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Adapting curricula to the requirements of the modern digital environment

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■ **Abstract.** The aim of the study was to determine the level of adaptation of curricula to the digital environment, analyse changes, challenges, and achievements related to the introduction of digital technologies, and develop recommendations for the further development of digital education. The results of this study provide recommendations for educational institutions that will facilitate more effective implementation of digital technologies in the educational process, requiring fundamental changes in curricula to improve the quality of education and prepare specialists for the requirements of the modern digital environment. To collect qualitative data, a series of interviews were conducted with students, teachers, and administrators of educational institutions in Lviv, Kyiv, Volyn, and Zhytomyr regions. The interviews were aimed at identifying barriers and opportunities arising from the introduction of digital technologies, as well as effective strategies and approaches to adapting curricula. The results of the interviews showed that most educational institutions are actively implementing digital technologies, using online platforms, interactive whiteboards, virtual laboratories and other digital tools. The main challenges include insufficient technical equipment, unequal access to technology, and the need for continuous professional development of teachers. At the same time, digital technologies help to increase students' interest in learning and improve their results. Adapting curricula to the requirements of the modern digital environment is a prerequisite for ensuring quality education. The use of digital technologies helps to personalise learning, increase student motivation and prepare them for modern challenges. Further development of digital education requires a comprehensive approach that includes technical support, training, and support for teachers and students

■ **Keywords:** integration; educational materials; technology; digitalisation; standards

■ Introduction

In the world of rapid development of information technology and digital technologies, educational institutions face the need to adapt their curricula to the new requirements of the digital society. Digital transformation requires not only the introduction of modern technologies, but also a revision of teaching approaches, curriculum content, assessment methods and teacher training. This is because technology is evolving at a rapid pace, creating a gap between the knowledge students gain during their studies and the skills required in the labour market. Many curricula are based on outdated materials that do not meet the current needs of

the digital economy. And teachers may not have sufficient training to work with modern digital tools and teaching methods.

The main problem is that most educational programmes still focus on outdated teaching methods and do not include the necessary digital skills and competencies. This creates a gap between the requirements of the modern labour market and the training of graduates. It is also important to note that there is an inequality in access to modern digital technologies between urban and rural schools, which further exacerbates this problem. To solve this problem, it is necessary to revise and update

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curricula, provide teachers with the necessary knowledge and skills, and create equal conditions for access to modern technologies for all educational institutions.

A significant number of researchers have studied the adaptation of curricula to the requirements of the modern digital environment. In particular, O. Muliarevych *et al.* (2023) consider digital learning centres to be an essential component of knowledge and the digital learning environment. Scientists believe that the creation of such centres will facilitate the integration of information technology into the educational process and provide students with access to the latest digital resources and platforms.

The adaptation of psychological training programmes to digital technologies contributes to increasing the accessibility of psychological support for different population groups, so the inclusion of digital technologies in modern psychological training programmes allows people to receive psychological support anytime and anywhere through online consultations, mobile applications or web platforms. This will provide an opportunity to learn more, and become more accessible and flexible. Therefore, S. Pihet *et al.* (2024) studied the adaptation of psychoeducation programmes to improve psychological support for caregivers of patients with dementia. Focusing on the medical aspect of their work and how, by adapting the programme, they concentrate on the effectiveness of training and support in different situations, the authors emphasised the importance of individualised approaches and the use of the latest digital tools to ensure high-quality support.

The pandemic has significantly changed approaches to learning, making online education the main teaching method for many educational institutions. O. Pishchukhina *et al.* (2024) focused on the delivery of computer science modules for part-time software students. The researchers analysed how the learning process has changed from the pre-war to the post-pandemic period, focusing on the online learning experience. The study shows that the growing popularity of online learning contributes to greater flexibility and accessibility of educational programmes, especially for those who cannot attend classes in a traditional format. Online education allows students to study at their own pace and place, which is especially important in modern environment.

Modern digital challenges and technologies in the educational environment of higher education institutions are key factors for improving the quality of education. M. Pleskach *et al.* (2020), O. Priadko *et al.* (2022) investigated modern digital challenges and technologies in the educational environment of higher education institutions. They note that the use of the latest technologies, such as virtual reality and artificial intelligence, contributes to improving the effectiveness of learning and student development. The researchers emphasise the need to constantly update educational programmes to meet the modern requirements of the digital world,

which ensures the competitiveness of graduates in the labour market. The professional self-realisation of Ukrainian youth is an integral part of their social and economic development.

Adapting educational programmes to modern labour market conditions and digital challenges is essential for successful integration into professional life. In their research, A. Podolyaka *et al.* (2021), W.S. Mohammad & A.F. Aldakhil (2024) studied the economic, legal and psychological conditions for the professional self-realisation of Ukrainian youth. Focusing on the social aspect, the paper also points out the importance of adapting educational programmes to changing labour market conditions and digital challenges. Ensuring the quality of educational programmes is a key aspect of adapting to the digital environment. The study puts an emphasis on the importance of ensuring the quality of educational programmes through regulatory compliance and support.

Adequate support for teachers and students can significantly increase the effectiveness of educational programmes, which includes providing the necessary resources, professional development for teachers, and creating conditions for effective learning, according to D.M. Quinn & J.S. Kim (2017). Emphasising the importance of artificial intelligence and other modern technologies in modernising the educational process, V.K. Quy *et al.* (2023) also noted that digital transformation contributes to increasing access to education and provides students with the opportunity to acquire knowledge and skills that meet the requirements of the modern labour market.

Adaptation of educational programmes to the needs of displaced children is a critical aspect to ensure their successful learning in a new environment, O. Samoilov *et al.* (2024) explored the psychological and pedagogical aspects of adapting displaced Ukrainian children to a new educational environment. This study shows how important it is to take into account the special needs of students in the process of adapting the educational programme. According to researchers L.M. Sergeieva *et al.* (2022), vocational education also needs to be digitised to improve the efficiency of learning and the training of qualified specialists. Scientists focused on the development of a modern educational environment in the digital space in vocational education and training institutions.

The purpose of the article was to analyse the process of adapting curricula to the needs of modern society in the context of active digitalisation, and to identify challenges and approaches that contribute to improving the quality of education. Objectives of the study are:

- analysis of international experience in implementing digital technologies in the educational process;
- systematising the interview data and identifying the key problems and challenges faced by modern educators in adapting programmes;

- identifying further areas for research and implementing changes to the curriculum.

■ Materials and Methods

The study was conducted using mixed methods to provide an in-depth analysis and a comprehensive understanding of the issues of adapting curricula to the digital environment. The initial stage of the study was a comprehensive review of scientific literature and current research. This included an analysis of academic articles, books, monographs, reports, and research organisations that focus on adapting curricula to the requirements of the modern digital environment. The purpose of the review was to identify the main principles underlying successful adaptation and to identify the main challenges faced by educational institutions. Based on this, the review addressed such aspects as the integration of digital technologies into the educational process, the development of digital competencies among teachers and students, and the impact of digitalisation on the quality of education.

Based on the information gathered, the curricula that have already been adapted to the digital environment are described. This analysis allowed identifying effective practices and tools used in different universities and educational institutions. Particular attention has been paid to both positive examples and cases where difficulties have arisen in the process of adaptation. This helped to get a balanced picture and identify key success factors and risks. To collect qualitative data, a series of interviews were conducted with students, teachers, and administrators of various educational institutions in the Lviv, Kyiv, Volyn, and Zhytomyr regions. The sample included representatives of different levels and types of educational institutions: secondary schools, gymnasiums, lyceums, technical schools, colleges, and universities. The total number of respondents was 100, including:

- 40 students, including students of technical schools and colleges (20 people) and university students (20 people). The students were selected based on their age, speciality, and level of study;
- 30 educators, including teachers and lecturers of various subjects, including humanities, natural sciences and sciences. Their length of service and experience in using digital technologies in education were also taken into account;
- 30 leaders, including school directors, head teachers, deans of faculties, vice-rectors and other administrative staff with experience in managing educational institutions and implementing digital innovations.

The study was conducted in accordance with the Declaration of Helsinki (2013). The participants gave their consent for the experiment. The sample was formed in such a way as to ensure a diversity of opinions and experiences of the respondents, as well as to consider the specifics of different regions and types of

educational institutions. The interviews were conducted in the format of in-depth semi-structured conversations, which allowed for detailed and substantiated answers to questions related to the adaptation of curricula to the requirements of the modern digital environment. The interviews were aimed at identifying barriers and opportunities that arise during the implementation of digital technologies in the educational process, and at identifying effective strategies and approaches that contribute to improving the quality of education and professional training. The main issues discussed were:

1. How do you assess the current level of adaptation of your institution's curricula to the requirements of the modern digital environment?
2. What specific changes have been made to the curriculum in recent years to integrate digital technologies?
3. What are the challenges of implementing digital technologies in the educational process?
4. How do you assess the readiness of teachers to use digital technologies in teaching?
5. What resources and tools are used to improve teachers' digital skills?
6. What digital tools and resources are used in the educational institution?
7. What results or achievements can you point to after the introduction of digital technologies in the curriculum?
8. How do you see the future of digital education, and what steps is your institution taking to be at the forefront of this process?

The collected opinions allowed determining the key challenges they face when adapting curricula. This will help to understand their experience of using new approaches and tools in the learning process, to identify the advantages and disadvantages of these methods from the point of view of end users. It also provided an opportunity to identify practical problems that may not be reflected in the scientific literature and to obtain real-life examples from practice.

■ Results

Adapting curricula to the requirements of the modern digital environment is a relevant and essential issue in the modern world. It not only improves the quality of education, but also ensures that future professionals have the necessary skills to work successfully in the digital world. Firstly, the digital environment is constantly evolving. New technologies, software products, data processing methods and communication tools are emerging. Traditional curricula that do not take these changes into account are quickly becoming outdated. For example, artificial intelligence, machine learning, and big data technologies are already affecting all industries. If students do not acquire knowledge and skills in these areas during their studies, they lose their competitiveness in the labour market.

Secondly, adapting curricula to the digital environment promotes critical thinking and creative problem-solving. Digital tools allow students to work with large amounts of information, analyse data and create new knowledge. This stimulates their ability to think systematically, critically evaluate information and find innovative solutions. For example, using simulation software allows students to model different scenarios and experiment with different approaches to solving problems. Third, adapting to the digital environment increases the interactivity of the learning process. The use of multimedia resources, online courses, virtual laboratories and other digital tools makes learning more engaging and accessible. This is especially important for students, who are growing up in the context of widespread digitalisation. They are used to receiving information quickly and in a format that is convenient for them. Therefore, the integration of digital technologies into the learning process allows better meeting their expectations and needs.

Adaptation of curricula also contributes to the training of specialists who are able to work in the digital economy. The ability to use modern information technology, work in a team, lead projects and communicate in a digital environment are essential skills for a future professional. Such knowledge can only be acquired by adapting curricula to the latest requirements and standards (Jian & Abu Bakar, 2024). With the globalisation of education, students have the opportunity

to choose the best study programmes around the world. Therefore, educational institutions that do not implement digital innovations risk losing their prestige and attractiveness to applicants. Institutions that actively integrate digital technologies into the educational process have a better chance of attracting talented students and providing them with a high-quality education. Digital technologies play a key role in ensuring sustainable development, increasing production efficiency and improving the quality of life. Educational programmes that train specialists capable of implementing and using these technologies make a significant contribution to the development of society. Thus, adapting curricula to the requirements of the modern digital environment is a prerequisite for training competitive specialists, developing critical thinking, increasing the interactivity of the learning process and addressing global challenges. It is an investment in the future that ensures sustainable development of both individuals and society as a whole.

The development of technology and digital tools has a significant impact on the educational process, requiring new approaches to learning and teaching. This includes the integration of the latest technologies into curricula, the development of new teaching and assessment methods, and the improvement of digital literacy of students and teachers. The main aspects of adapting curricula to the requirements of the modern digital environment are highlighted in Table 1.

Table 1. Characteristics of aspects of curriculum adaptation

The adaptation aspect	Description	Example of implementation
Implementation of online resources	Using digital platforms for learning	Use of platforms such as Moodle, Google Classroom
Interactive learning materials	Use of multimedia elements and interactive courses	Video lectures, interactive simulations, online laboratories
Flexible forms of education	Developing programmes with distance and blended learning options	Asynchronous courses, webinars, video conferences
Digital skills of teachers	Professional development of teachers in the field of IT and digital technologies	Digital literacy courses for teachers
Personalisation of training	Individual approach to learning with the use of technology	Adaptive learning platforms, analytics of student performance
Assessment in digital format	Implementation of online testing and assessment tools	Online tests, e-portfolios, assessment systems
Data protection and cybersecurity	Ensuring data security and protection against cyber threats	Use of secure platforms, cybersecurity training
Support and accessibility	Providing access to learning materials for all students	Support for various devices, adaptation for students with special needs

Source: compiled by the author based on J. Cabero-Almenara et al. (2020), O. Sushchenko et al. (2021)

One of the key aspects of adapting curricula to the requirements of the modern digital environment is the introduction of digital technologies into the learning process. This includes the use of computers, tablets, interactive whiteboards, online platforms and software

that enhance learning. For example, distance learning platforms such as Google Classroom, Moodle, or Zoom have become indispensable tools during the pandemic, as educational institutions around the world have switched to distance learning (Table 2).

Table 2. Characteristics of platforms according to the requirements of the digital environment

Platform	Applications in line with the requirements of the digital environment	Ways to improve the usage
Moodle	Organising courses, tests, and forums; integration with other services (Zoom, Google Meet).	Regular updates and tweaks to the platform; improving the skills of teachers in working with the platform.
Google Classroom	Working together on documents; using Google Drive to store materials; use of integrations with other applications (Jamboard, Google Meet).	Extending the platform's capabilities with third-party applications; training teachers and students in the use of all platform functions.
Microsoft Teams	Video conferencing, chat groups, collaboration; integration with Office 365 for easy document management.	Regular trainings for teachers and students; use of analytical tools to assess the effectiveness of training.
Zoom	Conducting webinars and online classes; use the video recording and saving functions.	Improving cybersecurity and educating users on the basics of security; integration with other platforms to improve interaction.
Coursera	Access to courses from the world's leading universities; the possibility of obtaining certificates upon completion of the courses.	Creating local courses for students; use of analytics to increase student engagement.
EdX	Use to access educational resources; interactive courses with practical tasks.	Integration with other educational platforms; feedback from teachers and students to improve the content.
Khan Academy	Use of video tutorials and interactive tasks; personalised training with progress tracking.	Development of additional resources for teachers; Adaptation of content to the requirements of local curricula.
Udemy	A variety of courses on any topic; the ability to create one's own courses with teachers.	Improving the quality of content through feedback; use of the platform for professional development of teachers.

