second day included creating a brochure using Canva (individual work). In the brochure, students had to reveal the essence of their individual research. The active development of digital technologies allows the use of STEM toys, STEM-games, gamified platforms with the aim to develop STEM competences (Wordwall, Mentimeter, Quizlet, LearningApps, Powtoon, Slido, Liveworksheets). The use of STEM games improves practical training. Game technologies make it possible to use the latest technologies; to experiment and solve problems; to immerse the participant in conditions close to real; get acquainted with the peculiarities of project activities, allow you to combine imagination with innovation and contribute to the formation of interest in the subject and further study of STEM technologies.
In this context, the students created an interactive exercise in the group on the topic of their research in the Wordwall resource. The interactive exercise reflected one of the areas of their research.
Interactive animated videos are an excellent tool for qualitative learning, especially in the context of STEM education. With the help of interactive videos, you can concisely and at the same time interestingly and meaningfully convey the key content of the programme material. One of the tasks for the digital content of the developed STEM project was to create an interactive video in the PowToon environment. In the video, students revealed the practical component of their part of the study.
Day 4. Promotion of the project.
Promotion of the project is important at the stage of its implementation. The task of the fourth day was to discuss in a group way to promote the STEM project (group work) using digital tools (Google documents, interactive whiteboards, mind maps).
The opinion of experts is also important for the successful implementation of the project. Experts on students' STEM projects were students of another group. In the context of this task, students created a questionnaire on the topic of their STEM project using the Mentimeter feedback resource.

Day 5. Project defence.
At the last stage of creating STEM projects there was a presentation of the research results (group work). Students presented their project using the created presentation (up to 10 minutes). In the presentation of the STEM project, it was necessary to reveal the practical component of their research (developed resources on the project topic, recommendations, project calculation, etc.). Students created the presentation using selected online resources for creating presentations: Google presentations, Canva, Prezi.

4.2. Project example

As an example of such a project, we will give as an example the STEM project developed by students for learning English "English language courses for children AKMA" (Figure 3).
Students selected digital tools that involve learning a foreign language in the form of games, developed appropriate methodological support using digital tools and project calculations for its implementation.
The implementation of this STEM project in the educational process of educational institutions involves the formation of "4C" skills, which we described above.

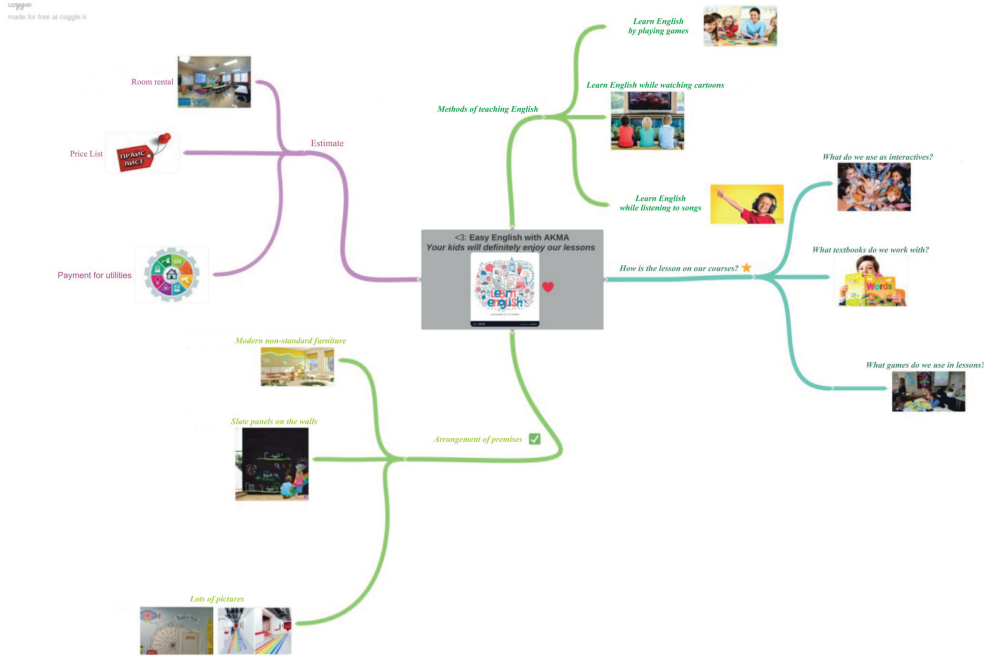


Figure 3. Project knowledge map

Source: Own work.

The proposed method of training future teachers for the use of STEM technologies in professional activities allows forming a specialist with a certain level of digital competence. They will acquire the following STEM learning skills: critical thinking

(A1), problem solving (A2), active communication (A3), collaboration (A4), creativity (A5), Internet safety (A6), innovative approaches to creating projects (A7), creating STEM digital content (A8).

5. SURVEY OF STUDENTS

According to these descriptors, a survey of students was conducted regarding the level of the above skills. The survey was conducted using Google questionnaires. Students could evaluate the formation of their own skills at four levels: low, medium, sufficient and high. According to the results of the survey, it is possible to establish the sufficient level of formation of all descriptors. The lowest score of the sufficient level is to the descriptor A8 (Figure 4).

According to the students, they know many such digital tools. However, it is not easy for them to create STEM digital content from the given problem, since this is the first year of their study under the educational programme and they have not learned the teaching methods of the subject yet.

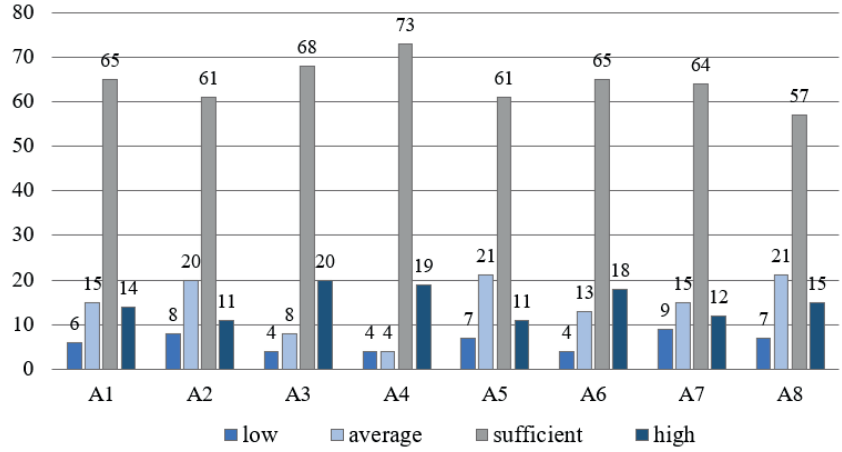


Figure 4. Assessment of the respondents' own STEM learning skills

Source: Own work.

After studying this module, we conducted a re-survey of the possibilities of implementing STEM technologies in professional activities.

Based on the analysis of the questionnaires, it can be stated that there is a significant percentage increase in the number of students who understand the possibilities of implementing STEM technologies in professional activities and have STEM technologies.

According to the survey results, 11.6 per cent of students have a high level and 49.1 per cent of students have a sufficient level of motivation to work with the use of STEM technologies. The survey shows a significant percentage increase in the sufficient and high levels (Figure 5).

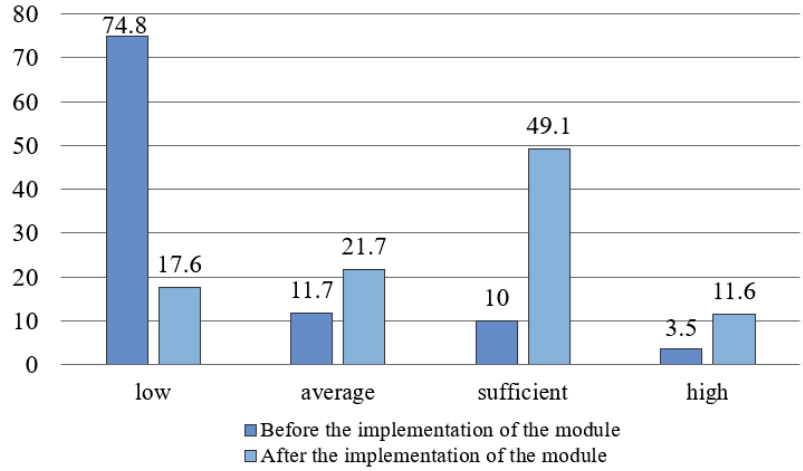


Figure 5. Survey results after the studied module

Source: Own work.

The main purpose of the content module "STEM technologies in foreign languages" was to conduct independent research of students using STEM technologies and their own creative STEM projects. Computer practice classes involved the growth of students' creative skills in the process of research and the creation of STEM-projects.

CONCLUSION

The design and organisation of the educational process based on the development of STEM technologies requires special training of future teachers, which will ensure the mastery of this technology at a high professional level. Therefore, the training module "STEM technologies in the study of foreign languages" should be a necessary component of the main educational programme for the training of future humanities teachers. Mastering STEM learning technologies at the bachelor's level students will create conditions for the diversification of their own pedagogical activity in the future and will allow them to carry out an interdisciplinary approach in work with pupils, and also to use the acquired competences for the organization of pupils' independent activity and development of their digital competence.

REFERENCES

Andrievska, V. (2017). Project as a method of realization of STEAM-education in the primary school. *Scientific Bulletin of Uzhhorod National University. Series: Pedagogy, 2*(41), 11–14 [In Ukrainian].

Atamanchuk, P. & Forkun, N. (2019). Implementation of elements of STEM education in the educational process. *Scientific notes Central Ukrainian State Pedagogical University named after Vol odymyr Vynnychenko. Ser.: Pedagogical sciences*, *179*, 15–24 [In Ukrainian].

Balyk, N., Barna, O., Shmyger, G., & Oleksiuk, V. (2018). Model of professional retraining of teachers based on the development of STEM competencies. ICT in Education, Research and Industrial Applications: Integration,Harmonization and Knowledge Transfer (Proc. 14th Int. Conf. ICTERI), 318–331 [In Ukrainian].

Basogain, X., Gurba, K., Hug, T., Morze, N., Noskova, T., & Smyrnova-Trybulska, E. (2020). STEM and STEAM in contemporary education: challenges, contemporary trends and transformation: a discussion paper. In Smyrnova-Trybulska (Ed.) *Innovative Educational Technologies, Tools and Methods for E-learning.* "E-learning" 12 (pp. 242–256). Katowice–Cieszyn: STUDIO NOA for University of Silesia. ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-19-3. http://doi.org/10.34916/el.2020.12.21.

Department of education.science, technology, engineering and math: Education for global leadership. Retrieved from https://www.ed.gov/stem (accessed 15 June 2022).

Ghrynevych, L., Eljkin, O., Kalashnikova, S., Kobernyk, I., & Kovtunecj, V. (2016). New Concept of the Ukrainian School. Retrieved from https://www.kmu.gov.ua/storage/app/media/reforms/ukrainska-shkola-compressed.pdf (accessed 8 June 2022) [In Ukrainian].

Henseruk, H., Buyak, B., Kravets, V., Tereshchuk, H., & Boiko, M. (2020). Digital transformation of the learning environment at university. In E. Smyrnova-Trybulska (Ed.). *Innovative Educational Technologies, Tools and Methods for E-learning.* "E-learning" 12 (pp. 238–243). Katowice–Cieszyn: STUDIO NOA for University of Silesia. ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-19-3. https://doi.org/10.34916/el.2020.12.28.

Kim, C., Kim, D., Yuan, J., Hill, R., Doshi, P., & Thai, C. (2015). Robotics to promote elementary education pre-service teachers' STEM engagement, learning, and teaching. *Computers & Education, 91*, 14–31. http://doi.org/10.1016/j.compedu.2015.08.005.

McAuliffe, M. (2016). The potential benefits of divergent thinking and metacognitive skills in STEAM learning: A discussion paper. *International Journal of Innovation, Creativity and Change*, *2*(3), 71–82.

Mutakinati, L., Anwari, I., & Kumano, Y. (2018). Analysis of students' critical thinking skill of middle school through stem education project-based learning. *Journal Pendidikan IPA Indonesia, 7*(1), 54–65. http://doi.org/10.15294/jpii.v7i1.10495.

Morze, N., Gladun, M., & Dziuba, S. (2018). Formation of key and subject competences of students by robotic kits of STEM-education. *Information Technologies and Learning Tool*s, *65*(3), 37–52. http://doi.org/https://doi.org/10.33407/itlt.v65i3.2041 [In Ukrainian].

Morze, N., Smyrnova-Trybulska, E., & Gladun, M. (2018). Selected aspects of IBL in STEM-education. In E. Smyrnova-Trybulska (Ed.). *E-learning and Smart Learning Environment for the Preparation of New Generation Specialists*. "E-Learning" 10 (pp. 361–381). Katowice–Cieszyn: STUDIO NOA for University of Silesia. ISSN 2451-3644 (print edition), ISSN 2451-3652 (digital edition), ISBN 978-83-66055-05-6.

Morze, N., Strutynska, O., & Umryk, M. (2018). Educational Robotics as a prospective trend in STEM-education development. *Open educational e-environment of modern University*, *5*, 178–187. http://doi.org/0.28925/2414-0325.2018.5.178187 [In Ukrainian].

Smyrnova-Trybulska, E., Morze, N., Kommers, P., Zuziak, W., & Gladun, M. (2017). Selected aspects and conditions of the use of robots in STEM education for young learners as viewed by teachers and students. *Interactive Technology and Smart Education*, *14*(4), 296–312. http://doi.org/10.1108/ITSE-04-2017-0024.

Smyrnova-Trybulska, E., Morze, N., Kommers, P.A.M., Zuziak, W., & Gladun, M. (2016). Educational Robots in Primary School Teachers' and Students' Opinion About STEM Education for Young Learners. In P. Kommers, T. Issa, Th. Issa, E. McKay, & P. Isaías. *Proceedings Of The International Conferences On Internet Technologies & Society 2016 (ITS 2016) Educational Technologies 2016 (IcEduTech 2016) And Sustainability, Technology And Education 2016 (STE 2016)*. Melbourne, Australia, 6–8 December, 2016. International Association for Development of the Information Society (IADIS) 2016 (pp. 197–204). ISBN 978-989-8533-58-6.

Schmidt, M. & Fulton, L. (2016). Transforming a traditional inquiry-based science unit into a STEM unit for elementary pre-service teachers: A view from the trenches. *Journal of Science Education and Technology, 25*(2), 302–315. http://doi.org/10.1007/s10956-015-9594-0.

Strizhak, O., Slipukhina, I., Polisun, N., & Chernetsky, I. (2017). STEM education: main definitions. *Information Technologies and Learning Tools*, *62*(6), 16–33. http://doi.org/10.33407/itlt.v62i6.1753 [In Ukrainian].

The concept of STEM education development. (2020). Retrieved from https://zakon.rada.gov.ua/laws/show/960-2020-%D1%80#n8 (accessed 29 June 2022) [In Ukrainian].

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 257–267
https://doi.org/10.34916/el.2022.14.19

IDENTIFICATION OF STUDENTS WITH SIMILAR BEHAVIOURAL PATTERNS USING CLUSTERING TECHNIQUES

Janka Pecuchova[1] **& Martin Drlik**[2]
[1,2] Constantine the Philosopher University in Nitra
[1] janka.pecuchova@ukf.sk, ORCID 0000-0002-9225-7449
[2] mdrlik@ukf.sk, ORCID 0000-0002-5958-7147

Abstract: *A log file is used by most e-learning platforms to hold the data collected concerning the learning and teaching activity of the stakeholders. The data gathered needs to be transformed into a helpful form before any decisions can be made. Using educational data mining techniques, one may analyse this data to understand the learning process better and predict their outcomes or early dropout. Simultaneously, it is possible to identify students with similar behavioural patterns. However, students should not be categorized only according to their grades. Instead, their engagement with the educational resources and activities presented within e-learning courses should also be considered. Therefore, this paper presents research in which an unsupervised clustering algorithm is applied to logs to identify groups of students with similar characteristics based on their actions within the context of course data. The most widely used metrics were used to evaluate the proposed clustering model (Silhouette Coefficient, Davies-Bouldin Index, and Calinski-Harabasz Index). A Silhouette score of 0.762 suggests that the clusters are partitioned more effectively, and a Davies-Bouldin score of 0.39 reveals less variance between the clusters. The research results revealed that the k-means clustering algorithm is suitable for identifying students with similar behavioural patterns.*

Keywords: Educational Data Mining, Clustering, Log files, k-means algorithm.

INTRODUCTION

The advent of the information and technology era has resulted in harvesting of vast amounts of data. The information gathered needs to be transformed into a useful form before any decisions can be made. There are reams of student records kept at any university or other institution of higher education. The diversity of educational data is increasing, but the extent to which this growth varies from one e-learning platform to the next is inconsistent. The task of effectively managing this vast amount of

varied educational data is not easy and brings a number of challenges. However, it is not possible to directly apply traditional data mining methods to educational data because of the volume, nature, and structure of the data. As a result, educational data mining (EDM) has just come into existence to help solve this issue. Additionally, in order to get better results from the EDM process, one of the most crucial things to do is to prepare the data for further analysis (Dutt et al., 2017).

Discovering student behavioural patterns and taking the appropriate actions to maximize the educational process is an important effort of contemporary education. According to (Aljohani et al., 2019), educational data from learning management systems (LMS) provides chances to analyse students' behaviour patterns and improve the effectiveness of teaching and learning behaviours. One example would be identifying numerous behavioural characteristics that have strong correlations with academic success, assessing the learning behaviours of students to enable educators to modify their lesson plans to get better results and providing early warnings to students who are at risk of not passing examinations and identify any unusual behaviours exhibited by students. According to (Hussain et al., 2019), the instructor's primary resource for monitoring a student's level of online engagement and ensuring that they receive a high-quality education is the data obtained from the virtual learning environment (VLE) in the form of logs. However, it might be challenging for teachers to keep track of and access each student's data on the online platform, making it impossible for them to evaluate the degree of student participation in their classes.

Applying educational data mining techniques to this data allows qualitative and quantitative analysis to be carried out. Performance evaluation plays an essential function in educational settings at a higher level. In other words, understanding the student's behaviour or learning experience within the course is an important aspect. Grades are the essential factor that is considered when determining a student's overall performance in college. However, a student's potential for employment is also affected by various other factors, including the completion of projects, participation in joint activities, and interaction with other stakeholders within the course. Therefore, students should not be categorized solely according to the grades they have been receiving, with their participation in extracurricular activities being ignored in the process. In order to acquire a full view of the student's performance and simultaneously ascertain information from their performance from time to time, it is important to know groups of students based on these factors (Palani et al., 2021).

Therefore, this paper presents research in which an unsupervised clustering algorithm is applied to logs to identify groups of students with similar characteristics based on their actions within the context of course data. The most important contribution of this study is that it assists educators in keeping track of their students' online activities and better understanding their profiles. This may help forecast the future consequences of student performance, which can then be used to adjust the teaching content. It also helps to optimize the learning environment within the learning management system.

1. RELATED WORKS

In the framework of EDM, researchers examine the practicability and viability of clustering algorithms from an application standpoint. Clustering algorithms have been recently developed as an effective method for extracting information from large amounts of data in various sectors. Because there are so many kinds of data to examine, several different clustering techniques have been created simultaneously to accommodate this diversity. These algorithms aim to group similar objects into the same cluster. These algorithms can be roughly classified into the following five categories: partitioning methods, hierarchical methods, density-based methods, grid-based methods, and model-based methods. Each method of clustering has benefits and drawbacks that should be considered during the data clustering process. Therefore, it is natural that a single universal clustering method is still not available to manage all forms of data, including text, numbers, photos, and videos (Hervianti, 2018). Agnihotri et al. (2015) used data-driven clustering techniques K-means to determine which students in online courses had the highest and lowest levels of success. K-means clustering is a technique used to divide students into classes based on factors such as their login history and the number of times they have attempted to pass the course. Unfortunately, the data aggregations used in this study were handled incorrectly. During the training phase of the model, there was a large number of null values. Simultaneously, fewer factors were used to form the model during this phase. In order to investigate the study habits of the students, Preidys and Sakalauskas (2010) collected a large quantity of data from the BlackBoard Vista platform often used for online education. The dataset was partitioned into three groups using K-means clustering: Important, Unimportant, and Average importance. However, the final dataset also contained many outliers, which could negatively influence a final clustering model.

The challenges related to the correct clustering of educational data were researched further in (Navarro & Moreno-Ger, 2018). In this study, a large dataset with no outliers was used to evaluate which clustering technique could more effectively predict a low proficiency level of students in the LMS. This work used seven different clustering models. Moreover, various evaluation metrics such as the Dunn Index, the Silhouette score, and the Davies-Bouldin score were compared to benchmark their performance. This was done to determine which algorithm performs better. However, a notable disadvantage of this research was that missing data in instances in the factors were removed, which might include helpful information and provide more insights.

In contrast to these related works, the study presented in this paper directly investigates the LMS Moodle logs, where data is stored in xAPI format. The logs are stored in LMS Moodle database tables. The data represents the LMS stakeholders' interaction with different instructional materials and activities.

The dataset used in this study was created as an export from the database. It includes the following input variables: *component*, *action*, *target*, *objectid*, *contextid*, *contextlevel*, *contextinstanceid*, *userid*, *courseid* and *timecreated*.

As was mentioned earlier, this study aims to deploy the clustering model on the log and determine the groups of students with the same level of learning engagement exhibited by the students enrolled in the chosen course.
The K-means clustering algorithm is utilized for this purpose. The algorithm possesses two significant aspects. The first is selecting the ideal centre point and the second is detecting and eliminating disturbances. In addition, choosing the correct number of potential clusters *k* is essential when using the K-means clustering algorithm. This is because establishing an inappropriate *k* value may alter the data characteristics that are exhibited by the clusters.
Canopy, Elbow, Dunn Index, Silhouette Coefficient, and Gap Statistic are some of the various ways that can be used to understand the identified clusters better. Other options include Gap Statistic. The Elbow method was chosen in this study to determine the initial number *k* of clusters. The Elbow method proved to be effective in identifying the optimal number of clusters for the partitioning-based clustering algorithms (Moodle 4.0 Documentation, 2022).