Source: compiled by the author based on O. Shkatula et al. (2023), O. Banit et al. (2023)

Different platforms can be used to meet the requirements of the modern digital environment, and it is important to consider the above steps to improve their use in the educational process. In order to effectively adapt curricula to the digital environment, it is necessary to increase the level of digital literacy among both students and teachers. This includes the ability to use computers, work with various applications and online resources, and cybersecurity knowledge. Educational institutions can organise professional development courses for teachers, as well as include the basics of digital literacy in school curricula.

Digital technologies open up new opportunities for personalising the learning process. Through the use of adaptive curricula and platforms, students can learn at their own pace, receive assignments tailored to their abilities and needs, and have access to additional resources to deepen their knowledge. For example, platforms like Khan Academy offer customised learning plans that allow learners to progress at their own pace. Interactive teaching methods are another crucial aspect of adapting curricula to the modern digital environment. The use of multimedia materials, virtual laboratories, interactive simulations and games helps to engage students in the learning process and increase their motivation. For instance, virtual laboratories allow students to conduct experiments that cannot be performed in real life due to equipment or safety limitations (Gabara et al., 2020). Despite the obvious benefits of digitalising education, there are also challenges. One of them is unequal access to digital technologies. In some regions or among certain social groups, access to computers and the internet may be limited, creating barriers to quality education. Another challenge is the need to constantly update the knowledge and skills of

both teachers and students, which requires additional resources and time.

An important aspect is to prepare teachers to work in a digital environment. This includes not only technical skills, but also methodological training on how to use digital tools in the learning process. Teachers need to be able to integrate digital resources into their lessons, develop interactive tasks, and use distance learning platforms effectively. Adapting curricula to the digital environment requires revising and updating them. This encompasses the inclusion of new subjects and topics related to digital technologies, as well as the adaptation of existing programmes to new requirements. For example, courses on programming, robotics, digital literacy and cybersecurity can be included in the curriculum. STEM education is a critical component of modern curricula. The integration of STEM disciplines allows students to acquire the knowledge and skills necessary to work successfully in the modern technological environment. The use of digital technologies in teaching STEM subjects, such as programming, 3D printing, robotics and virtual reality, contributes to the development of critical thinking and creativity of students.

One of the main advantages of digital learning is its flexibility. Learners can study at a time and place convenient for them, which is especially relevant in cases where traditional learning is not possible due to objective circumstances. In addition, digital technologies make it possible to create more visual and interesting learning materials, which contributes to better knowledge acquisition. Adapting curricula to the requirements of the modern digital environment is a prerequisite for ensuring high-quality and up-to-date education. The introduction of digital technologies, development

of digital literacy, personalisation of learning and interactive teaching methods contribute to improving the educational process and increasing the level of knowledge of students. However, successful adaptation also requires addressing the challenges associated with unequal access to technology and the need to constantly update knowledge and skills. A major part of this process is teacher training and updating curricula to reflect current requirements and trends.

The following answers were received to question 1:

1. One of the teachers interviewed in Kyiv noted that their educational institution had made a significant step forward in digitalisation, and the use of online platforms and interactive materials had become an integral part of the educational process.

2. A student from Lviv believed that they are still on the way to full adaptation, as many teachers actively use digital tools, but there are still those who prefer traditional teaching methods.

To question 2, respondents expressed the following opinions:

1. One of the leaders from Zhytomyr is convinced that many participants in the educational process have already added courses on the basics of digital literacy and programming, as well as introduced the use of virtual laboratories for natural sciences.

2. One of the Volyn teachers interviewed noted that the use of online platforms for homework and testing has become a standard, and he has already started using multimedia presentations and video lessons.

The respondents answered question 3 as follows:

1. One of the Kyiv teachers is convinced that the main challenge is insufficient technical resources, as not all students have access to the necessary devices and stable internet.

2. At the same time, a student from Volyn found that a big problem is that not all teachers have sufficient digital skills, which slows down the process of introducing new technologies.

The following answers were received to question 4:

1. One administrator from Kyiv emphasised that most of their teachers are eager to improve their skills, but the level of training varies, and this is because some have a high level of digital literacy, while others need additional training.

2. One of the teachers in Lviv identified that teachers are ready to use digital technologies, but need regular training and support from the administration.

The respondents provided the following answers to question 5:

1. One of the teachers from Zhytomyr revealed that their institution organises regular seminars and webinars and cooperates with educational platforms such as Prometheus and EdEra.

2. One of the administrators of Volyn noted that they provide access to online courses and trainings, as well as engage experts to conduct masterclasses.

In response to question 6, respondents expressed the following opinions:

1. The Kyiv student emphasised that various distance learning platforms are used, such as Google Classroom, Zoom, as well as specialised software products for studying specific disciplines.

2. One of the Lviv teachers interviewed noted that she actively uses interactive whiteboards, virtual laboratories and software to create multimedia materials.

The respondents provided the following answers to question 7:

1. One of the administrators of Zhytomyr city noted that there is an active growth of students' interest in learning, improvement of their results and growth of digital literacy.

2. One of the Kyiv teachers noted that he sees a significant increase in the efficiency of the learning process, as students have access to more information and can study at their own convenience.

The following opinions were received on the last question:

1. One of the administrators from Volyn noted that he sees the future of education in the full integration of digital technologies, as he plans to expand the use of virtual reality and artificial intelligence in his own educational process.

2. A teacher from Lviv noted that all teachers are actively working on creating digital learning materials and expanding distance learning opportunities, as they strive to ensure equal access to quality education for all students, regardless of their place of residence.

Interviews with educational stakeholders show that the introduction of digital technologies into the curriculum has already had a significant positive impact. However, for further successful development, it is necessary to overcome existing challenges, ensure equal access to digital resources and continuously improve the qualifications of teachers. Only under these conditions is it possible to achieve high-quality education and prepare students for the modern requirements of the labour market.

The introduction of digital technologies into the learning process is an important step in the development of modern education. International experience shows a variety of approaches and strategies that can be useful for improving the Ukrainian education system. In particular, in the United States, digital technologies are actively integrated into the educational process at all levels. One of the leading initiatives is the E-Rate programme, which provides schools with access to broadband internet. Online learning platforms such as Khan Academy and Coursera, which offer free educational resources, play a pivotal role. A critical emphasis is placed on personalised learning, where technology helps to adapt educational content to the individual needs of each student. For example, Finland, which is known for its high quality of education, is actively

introducing digital technologies into the learning process. All schools have access to the Internet and modern equipment. Platforms such as Moodle and Edmodo are used to manage the learning process and communicate between students and teachers. In addition, teachers receive special training to effectively use digital technologies in teaching. Singapore is actively implementing digital technologies in education through the Smart Nation programme. All schools are equipped with interactive whiteboards, tablets, and computers. The Singaporean education system uses online platforms to support distance learning and assess students' knowledge. Special attention is paid to STEM education, where digital tools help students learn complex concepts through interactive simulations and projects. South Korea is one of the leaders in the introduction of digital technologies into the educational process. All schools are provided with high-speed internet and modern equipment. Teachers use e-textbooks, online courses and learning management platforms such as K-MOOCs. The government also supports teacher training programmes for the use of digital technologies in teaching, which helps to improve the efficiency of the educational process. Estonia, known for its digital transformation, is also actively implementing digital technologies in education. All schools have access to the Internet and digital learning materials. An important element is the ProgeTiiger programme, which includes programming and digital literacy training from an early age. Distance learning platforms such as eKool and Moodle are used, providing interactive and personalised learning, as Y. Slutskiy *et al.* (2023) noted.

International experience in introducing digital technologies into the educational process demonstrates the importance of a comprehensive approach. Key elements include access to modern equipment and the Internet, teacher training, the use of online platforms for learning management and assessment, and the integration of digital literacy and programming into the curriculum. Ukraine can use these examples to develop its own strategies and initiatives to help improve the quality of education and ensure that students are prepared for modern challenges. Education plays a key role in preparing the younger generation for the challenges they face. For Ukraine, identifying further areas for research and implementing changes to curricula is an indispensable step in ensuring the country's competitiveness and development. Given the rapid development of technology, it is important to continue researching and implementing digital tools in the curriculum. This includes the creation of interactive textbooks, virtual laboratories, online learning platforms and digital libraries. These tools not only make learning more interesting, but also help students develop independent learning and critical thinking skills.

One of the key areas is the development of personalised learning approaches. Research in this area could

focus on creating adaptive curricula that take into account the individual needs and abilities of each student. This will allow for more effective development of each child's potential, reduce the number of students experiencing learning difficulties, and increase overall academic performance. Modern education should focus on developing skills that are essential in the 21st century. This includes critical thinking, creativity, communication skills, teamwork, problem-solving and digital literacy. It is relevant to conduct research to determine the most effective methods of developing these skills and integrate them into the curriculum. STEM education is an integral part of the modern educational process. In Ukraine, there is a need to expand opportunities to study STEM disciplines, starting with primary school. Research in this area could include the development of new teaching materials, the creation of laboratories and technology parks, and teacher training programmes. Ensuring equal opportunities for all students, regardless of their physical or psychological characteristics, is a crucial aspect of modern education. Research in this area could focus on developing methods and materials for inclusive education, adapting curricula, and training teachers to work with children with special needs. Given the global environmental challenges, it is important to integrate environmental education into the curriculum. This includes learning about sustainable development, environmental protection, energy conservation and environmentally friendly technologies. Research in this area can contribute to the development of educational materials and programmes that help students understand the importance of environmental responsibility. Another crucial aspect is preparing students for future careers. This encompasses career guidance programmes, internships, and cooperation with businesses. Research could focus on identifying effective models of interaction between schools and employers to help students better understand their professional interests and opportunities.

Identifying further areas for research and curriculum change in Ukraine includes integrating digital technologies, developing personalised learning, promoting STEM education, ensuring inclusive education, environmental education and career guidance – these are key areas that will help improve the quality of education and prepare students for modern challenges. It is relevant to continue research in these areas and implement best practices to ensure a successful future for Ukraine. Adapting educational programmes to the requirements of the modern digital environment is extremely important for ensuring high-quality education. Modern technologies are developing rapidly, and their integration into the educational process makes learning more accessible, interactive and effective. The introduction of digital tools helps students develop critical thinking, independent learning and problem-solving skills, which are key to a successful career in the modern world. In

addition, the digitalisation of education allows for the creation of personalised curricula that take into account the individual needs and abilities of each student. It also contributes to the development of digital literacy, which is essential for modern life. Therefore, the adaptation of educational projects to digital reality is an integral part of the modernisation of Ukrainian education.

■ Discussion

The results show that the modern world is rapidly changing under the influence of digital technologies, and the adaptation of curricula to the requirements of the digital environment is becoming a key aspect of ensuring the competitiveness of graduates. Changes in education are needed to provide students with the knowledge and skills necessary for a successful career in the new economy. The study showed that traditional disciplines often do not take into account the latest technological advances, making graduates less competitive in the labour market. The Internet and digital platforms allow students and teachers to interact with colleagues around the world. Curricula need to take this global context into account and prepare students for international cooperation and competition. This is supported by the work of many other researchers. For example, according to research by S. Syahrizal *et al.* (2024), M.S. Alsaeed & M.K. Aladil (2024), updating the content of education, including courses in programming, data analysis and information security, is a necessary condition for ensuring the relevance of education. The data confirms that the inclusion of such disciplines in the curricula of technical specialities increases the level of students' training and increases their chances for a successful career.

The analysis of modern curricula has shown that the integration of digital technologies, such as virtual laboratories, simulations and online learning platforms, significantly increases the effectiveness of learning. This is consistent with the views of Y. Slutskiy *et al.* (2023), who noted that the use of modern technologies creates an interactive and inclusive learning environment. And virtual laboratories allow students to conduct experiments in a safe digital environment, which confirms the effectiveness of this approach. As it turned out, hybrid teaching methods that combine traditional lectures with online courses remain successful. This is another important aspect of curriculum adaptation. The results showed that this approach allows students to gain knowledge at a time and pace convenient for them, increases learning efficiency and reduces stress, which coincides with the work of O. Kondur & N. Fuchynska (2021), V.M. Rebenok & A.P. Yushchenko (2022), S. Drossard & A. Hartl (2024). They noted that such training contributes to the development of independence and self-learning skills, which is essential for a successful career in the digital society. It is found that the adaptation of curricula is not only desirable,

but also a necessary condition for preparing students for future professions. The introduction of the latest technologies, updating the content of education and the use of hybrid teaching methods can improve the quality of education and make it more relevant to the requirements of the labour market. However, in order to achieve these goals, significant challenges need to be overcome, including financial support and professional development of teachers.

Despite its many advantages, adapting curricula to the requirements of the digital environment faces several challenges. One of the main ones is the lack of qualified personnel capable of implementing and using the latest technologies in the educational process. The study showed that teacher training is essential for successful adaptation. This is confirmed by the research of N. Morze *et al.* (2019), K. McNelis *et al.* (2022), which points to the need to create professional development programmes for each teacher to master the latest technologies and teaching methods. Another challenge is financial constraints. The introduction of modern technologies requires significant investment, which can be problematic for many educational institutions, especially in countries with limited budgets. Therefore, it is crucial to constantly seek new sources of funding, including through partnerships with private companies and international organisations. Such hypotheses were confirmed by the results of the study, which coincide with the findings of N. Morze *et al.* (2023), J. Cao *et al.* (2024).