2. METHODOLOGY

In this section, we will discuss the EDM process that has been selected to manage the knowledge discovery process. The proposed method can be broken down into four main phases as shown in Figure 1.

Figure 1. An outline of the EDM framework that has been adopted

Source: Own work.

Collecting relevant data is the first and most crucial step in every educational data mining approach. We started with collecting activity logs of the Moodle LMS. The raw dataset consisted of 1,529,342 log records produced by 4623 users participating in 894 courses and were accessible between February 1, 2019, and December 31, 2019.
The distribution of the logs between the courses was very diverse. For example, there were courses with few participants or minimal activity. Therefore, it did make sense to identify groups of students with similar behaviour on the dataset containing these outliers.
Therefore, we suggested to create a subset of the courses with higher activity during the knowledge discovery process pre-processing phase. The course selection was based on the number of activities, interactions, and the number of students who enrolled on the course.
As a result, an intensively used course was selected to extract information from the log data and show if the clustering could uncover some interesting insights into the course. The final dataset consisted of the students of one science course from 2019.

This course consisted of 82 users and 96 277 actions. Clustering analysis was performed on this dataset.
Figure 2 shows the list of features labelled as *component*, *action*, *target*, *objectid*, *contextid*, *contextlevel*, *contextinstanceid*, *userid*, *courseid* and *timecreated*, which were included in the input dataset.
The extracted data were pre-processed, and the detected outliers and missing values were removed.
Then, data were normalised, and relevant features of the data were selected.
Because we worked with the Moodle log file, it was vital to understand the individual attributes to pre-process the data correctly.
Mainly, it was necessary to take a closer look at the *edulevel* attribute since we attempted to classify students into individual clusters based on the same criteria. This feature provides information on the dates on which particular actions were carried out, mostly the educational significance of those acts. This feature can take on the values 0 through 2, specifically.
The records assigned the value 2 are all pertinent activities or events undertaken by a user. They are all connected to the user's learning experience.
According to the official documentation for Moodle logs, entries with a value of 1 represent teaching actions and have a teaching value. Therefore, entries with a value of 1 should not be mixed with participating events marked with a value of 2, as this is not recommended. The last group of entries were entries with a value of 0, representing any other action related to the administration of the website or any other users. Because these actions also did not have any educational value, they were not considered. As a result, entries with *edulevel* attribute values of 1 or 0 were not considered and were removed by forming a final pre-processed dataset.

	component	action	target	objectid	contextid	contextlevel	contextinstanceid	userid	courseid	timecreated
0	mod_page	viewed	course_module	7027	212936	70	95231	17	1489	1550343718
1	mod_resource	viewed	course_module	32534	213483	70	95760	10746	1489	1550349523
2	mod_resource	viewed	course_module	32532	213481	70	95758	10746	1489	1550349602
3	mod_resource	viewed	course_module	32534	213483	70	95760	10746	1489	1550349773
4	mod_resource	viewed	course_module	32280	212944	70	95239	10746	1489	1550352803

F i g u r e 2. Pre-processed final dataset

S o u r c e: Own work.

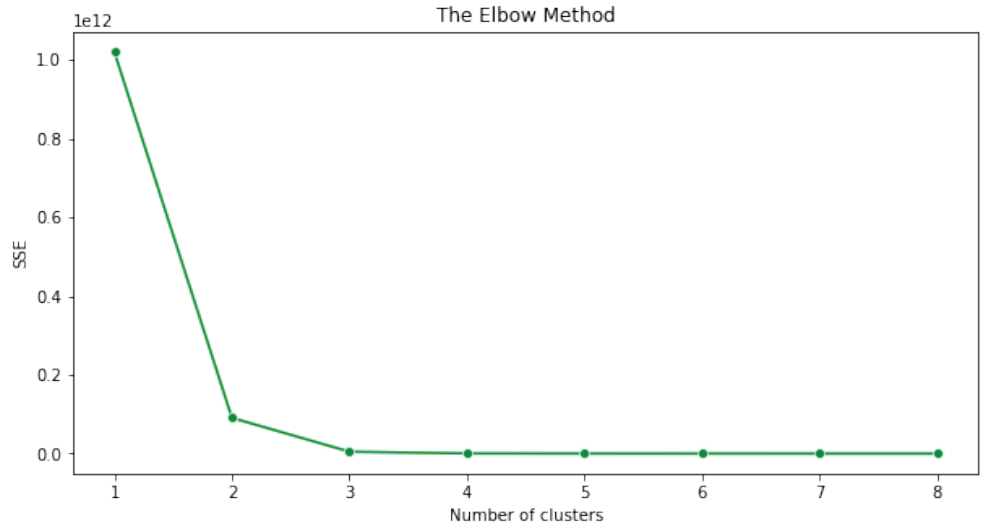
Also, according to the specification, the *ghost* role records can take on the values 0 or 1. It is advised that event records with a value of 1 should be ignored. Finally, after these pre-processing tasks, we were able to obtain a pre-processed final dataset that was suitable for the clustering algorithm. The revised dataset had ten attributes and comprised 44,285 records created by the activity of 77 different users.
The third step (Figure 1), in which we analysed data through data clustering, is one of the most critical steps in our proposed methodology. K-means algorithm was applied to the pre-processed data set for obtaining the clusters. Before clustering our education data, it was quite challenging to determine which clustering algorithm was the

most suitable because every algorithm has its unique set of characteristics that make it suitable for a specific application. Despite this, we investigated the hierarchical clustering method, which, compared to the partitioned clustering techniques, requires a more significant amount of CPU and memory resources. In addition, a hierarchical approach might quickly become expensive when used with extensive datasets. The primary areas where hierarchical and partitioned approaches are differentiated are computing time, prior assumptions, data sets, and clustering goals and results.
On the other hand, by applying certain mathematical techniques, the unsupervised clustering method is used to group the data from the vast dataset that are the most comparable to one another.
The k-means clustering technique is a method that is both straightforward and efficient when it comes to dividing up data. K-means clustering is an excellent method, although it does have a few drawbacks, the most notable of which are the inability to determine the number of clusters and the absence of an ideal centre. The total number of k values used in the k-means clustering technique is one factor that significantly impacts the data analysis findings.
In order to determine the correct value of k for the k-means clustering algorithm, the Elbow approach was applied. In its most basic form, the Elbow method works by computing the value of the sum of squared errors (SSE) in each cluster to determine the optimal number of clusters for a dataset. A low SSE value indicates that the cluster in question will be of high quality (Hussain et al., 2018).
Following its deployment, the k-means algorithm should be analysed for its effectiveness. The performance of a clustering method can be evaluated using a process known as cluster validation, consisting of internal and external evaluations. The findings and the ground truth are compared in order to carry out the external evaluation. For instance, the results of clustering are compared with public class labels in order to ascertain how well the cluster approach works with actual data groups on the dataset that is now available (Dobashi, 2017). Techniques used internally evaluate the degree to which one object in a cluster is similar to other objects in the cluster, as well as the degree to which one cluster differs from another.
Silhouette Coefficient (SC) is an internal validity measure that evaluates clustering performance based on the pairwise difference between and within cluster distance (Estacio & Raga, 2017). The findings fall somewhere between –1 and 1. The closer they are to 1, the more similar the entities are to one another. Vice versa, the further they are from 1, the less similar the entities are to each other (Kadoić & Oreški, 2018).

3. EXPERIMENTAL RESULTS

In this section, we discuss the various results obtained from the experiments. In the first step of this process, we clustered the data and then extracted the fundamental statistical characteristics from each cluster. Next, we used the Elbow method on the dataset to figure out the appropriate number of clusters to use, denoted by the letter k. To begin, we randomly selected a number of clusters and then calculated the SSE value for each cluster. As shown in Figure 3, the SSE value converges once the number of clusters equals 3. In accordance with the findings of the Elbow technique,

we were able to determine the suitable number ($k = 3$) of clusters to use for the primary clustering operation when applied to the dataset using the k-means algorithm.



F i g u r e 3. Optimal *k* value selection using the Elbow method

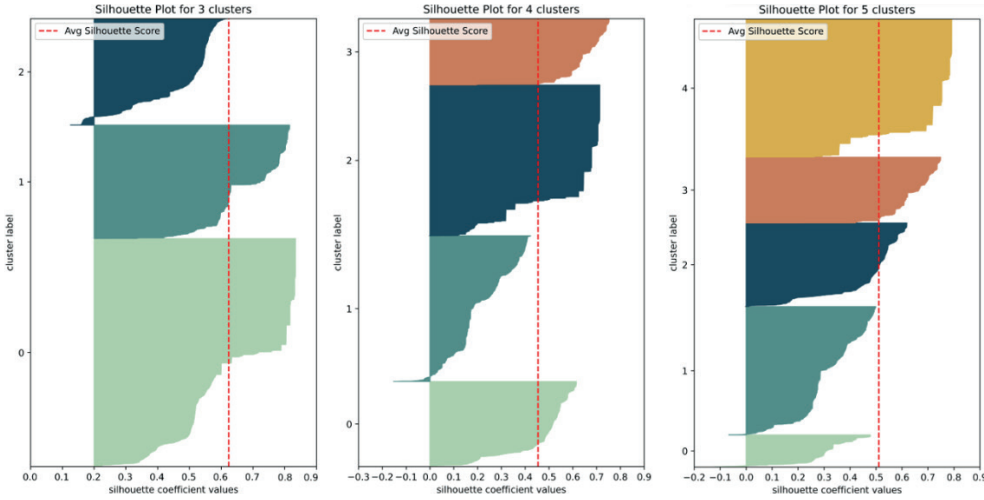
S o u r c e: Own work.

In order to investigate the distance between the generated clusters, silhouette analysis can be utilized. Because it measures how close each point in one cluster is to points in the neighbouring clusters, the silhouette plot offers a means to evaluate factors such as the number of clusters visually. This measurement has a range from –1 to 1. When the silhouette coefficients (another name for these values) are close to 1, the sample is located at a significant distance from the nearby clusters. Contrary, a score of 0 indicates that the sample is either on the decision border between two neighbouring clusters or extremely close to it. Negative values indicate that such samples may have been incorrectly assigned to the cluster they belong to.

In this case as shown in Figure 4, silhouette analysis is utilized to determine the best possible value for n clusters. The silhouette plot demonstrates that n clusters equal to 3 or 4 were relatively good choices for the proposed data due to the presence of clusters with above-average silhouette scores in the case for these clusters. Furthermore, we can see that there are relatively small fluctuations in the size of the silhouette plots in each case.

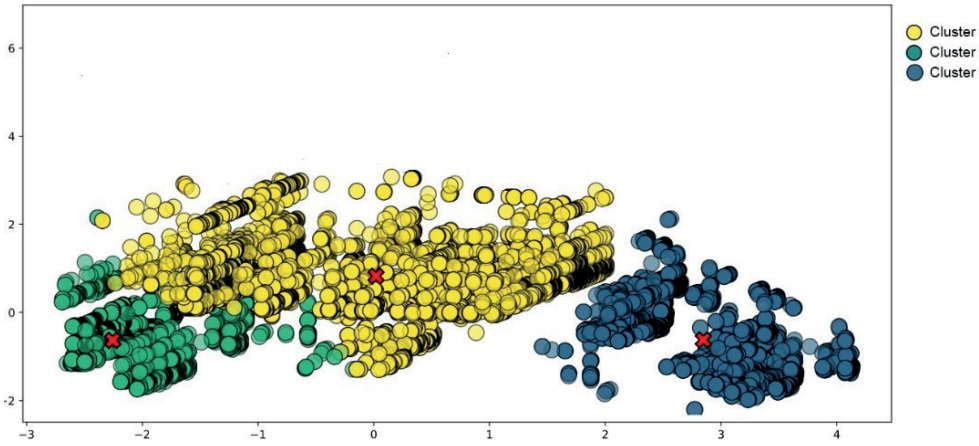
Furthermore, there are no spaces between the various groups of data, which is another indication that they are accurate. As can be seen, the silhouette analysis shows that the option with $n = 3$ would produce more accurate coefficient values. Therefore, it was chosen over $n = 4$.

The dataset was then subjected to random initial centre selection (RCS), followed by k-means clustering techniques. Figure 5 depicts the cluster data visualization created using RCS in conjunction with K-means. Finally, the data were organized into neat clusters by an algorithm.



F i g u r e 4. Silhouette plots for 3,4 and 5 clusters

S o u r c e: Own work.



F i g u r e 5. The result of K-means clustering with randomly selected initial centres

S o u r c e: Own work.

Following the application of the clustering technique, we discovered that 50.92 per cent, 25.35 per cent, and 23.73 per cent of the students, respectively, belonged to clusters 1, 2, and 3. In order to evaluate the k-means model performance as well as the hyperparameters tuning, we used the most common metrics such as Silhouette Coefficient, Davies-Bouldin Index and Calinski-Harabasz Index according to the Table 1. Because categorical variables are discrete and do not have any natural origin, the K-means algorithm cannot be applied to categorical data. As a result, we transformed them into numeric data by employing label encoding, which might have resulted in a decrease in the performance of the model.

Table 1. Results for evaluation of metrics on the K-means model

Silhouette Coefficient	Davies-Bouldin Index	Calinski-Harabasz Index
0.627	0.39	91715

Source: Own work.

However, the overall performance was not skewed, and according to the findings, the k-mean clustering model was accurately distributed. Table 1 shows that the silhouette coefficient score for the k-mean model was 0.627, indicating a high separation level as the value is close to 1. Therefore, samples are not placed in the incorrect clusters. In order to evaluate the scaled data, the Davies-Bouldin score was computed. The lower the value of the Davies-Bouldin score, the more clearly the clusters may be distinguished. The score, according to the k-means model, is 0.39.

Next, the Calinski-Harabasz score was applied to determine the extent of the variation in the data points between the clusters. If the value of the score is higher than expected, then the cluster is dense and has clear boundaries between its members. The Calinski-Harabasz score for k-means was 91,715, which is higher than each cluster distribution because there are 22,549 records in cluster 1, 11,227 in cluster 2, and 10,509 in the third cluster.

CONCLUSION

Identifying students in an online learning environment with similar behaviour, which can lead to a low level of involvement, is vital since this allows the instructor to influence or target the student's behaviour (Kabathova & Drlik, 2021).

Considering the study results, we can confirm the findings of other researchers that data mining in education can assist in extracting useful information from large datasets. Moreover, EDM can help to build a model of e-environment of the university, which would take into account the needs of today's students and today's market and would ensure a high level of university competitiveness (Morze et al., 2015). Cluster analysis is a method for performing data analysis that does not require prior information from the analyst and knowledge about the internal structure of the dataset. Understanding the data structure, the kind of analysis that is wanted, and the quantity of the dataset being analysed are all critical factors to consider when selecting the appropriate clustering technique (Munk et al., 2010).

Data used in this study were extracted from LMS Moodle. The next thing needed was to transform the data into a format that could be used as input into the clustering model. After that, the k-mean technique was applied to the data to identify students with similar characteristics. Finally, the most common metrics were used to evaluate the performance of the proposed model (Silhouette Coefficient, Davies-Bouldin Index, and Calinski-Harabasz Index). As a result, three clusters have been identified. The findings demonstrated that the k-mean clustering algorithm is an appropriate algorithm model in this particular case. The Silhouette score of 0.627 indicates that

the clusters are partitioned more effectively, and a Davies-Bouldin score of 0.39 demonstrates less variance across the clusters.

In this study, all experimental findings were derived from the information gathered during a particular class. Therefore, the findings of experiments might differ from the data obtained in other classes. Therefore, the number of clusters produced by the k-means method is subject to change depending on the dataset.

As a result, the EDM framework that was proposed may produce satisfactory or unsatisfactory results when applied to additional data sets. Another limitation of this study is that the used model demonstrates a few spots in which clusters are overlapping. This fact could lead to failing to find students struggling academically with high performance.

For future work, we would like to apply association and pattern mining algorithms to each cluster to achieve a more comprehensive study of student performance, better understand their behaviour and compare results with the findings obtained in our previously proposed approach (Drlik et al., 2021).

ACKNOWLEDGEMENTS

This research was funded by the Science grant agency of the Ministry of Education of the Slovak Republic, grant number: 1/0490/22 "Design and Evaluation of Selected Learning Analytics Methods for Understanding and Improving the Learning Process and Virtual Learning Environment," European Commission under the ERASMUS+ Programme 2021, KA2, grant number: 2021-1-SK01-KA220-HED-000032095 "Future IT Professionals EDucation in Artificial Intelligence," and the Ministry of Education of Slovakia, grant number 004UKF-2-1/2021 "Preparation and development of teaching courses in English with a focus on artificial intelligence in the form of blended-learning".

REFERENCES

A g n i h o t r i, L. et al. (2015). 'Mining Login Data For Actionable Student Insight', Proceedings of the 8th International Conference on Educational Data Mining (EDM) (pp. 472–475). ISBN 978-84-606-9425-0.

A l j o h a n i, N.R., F a y o u m i, A., & H a s s a n, S.U. (2019). Predicting at-risk students using2 clickstream data in the virtual learning environment. *Sustainability*, *11*(24), 7238. https://doi.org/10.3390/su11247238.

D o b a s h i, K. (2017). Automatic data integration from Moodle course logs to pivot tables for time series cross section analysis. *Procedia computer science*, *112*, 1835–1844. https://doi.org/10.1016/j.procs.2017.08.222.

D r l i k, M., M u n k, M., & S k a l k a, J. (2021). Identification of Changes in VLE Stakeholders' Behavior Over Time Using Frequent Patterns Mining. *IEEE Access,* 9, 23795–23813. https://doi.org/10.1109/ACCESS.2021.3056191.

D u t t, A., I s m a i l, M.A., & H e r a w a n, T. (2017). A systematic review on educational data mining. *Ieee Access*, *5*, 15991–16005. https://doi.org/10.1109/ACCESS.2017.2654247.

Estacio, R.R. & Raga Jr, R.C. (2017). Analyzing students online learning behavior in blended courses using Moodle. *Asian Association of Open Universities Journal*. ISSN 2414-6994.

Hassan, S.U., Waheed, H., Aljohani, N.R., Ali, M., Ventura, S., & Herrera, F. (2019). Virtual learning environment to predict withdrawal by leveraging deep learning. *International Journal of Intelligent Systems*, *34*(8), 1935–1952. https://doi.org/10.1002/int.22129.

Hervianti, S.P. (2018). Analisis Pengelompokan Penyebaran Lulusan Mahasiswa Universitas Gunadarma Menggunakan Metode Clustering. *ikraith-informatika*, *2*(2), 42–48. e-ISSN 2654-8054.

Hussain, S., Atallah, R., Kamsin, A., & Hazarika, J. (2018, April). Classification, clustering and association rule mining in educational datasets using data mining tools: A case study. In *Computer Science On-line Conference* (pp. 196–211). Cham: Springer. https://doi.org/10.1007/978-3-319-91192-2_21.

Kabathova, J. & Drlik, M. (2021). Towards predicting student's dropout in university courses using different machine learning techniques. *Applied Sciences*, *11*(7), 3130. https://doi.org/10.3390/app11073130.

Kadoić, N. & Oreški, D. (2018, May). Analysis of student behavior and success based on logs in Moodle. In *2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)* (pp. 0654–0659). IEEE. https://doi.org/10.23919/MIPRO.2018.8400123.

Moodle 4.0 Documentation. Retrieved from https://docs.moodle.org/dev/Events_API.

Morze, N., Smyrnova-Trybulska, E., & Umryk, M. (2015). Designing an e-university environment based on the needs of net-generation students. *International Journal of Continuing Engineering Education and Life-Long Learning, 25*(4), 466–486. https://doi.org/10.1504/IJCEELL.2015.074230.

Munk, M., Kapusta, J., & Švec, P. (2010). Data pre-processing evaluation for web log mining: Reconstruction of activities of a web visitor. *Procedia Computer Science, 1*, 2273–2280. https://doi.org/10.1016/j.procs.2010.04.255.

Navarro, Á.M. & Moreno-Ger, P. (2018) 'Comparison of Clustering Algorithms for Learning Analytics with Educational Datasets', International Journal of Interactive Multimedia and Artificial Intelligence, *5*(2), p. 9. https://doi.org/10.9781/ijimai.2018.02.003.

Palani, K., Stynes, P., & Pathak, P. (2021). Clustering Techniques to Identify Low-engagement Student Levels. In *CSEDU (2)* (pp. 248–257). https://doi.org/10.5220/0010456802480257.

Preidys, S. & Sakalauskas, L. (2010). 'Analysis of students' study activities in virtual learning environments using data mining methods'. *Technological and Economic Development of Economy, 16*(1), 94–108. https://doi.org/10.3846/tede.2010.06.