Successful curriculum adaptation requires a strategic approach that includes several key elements. The study showed that regular monitoring of the latest technological and market trends allows educational institutions to respond quickly to changes and update curricula in accordance with current requirements. This is supported by the findings of S. Karpluk (2019), B. Muckenhofer *et al.* (2023), who pointed out the importance of analysing market trends for adapting curricula. Also, the organisation of professional development courses for teachers to master the latest technologies and teaching methods is a key element of successful adaptation, as K. Dyrfjor *et al.* (2023) noted. The creation and implementation of modern learning materials that take into account the specifics of the digital environment is an important aspect of curriculum adaptation. The study results show that e-textbooks, interactive tasks and video lectures provide a variety of learning modes. Partnerships with companies working in the field of IT and digital technologies are successful, as noted by researchers N. Kravtsova *et al.* (2022), S. Alkhayyal & S. Bajaba (2024), who argued that this allows educational institutions to obtain up-to-date information on labour market needs and adapt curricula to meet them. The data confirms that such cooperation creates opportunities for student internships and the involvement of practitioners in the educational process. This is consistent with the findings of this study.

Regular evaluation of the effectiveness of study programmes to improve them is a key element of successful adaptation. The results indicate the importance of student feedback and analysis of graduates' performance in the labour market. This is supported by the study by L.A. Kolesnichenko *et al.* (2021), who emphasised the importance of regular programme evaluation and improvement. The results of this study show that the introduction of digital technologies in the educational process significantly increases student engagement and their readiness to work in the modern digital environment. After all, digital technologies make it possible to adapt curricula to the individual needs of students, providing a more efficient and relevant educational process. The findings of the researcher E. Balashov (2023) confirm the data on the importance of using innovative technologies. Other studies, including the work of K. Kolesnik *et al.* (2023), O. Borzenko *et al.* (2024), indicate that in a rapidly changing digital environment, professional and personal learning is becoming a continuous process. Adapted curricula help students develop independent learning skills and readiness for change.

Adapting curricula to the requirements of the modern digital environment is an integral part of the development of the education system. This study, as well as the research of other scholars, confirms that the introduction of the latest technologies, updating the content of education and the use of hybrid teaching methods helps to improve the quality of education and prepare students for a successful career in the digital economy. However, to achieve this goal, several challenges need to be overcome, including the provision of qualified staff and sufficient funding. A strategic approach, including monitoring trends, professional development of teachers, cooperation with industry and regular performance evaluation, is key to successfully adapting curricula to the modern digital environment. Education must be a dynamic and flexible system that can respond quickly to changes in technology and the labour market, equipping students with the knowledge and skills they need for a successful future. It is important for educational institutions to actively innovate, develop partnerships with industry and invest in the professional development of their teachers.

An analysis of the research findings in the context of other scholars' work shows that there is a consensus on the need to integrate digital technologies and adapt curricula. This confirms the importance of a strategic approach to changes in the educational process, including monitoring trends, collaboration with industry, and regular performance evaluation. Education must be ready to respond quickly to changes in technology and labour market demands. This is the only way to provide students with the knowledge and skills that will allow them to successfully integrate into the modern digital environment and achieve professional success.

■ Conclusions

The adaptation of curricula to the requirements of the modern digital environment is a pressing issue that is becoming increasingly significant in the context of modern education. The interviews with students, teachers, and administrators of educational institutions in Lviv, Kyiv, Volyn and Zhytomyr regions allowed gaining valuable insights and identifying the main areas for further action. The majority of students, teachers, and managers surveyed have a positive attitude towards the introduction of digital technologies in the educational process. They noted that digital tools help to increase student engagement, make learning more interactive and accessible. It is important to continue to maintain and develop this positive attitude through training of teaching staff and provision of necessary resources.

One of the main challenges identified by respondents is the lack of technical support for educational institutions. Insufficient number of computers, outdated equipment, and unstable internet access are becoming obstacles to the effective integration of digital technologies. It is recommended to increase investment in the technical support of schools and universities, as well as to ensure stable access to high-speed Internet. Teachers noted the need for additional training to effectively use digital tools in teaching. Many of them do not have sufficient skills and knowledge to work with the latest technologies. Professional development programmes and trainings for teachers should be developed to help them master new methods and tools. The students emphasised the importance of a personalised approach to learning, which is made possible by digital technologies. They noted that individualised curricula help them to learn better and develop their own skills. Educational institutions should work to create adaptive curricula that take into account the individual needs and interests of students. The interviews showed that there is a need to increase the level of digital literacy among students and pupils. It is critical to include digital literacy courses in the curriculum from an early age, which will allow students to acquire the necessary skills to use digital tools effectively in their studies and everyday life.

The heads of educational institutions noted the importance of supporting innovative initiatives and projects in the field of education. They pointed out the need to create conditions for the development of start-ups and innovative programmes that contribute to the digital transformation of education. It is recommended to introduce grant programmes and competitions to support innovative ideas. An important aspect is to create a system of feedback and evaluation of the effectiveness of digital technologies. Teachers, students, and administrators should participate in regular surveys and questionnaires to identify problems and find solutions. Adapting curricula to the requirements of the modern digital environment requires a comprehensive approach and coordinated work of all participants in the

educational process. The interviews indicate the need for technical support, training of teaching staff, development of digital literacy and support for innovation. It is essential to take into account the opinions and needs of students, teachers, and administrators to create an effective and modern educational system in Ukraine.

A limitation of the study was that the interviews covered only four regions of Ukraine: Lviv, Kyiv, Volyn and Zhytomyr. This limits the possibility of generalising the results to the whole country, as the conditions

and level of development of educational technologies may differ significantly in other regions of Ukraine. For a more comprehensive analysis, other regions, such as the eastern and southern regions, should be included.

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■ Conflict of Interest

None.

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Адаптація навчальних програм до вимог сучасного цифрового середовища

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■ **Анотація.** Метою дослідження було визначення рівня адаптації навчальних програм до цифрового середовища, аналіз змін, викликів та досягнень, пов'язаних з впровадженням цифрових технологій, а також розробка рекомендацій щодо подальшого розвитку цифрової освіти. У результатах даного дослідження розроблено рекомендації для освітніх установ, які сприятимуть більш ефективному впровадженню цифрових технологій у навчальний процес, що вимагають кардинальних змін у навчальних програмах для підвищення якості освіти та підготовки фахівців до вимог сучасного цифрового середовища. Для збору якісних даних було проведено серію інтерв'ю зі студентами, викладачами та адміністраторами освітніх закладів Львівської, Київської, Волинської та Житомирської областей. Інтерв'ю були спрямовані на виявлення бар'єрів та можливостей, що виникають під час впровадження цифрових технологій, а також ефективних стратегій та підходів до адаптації навчальних програм. Результати інтерв'ю показали, що більшість закладів освіти активно впроваджують цифрові технології, використовуючи онлайн-платформи, інтерактивні дошки, віртуальні лабораторії та інші цифрові інструменти. Основні виклики включають недостатню технічну оснащеність, нерівний доступ до технологій та необхідність постійного підвищення кваліфікації викладачів. Водночас цифрові технології сприяють підвищенню зацікавленості студентів у навчанні та покращенню результатів. Адаптація навчальних програм до вимог сучасного цифрового середовища є необхідною умовою для забезпечення якісної освіти. Використання цифрових технологій сприяє персоналізації навчання, підвищенню мотивації студентів та підготовці їх до сучасних викликів. Подальший розвиток цифрової освіти вимагає комплексного підходу, що включає технічне забезпечення, навчання та підтримку викладачів та студентів

■ **Ключові слова:** інтеграція; освітні матеріали; технології; цифровізація; стандарти



The impact of distance learning on the development of information and communication skills of students of higher education institutions

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■ **Abstract.** The aim of the article was to identify the impact of distance learning on the development of information and communication skills of students in higher education institutions. The article examined the impact of distance learning on the development of information and communication technology (ICT) skills of students in higher education institutions. It has been found that in the context of the pandemic, educational institutions were forced to switch to a distance learning format, which emphasised the importance of digital literacy and technical competence of students. It is determined that ICT is crucial for modern education and professional development of students. The study surveyed 100 students about their experience of using ICT in distance learning, which was conducted in three stages with students of different specialities to identify their views on changes in the level of ICT competencies. The results showed that students have significantly improved their skills in working with software, using online resources and interacting in the digital environment. At the same time, certain obstacles were identified in the context of distance learning, which are related to technical problems and lack of practical experience. However, the analysis showed positive changes in academic achievement for a significant number of students after using ICT. This made it possible to identify that distance learning has become quite effective for learning the material. The conclusions show that distance learning, despite its shortcomings, has a significant positive impact on the development of students' ICT skills. It is recommended to integrate elements of distance learning into the traditional educational system to ensure more effective formation of digital competences

■ **Keywords:** students; online learning resources; digital literacy; technological competence; educational platforms

■ Introduction

The rapid development of information and communication technologies (ICTs) is being witnessed, which are penetrating all spheres of life, including education. Distance learning is becoming more and more relevant and important every year due to the development of digital technologies, globalisation, and constant challenges, including the COVID-19 pandemic in the world. The relevance of distance learning is also growing in times of war, as it ensures the continuity of the educational process when physical attendance at educational institutions becomes impossible or

dangerous. In this case, distance learning allows children to continue to receive knowledge regardless of their location, reducing risks to their safety. It also helps to maintain the psycho-emotional state of children by giving them the opportunity to communicate with their peers and teachers. The use of modern technology makes education more flexible and accessible in challenging environments.

Due to such obstacles, the ability to use ICTs becomes especially relevant for students of higher education institutions (HEIs). It is critical to identify the

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impact of distance learning on the development of information and communication skills of higher education students. Despite the constant introduction of distance learning, there are numerous problems and challenges that require additional research and analysis. The main task is to determine the impact of distance learning on the development of students' information and communication skills. The study of this aspect is considered necessary to improve the educational process, adapt teaching methods and support higher education students in the new environment.

The relevance of the topic of the impact of distance education on the development of information and communication skills of university students is confirmed by a number of studies. In particular, I. Vasylykiv *et al.* (2024) emphasised that distance technologies have significantly expanded the capabilities of each participant in the educational process. In the modern world, education can be obtained from anywhere in the world. And although traditional forms of education are not losing ground, distance education technologies are becoming increasingly popular. The research results presented by A. Hibszer & M. Tracz (2023) point out the importance of using a variety of technologies in HEIs and their integration into the pedagogical practice of individual disciplines. The researchers focused on supporting individual learning of students, interaction between participants in the educational process and collaboration through digital technologies. D. Perbandt *et al.* (2021) studied the impact of online learning on the development of students' communication skills, finding that active participation in online discussions and group projects significantly improves these skills.

A. Kumi-Yeboah *et al.* (2023), Yu. Kuchyn & L. Lyman (2023) studied blended learning (a combination of distance and face-to-face learning) and its impact on the learning process. They emphasised that blended learning combines the advantages of both forms of learning, contributing to the development of various skills of students. N. Sharata *et al.* (2022) investigated the factors that influence higher education students' engagement in online learning, finding that active engagement depends on the quality of learning materials, feedback from teachers, and opportunities for social interaction. E.M. Weaver *et al.* (2022) identified key aspects of creating effective learning communities for online learning, highlighting the importance of maintaining a sense of community among students. D. Yan & Q. Fan (2022) studied adaptation to distance learning and the development of autonomy, showing that distance learning increases students' autonomy by developing self-organisation and self-control skills. At the same time, the study found that not all students adapt equally easily to new conditions, which can cause stress and reduce motivation.

A. Conti Gomes de Souza *et al.* (2023) noted that distance learning contributes to the improvement of technical skills of students who successfully master new learning platforms (Microsoft Teams, Zoom, Moodle). However, insufficient technical support and different levels of access to digital technologies can create discomfort for some students. Y. Peng *et al.* (2023) found that distance learning has a mixed effect on students' psychological state. Flexible scheduling reduces the stress associated with physical attendance, but the lack of face-to-face interaction can lead to isolation and reduced motivation. The study by A. Rosetta *et al.* (2021) showed that distance learning has a positive effect on the development of communication skills in virtual teams, promoting interpersonal communication in a digital environment. However, the lack of physical presence can lead to feelings of isolation and lack of personal contact, which negatively affects communication.

The analysed studies confirm that distance learning has a significant impact on the development of information and communication skills of higher education students. However, this impact is multifaceted and depends on many factors, including technical support, the level of support from teachers, and individual characteristics of students. In most cases, researchers have identified the positive and negative aspects of distance learning, determined the psychological factors of influence on students, but not enough attention has been paid to the impact of distance learning on the development of information and communication skills of higher education students.

The purpose of the article was to identify the impact of distance education on the development of information and communication skills of university students. In accordance with this goal, the objectives of the study were:

- conducting a theoretical analysis of the scientific literature on distance learning and ICT;
- carrying out a survey of students about their experience of using ICT in distance learning;
- performing a comparative analysis of students' performance in the context of distance learning.

■ Materials and Methods

The purpose of the survey was to investigate the experience of higher education students in using ICT in distance learning. In particular, the survey was aimed at identifying their level of satisfaction, the main challenges and benefits they faced, as well as the impact of distance learning on their ICT development.

The experiment was conducted from October 2022 to June 2023. The study involved 100 students of Ivan Franko National University of Lviv. The participants of the experiment were aged 17-19, of whom 68% were girls and 32% were boys. The survey was conducted among students of different specialities and courses of the university using an online questionnaire. The questionnaire consisted of 20 questions, including both

closed and open-ended questions, to obtain detailed information. The survey was conducted using an online questionnaire that included both closed and open-ended questions, which provided detailed information about students' experiences and attitudes towards ICT use. The survey was carried out in three stages, taking into account ethical standards, namely voluntary participation, confidentiality, honesty, and transparency. Adherence to these ethical standards contributes to scientifically sound and ethically correct research, increasing the trust of respondents and the quality of the data obtained:

Stage I. General information about the respondents. Students answered the following questions in the questionnaire:

1. Frequency of ICT use. Frequency of ICT use for learning (daily, several times a week, rarely, never);
2. Types of devices used. Types of devices used by respondents for studying (computer, laptop, tablet, smartphone);

3. Level of ICT proficiency. Level of ICT skills (beginner, intermediate, advanced);

4. The purpose of using ICT. Purpose of using ICT (searching for information, completing assignments, communicating with teachers, participating in online courses, working with learning platforms);

5. Problems in using ICTs. Difficulties in using ICT (technical problems, slow internet speed, lack of skills, lack of necessary equipment);

6. The impact of ICT on academic performance. Respondents' assessment of the impact of ICT on their academic performance (positive, neutral, negative).

This data helped to understand how students and teachers use ICT in the educational process, identify problem areas and improve technological support at the university. According to the information provided by the students, a group of 100 respondents was formed. Based on the first section of the survey, general information about the respondents, Table 1 is compiled according to the number of respondents.

Table 1. General information about the respondents

	Faculties					
	Pedagogical	Philological	Journalism	International relations	Legal	Historical
Age	18-19 years old	17-18 years old	17-18 years old	18-19 years old	17-18 years old	17-18 years old
Gender f/h, %	78/22%	57/43%	56/44%	35/65%	71/29%	48/52%
Course of study	2 nd year	1 st year	1 st year	2 nd year	1 st year	1 st year
Number of respondents	25	19	14	11	20	11

Source: compiled by the author

Experience in using ICT:

- frequency of ICT use before starting distance learning;
- types of ICTs used (computers, tablets, smartphones, software);
- level of ICT skills before starting distance learning.

Experience in distance learning:

- duration of distance learning;

- platforms and tools used for distance learning (Zoom, Google Classroom, Moodle);

- frequency of ICT use in distance learning.

Stage II. Components of the survey during the second stage:

1. Checking the average score of the test session before and after the use of ICTs according to the European Credit Transfer and Accumulation System (ECTS) scale (Table 2).

Table 2. Criteria for assessing the learning outcomes of higher education students according to the ECTS scale

ECTS scale	
A	90-100
B	82-89
C	75-81
D	67-74
E	60-66
FX	35-59
F	0-34

Source: compiled by the author based on N. Tjahjamoornarsih et al. (2023)

At the second control stage, a comparative analysis of student performance before and after the introduction of distance learning was conducted to identify

changes in the academic performance of higher education students, assess the effectiveness of distance learning, and its impact on the overall level of knowledge and

success of university students. The analysis included several key stages:

1. Data collection and preparation – academic indicators of students were collected for two periods – before the introduction of distance learning and during its implementation. This included the average grade per semester, the number of exams and tests successfully passed, the percentage of students who received high grades (excellent students), and the percentage who failed exams (unsatisfactory grades).

2. Use of methods of academic performance assessment criteria – various methods of assessing student performance were used to conduct the analysis. The main criteria were the average grade per semester (ECTS scale), the number of exams and tests successfully passed (the total number per semester is 8), and the percentage of students who received high and low grades.

The impact of distance learning on ICT skills:

- assessment of changes in the level of ICT skills (improvement, no change, deterioration);
- skills that have improved the most (working with software, online communication, searching for information);
- the main difficulties and challenges faced by students (technical problems, Internet access, lack of necessary devices).
- Satisfaction with distance learning;
- overall level of satisfaction with distance learning;
- advantages of distance learning (flexibility, convenience, access to additional resources);
- disadvantages of distance learning (lack of practical classes, insufficient interaction with teachers and fellow students).

A comparative analysis of students' performance before and after the introduction of distance learning

has revealed both positive and negative aspects of the impact of distance learning on academic results. It is important to take into account the individual technical and socio-economic conditions of students to ensure equal opportunities and improve the efficiency of the learning process. Based on the results obtained, recommendations were developed to improve the quality of distance learning and its integration into the traditional educational system. The surveys and comparative analysis of students' academic performance made it possible to formulate recommendations for improving the impact of distance learning on the development of information and communication skills of university students. The findings became the basis for recommendations for improving the educational process and integrating ICTs into education. This survey helped to understand how distance learning affects the development of students' ICT skills and what changes need to be made to improve the efficiency of the educational process in the future.

Stage III. Providing suggestions for improving distance learning:

1. students' recommendations for improving the use of ICT in the educational process;
2. ideas for integrating ICT into traditional learning after returning to the classroom format.

■ Results

The primary objective of the survey was to determine the frequency of ICT use. This section of the questionnaire aimed to find out how often students used ICT before the introduction of distance learning. The question included the following answer options: "daily", "several times a week", "rarely", "never". The answers presented in Table 3 allowed analysing the frequency of ICT use and moving on to the next question.

Table 3. Results of the study of the frequency of ICT use before starting distance learning

	Number of respondents according to the answers received			
	Daily	Several times a week	Rarely	Never
Respondents from the Faculty of Education	10	8	7	-
Respondents of the Faculty of Philology	5	-	13	1
Respondents from the Faculty of Journalism	4	6	4	-
Respondents of the Faculty of International Relations	3	8	-	-
Respondents of the Law Faculty	6	7	7	-
Respondents of the Faculty of History	2	-	8	1

Source: compiled by the author

Given the results, it was found that 30% of students regularly and 29% several times a week used ICT to complete academic tasks such as searching for information on the Internet, preparing essays and doing homework. 39% of respondents rarely used ICT, and 2% never used it. Students of different faculties use different types of ICT to facilitate learning and research. In particular, the study selected respondents from six different faculties of humanities. Students studying in the hu-

manities use the following ICTs: text editors (Microsoft Word, Google Docs) for writing essays and research papers; data processing software (Excel, SPSS) for analysing sociological data; online libraries and archives for accessing historical documents and literature. The use of ICT helps students of various specialities to succeed in their studies and research. In this section of the survey, respondents indicated which devices and software they used. Answer options included "computers", "tab-

lets”, “smartphones”, “specialised software”. Figure 1 shows the results of this stage of the survey among the

respondents, taking into account that the surveyed students had the opportunity to choose several answers.

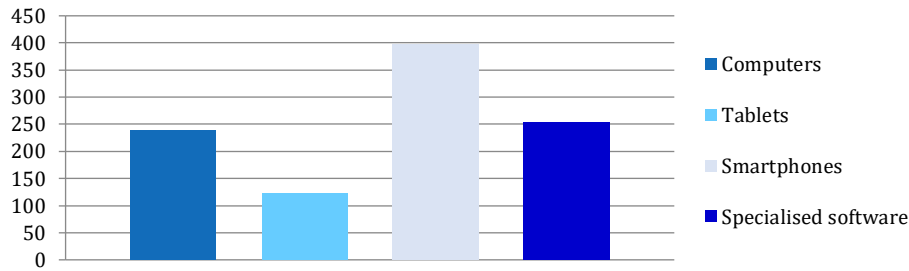


Figure 1. Results of the survey of respondents' use of ICT

Source: compiled by the author

According to the survey, it was found that almost all students use a smartphone in everyday life and during the educational process (99%). Specialised software is second among the tools used by higher education students, with 64% of students using it. Further, 60% of students use computers and 31% use tablets. The next stage of the survey was for students to assess their level of ICT skills before starting distance learning using the following scale: “very low”, “low”, “sufficient”, “high”, “very high”. This question allowed identifying the initial

level of students' ICT skills. The questionnaire was designed to provide a complete and objective picture of ICT use among university students. The data obtained will help to identify the main problems and needs of students in the field of ICT, as well as to develop recommendations for improving the effectiveness of distance learning. An important aspect was to determine the level of ICT skills among the respondents before starting distance learning, which will form the basis for the control phase of the study (Fig. 2).

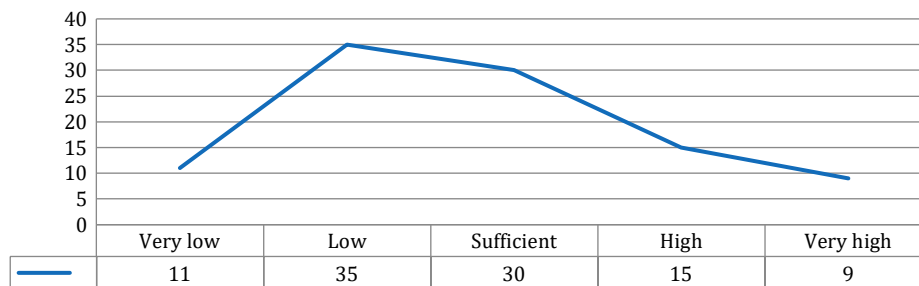


Figure 2. Results of the survey of ICT skills prior to the start of distance learning

Source: compiled by the author

The results of the respondents' self-assessment of their ICT skills showed that students in the first and second years of study consider their skills insufficient to use ICT in learning effectively. Only 9% of students rated their skills at a very high level, which indicates low confidence in using various technological tools and platforms for learning among the majority of respondents. This means that only a small proportion of students have sufficient skills to work effectively with ICT, which may affect their ability to adapt to distance learning and use modern technologies in the learning process. These students are likely to have previous experience of active use of ICT in their academic or personal activities. A high level of proficiency was rated by 15% of students. This group of students is also well-versed in basic tools and platforms, but may have some difficulty with more complex tasks or new technologies. The sufficient level is defined by 30% of higher education students as

having the basic knowledge and skills necessary to perform basic ICT tasks, but having problems with more complex or unusual tasks. The largest group of students (35%) rated their ICT skills as low. These students experience significant difficulties in using technology for learning and may need additional support and training to adapt to the demands of distance learning. 11% of respondents rated their skills as very low. This group of students has minimal knowledge and skills in ICT and may face serious obstacles in the learning process. These results emphasise that most students feel insecure about their ICT skills.

A variety of platforms and tools were used for distance learning to ensure an effective learning process (Fig. 3). The main platforms were Zoom, Google Classroom, Moodle, and Microsoft Teams. Zoom was used for synchronous lectures, online classes and seminars. Zoom enabled video conferencing, group discussions

and real-time collaboration. Moodle was used as a platform for course management and asynchronous classes. Moodle allowed teachers to create interactive courses, conduct tests and evaluate students' results. Google Classroom was used to organise the learning process, post materials, assignments, and feedback. This learning tool provided a user-friendly interface for student and teacher interaction and content management. Microsoft Teams helped to organise teamwork and was used for communication and online meetings. Teams provided the ability to collaboratively edit documents, chat and organise project work.

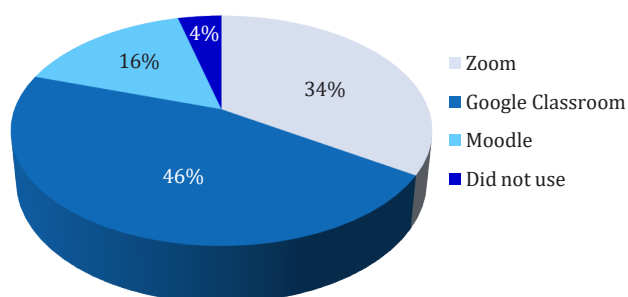


Figure 3. Results of the survey of respondents' use of distance learning platforms and tools

Source: compiled by the author

The frequency of ICT uses increased significantly in distance learning compared to traditional learning. Students used ICT on a daily basis for various purposes. Firstly, there were daily online classes. Students participated in synchronous online classes via Zoom or Microsoft Teams. On average, 3-4 hours of online classes were held daily. Next came the work with study materials. Students used Google Classroom and Moodle to access these materials, complete assignments and receive feedback from teachers. On average, 2 hours a day were spent working with the platforms. Students had time for independent study and research, using the Internet to find additional information, work with e-books and resources. This took about 1 hour a day. Finally, communication and group work were equally important in the study. Students used instant messengers, email, and Microsoft Teams to communicate with their classmates and teachers, as well as to complete group projects. This took an additional 1-2 hours per day. In accordance with the frequency of ICT use, students had intensive experience in this area during distance learning, which contributes to the development of their digital skills and adaptation to modern educational technologies. Having collected data on the learning outcomes of higher education students before and after the introduction of ICT, Table 4 compiles the results obtained.

Table 4. Checking the academic performance of higher education students before and after the use of ICTs according to the ECTS scale

Criteria for grades in accordance with the students' faculty		Academic performance according to the period of the study		
		Before the introduction of distance learning without ICT	After the introduction of ICT-enhanced distance learning	
			First semester (October 2022-January 2023)	Second semester (February 2023-June 2023)
Semester grade point average according to the ECTS scale (max. 100)	Students of the Faculty of Education	82 (B)	83 (B)	86 (B)
	Students of the Faculty of Philology	79 (C)	87 (B)	90 (A)
	Students of the Faculty of Journalism	90 (A)	91 (A)	92 (A)
	Students of the Faculty of International Relations	73 (D)	75 (C)	82 (B)
	Students of the Faculty of Law	89 (B)	90 (A)	90 (A)
	Students of the Faculty of History	81 (C)	87 (B)	91 (A)
Number of exams and tests successfully passed (credited)	Students of the Faculty of Education (max. 200)	154	163	178
	Students of the Faculty of Philology (max. 152)	108	146	147
	Students of the Faculty of Journalism (max. 112)	97	102	109
	Students of the Faculty of International Relations (max. 88)	46	52	57
	Law students (max. 160)	123	151	151
	Students of the Faculty of History (max. 88)	59	68	79
Percentage of students who received low/high grades	Students of the Faculty of Education	29/71%	14/86%	12/88%
	Students of the Faculty of Philology	41/59%	30/70%	21/79%
	Students of the Faculty of Journalism	23/77%	21/79%	9/91%
	Students of the Faculty of International Relations	54/46%	47/53%	41/59%
	Students of the Faculty of Law	28/72%	11/89%	11/89%
	Students of the Faculty of History	17/83%	15/85%	7/93%

Source: compiled by the author

Based on the analysis of the results, the following aspects of the study were identified:

1. There has been an increase in the average grade point average of students from different faculties after the introduction of distance learning using ICT. This may indicate that distance learning methods are more effective, or that students have adapted better to the new learning format, which has had a positive impact on their academic performance.

2. All students of the respective faculties have increased the number of exams and tests they pass. This is due to the fact that the use of ICT contributes to more effective learning and preparation for exams.