E-learning in the Transformation of Education in Digital Society
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 14, Katowice–Cieszyn 2022, pp. 268–287
https://doi.org/10.34916/el.2022.14.20

SPECIAL COURSE ON INFORMATION HYGIENE AS A TOOL FOR DEVELOPING YOUTH'S ABILITY TO RESIST INFORMATIONAL INFLUENCES

Yuliia Rudenko[1], Marina Drushlyak[2], Olha Naboka[3], Volodymyr Proshkin[4], & Olena Semenikhina[5]

[1] Sumy professional College of Economics and Trade, Troitska str., 37, Sumy, Ukraine
[2,5] Makarenko Sumy State Pedagogical University, Romenska str., 87, Sumy, Ukraine
[3] Donbas State Pedagogical University, Henerala Batyuka St. 19, Sloviansk, Ukraine
[4] Borys Grinchenko Kyiv University, Bulvarno-Kudriavska St. 18/2, Kyiv, Ukraine
[1] yango641@ukr.net, ORCID 0000-0003-3162-1216
[2] marydru@fizmatsspu.sumy.ua, ORCID 000-0002-9648-2248
[3] olganaboka911@gmail.com, ORCID 0000-0003-4635-0009
[4] v.proshkin@kubg.edu.ua, ORCID 0000-0002-9785-0612
[5] e.semenikhina@fizmatsspu.sumy.ua, ORCID 0000-0002-3896-8151

Abstract: *The authors raise the problem of informational influences on young people, who are often thoughtless consumers of Internet content, and actualize the need to train young people in the skills of information hygiene. According to the results of the student survey, the trustworthiness of young people to information content and the lack of ideas about the possible negative impact of information technologies, computer applications, social networks, and services on their health were confirmed. The author's special course on information hygiene is described as a tool for developing youth's ability to resist informational influences. It is shown how the tasks of the special course are achieved: to form a responsible attitude toward the consumption of information content; develop the ability to counteract destructive influences based on emotional colouring (psychological manipulations, propaganda, disinformation, etc.); develop practical skills to verify media products for their critical evaluation; to improve the skills of protecting one's own information space. The methods and tools of learning that contribute to solving the tasks are described. The results of the pedagogical experiment are presented, which confirm the effectiveness of the developed special course.*

Keywords: informational hygiene, informational influence, resistance to informational influences, special course on informational hygiene, professional training of youth.

1. INTRODUCTION

The development of digital technologies and widespread access to information sources and data via the Internet, the possibility of interactive interaction within the information resource, along with positive effects on society, contribute to the growth of social threats, including information aggression, manipulation of consciousness, cyber-attacks and cybercrime, etc.

The young generation, which grew up during the period of rapid development of digital technologies, confidently uses the Internet and digital tools for communication, education, and professional activities. Young people everywhere use mobile applications that are quick, often free of charge, installed, and quickly mastered. At the same time, a frivolous attitude towards digital technologies and tools gives rise to the consumption of information content of questionable quality, often reckless and thoughtless behaviour in cyberspace, as well as ignoring possible information threats. Young people's lack of skills in critical analysis of shared content, a critical look at subjective assessments of individual facts or opinions shared on the network, the inability to have their own point of view, and the ability to defend it with arguments often lead to such a trusting attitude to information that very often young people not only become a victim of manipulation but also contributes to the spread and further growth of false data, biased assessments of facts, the spread/popularization of ambiguous judgments, etc. It should also be mentioned about the irresponsible attitude to personal data (phone number, e-mail address, photo, texts, geolocation, etc.), which can be used by others for criminal purposes. This actualizes for the average citizen the ability to resist destructive information influences, and therefore the problem of young people observing information hygiene as a response to the various effects of Internet technologies and tools.

2. ANALYSIS OF THE DEVELOPMENT STATE OF THE PROBLEM

The importance of information hygiene began to be discussed at the end of the 20th – beginning of the 21st century. Thus, in the work (Eremin, 1995), a new scientific direction is initiated – information hygiene as a holistic system of knowledge about the patterns of influence of information (information technologies) on the state of mental, physical, and social health of a specific person and society as a whole.

According to Khalamendyk (2008), information hygiene should be considered at three levels – personal, social, and state. At the personal level, information hygiene contributes to solving issues of prevention and preservation of human health, determining information life priorities, saving one's time as the most valuable resource today. At the level of society, information hygiene contributes to the formation of information culture among its members, which, among other things, is designed to develop the ability to adequately perceive and quickly process data of various types (perceive, analyse, interpret, critically evaluate, disseminate, etc.). At the state level, information hygiene contributes to the implementation of an effective and balanced information policy in order to preserve the health of the nation and its spiritual culture.

The systematization of scientific results proved the presence of different approaches in marking the ability to resist informational influences. Along with the term "information hygiene" there is the following concepts:

- infomedia literacy and infomedia culture, which, according to their interpretation, also include a certain set of skills to work correctly with Internet sources, which is stated, in particular, in the works (Jeong, Cho, & Hwang, 2012; Bulatovic, Bulatovic, & Arsenijevic, 2014);
- information/digital literacy of young people (Zhu et al., 2021; Pérez-Torner & Tayie, 2012).

The generalization of scientific publications, which are devoted to the ability of society in general and youth, in particular, to resist informational influences, proved the relevance of such research in the countries of Eastern Europe (Belarus, Armenia, Bulgaria, Hungary, Georgia, Poland, Romania, Slovak Republic) (Fedorov et al., 2014); in Ukraine (Drushlyak, 2022); in Finland, Sweden, France, Germany, Great Britain and Spain (Horbenko, Hondiul, & Fruktova, 2020).

It should also be noted in publications that raise the problem of combating informational influences:

- V. Varynskyi et al. have analysed the state of the information hygiene segment of the Ukrainian Internet media in conditions of global threats (Varynskyi et al., 2021).
- Loukas, G., Murugesan, S., and Andriole, S.J. are focused on combating disinformation in the news and mass media (Loukas, Murugesan, & Andriole, 2022).
- Grimes, D.R. emphasizes the need to recognize the harmful effects of misinformation and take precautions to avoid the spread of misinformation (Grimes, 2020).

According to the results of the analysis, we state that in the conditions of the multiplicity of existing and potentially possible information threats in society, the need to reduce the negative impact of information processes on the health of young people is increasing. Such a need, on the one hand, requires the development of young people's ideas about information hygiene and existing destructive influences, and, on the other hand, actualizes in the conditions of an educational institution the need to implement a special course on information hygiene (elective courses, groups, a number of extracurricular activities) as a tool designed to learn to see the risks of consuming information content and to distinguish dangers in the conditions of information confrontations.

The purpose of the article is to develop and experimentally confirm the expediency of implementing a special course on information hygiene for young people in the conditions of an educational institution.

Achieving the goal determined the solution of a number of tasks: 1) to investigate the real state of compliance with information hygiene by young people; 2) to develop the content of the special course on information hygiene and describe the features of its implementation; 3) to find out the impact of the special course on the ability of young people to resist informational influences.

3. MATERIALS AND METHODS

126 students of A.S. Makarenko Sumy State Pedagogical University and Sumy Vocational College of Economics and Trade were involved in the experiment.
The special course was implemented in 2020–2022 as a separate elective discipline or as one of the modules of standard courses ("Infographics in the work of a teacher", "Data visualization", "Internet security").
To solve the first task, a survey was used as an empirical method of scientific knowledge. 126 respondents took part in the survey.
To solve the second task of the research, the experience of teachers available in the network regarding the implementation of courses on the formation of information security skills, own experience of teaching courses, and conversations with leading teachers of the departments of computer, psychological and sociological disciplines of A.S. Makarenko Sumy State Pedagogical University, Donbas State Pedagogical University, Borys Grinchenko Kyiv University were used.
To solve the third task, a non-parametric method of statistical evaluation of the data of the pedagogical experiment was used – the sign criterion, which was based on the results of the survey (Table 1). Each correct answer was valued at one point. The maximum that can be scored based on the evaluation results is 7 points.

Table 1. Survey on the ability to resist informational influences

№	Question	Answer options
1.	Fact vs judgment. Choose which, in your opinion, is a fact from the proposed ones.	• Information that contains a personal assessment. • An event that contains an emotional evaluation. • Information asserted or denied. • A real event that can be tied to a specific time or place. • Proven information. • Expression of a person's thoughts. • Exaggeration, generalization or one-eyed description of a fact.
2.	What do you think is effective in verifying the authenticity of information from the Internet? (several correct answers)	• It is impossible to verify the photo, so it is not necessary to pay attention to it. • It is worth checking whether the title corresponds to the main part of the message. • The author with the specified name and photo is a real person, so such information should be trusted. • It is necessary to check the presence of emotional influence in the message. • The presence of errors in the text is only typographical errors, so you should not pay attention to them.

№	Question	Answer options
3.	Which of the following statements do you think are correct? (several correct answers)	• Fake news often has flashy titles written in capital letters with exclamation marks. • Fake sites never make mistakes in spelling and punctuation. • Copies of well-known pages or sites are often created to promote fake information. • Fake news contains real photos and videos. • Many items of fake news have no publication date.
4.	Which of the following statements characterize, in your opinion, safe online behaviour? (several correct answers)	• I have the same logins and passwords for all my accounts on the network. • A password that contains numbers, upper and lower case letters, and symbols is the most reliable. • It is necessary not to disclose personal data. • I open all emails. • I do not trust information from suspicious sites.
5.	Using what tools do you think manipulators can collect our data in social networks?	• Tests. • Flash mobs. • Games. • All mentioned. • None of the above.
6.	How do you think a bot can be recognized? (several correct answers)	• There are no photos, or all photos were published in the same period. • On the page every day there are posts of their own, advocating the same position. • Bots usually have a small number of friends. • The bot page was created recently, perhaps a few months before an important event for the country. • One bot leaves only one comment under a post and does not respond to counter-comments.
7.	Choose three rules of behaviour in messengers that you think are safe.	• Do not open links from strangers. • Limit the ability to add you to communities. • Use the application only as a messenger. • Use the messenger to receive news sent by friends from the community. • Take part in draws. • Do not consume information from anonymous channels. • Check channels for artificial popularity.

Source: Own work.

4. RESULTS

4.1. The real state of compliance with information hygiene by young people

We conducted a survey to identify the state of information hygiene compliance by young people. 126 students from various educational institutions took part in the survey. Survey questions and their results are presented in Table 2.

Table 2. Results of the student survey

№	Question	Answer options (choose one of several)	% answers
1.	Do you have to participate in quizzes and games published on social networks?	So, why not have fun?	47%
		Never, I am wary of such offers.	53%
2.	The super program offers to see yourself with a different hairstyle. To do this, you need to download the application and grant access to the camera or photos.	Yes, because I have nothing to hide.	39%
		No, I am suspicious of such programs.	61%
3.	As soon as I inquired about the trip on the social network, similar messages immediately appeared in the feed. Why?	Social networks are tapped.	19%
		This is the work of special algorithms.	66%
		I do not know.	15%
4.	Why do you see news from some friends on social networks much more often, and from others there is no news at all?	Friends are just inactive in social networks.	42%
		Algorithms of social networks track the frequency of interactions.	51%
		I could be removed from friends.	7%
5.	„Sent a message to 10 friends!". How do you react to „letters of happiness"?	I'll pass; it's not difficult for me.	13%
		Never send, it can be dangerous.	74%
		I don't want to waste time on it.	13%
6.	„We need to collect a million votes so that Viber or Facebook are not paid!" Would you like this call?	Yes, it's not difficult for me.	19%
		Yes, because I am for the free distribution of software.	19%
		First, I will check the validity of the call.	39%
		I will never like it. I read the terms of use (it's free).	23%

№	Question	Answer options (choose one of several)	% answers
7.	You are sure that the coronavirus is often incurable disease. Your friends on the social network think the same. Why?	We are in an information „bubble”.	51%
		All reasonable people think so.	49%
8.	Do you read the terms of the use of a web application before signing up?	No, I automatically agree with the rules.	66%
		Yes, I always read these rules.	34%
9.	„Democracy is the best political regime.” Is this fact or opinion?	Fact.	34%
		Opinion.	66%
10.	How much time do you spend on the Internet and social networks?	All the time.	76%
		From 2 to 5 hours a day.	20%
		From 1 to 2 hours a day.	4%
		Less than an hour a day.	–

Source: Own work.