3. The distribution of academic performance has improved, as the percentage of students with high academic performance has increased significantly in most faculties after the introduction of ICT. At the same time, the percentage of students with low academic performance has decreased, which is also a positive indicator.

4. Adaptation to new teaching methods is observed, as students quickly adapted to the new ICTs, which is reflected in the improvement of academic performance in the first semester after the introduction of ICTs. The second semester showed even better results, which may indicate further improvement of the learning process and students' adaptation to the new conditions.

5. Positive changes have been identified at all faculties, regardless of their profile. This shows that ICTs are universal tools that can be effectively integrated into the educational process regardless of specialisation.

According to the results obtained, it can be noted that the use of ICTs provides students with better access to learning materials, additional resources and online lectures, which contributes to better preparation for classes and exams. And interactive teaching methods, which are possible thanks to ICT, can increase the involvement of higher education students in the learning process, increase their motivation and interest in the subject, which ultimately improves academic performance. The data shows an overall improvement in students' academic performance after the introduction of ICT, which indirectly indicates an increase in ICT skills. Students have demonstrated the ability to use technology effectively for learning, indicating an increase in their ICT skills.

Analysing the learning outcomes, it was found that students improved their ICT skills. The use of various learning platforms and software for distance learning, such as learning management systems, video conferencing software (Zoom, Microsoft Teams) and other learning resources, contributed to the improvement of skills in working with these tools. At the same time, higher education students have improved their online communication skills through the constant use of chats, forums, emails, and video meetings to discuss learning tasks, group projects, and interact with teachers. The transition to distance learning required students to

exercise more self-discipline and manage their time effectively to complete assignments and participate in online classes. Despite the positive results, university students faced certain difficulties and challenges, namely:

1. Technical problems (students may have encountered various technical problems, such as problems with computers, software or video connections, which sometimes prevented them from participating in online classes).

2. Access to the Internet (some students did not have a stable and fast Internet connection, which was a significant problem, especially for those living in areas with limited access to the network).

3. Lack of appropriate devices (not all students had access to appropriate devices such as computers, laptops or tablets, which could have made it difficult for them to participate in distance learning).

4. Learning environment (the home environment was not always conducive to effective learning, especially if students did not have a separate quiet place to study).

5. Psychological challenges (the lack of direct contact with fellow students and teachers, as well as isolation, could have a negative impact on the overall psychological state of students).

The introduction of distance learning has had a positive impact on the development of students' ICT skills, especially in terms of software, online communication and information retrieval. However, students faced various difficulties, such as technical problems, limited access to the Internet and necessary devices, which may require additional support and resources to overcome these challenges in the future.

The overall level of satisfaction with distance learning can vary depending on various factors, including individual student preferences, technical proficiency and personal circumstances. Given the positive academic performance after the introduction of ICT, it can be assumed that most students are satisfied with the new learning format. However, there is a possibility that some students faced challenges that could affect their satisfaction with the learning process. Higher education students have identified a number of advantages of distance learning:

- flexibility (the ability to plan one's own study schedule, combine studies with work or other commitments);

- convenience (the ability to study from anywhere, which saves time and money on transport);

- access to additional resources (access to numerous additional materials, video lectures, e-books and other resources that facilitate deeper learning);

- development of self-organisation and independence (distance learning contributes to the development of skills of independent time planning and organisation of the learning process);

- interactive teaching methods (the use of interactive platforms and tools can make the learning

process more interesting for the participants in the learning process).

Despite the significant advantages, university students also identified certain disadvantages of distance learning, namely the lack of practical classes, insufficient interaction with teachers and fellow students, certain technical problems and psychological challenges. Distance learning requires a high level of self-discipline and organisation from students, which can be a challenge for some of them. Thus, the survey and research helped to understand how distance learning affects the development of ICT skills among students and what changes need to be made to improve the efficiency of the educational process in the future. Distance learning has significantly increased the overall level of ICT skills among students. They were forced to learn new technologies and tools to participate in online classes, complete assignments and communicate with teachers and fellow students. Students developed their self-organisation and time management skills, as distance learning required them to plan and complete their learning tasks independently. They also became more familiar with online communication tools, using email, chats, forums and social networks to exchange information and work together.

Based on the data and results of the study, it is worth highlighting the changes that are necessary to improve efficiency in future educational processes. The first priority is to improve technical support, as students need to be provided with stable Internet access and appropriate equipment for successful learning, and technical support should be provided to solve problems related to software and hardware, as obstacles have been identified. Investing in the training and development of teachers in ICT and pedagogical technologies, as this will help to increase the effectiveness of distance learning methods. The development of hybrid learning models that combine elements of distance and face-to-face learning will also be valuable for modern students, as it can provide a more efficient and convenient educational process. There is always a need to improve the quality of online resources, and the development and implementation of high-quality online courses, interactive tasks, video lectures and other resources can help to improve the learning experience and increase student motivation. The changes also include interactivity and interaction, i.e. increasing the level of interactivity of classes through the use of video conferencing, virtual laboratories and other collaboration tools, which will help maintain a high level of interaction between participants in the educational process. Despite the advantages of distance learning, psychological support for students should not be forgotten, namely, providing access to counselling that can help them cope with stress and maintain high motivation during the learning process. Students should be encouraged to maintain a balance between studying and leisure to prevent burnout.

The main recommendations for the effective development of ICT skills of university students include the following aspects:

- introduction of interactive learning platforms, namely the use of LMS (Learning Management Systems), such as Moodle, Canvas or Blackboard, to organise the learning process and interactive resources, video lectures, interactive modules, online courses and simulations to increase the engagement of higher education students;
- development of digital literacy, in particular, it can be the organisation of courses or trainings on the basics of digital literacy and the use of software for students; constant updating of knowledge related to new technologies and software products used in their field of study;
- providing technical support to help students solve technical problems that arise during online learning and providing detailed instructions on the implementation of learning platforms and software;
- stimulating communication and cooperation, i.e. promoting group work through various online platforms that promote the development of communication skills and teamwork, and various forums and chats to discuss educational issues and exchange experiences between participants in the educational process;
- maintaining motivation and engagement – interactive teaching methods (game elements, surveys, quizzes to maintain interest in learning) and regular feedback on student performance and progress will help;
- evaluation and improvement of processes, as regular analysis of the effectiveness of ICT in the learning process and making the necessary adjustments helps to improve learning.

The recommendations provided will enable higher education institutions to effectively integrate ICTs into the educational process in order to provide students with modern and high-quality education in distance education. The survey has provided a rethinking of how distance learning affects the development of ICT skills of higher education students. Positive results indicate an improvement in software skills, online communication, and information retrieval. At the same time, to improve the efficiency of the educational process in the future, it is necessary to take measures to overcome technical problems, ensure flexibility of learning, improve the quality of online resources and provide psychological support. Investments in the professional development of teachers and the creation of a favourable learning environment are also key factors in the successful implementation of distance education.

■ Discussion

The results obtained show that new ICTs in education now occupy a proper place in the work of educational institutions at all levels. The need to use them in harmony with traditional teaching methods is recognised by

these authors. This opinion coincides with the study by T. Fursykova *et al.* (2022), who added that a modern educational institution should be primarily a system with modern methods of organising the educational process, monitoring results, and managing student learning outcomes. The main features of the higher education system are technologies for training not only students but also staff for effective work in higher education institutions. It has been found that the full and effective development of pedagogical innovations is possible only with a comprehensive theoretical and practical consideration of pedagogical innovations. Therefore, the purpose of this study was to analyse a systematic and effective methodology for the introduction of new forms of knowledge and the development of ICT for distance learning in educational institutions.

The results also show that the main direction of ICT development is determined by the choice of its components. It is determined by the choice of its components. These technical aspects have a significant impact on the formation of the main directions of ICT. Updating, expanding and continuously improving learning services. This can be called the adaptation of the quality of knowledge through modern educational technologies. The same results were obtained in the works of G. Green & T. Shorer (2022), S. Abdellatif *et al.* (2023), C. Yuan *et al.* (2024). These studies complement the results obtained and help to understand the mechanism of influence of distance learning on the development of information and communication skills in students, and what changes need to be made to improve the efficiency of the educational process in the future.

The article identified the significant impact of distance education on the development of information and communication skills of university students. In general, there are several indispensable aspects of this impact. These include: increasing technological literacy, independence and self-discipline, improving communication skills, expanding access to information. This study provides recommendations for improving the relevant skills of students in working with ICT in distance learning. In particular, students have to use different platforms and tools for distance learning, their technological literacy improves, and they become more confident in using ICT. The findings are in line with the work of L.M. Belfi *et al.* (2022), who noted that distance learning often requires students to be more independent, which contributes to the development of self-organisation and self-discipline skills. As a result, students are better able to manage their time and resources. Using the Internet as the main source of information and learning materials, students have access to the latest data and research in their field. Distance learning often involves the use of communication tools such as email, video conferencing and chat rooms, which can help students develop effective communication skills. Tools such as virtual labs, simulations, and other interactive

learning methods allow students to develop practical skills and apply theoretical knowledge in a virtual environment. Distance education provides an opportunity to communicate and share experiences with students and teachers from other countries.

An important condition for effective distance education is the availability of quality technical support and appropriate learning materials. The assumption that distance education has certain disadvantages, such as limited social contacts, difficulties in maintaining students' motivation and desire to learn, as well as problems with access to technology for some students, was confirmed by the results of the study and coincides with the findings of O. Prakash Gusai *et al.* (2023), M. Sablic & A. Mirosavljević (2024), R.T. Enakrire (2024). These scholars are actively researching the impact of online learning on the development of ICTs in students, namely, they note both positive and negative aspects of this process. They emphasise the need to combine online and offline learning methods to achieve optimal results. A hybrid learning model, which includes both traditional and digital methods, is considered to be the most effective for developing ICT and other skills in students.

Scientists K. Al-Tkhayneh *et al.* (2023), in correlation with the results of this study, actively investigate the development of ICTs and their impact on various spheres of life, including education. Based on the results, it was determined that ICTs greatly simplify access to educational materials and resources. Students can receive information from anywhere in the world, which expands their learning and research opportunities. The use of ICTs allows for the creation of interactive learning materials that can be adapted to the individual needs of students, increasing the effectiveness of the learning process. In addition, they improve communication between students and teachers, allowing for quick information exchange and feedback. The results of this study proved the opinions of leading scientists S. Grassini & L. Lombardo (2024) that not all students have equal access to ICT, which can create educational inequality. It is important to ensure that all students have access to the necessary resources, regardless of their socioeconomic status. A study by O. Churikova-Kushnir *et al.* (2021) complements the results of this study and shows that students may experience a decrease in motivation and engagement during distance learning, especially without proper support and incentives. And the introduction of new technologies can be accompanied by technical challenges, requiring additional support and training for students and teachers.

This study, as well as the work of P. Dlugosz *et al.* (2022), aimed to recommend an active process of integrating ICT into the curriculum so that students can develop the necessary skills and be competitive in the labour market. It is essential to organise trainings and courses to improve technical literacy for both students and teachers to ensure effective use of technology. The

introduction of ICTs should be accompanied by measures to support students' mental health, including social interaction and psychological support. The results of the study showed the need to integrate ICT into the curriculum to create a more dynamic and interactive learning environment, which was confirmed by A. Be-húnová *et al.* (2022) and O. Grytsiuk *et al.* (2022). Researchers have identified the social aspects of ICT use and, in the future, skills in education, emphasising that technology can both improve and exacerbate existing inequalities in access to education.

Summarising the main discussions and opinions of scholars and the results of this study, the development of ICTs is an important direction for modern education, as they open up new opportunities for learning and development. However, it is essential to take into account the challenges and problems associated with their implementation and work to create equal conditions for all distance learners. The development of ICTs is of great importance for modern society, as they affect all aspects of people's lives, increasing the efficiency, accessibility, and quality of services in various fields. However, it is also critical to take into account the challenges and risks associated with ICT development, such as cybersecurity, data privacy and unequal access to technology, and work to overcome them. ICT development has a huge impact on various areas of life, including the economy, education, healthcare, governance, and people's daily lives.

■ Conclusions

In the context of the pandemic, higher education institutions were forced to switch to a distance learning format, which emphasised the importance of digital literacy and technical competence of students. The analysis showed that ICTs are essential for modern education and professional development of higher education students, ensuring effective learning and preparation for the requirements of the modern labour market. A high level of digital literacy is becoming an integral part of the professional competence of a modern specialist, which is especially important in the context of rapid technological development.

The study was conducted in three stages: determining general information about the respondents, their experience of using ICT and distance learning; checking the average score of the test session before and after using ICT on the ECTS scale; determining the impact of distance learning on ICT skills and satisfaction with distance learning; and identifying suggestions for improving distance learning. Based on the results of the study, conclusions were drawn about the effectiveness of

distance learning. According to the analysis of the results, it was found that the average grade point average of higher education students changed after the introduction of distance learning. Trends in the majority of students' grade point averages were assessed. The analysis showed changes in the number of students who successfully passed exams and tests. This made it possible to identify that distance learning has become quite effective for learning the material. Analysing the percentage of students with high and low grades, it turned out that the number of excellent students increased by 23% and the percentage of students who failed exams decreased (14%). These results indicate the need for further introduction and improvement of ICT in the learning process to support and improve the academic performance of higher education students. It was assessed that distance learning had a positive impact on students' academic performance. Recommendations for improving distance learning methods and its implementation in the future were also developed. The comparative analysis provided a comprehensive picture of changes in student performance after the introduction of distance learning and an assessment of its effectiveness.

The overall level of satisfaction with distance learning among students was high, as they were able to study flexibly and conveniently, access additional resources and develop independence. However, disadvantages such as lack of practical classes, insufficient interaction with teachers and fellow students, technical problems and psychological challenges are also significant and may affect the satisfaction of individual students. The success of distance learning depends on the ability of the HEI to effectively address these issues and provide the necessary support to students. Despite some drawbacks, distance learning has a significant and positive impact on the development of ICT skills among university students. However, it is important to integrate elements of distance learning into the traditional educational system, which will ensure more effective development of digital competences.

The limitation of the study was that it was conducted among students of only one HEI and not all faculties, and may not fully reflect the situation in other HEIs or regions. Prospects for further research include conducting similar studies in different HEIs and regions to obtain even more qualitative and representative results.

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■ Conflict of Interest

None.

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Вплив дистанційного навчання на розвиток інформаційно-комунікаційних навичок студентів закладів вищої освіти

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■ **Анотація.** Метою статті було виявлення впливу дистанційного навчання на розвиток інформаційно-комунікаційних навичок студентів у закладах вищої освіти. У статті досліджено вплив дистанційного навчання на розвиток навичок інформаційно-комунікаційних технологій (ІКТ) у здобувачів освіти закладів вищої освіти. З'ясовано, що в умовах пандемії освітні заклади були змушені перейти на дистанційний формат навчання, що підкреслило важливість цифрової грамотності та технічної компетентності студентів. Визначено, що ІКТ мають вирішальне значення для сучасної освіти та професійного розвитку студентів. У дослідженні було проведено опитування 100 студентів щодо їх досвіду використання ІКТ у дистанційному навчанні, яке проводилось у три етапи із студентами різних спеціальностей для виявлення їхніх поглядів на зміни у рівні ІКТ-компетентностей. Результати показали, що студенти значно покращили свої навички роботи з програмним забезпеченням, використанням онлайн-ресурсів та взаємодії в цифровому середовищі. Водночас було виявлено в умовах дистанційного навчання певні перешкоди, які пов'язані з технічними проблемами та відсутністю практичного досвіду. Та аналіз показав позитивні зміни академічних досягнень у значній кількості студентів після застосування ІКТ. Це дало змогу виявити, що дистанційне навчання стало достатньо ефективним для засвоєння матеріалу. У висновках визначено, що дистанційне навчання, незважаючи на свої недоліки, має значний позитивний вплив на розвиток ІКТ-навичок у студентів. Рекомендовано інтегрувати елементи дистанційного навчання в традиційну освітню систему для забезпечення більш ефективного формування цифрових компетенцій

■ **Ключові слова:** здобувачі освіти; навчальні онлайн ресурси; цифрова грамотність; технологічна компетентність; освітні платформи



Conditions for developing professional forecasting of future managers

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■ **Abstract.** In the dynamic business environment, the development of forecasting skills in future managers has become an increasingly pressing issue that requires serious research and analysis. This relevance arises from the need for enterprises to adapt to constant changes in the business landscape and global economic challenges. The primary aim of this study was to examine the factors influencing the effectiveness of creating forecasting strategies for prospective corporate leaders. The research employed a complex of various scientific methods. These included analytical, synthetic, comparative, abstraction, generalisation, systematisation, and theoretical modelling methods. Empirical data was obtained through testing, including verbal and projective methods. Questionnaires and trainings were also conducted. The “cross-sectional study” approach was used to organise the obtained information. Mathematical methods were applied to process the statistical data. The results of this study highlight the importance of systematic assessment and evaluation of potential leaders for the successful forecasting of future managers. This process involves identifying individuals with strong leadership qualities and assessing their strengths and weaknesses. A key step is also the careful planning and tailored preparation of prospective leaders. The research emphasises that developing leadership skills, communication abilities, and strategic thinking are essential components for future managers to successfully fulfil their roles. Additionally, the findings indicate that the active use of modern tools and technologies, such as data analytics and artificial intelligence, can significantly enhance the processes of forecasting and staff development. These technologies enable the collection and analysis of large volumes of data, contributing to more accurate identification of potential leaders and personalised development plans. In conclusion, the research findings provide educational institutions with the opportunity to more effectively prepare future leaders, ensuring their competitiveness

■ **Keywords:** advanced tools; business environment; management levels; strategic planning; communication

■ Introduction

The modern world is undergoing rapid changes driven by technological advancements, globalisation, and the increasing complexity of the business environment. These transformations present new, complex challenges for organisations and society as a whole. Among

these, one of the key issues is ensuring the successful development of future managers who can function effectively in conditions of constant uncertainty and instability. This issue is particularly relevant as it directly affects the competitiveness of organisations and their

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ability to adapt to ever-changing conditions. The research problem focuses on identifying and analysing the factors that influence the successful development of future managers. This analysis includes examining their leadership qualities, skills, and potential, as well as considering the impact of modern technologies and methods on this process. Special attention is given to identifying and developing individuals who are not only able to adapt to change but also anticipate and influence the course of events in a dynamic business environment. Such research is crucial for developing new approaches to the training and development of future leaders who will operate in conditions of uncertainty and change, ensuring the future competitiveness of organisations.

In a study focused on the development of strategic thinking among future educational leaders, M. Shevchuk (2023) delved into pedagogical approaches and conditions aimed at fostering strategic thinking in students and aspiring managers of educational institutions. However, it is worth noting that the research did not address aspects related to the development of forecasting skills in future managers. The absence of such analysis may limit the comprehensive understanding of the preparation process for educational leaders, particularly in the context of their ability to effectively forecast and adapt to changes within the educational sector.

The article by Zh. Virna & K. Shkarlatiuk (2011) focused on the features of creating forecasts for future managers. They presented a comprehensive strategy for creating such forecasts, which involves developing a theoretical model for a typological analysis of professional forecasts based on an analysis of motivational and behavioural characteristics. The study explored the psychological structure, content, and functions of professional forecasts, offering a deeper understanding of their unique features. The study also identified the impact of subjective factors on the process of forming professional forecasts for future managers. They concluded that integrating predictive-causal methods into a training course on professional self-development, alongside cognitive and reflective methods of subjective influence, helps optimise the full professional self-realisation of future managers.

In enhancing the understanding of preparing future managers for the demands of the modern business environment, E. Lutsenko (2020) emphasised the development of facilitation skills through pedagogical conditions. The author explored the use of tools and methods aimed at fostering collaborative decision-making, cooperation, and creative thinking within organisational contexts. However, it is noteworthy that the research did not delve into the conditions required for developing professional forecasting skills in future managers. This omission may lead to gaps in understanding how to cultivate the skills related to foresight and adaptability to changes in the business environment during their training.

The opportunities for improving the preparation of future managers in the educational sector form the primary focus of the study by H. Dudchak (2020). The author thoroughly examined modern concepts and approaches aimed at enhancing curricula and methods designed to equip future managers with the necessary skills and knowledge for managing educational institutions. However, it is noteworthy that the study did not address the development of professional forecasting skills among these future managers. This omission may lead to shortcomings in understanding how the ability to foresee and adapt to changes is accounted for in the training of professionals within the educational field.

L. Poleshchuk (2021) study highlighted the development of essential qualities for future educational managers, particularly the competencies required for successful role performance. The author identified key competencies such as leadership skills, analytical abilities, communication skills, and the ability to collaborate with various stakeholders in education. Notably, the research did not delve into aspects related to the development of professional forecasting skills in future managers. The absence of such analysis may lead to an incomplete understanding of how forecasting and adaptation skills are addressed in the preparation of specialists in the educational sector.

The primary aim of this article was to examine the influential factors in the successful process of developing forecasting strategies for future corporate leaders.

■ Materials and Methods

A variety of research methods were employed in the study aimed at developing professional forecasting competence among future managers. Theoretical methods such as analysis, synthesis, comparison, abstraction, generalisation, and systematisation were used to structure existing knowledge in the field of professional forecasting. These methods aided in the development of a theoretical model for professional forecasting competence and identified the key aspects necessary for training future managers.

The empirical study focused on analysing the clarity of professional forecasts among graduating students. Participants were selected from various courses and groups, including students from the 4th and 5th years, and were divided into groups 4C+, 4C-, 5C+, and 5C-. The research employed a range of data collection methods, including surveys, observations, tests, interviews, and training sessions. To facilitate the development of self-designing skills for professional pathways and to strengthen the professional self-concept of students with clear professional forecasts, an experimental training course was established. The experimental group consisted of 16 individuals from groups 4III and 4IV, while the control group comprised 38 students from groups 4I and 4II. All participants provided written consent for the processing of their personal data. The training

lasted for two months, consisting of eight sessions held weekly, each lasting three hours. Various methods were employed, including psychodrama, role-playing, mini-lectures, relaxation techniques, and others. To assess the effectiveness of the training, comparisons were made between the baseline levels of professional forecasts, as well as the personal, motivational, and behavioural characteristics of student managers, both before and after the experiment, concerning the control group results. Observations involved the use of protocols that accounted for specific criteria. Tests were designed to evaluate various aspects related to professional forecasting. Interviews aimed to ascertain the motivations and perceptions of students regarding their future professional activities. The training sessions had specific objectives for skill and knowledge development, and their effectiveness was evaluated within the framework of the study. Research was conducted following the principles outlined in the Declaration of Helsinki (2013).

Statistical methods played a crucial role in the processing and analysis of the data obtained in the study. They were employed to identify correlations and relationships between various aspects of professional forecasting competency among future managers. One of the primary tasks of the statistical data analysis was to establish objective connections between different variables that reflected the readiness level of future managers for professional forecasting. This included analysing survey results, test scores, observational data, and

other sources of information accumulated throughout the research. The application of statistical methods allowed for the identification of significant correlations between indicators, highlighting the interrelationship among various aspects of professional forecasting competency. The results provided an objective and quantitative assessment of the readiness level of future managers and pinpointed areas where improvements could be made. Utilising statistical methods facilitated a thorough and scientific analysis of the research findings, as well as the identification of specific steps for enhancing the training of future managers in professional forecasting. This approach ensured the scientific validity and objectivity of the conclusions and recommendations derived from the study.

■ Results

Based on self-assessments of achievements in achieving personal life goals, the graduating students were categorised according to the clarity of their professional plans. Specifically, 56% of the research participants stated that they were clear about their future professional activities. Of this number, 38% were 4th-year students (group 4C+), and, correspondingly, 72.2% were 5th-year students (group 5C+). As for the remaining 46% of students, they did not have a clear definition of their future professional plans, with 65% of them being 4th-year students (group 4C-) and 23.2% being 5th-year students (group 5C-) (Table 1).

Table 1. Analysis of the adequacy of students' predictions about their professional future based on their assessment of achieving their life goals

Student group	Clarity of professional forecasts	Percentage of research participants
4C+	Yes	38%
5C+	Yes	72.2%
4C-	No	65%
5C-	No	23.2%

Source: developed by the authors

Characteristics of students with clear professional forecasts:

1. Adequacy, prudence, and a realistic approach to planning.
2. Awareness of operational aspects and key personal qualities.
3. Intrinsic motivation, inspiration, and strong confidence in achieving life goals.
4. High levels of responsibility, social flexibility, and creativity.

Characteristics of students without clear professional forecasts:

1. Unclear goals for professional fulfilment and lack of awareness regarding operational aspects.
2. Low self-esteem, absence of inspiration and motivation.

3. Insecurity, tendency towards interpersonal dominance, and conflict.

4. Motivation focused on material provision, without holistic self-development.

The clarity of their professional forecasts varied across several characteristics. Students with clear forecasts exhibited adequacy, prudence, and a realistic approach to planning their future practical activities. They were consciously aware of the essential operational aspects of their professional roles and the key personal qualities necessary for a qualified specialist. Such students demonstrated intrinsic motivation, inspiration, and strong confidence in achieving their life goals. They also displayed a high level of responsibility, social flexibility, and creativity in their professional endeavours. Their inclination towards intrinsic

motivation manifested in their social relationships through a focus on collaboration, openness, and readiness for professional mobility. Overall, their values were interconnected with the fulfilment of spiritual needs, such as self-realisation, the attainment of a spiritual ideal, affirmation of oneself in the world as an individual, and authenticity, which were expressed through their work, high qualifications, and the potential for developing their own businesses. This analysis was made possible by employing self-assessment methodologies concerning the achievement of personal life goals, which provided insights into the consciousness and values of the students, as well as their readiness for professional realisation. Students who were unable to clearly define their future professional activities (groups 4C- and 5C-) exhibited a contrasting set of qualities. Their professional goals were characterised by a lack of clear awareness regarding the essential operational aspects of their professional roles and key personal attributes. They demonstrated low self-esteem, as well as a lack of inspiration and motivation for professional realisation. Many experienced uncertainties, which stemmed from limited social practice, and this uncertainty manifested as a tendency to establish interpersonal control. Such an externally influenced position led to conflict and a lack of equilibrium in their perception of social relationships. The motivation and orientation of these individuals were defined by a desire for material security, which precluded holistic self-development and a realistic understanding of their professional aspirations and personal desires. Their assessment of the reality of future professional life indicated a general trend towards a lack of life fulfilment, as all significant events in their lives were projected into the future, shaping their intent for prospective realisation.

The results of this study allowed for a revision of the proposed typology of professional forecasts. By incorporating indicators of motivational orientation towards either “process” or “outcome”, the typological model of professional forecasts has been expanded to include the following categories: I – Category 1 – clear, achievement-oriented; II – Category 2 – clear, performance-oriented; III – Category 5 – unclear, achievement-oriented; IV – Category 6 – unclear, performance-oriented.

Using the established typology, empirical data were analysed through comparisons between 4th- and 5th-year management students. The results revealed differences among various types of professional forecasts in terms of motivation, personality, and behaviour. Students with a clear understanding of their future professional activities exhibited marked introversion and emotional stability. They displayed high levels of irritability and a desire for dominance. Conversely, students lacking a clear vision of their future professional pursuits demonstrated neuroticism and

irritability, as well as a low level of motivation for success and negative forms of professional identification. Based on these findings, a strategy for a formative experiment was developed, focusing on tasks designed to enhance professional self-awareness, identify needs for self-development, and familiarise students with the principles of effective professional and personal self-realisation.

Following the experimental training, the experimental group exhibited increases in motivation for success, communicativeness, emotional stability, social adaptation, tolerance towards others, emotional comfort, forecasting ability, and planning for future actions, as well as enhanced self-control. The motives for transformation, communication, and cooperation also became more pronounced. Analysis revealed that the form of professional identification among participants changed after the training, shifting from a contrasting-negative form to a prospective-positive and contrasting-positive form. Additionally, the accuracy of predictions was examined, with results indicating an improvement in the precision of forecasts among participants in the experimental group after the training, bringing their performance closer to that of the control group. This suggests a positive transformation in their professional abilities towards greater rationality and competence.