The answer to the first question was almost equally divided by the respondents, which means that almost every second student participates in Internet tests or surveys, which are very common in social networks and are aimed at collecting the personal data of users.

The answers to the second question showed that almost every two out of five students do not see a problem in giving the application access to their phone's camera or personal photos.

The third and fourth questions of the survey revealed that almost a third of respondents have no idea about the features and principles of the algorithms that are embedded in modern social networks.

The answers to the fifth, sixth and eighth questions indicate that every eighth respondent (13%) is an extremely trusting person and does not realize the risks that even a repost or like on a social network exposes him too and that 35–40% of respondents do not read the social network's operating policy or the terms of its installation on their own mobile device.

The seventh question made it possible to determine the number of students who are really in an information bubble and do not have developed skills for critical evaluation of events and it's almost half of them.

The answers to the ninth question confirmed that every third respondent does not distinguish between facts and judgments.

The tenth question confirmed that the vast majority of respondents are online on social networks "constantly" – three out of four respondents and a fifth of respondents spend from 2 to 5 hours communicating online every day. At the same time, no respondent mentioned that he spends less than an hour online.

The analysis of the answers confirmed our expectations regarding the trustworthiness of young people to information content and their lack of ideas about the possible negative impact of information technologies, computer applications, social networks, and services on their health.

4.2. Special course on information hygiene and forms, methods, and tools of its implementation

We have developed a special course "Information hygiene" designed to develop young people's understanding of the impact of information processes on their physical, mental and social health.

The special course is designed for 3 credits and is focused on solving such tasks.

Task 1. To form a responsible attitude to the consumption of information content.

Task 2. To develop the ability to counteract destructive influences based on emotional colouring (psychological manipulations, propaganda, misinformation, etc.).

Task 3. Develop practical skills to verify media products for their critical evaluation.

Task 4. Improve the skills of protecting one's own information space.

The distribution of the curricula and the features of the implementation of the special course are described in Table 3.

Table 3. Features of the implementation of the special course

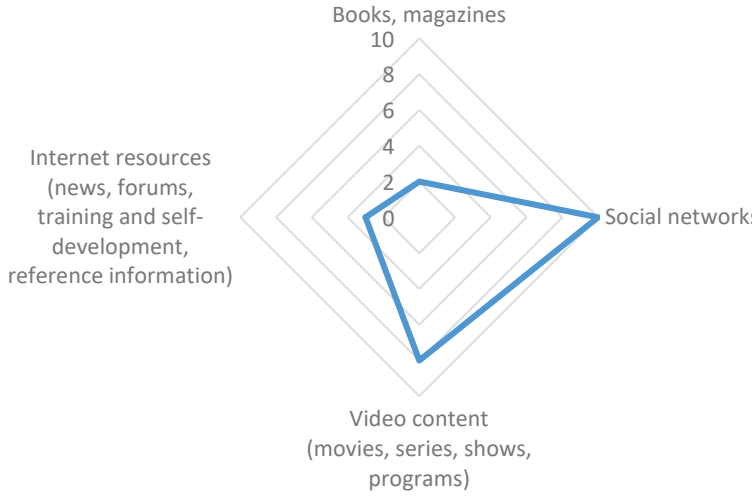
Task	Hours \ of them independently	Form of training	Teaching method	Learning tool
Task 1. To form a responsible attitude to the consumption of information content.	10\6	Practical training	Conversation, discussion, content analysis, search methods	Petal diagram, exercises, Internet resources
Task 2. To develop the ability to counteract destructive influences based on emotional colouring (psychological manipulations, propaganda, misinformation, etc.).	16\6	Training, web quest	Creative, problem-solving, content analysis, explanatory and illustrative	Web trainer, exercises, Internet resources
Task 3. Develop practical skills to verify media products for their critical evaluation.	40\30	Master class, research project	Reproductive methods, explanatory and illustrative	Practical tasks, exercises, Internet resources
Task 4. Improve the skills of protecting one's own information space.	24\18	Practical classes, testing	Explanatory and illustrative, conversations	Exercises, Internet resources

Source: Own work.

Below we detail the ways we have chosen to solve the tasks.

4.2.1. Task 1. To form a responsible attitude to the consumption of information content

A responsible attitude to the consumption of information content is identified by us with limitations in the time spent on the network (the problem of time). For the awareness of the problem of time to occur, we suggest that each student construct a petal diagram (Figure 1) – on a 10-point scale, so that students can give a subjective assessment of the importance of different types of content for them. Based on the analysis of the diagram, we demonstrate how psychological dependence on Internet resources is formed/developed. We build similar charts for the time spent by the student on each type of content per day. We also compare the charts of different students and show how much time others spend. We draw analogies. We ask the following questions: "Why exactly is this type of content important to you?", "Why do you spend the most\least time on a certain type of activity?", "What other types of content do you consume? How often?", "Why do you spend so much time-consuming entertainment content?".



F i g u r e 1. Information space of the student

S o u r c e: Own work.

We explain that the goal of all digital giants, such as Facebook, and YouTube, is to increase the time spent by the user on their network, for which mechanisms are borrowed from the gambling industry. Therefore, the analogy of "gambling – social networks" seems appropriate: raising the mood, avoiding the feeling of loneliness, success, etc. At this stage, we explain the peculiarities of the human brain in relation to the emotional colouring of life. We ask additional questions: "Why do digital giants benefit from you staying online?", "How do digital giants make money?", "How often do ads appear? What does it depend on?", "Do you know the cost of advertising?", "Is it possible to order advertising for a certain type of consumers?", etc. Students

try to find answers to the questions on their own. It is possible to split into groups to study different social networks and their functioning. Then there is a discussion. Based on the results of the discussion and awareness of the time problem, we formulate recommendations together with the students, including, for example:

- install the application "Digital well-being" (https://play.google.com/store/apps/details?id=com.google.android.apps.wellbeing&hl=uk&gl=US) and adjust screen time (disable notifications, set time limits on various applications, enable night mode, etc.);
- adjust the "comments", "recommended videos", "automatic playback" options;
- in the Chrome browser, configure the News Feed Destroyer application News Feed Eradicator for Facebook (https://chrome.google.com/webstore/detail/remove-youtube-recommende/khncfooichmfjbepaaaebmommgaepoid) .

4.2.2. Task 2. To develop the ability to counteract destructive influences based on emotional colouring (psychological manipulations, propaganda, misinformation, etc.)

Emotional sensitivity and social passivity are characteristic of young people. Such a feature simplifies the manipulation of their consciousness through informational influences with an emotional colour. It is important to convey to students that their emotionality blocks the mechanisms of thinking, which are used to manipulate their consciousness. To do this, it is worth providing statistics on the distribution of emotional messages compared to neutral ones (for example, Research: The Emotions that Make Marketing Campaigns Go Viral. https://hbr.org/2013/10/research-the-emotions-that-make-marketing-campaigns-go-viral) and recommend mastering the practice of "emotional pause" (students should find out on the Internet what this practice is and how it is implemented).

We also offer to analyse the "fact-judgment" pair (Figure 2), in order to develop students' skills of emotionless data analysis and to check the news feed of various online resources in order to identify judgments with an emotional colour.

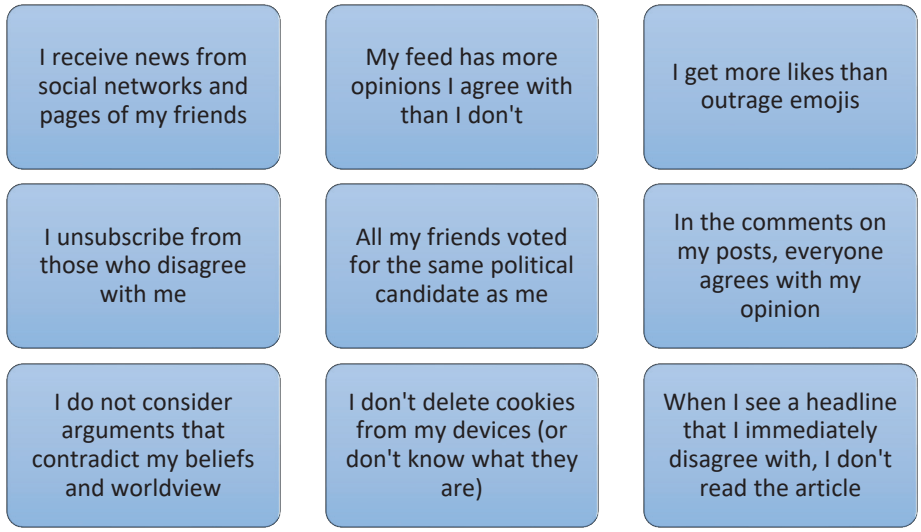
F i g u r e 2. Examples for choosing facts and judgments

S o u r c e: Own work.

We also consider exercises for creating a list of facts and examples of judgments on various informational sites to be effective, including news resources.

To demonstrate to students that most of them are in an information bubble, we solve an exercise developed by the international organization IREX (https://www.irex.org/region/europe-eurasia/ukraine).

Exercise. It is suggested to circle the statements with which you agree. If 3 statements are circled diagonally, vertically or horizontally, then you are in an information bubble (Figure 3).



F i g u r e 3. An example of an exercise to determine being in an information bubble

S o u r c e: Own work.

After students understand the problem of the information bubble, it is important to explain the principles of social network algorithms and search queries. Focus students' attention on the fact that each user action (favourite, comment, view, repost, search request) is analysed by special programs that detect the user's preferences and based on them, form a "sheet" of information content for a specific account. Information that the user ignores gradually disappears from the mentioned list. As a result, an information bubble is formed, in which search algorithms, and not the user, determine which posts will be in the feed, and which sites will be the first in the ranking of submissions for a specific search query. Falling into an information bubble is also facilitated by psychological factors, in particular, emotions, cognitive distortions, and the inability to distinguish fact from judgment.

Among the negative consequences of falling into an information bubble, we note the imbalance (non-objectivity) of opinions, prejudiced confidence in one's rightness, omission of really important messages, and falling under the manipulative influence. After the students become aware of the problem of the destructive influence of Internet content based on emotional colouring, we determine together their ways to solve the specified problems:

- to work in "Incognito" mode, delete cookies, clear\delete search history, etc.);

- to diversify the search bar, including thorough search based on the principle of balance of opinions, alternative opinions, etc.;
- to develop skills to distinguish facts from judgments, taking into account the emotional colouring of judgments.

4.2.3. Task 3. Develop practical skills to verify media products for their critical evaluation

Media products (text, video, audio, photo) are today a common resource of the Internet space. Their simplified distribution has contributed to the appearance of fakes (unreliable data), so the ability to verify data is relevant for further adequate perception of content.

In classes, we offer students exercises to verify text messages, photos, and videos to form/develop their relevant skills.