Surveys of students revealed a clear orientation towards the demands of their future professional activities, reflected in specific aspects of their work. Over 87% of students in both the experimental and control groups expressed inspiration and motivation for professional fulfilment. The results also highlighted the significance of various factors, including the availability of a personal budget, access to credit, concern for others' issues, the ability to listen to others, the capacity to appreciate others, engagement in self-education, the existence of a personal development plan, and the ability to cultivate personal motivation.

Trends towards increasing innovative and creative potential indicate an expansion of the functional capabilities of future professionals (Bharthvajan *et al.*, 2018; Nikolopoulos & Thomakos, 2019). All these changes confirm that professional forecasting contributes to the formation of psychological benchmarks and the activation of potential for professional self-realisation. The creation of professional forecasts activates psychological resources and establishes the boundaries of personal professional growth by aligning personal and psychological aspects.

It is important to emphasise that the effectiveness of psychological influence on self-determination in a professional context depends on the quality of the influence process and the level of knowledge, experience, and readiness to engage in a specific professional activity (Fig. 1).

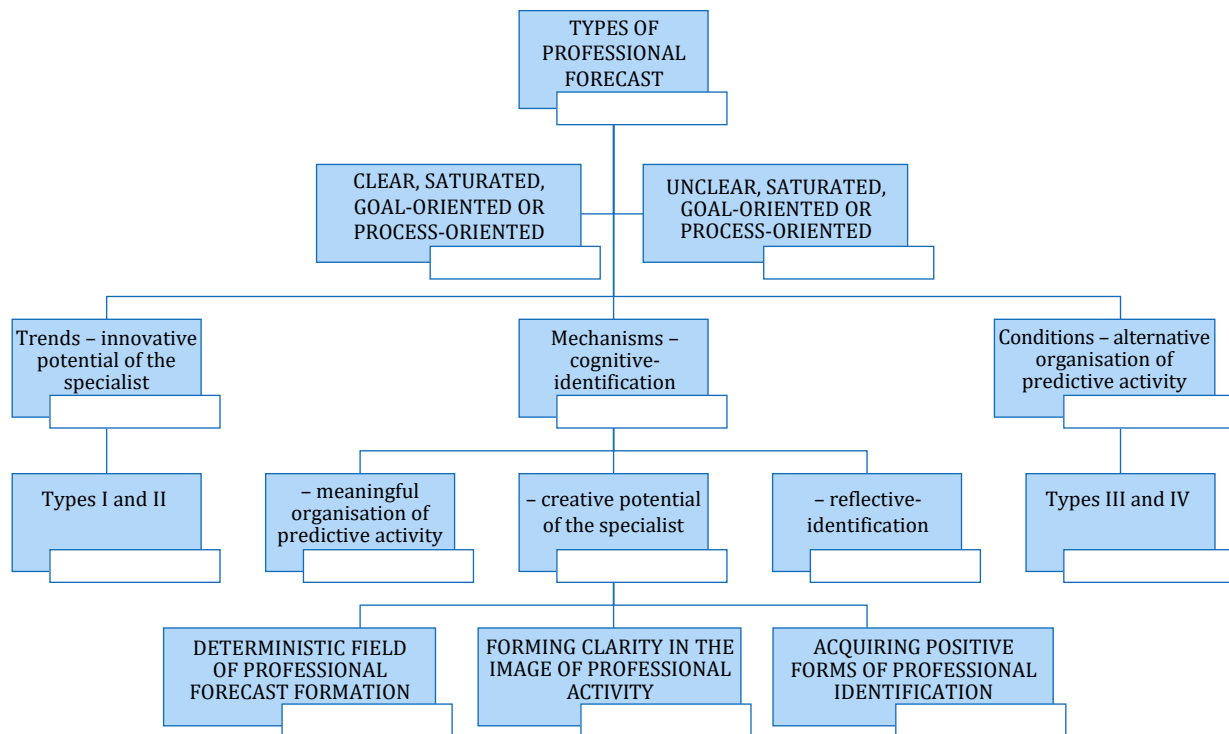


Figure 1. Psychological conditions, mechanisms and trends defining the deterministic field of professional forecast formation

Source: developed by the authors

Professional consciousness encompasses personal and social traits related to both individual and social spheres of life. The interrelatedness of these characteristics can lead to their mutual transformation (Zhang *et al.*, 2021; Boylan & Syntetos, 2021). Self-assessment of professional qualities is crucial for the predictive self-realisation of future managers. Furthermore, effective professional self-realisation necessitates the forecasting of practical activities. Perceptions of professional activity transform it into an object of contemplation and the necessary means for forecasting (Polshchuk, 2020; Bloom *et al.*, 2022). However, the current system of higher education fails to address the formation of professional forecasts (Beckmann & Czudaj, 2020; Hyndman & Athanopoulos, 2021), as academic disciplines do not provide the essential methodological knowledge required to optimise the predictive functions of future specialists.

This study proposes a system of formative research integrated into the practice of professional self-realisation, which addresses this issue and provides practical value. Specifically, this system encompasses the following aspects:

1. Identification of specific methods and approaches for data collection and analysis. Techniques such as surveys, interviews, observations, and the analysis of existing data will be employed.

2. Formulation of goals and objectives. Expected outcomes will be defined in advance. The research

tasks will clearly forecast what needs to be achieved for the successful implementation of the study.

3. Definition of metrics and evaluation criteria. Specific parameters will be established to assess the effectiveness of professional forecasting, including the level of predictability and the degree of adaptability to change.

4. Selection of the audience and scope of research. The target demographic for the study will be determined (e.g., management students) along with the number of participants anticipated.

5. Development of the research instruments. Concrete tools will be created for conducting the research, such as questionnaires and structured interviews.

6. Conducting the research. The defined stages of data collection and processing will be implemented by the chosen methods and approaches.

7. Analysis of results and conclusions. An analysis of the collected data will be carried out to identify key trends, formulate conclusions, and provide recommendations for further action.

8. Implementation of findings. Practical recommendations and programmes will be developed for utilising the acquired knowledge in the training of future managers.

9. Assessment of the system's effectiveness. Parameters will be established to evaluate the impact of the proposed formative research system on the professional training of future managers.

10. Systematisation and publication of results. The collected data will be organised and presented in academic or practical publications for broader application and dissemination.

■ Discussion

Researchers agree that acquiring professional experience and developing professional consciousness is an integral process that continues throughout one's life. A marker of effective professional identity is an understanding of one's own role in activities and a personal attitude towards the work being done, both during education and in the course of professional life. Considering the personal development of individuals is justified, as individuals play a crucial role in activities, a fact emphasised by various scholars.

According to the article of N.B. Kalyan (2020), in the field of management, it is the managers who define strategies, organise activities, select and form teams, and provide guidance and control over human and financial resources within the collective efforts of a group to achieve established individual and group objectives. In doing so, they ensure the efficiency and effectiveness of the entire organisation. However, in the past, management was not regarded as a key component of development. During the Industrial Revolution of the 17th and 18th centuries, economists proposed numerous concepts and functions of management. Research findings indicate that it was only in the 19th century that management emerged as an independent field of study, as various management issues began to be identified, leading to a demand for their resolution. Today, the business environment is undergoing significant changes, primarily due to the rapid development of transport and communication infrastructure, innovative knowledge, globalisation of business, and the interaction of multicultural professionals, which presents new challenges for managers. Self-development plays a crucial role in addressing these challenges, as personal traits are shaped by individual needs aimed at achieving a certain level of self-realisation. In particular, it is essential to recognise the uniqueness of each professional and their right to independently seek their own professional path.

One of the challenges identified by S. Kraus *et al.* (2022) is digital transformation (DT). The aim of the study was to illustrate the thematic development of DT research within the fields of business and management, as previous studies in these areas have thus far been limited to specific domains. To achieve this, articles published in journals rated ≥ 2 by the Association of Business Schools (ABS) were identified and reviewed. Based on these findings, the second aim is to propose a synergistic framework that links existing DT research to the professional forecasting of future managers. This proposed framework can play a pivotal role in future discussions and guide future research in this area.

Both studies illuminate the evolution of managerial practices across different eras and in the context of contemporary challenges. N.B. Kalyan (2020) research emphasised management functions, while S. Kraus *et al.* (2022) focused on digital transformation as a significant contemporary challenge in business and management. It aimed to map the thematic development of research in this context. However, both studies acknowledge significant changes in the business environment, such as globalisation and innovation, which present new challenges for managers. As in this study, and all subsequent research, it is crucial to consider that managerial functions and approaches may evolve in line with societal and technological changes.

The findings of K.R. Murphy (2020) research emphasise the significance of systematic study and evaluation of potential leaders for the successful forecasting of future managers. According to the researcher, this process involves identifying individuals with strong leadership qualities, highlighting their strengths and weaknesses, as well as careful planning and personalised preparation of prospective leaders. He also noted that the development of managerial skills, communication abilities, and strategic thinking is crucial for future managers to fulfil their responsibilities effectively. The use of modern tools and technologies, such as data analytics and artificial intelligence, can also significantly enhance the forecasting and personnel development processes. The results of this study may enable educational institutions to prepare future leaders more effectively, thereby ensuring their competitiveness.

F. Petropoulos *et al.* (2022) emphasised that machine learning can be beneficial in the process of developing professional forecasts for future managers. One notable application of this method is the analysis of large volumes of data. Machine learning can assist in processing and analysing extensive data sets related to career development and employee success. Algorithms can identify patterns and trends that may be overlooked by human analysis. Another effective method highlighted by researchers is the prediction of leadership qualities. Machine learning can aid in creating models that forecast leadership attributes and potential. Given the variety of assessed indicators, algorithms can determine characteristics that signify a high level of leadership. Based on training and performance data, machine learning can be used to create personalised development plans for each employee. Algorithms can recommend specific courses, training sessions, or tasks aimed at improving particular skills. Furthermore, machine learning can assist in evaluating resilience to stress and conflict resolution skills by analysing data on reactions to conflict or stress situations and incorporating these into forecasts. Thus, machine learning can significantly enhance the accuracy and objectivity of the forecasting process for future managers, providing organisations with a more effective and innovative approach to leadership development.

However, some factors may influence the effectiveness of this method in forecasting future managers. Among these are the subjective qualities of each individual, which manifest during the learning process. Machine models may encounter difficulties in interpreting context or taking into account the unique circumstances that can affect a specific individual's professional development. This is highlighted in the article by V.B. Nunes & L.L. de Souza (2018). Furthermore, according to the article, some machine learning algorithms may be limited in their understanding of complex or dynamic aspects of leadership and management. Effectively measuring soft skills, such as communication, empathy, and collaboration, can also prove to be a challenging task for machine learning. Additionally, if the data upon which the model is based contains errors or inaccuracies, this can lead to imprecise forecasts. Considering these factors, it is crucial to carefully design and refine models, as well as to combine their use with expert evaluation and other methods, to ensure more accurate and reliable outcomes in the context of forecasting future managers.

More effective strategies in the area of professional forecasting for future managers can be developed by considering several additional aspects outlined in the Future of professional's report (2023). In particular, the implementation of an effective feedback system can help identify and correct inaccuracies or errors in forecasts, which may arise from changes in the company's strategy or the employee's development. Engaging experts when specific knowledge or assessment of soft skills is required can assist in accounting for factors that may be difficult to measure or analyse automatically (Ogolo, 2019; Varmus *et al.*, 2021). Finally, a systematic analysis of the effectiveness of forecasting strategies will enable the rapid identification of the most successful approaches and the refinement of forecasting methods.

In summary of the research by V.B. Nunes & L.L. de Souza (2018) and the Future of professional's report (2023), it can be noted that the approach focuses on the integration of short-term factors and the active utilisation of machine learning methods to achieve accurate and predictive outcomes. The distinction of this study lies in its emphasis on the short-term influences on professional forecasting. This comprehensive approach, which incorporates short-term factors, has the potential to enhance the understanding of their impact on outcomes and contribute to the development of more effective strategies in the field of professional forecasting for future managers.

■ Conclusions

The study established that professional forecasting encompasses aspects of the organisational and managerial activities of specialists and also determines the quality of their professional preparation. The context

of the scientific research on personality forecasting was examined in both life and professional spheres. Furthermore, the analysis of key conceptual models revealed that professional forecasting plays a significant role in shaping a professional's subjective perception of their vocational activities. It also greatly contributes to an individual's ability to navigate the expectations placed upon them.

Through the investigation of the theoretical aspects of the studied topic, a typological analysis of professional forecasts was conducted. As a result, a comprehensive strategy for their formulation was established by examining the psychological structure, content, and functions involved. The study identified correlations between the typological diversity of professional forecasts (such as clarity and motivational orientation) and their psychological content at the level of personal manifestations, as well as motivation and behaviour. These findings were substantiated by the correlational relationships presented in the research results.

The main outcome was the formulation of a typology of professional forecasts: I – Category 1 – clear, achievement-oriented; II – Category 2 – clear, performance-oriented; III – Category 5 – unclear, achievement-oriented; IV – Category 6 – unclear, performance-oriented. This typology has facilitated a better understanding of how professional forecasts are formed in future managers. The inclusion of predictive-causal tools in the training and practical course on professional self-futuring, alongside cognitive-identification and reflective-identification techniques, aids in optimising the professional self-realisation of future managers. The results of the training course on professional self-determination for future managers reflect diversity in both content and structure, leading to a positive impact on their professional self-awareness and the identification of needs for personal and professional development. This course also helped to specify the essential professional and life competencies, as well as to identify the key areas for successful professional and personal fulfilment, contributing to the creation of an individual targeted profile for future professional activities.

Statistically sound evidence indicates the effectiveness of the training course on professional self-determination for future managers. This impact should be extended to a larger population, as statistically significant differences have been identified in motivation for success, communicativeness, social-behavioural adaptation, acceptance of others, emotional comfort, self-management, as well as motivation for collaboration and achievement.

The potential for implementing psychotechnologies to shape professional forecasts for future specialists as a tool for enhancing educational programmes for manager training is a pertinent avenue for further research.

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■ Conflict of Interest

None.