Text message verification exercises

1. Find out the type of message (fact or opinion), determine the purpose of the message (who benefits from it?), and check the presence of emotional impact, and the presence of errors in the text.
2. Determine the date of the message, the author (real person, bot), the reputation of the primary source (official site, "yellow" press, fake site, etc.), and the presence of links to confirm the information.
3. Perform structural analysis of the message (heading, body, comments). The main elements of structural analysis and examples are given in Table 4.

Table 4. Analysis of text messages

Method	Example	Goal	Warning
Too emotional a headline.	"Shock!!!!" "You won't believe it!"	An appeal to the reader's emotions in order to reduce the degree of critical analysis	Judgment is presented as fact. Psychological manipulation. Exaggeration.
The title does not correspond to the content of the article.	"The British and the russians had a blast at the resorts of the world!"	Increase the number of views (clickbait).	It is about the rating of the visit to the resort (cut out of context).
The article contains opinions, assessments, and assumptions, but not facts.	"Everyone says…" "You can't be silent…"	To shape public opinion in a direction beneficial to the author. Disorientation, intimidation, propaganda.	Trying to influence the perception of the world, not to inform.

Method	Example	Goal	Warning
Use of hate speech, labeling, and unethical statements.	“Radicals and nazis use the civilian population…”	Formation of favorable stereotypes in the mind.	Propaganda, negative influence.
Statistics, numbers.	President of belarus lukashenko “My father died at the front”. a. lukashenko was born on September 30, 1954.	Presentation of information in a favorable light for lukashenko	Misinformation attempts to embellish, extinguish the event.

Source: Own work.

Photo verification exercises

1. In the Google Chrome browser do right-click on the image and select “Find this image in Google”. The search result will provide publication dates, sites, and similar photos. Figure 4 shows an example of an unreliable photo.

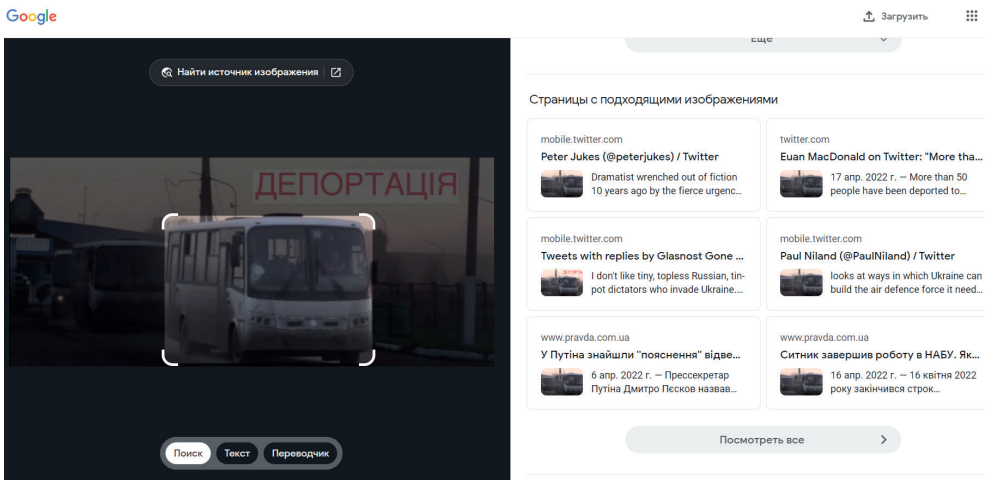


Figure 4. An example of an unreliable photo

Source: Own work.

2. Install the Tineye service extension in the browser. The service allows you to find not only the original photo but also additional metadata. Found photos are sorted by publication date, so you can see if the photo has been edited and when the original version was published. The photo, which was edited and presented in another publication, is presented in Figure 5.

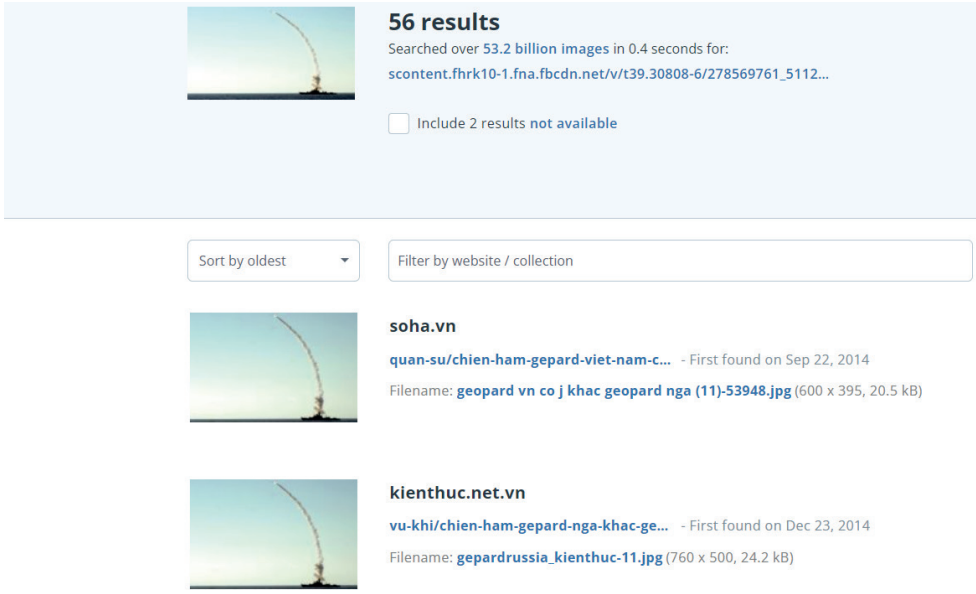


Figure 5. A photo that has been edited and featured in another post

Source: Own work.

3. Verification using geolocation. The services of Google Maps, Google Street View, and the Chinese service Baidu allow you to get comprehensive information about the place of the event. Careful analysis of the image for the presence of visual clues (street names, road signs, buildings, trees) allows you to compare the photo with a real map of the area and find the exact location of the camera at the time of taking the photo.

Video verification exercises

1. Checking the publication date. If it is not displayed in the lower corner of the result of the command View page code – Search – publishDate, then in the HTML code it is possible to see the exact date of publication (Figure 6).

Figure 6. The result of executing the video publication date search command in the HTML code

Source: Own work.

2. Verification of the reliability of weather conditions according to the date of publication. To verify the video, you can use the Wolfram Alpha service, which will allow you to compare the weather conditions on the video with the actual weather conditions on that day and in that place. To do this, you need to enter the text in the search field according to the template "weather city date month year". An example of an application is presented in Figure 7.

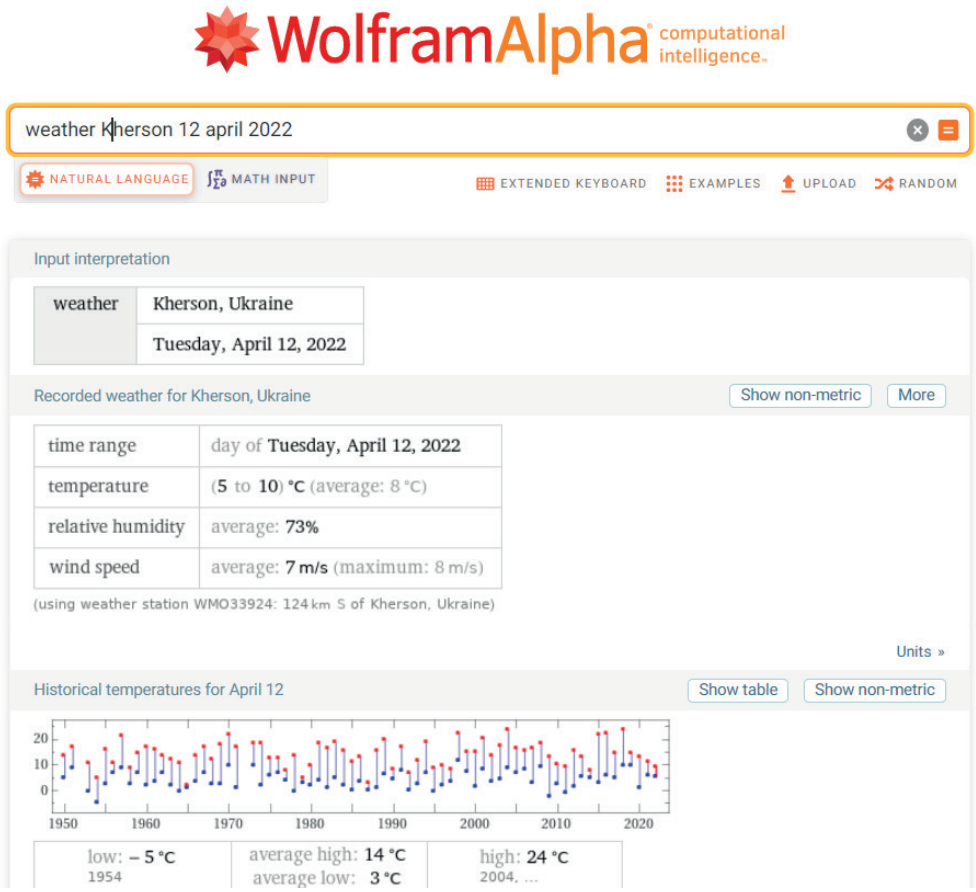


Figure 7. An example of using the "weather city date month year" template

Source: Own work.

3. Use of video analysis services. Features such as breaking down the video into keyframes, searching for similar videos on the network, and exact download time are provided by the free services YouTube DataViewer (a plugin installed in the Google Chrome browser) and InVID (https://citizenevidence.amnestyusa.org/). Table 5 provides some characteristics of these services.

Table 5. Characteristics of video analysis services

Characteristic	InVID	YouTube DataViewer
Download date/time	+	+
Search for old versions of videos	+	+
Video fragmentation and reverse search by video thumbnails in all search engines	+	–
Contextual information about the author of the video, source, geolocation, comments, presence of links	+	–
Magnifier lens (detailed analysis of scaled video screenshots)	+	–
The right to video	+	–
OCR (analysis of text on video, images)	+	–
CheckGif (a tool for proving forgery or authenticity)	+	–

Source: Own work.

As the table shows, the InVID service has more powerful functionality, and therefore we offer students research projects on video verification using it. Mastering the plugin is possible on your own or through master classes that include:

- for verification of photo mastering of computer tools – image analysis (image ID, platform, publication source, time of creation, link, number of likes, number of retweets, image URL), lens (zooming to analyse the details of the image), metadata (if the image contains geocoordinates, it points to this place on the Google map), CheckGif (visual evidence of image forgery by superimposing the processed image on the original image using mathematical software);
- for verification of video acquisition of computer tools – video analysis (location (if detected), most interesting comments, reverse image search), keyframe (segmentation of video by keyframes, which can then be searched by left-clicking on Google or using contextual menu on Google, Yandex, Tineye, Bing, Karma Decay (for Reddit) and Baidu images), thumbnails, metadata.

4.2.4. Task 4. Improve the skills of protecting one's own information space

The results of the survey proved that students have a superficial attitude to security in the information space. Their knowledge is limited only to the ability to set passwords and biometric authentication.

In order to form/develop the skills to protect one's own information space, we offer the exercise "Logical chain", in which the first sentence announces a potential (not always safe) action, for which students propose a chain of further potential dangers. The following dangers are discussed, for example: "If I talk a lot about myself on the Internet, then…", "If I feel safe accepting friend requests from strangers, then…", "If I grant access to the camera or geolocation to installed computer programs, then…", "If I don't update my software and operating system, then…", "If I irresponsibly open an email, then…", "If I use public Wi-Fi networks when accessing my mobile bank, then…".

4.3. Results of a pedagogical experiment

The effect of the special course "Information hygiene" on the ability of young people to resist informational influences was tested in the conditions of a pedagogical experiment using the non-parametric criterion of signs (Grabar & Krasnjanskaja, 1977).
Null hypothesis: the special course does not affect the ability of young people to resist informational influences.
Alternative hypothesis: the special course affects the ability of young people to resist informational influences.
We recorded two results: at the beginning of studying the special course (Result 1) and after studying it (Result 2). The results (Result 1 and Result 2) were determined by the students' answers to the questions in the questionnaire, which are listed in Table 1. The obtained results are presented in Table 6.

Table 6. Results of students before and after studying the special course

Student	Result1	Result 2	Student	Result 1	Result2	Student	Result 1	Result 2	Student	Result 1	Result 2	Student	Result 1	Result 2	Student	Result 1	Result 2
1	2	4	22	4	3	43	3	6	64	3	3	85	2	3	106	4	4
2	2	4	23	4	3	44	1	3	65	3	3	86	2	3	107	4	4
3	2	3	24	4	2	45	1	3	66	3	3	87	2	3	108	4	4
4	3	4	25	4	6	46	2	3	67	4	4	88	3	2	109	4	4
5	3	4	26	4	3	47	2	3	68	4	4	89	3	2	110	5	5
6	4	3	27	4	3	48	2	3	69	4	4	90	3	2	111	3	3
7	3	4	28	4	6	49	3	7	70	4	3	91	3	5	112	3	3
8	3	5	29	5	3	50	3	2	71	4	3	92	3	5	113	3	3
9	3	5	30	3	6	51	3	4	72	4	5	93	3	2	114	2	3
10	3	3	31	3	4	52	3	2	73	4	6	94	4	5	115	2	4
11	2	2	32	3	4	53	3	4	74	5	3	95	2	3	116	2	4
12	2	2	33	2	4	54	3	4	75	3	6	96	2	3	117	3	6
13	3	3	34	2	4	55	4	3	76	3	2	97	2	3	118	3	2
14	1	1	35	2	4	56	2	4	77	3	2	98	2	4	119	2	4
15	1	1	36	3	4	57	2	4	78	2	3	99	1	4	120	3	6
16	2	2	37	3	4	58	2	4	79	2	3	100	1	4	121	2	3
17	2	2	38	2	4	59	2	4	80	2	3	101	2	4	122	2	3
18	2	2	39	3	5	60	2	3	81	3	2	102	2	4	123	2	4
19	3	3	40	3	5	61	4	4	82	3	2	103	2	4	124	2	7
20	3	3	41	1	3	62	4	4	83	2	3	104	1	4	125	2	4
21	3	3	42	1	3	63	4	4	84	3	4	105	2	4	126	1	5

Source: Own work.

Based on the obtained results, Table 7 was formed to speed up the statistical analysis.

Table 7. Dynamics of student results

Score dynamics	Negative, «–»	Unchanged, «0»	Positive, «+»	Number of changes, n=«–»+«+»
Number of respondents	21	39	66	87

Source: Own work.

Since T_{exp} = *66* (this is the number of "+" signs in the sample), *n = 87* (this is the number of respondents who experienced changes in the results), then the area of acceptance of the null hypothesis after the relevant calculations: *[34.36; 52.64]* at the significance level of *0.05.*

Since T_{exp} is beyond the range of acceptance of the H*0* hypothesis, an alternative hypothesis should be accepted with the conclusion that the author's technique affects the ability of young people to resist informational influences. Since the assessment of skills constructed by us is accumulative, the exit of T*exp* (this is the number of positive shifts in the number of students) beyond the critical segment on the right means that a conclusion should be drawn precisely about the positive (not negative) impact of the special course on the ability of young people to resist informational influences.

5. DISCUSSION

The purpose of our research was to develop an effective special course on information hygiene due to the revealed low threshold of compliance with information hygiene by young people and, as a result, the tendency of young people to be manipulated, gullible in perceiving misinformation, unconsciously condoning criminal actions in cyberspace. The developed special course involves the use of active learning methods (trainings, master classes, problem-based lectures) and a significant number of practical tasks that are solved under the guidance of a tutor who acts as a coordinator and consultant. Therefore, the implementation of a special course today is possible rather in the conditions of formal training. However, within the framework of educational and professional training programmes, such courses are not mandatory (unless we are talking about narrow-profile specialties such as journalism) and are offered as a variable component of professional training.

It should be noted that the problem we considered is gaining popularity in the Ukrainian educational space, and similar courses are distributed on various online educational platforms:

- ED-ERA resource (https://www.ed-era.com/) offers free interactive courses «Online course on media literacy» and «Fact check: trust-verify» on methods of information influence on consciousness;
- VUMONLINE resource (https://vumonline.ua/) contains the course «Verification on the Internet» on methods of detecting disinformation and informational provocations;

- the national media project Filter (https://filter.mkip.gov.ua) is focused on the formation of media literacy of Ukrainians and the ability to detect manipulation.

But, regardless of the high quality of such courses, they have shortcomings inherent in informal online education in general: lack of interactive interaction, insufficient level of self-organization of course participants, insufficient level of their concentration skills, etc.

6. CONCLUSION

1. The problems facing the world due to globalization processes, caused by the development of information technologies and means, become especially relevant in the conditions of a military threat. Among such problems are informational influences that are implemented in virtual space, on society as a whole and on each individual citizen, in particular. The reduction of informational influences is possible provided that every member of society observes informational hygiene, the idea of which should be formed already in educational institutions. At the same time, the results of the survey proved that the majority of students today: have a low threshold of awareness of the importance of personal data protection; are gullible, not in the habit of checking information; have weak ideas about the operation of algorithms of the functioning of social networks; do not distinguish fact from judgment; have a low level of critical thinking in information consumption. As a result, students can easily be manipulated, believe misinformation, spread fakes, unknowingly indulge in criminal activities, and share personal data without realizing the possible consequences.
2. One of the ways to solve the problem of information hygiene compliance by every member of society is the purposeful formation of ideas among young people about the existing destructive effects of information technologies. Such formation is possible through the introduction of a special course on information hygiene (elective course, a group, a number of extracurricular activities) as a tool designed to teach how to see the risks of consuming information content and distinguish dangers in the conditions of information confrontations. The special course should solve the following tasks: to form a responsible attitude to the consumption of information content; to develop the ability to counteract destructive influences based on emotional colouring (psychological manipulations, propaganda, disinformation, etc.); to develop practical skills to verify media products for their critical evaluation; to improve the skills of protecting one's own information space.
3. Experimental verification of the effect of the special course on the ability of young people to resist informational influences proved its effectiveness. However, it left a number of problematic issues open, including: the problem of formulation/clarification/definition of information hygiene rules and technologies (practices) for their compliance; the problem of the young generation's lack of high-level thinking skills (analysis, synthesis, generalization, comparison, deduction, induction, analogy, critical evaluation, etc.). Their solution requires separate research at the interdisciplinary level of sociology, pedagogy and psychology.

REFERENCES

Bulatovic, L.L., Bulatovic, G., & Arsenijevic, O. (2014). The education of future teachers of multimedia literacy in Serbia." In EDULEARN14: *6th International Conference On education and new learning technologies* (pp. 590–597).

Drushlyak, M.G., Semenog, O.M., Hrona, H.V., Ponomarenko, H.P., & Semenikhina, O.V. (2022). Typology of internet resources for the development of youth's infomedia literacy. *Information Technologies and Learning Tools*, *88*(2), 1–22. https://doi.org/10.33407/itlt.v88i2.4786.

Eremin, A.L. (1995). K voprosu razvitija novogo napravlenija – informacionnoj jekologii [On the issue of developing a new direction – information ecology]. In *Abstracts of the 1st International Conference*. St. Petersburg: MANEB Center (pp. 238–239).

Fedorov, A.V., Levickaja, A.A., Chelysheva, I.V., Murjukina, E.V., & Grigorova, D.E. (2014). *Media education in Eastern Europe*. Moscow: MOO "Informacija dlja vseh".

Grabar, M.I. & Krasnjanskaja, K.A. (1977). *Application of mathematical statistics in pedagogical research Nonparametric methods*. Moscow: Pedagogika.

Grimes, D.R. (2020). Health disinformation & social media. The crucial role of information hygiene in mitigating conspiracy theory and infodemics. *EMBO REPORTS*, *21*, 11, 51819. https://doi.org/10.15252/embr.202051819.

Horbenko, H., Hondiul, O., & Fruktova, Y. (2020). Non-formal education of educators in media centers of leading European countries: educational and methodological aspect. *Continuing Professional Education Theory and Practice*, *4*, 103–109. https://doi.org/10.28925/1609-8595.2020.4.13.

Jeong, S., Cho, H., & Hwang, Y. (2012). Media Literacy Interventions: A Meta-Analytic Review. *Journal of communication*, *62*, 3. https://doi.org/10.1111/j.1460-2466.2012.01643.x.

Khalamendyk, V.B. (2008). Informatsiina hihiiena yak faktor zberezhennia psykhichnoho zdorovia liudyny [Informational hygiene as a factor in preserving human mental health]. *Humanitarnyi visnyk Zaporizkoi derzhavnoi inzhenernoi akademii [Humanitarian Bulletin of Zaporizhzhya State Engineering Academy]*, *35*, 83–91.

Loukas, G., Murugesan, S., & Andriole, S.J. (2022). Information Hygiene: The Fight Against the Misinformation "Infodemic", *IT Professional*, *24*, 2, 16–18. https://doi.org/10.1109/MITP.2022.3163007.

Pérez-Tornero, J.M. & Tayie, S. (2012). Teacher training in media education: curriculum and international experiences. *Comunicar*, *20*(39), 10–14. https://doi.org/10.3916/C39-2012-02-00.

Varynskyi, V., Varynska, A., Kostytsky, M., & Kushakova-Kostytska, N. (2021). Information security and information hygiene on internet media. *Nexo Revista Científica*, *34*(01), 120–128. https://doi.org/10.5377/nexo.v34i01.11291.

Zhu, S., Yang, H.H., Wu, D., & Chen, F. (2021). Investigating the Relationship Between Information Literacy and Social Media Competence Among University Students. Journal of educational computing research. 0735633121997360. https://doi.org/10.1177/0735633121997360.

ISBN 978-83-66055-31-5
ISSN 2451-3644 (print edition)
ISSN 2451-3652 (digital edition)

UNIVERSITY OF SILESIA
IN KATOWICE