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Умови формування професійного прогнозування майбутніх менеджерів

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■ **Анотація.** У динамічному бізнес-середовищі формування професійного прогнозування майбутніх менеджерів стає надзвичайно актуальною проблемою, яка вимагає серйозних досліджень та аналізу. Ця актуальність обумовлена потребою підприємств у здатності пристосовуватися до постійних змін у бізнес-середовищі та глобальних економічних викликів. Основною метою дослідження було вивчення чинників, що впливають на результативність процесу створення стратегій прогнозування для майбутніх корпоративних керівників. У ході дослідження використовувався комплекс різноманітних наукових методів. Серед них аналітичний, синтетичний, порівняльний, метод абстрагування, узагальнення, систематизації, а також метод теоретичного моделювання. Емпіричні дані були отримані завдяки тестуванню, зокрема, вербальному та проєктивному. Також були проведені анкетування та тренінги. Методом організації отриманої інформації слугував підхід «поперечних зрізів». Для обробки статистичної інформації застосовувались математичні методи. Результати цього дослідження свідчать про важливість систематичного вивчення і оцінки потенційних лідерів для успішного прогнозування майбутніх керівників. Цей процес включає в себе ідентифікацію осіб з високими лідерськими якостями та виділення їхніх сильних та слабких сторін. Важливим кроком є також ретельне планування та індивідуальна підготовка потенційних лідерів. У дослідженні підкреслено, що розвиток керівницьких навичок, комунікаційних вмінь та стратегічного мислення є необхідними складовими для успішного виконання майбутніми менеджерами своїх обов'язків. Крім того, результати показують, що активне використання сучасних інструментів та технологій, таких як аналітика даних та штучний інтелект, може суттєво покращити процеси прогнозування та розвитку персоналу. Це надає можливість зібрати та аналізувати великі обсяги даних, що сприяє більш точному визначенню потенційних лідерів та індивідуальному налаштуванню їхнього розвитку. Узагальнюючи, результати дослідження надають закладам освіти можливість ефективніше підготувати майбутніх керівників, забезпечуючи їхню конкурентоспроможність

■ **Ключові слова:** передові інструменти; бізнес-середовище; рівні менеджменту; стратегія планування; комунікації



Informational heuristics as a mechanism for ensuring success in the system of student research activities

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■ **Abstract.** Modern transformational processes driven by the rapid development of advanced technologies increase the demands on the quality of human capital, a crucial component of which is research activity. The higher education system faces the challenge not only of knowledge transmission but also of developing key research skills and abilities in students. Informational heuristics, which optimise the processes of searching, processing, and interpreting scientific information, act as a tool for enhancing the effectiveness of student research. Its application is essential to meeting the current demands of the global educational environment. The aim of this article was to present the content of the informational heuristic mechanism in its various manifestations as a guarantee for ensuring success in the formation of research skills among students of pedagogical higher education institutions (HEIs), using the example of teaching the educational component “Fundamentals of Scientific Research and Academic Writing”. The research employed the methods of analysis and synthesis, which made it possible to generalise knowledge on the issue: by analysing the types and forms of student research activities in pedagogical HEIs in the specialty 015 “Professional Education (by Specialisations)”, the compliance of such activities with legislative norms was established; by examining the process of acquiring research skills by students of pedagogical education in accordance with legal norms through the use of informational heuristic methods, their most significant application in the teaching of the educational component “Fundamentals of Scientific Research and Academic Writing” was identified; by analysing the peculiarities of productive formation of research skills in the educational process, the role of library heuristics in this process and in the development

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of text analysis skills was highlighted. The results of the study can be implemented in the educational process to optimise the teaching of courses on the fundamentals of scientific research, as well as to improve the effectiveness of academic writing instruction

■ **Keywords:** information; search methods; human capital; digital skills; text analysis; research skills of students; ability to work with selected information

■ Introduction

The rapidly transforming world, driven by the digitalisation of civilisational progress, demands profound changes in educational processes across all countries without exception. Contemporary scholars affirm a gradual transition towards a knowledge-based society, where information becomes the resource that forms human capital, the driving force behind global transformational processes. Information, its conscious processing followed by concrete technological application, is an integral part of the scientific process. Thus, in educational institutions focused on pedagogical training, it is particularly relevant for academic and pedagogical staff to direct their efforts toward developing students' skills in searching for and processing information, ensuring the acquisition of knowledge that becomes the primary productive resource, a source of scientific and creative activity, and a priority socio-cultural force. The knowledge and skills acquired by young teachers will inevitably be transferred to the educational processes of secondary schools, assisting in the formation of the scientific potential of the younger generation. Therefore, the issue of developing research skills in the educational process of pedagogical higher education institutions (HEIs), where informational heuristics play a significant role, is not only relevant but a task of utmost importance.

In his study on the transformation of educational colleges into higher education institutions in Myanmar, M.T. Kyaw (2022) specifically highlighted political (state) encouragement for teachers to engage in research activities. According to M.T. Kyaw (2022), state-driven motivation for research activity contributes to the advancement of the education system and enhances competitiveness. The scholar also draws attention to the role of internal motivation and the professional growth of teachers through research activities. In his publications, M.T. Kyaw (2022) emphasised the mechanisms of research activities among pedagogical staff, with particular attention to the autonomy of the research process.

In their research, A.-S. Grub *et al.* (2022) emphasised the importance of knowledge gained in HEIs for the professional development of future teachers and their ability to effectively manage the classroom using mechanisms such as “noticing” and “reasoning”. These mechanisms, in the authors' view, are well-formed and developed from the first year of study through research activities. “Noticing” is ensured through the educational

process of instructional work with information sources, while “reasoning”, as a component of knowledge-based ability, becomes a part of the educational process driven by internal motivation for professional expertise. “Reasoning” serves as a stimulus for deepening knowledge, which primarily occurs due to the scientific component of the educational process.

N. Brouwer *et al.* (2022) argued for the continuity of student-centered learning in the university and its subsequent impact on pedagogical activities, accompanied by continuous professional development through scientific work, the application of new teaching methods, and participation in various courses, seminars, and training sessions. All of this is in demand even at the HEI level, with student-centered learning fostering deep competence, which manifests through competence-based organisation of learning during university years and through self-learning during the teaching profession. The authors also pointed out the need for students to participate in university research programmes, where the culture of scientific communication and work influences the formation of the student's contextual personal thinking. The teaching staff increasingly invests their time in students to achieve scientific and professional-pedagogical outcomes.

Interesting is the proposal by N. Brouwer *et al.* (2022) regarding the creation of individual, personalised educational programmes in higher education institutions (HEIs), where both the teaching system and the form of practice are tailored to the individual. According to the authors, such a personalised approach to the educational process is effective. Scientific research requires knowledge and skills in writing academic texts; therefore, attention is drawn to the recommendations by W. Zhou *et al.* (2023) concerning the use of syntactically complex sentences in the introductions of research articles. The authors investigated the relationship between linguistic features and their rhetorical functions in academic writing and provide guidance for young researchers on using syntactically complex sentences when writing the introduction to research articles. Studying these recommendations is highly relevant when exploring the educational component “Fundamentals of Scientific Research and Academic Writing”, as they help form an understanding of the connection between linguistic features and their rhetorical functions in academic writing. In practical terms, they also assist in developing the skills

necessary to use syntactically complex sentences when writing academic papers.

H. Løje *et al.* (2017) focused on enhancing students' innovative interdisciplinary competencies. Although the authors primarily concentrated on the training of engineering students, the issues they examined are also relevant to the general training of pedagogical higher education students in a rapidly changing globalised world. The competence of HEI graduates significantly benefits from the acquired research skills and the development of innovative abilities. The acquisition of interdisciplinary competencies by students in pedagogical HEIs provides the ability to transfer knowledge, skills, and abilities from one field of science and professional activity to another, thus ensuring increased competitiveness in the job market. In preparing future professional education teachers (by specialisations) in pedagogical HEIs, interdisciplinary competence enables the formation of a symbiosis of knowledge, the synthesis of skills, and the enrichment of abilities.

The application of various forms of informational heuristics in the development of research skills among students of pedagogical higher education and the role of the educational component "Fundamentals of Scientific Research and Academic Writing" in this process constitutes the primary goal of this article. The task of this work was to analyse the most effective methods of informational heuristics in the process of forming research skills among students of pedagogical higher education.

During the research, various methods were employed for a thorough analysis and study of the issues related to research training in pedagogical education. The method of analysis allowed for a detailed examination of existing sources of information, such as academic articles, monographs, and studies on research training. This method helped identify key aspects and issues that require further study, as well as understand the current state and trends in this field. Synthesising information from various sources allowed for the integration of different approaches and concepts, creating a cohesive picture. Synthesis helped integrate the results of previous studies and identify general trends and patterns, contributing to the formulation of generalised conclusions and recommendations. The use of analogy allowed for comparisons of the studied aspects with similar processes in other fields or within the context of different educational systems, which helped uncover effective practices and solutions that could be adapted to improve research training in educational institutions. The comprehensive application of these methods not only facilitated the systematisation of existing data but also led to the formulation of new approaches and recommendations for enhancing the effectiveness of research training. The research results serve as a foundation for further scientific exploration in this area and open new perspectives for improving educational practices.

■ Heuristics and research training

An attempt to generalise scholars' views on the interpretation of the term "heuristics" was made by O.M. Zbanatska (2020). She argued that heuristics, as a science, is not yet fully formed. Its subject and methods are deeply integrated with philosophy, psychology, and the physiology of higher nervous activity, as well as many other scientific disciplines. This research expands the understanding of the boundaries and possibilities of heuristics, while also opening new perspectives for its further development and application in various scientific and practical contexts.

The importance of the research by O.I. Nefedchenko (2023) lies in its exploration of the theoretical and technological foundations of heuristic education, providing a clear understanding of its development both in Ukrainian and international pedagogy. The monograph substantiates the author's concept of periodisation in the development of heuristic education, allowing for a deeper understanding of the evolution of methods and approaches in this field. Furthermore, the study summarises the results of theoretical and experimental research conducted by academic schools and individual scientists, contributing to the further development and improvement of heuristic education.

The issue of creative thinking as a feature of modern heuristics, which is shaped by innovative cognitive approaches in the development of a "knowledge society" and the active integration into the informational world that immerses individuals in a new socio-cultural environment, and fosters the rethinking of the value of scientific knowledge for intellectual culture, was the focus of A.V. Sakun (2015) monograph. The correlations between the concepts of "bibliographic heuristics" and "bibliographic search", as well as the delineation of the communication environment of bibliographic heuristics, were discussed in the works of O. Zbanatska (2020).

The practical guide by the staff of the V.O. Sukhomlynskyi State Scientific and Pedagogical Library of Ukraine, authored by O.V. Hryhorevska *et al.* (2022), focuses on the formation of information resources in higher education institutions' libraries and the provision of access to them. These studies contribute to a deeper understanding and improvement of tools supporting scientific and educational processes and offer new perspectives and approaches for the development of key aspects of modern heuristics and informational resources. Zh.O. Kormosh *et al.* (2020) developed a manual that includes information aimed at developing students' ability to search for and analyse multi-source information. The authors provided practical recommendations and methods that contribute to the development of critical analysis skills and the effective use of library and digital resources.

Yu.I. Mingalova (2018; 2021) dedicated considerable attention in her publications to the issue of

students' research work during classes on the educational component "Fundamentals of Scientific Research". An interesting study by M.G. Drushlyak *et al.* (2022) focused on media education, students' media literacy, and the role of information self-learning. The authors conducted an analysis of the use of informational resources and identified their potential impact on the development of media literacy among young people.

From a methodological perspective, the educational manual offered by the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", is noteworthy (Sharpan, 2023). This manual addresses an important task-enhancing rational creative thinking among students and helping them gain experience in transitioning from a student-researcher to a scientist. The material of the manual fosters an understanding of the methodology of scientific creativity.

The methodological component of scientific research is also presented in the manual "Fundamentals of scientific research and the theory of experiment", compiled by Yu.B. Kapatsila *et al.* (2023). The materials of this manual not only focus on uncovering the essence of the principles and methods of scientific research but also thoroughly explore the sequence of conducting experimental research, ensuring theoretical modeling, and performing data analysis. The authors emphasised different types of research and offered various approaches to conducting experiments for study and use.

Having analysed a wide range of studies conducted by both foreign and domestic scholars, the following key aspects can be identified:

- The multidisciplinary nature of heuristics;
- Informational heuristics as a mechanism for searching knowledge sources aimed at shaping the scientific worldview and creative activity of future builders of the knowledge society;
- Educational heuristics as a method for transitioning from an inductive-elicitive knowledge acquisition mechanism to intuitive heuristics and heuristic programming;
- The role of higher education institutions (HEIs) in shaping knowledge on the diversity of independent information search methods;
- The importance of self-learning in acquiring skills for utilising informational resources;
- As a result, the formation of creative thinking and the development of research skills emerge.

The described scientific contributions have become a significant component in forming a holistic understanding of the role of information, informational heuristics, and research skills in the professional development of "new" pedagogical staff. It is on the knowledge potential of these individuals that the preparation of the "builders" of the globalised society of the 21st century will rely. Therefore, the processes characterised in this study represent a substantial step

toward forming effective "builders" of the information and knowledge-based society.

■ The role of transformational processes in the development of education and science in the context of globalisation

Transformational global processes create challenges for the modern development of the globalised economy, giving rise to interstate and civilisational confrontations, manifesting through societal tensions, regional conflicts, and local wars. These processes set a new vector for global development, where education and science play the role of a foundation for stabilisation: education as the basis for creating the intellectual resources of states, and science as the technical and technological guide for economic changes, along with the corresponding dynamic political framework that operates for the benefit of humanity, welfare, and well-being (Hryhorevska *et al.*, 2022).

Education is becoming a social institution tasked with the mission of shaping the future of a human-centered society. Higher education is gradually transitioning towards the active involvement of students in fundamental and applied scientific research, which is conducted by academic and pedagogical staff in collaboration with potential employers, research institutes, and business centers. Therefore, from the very first years of study at higher education institutions (HEIs), students must acquire skills in conducting research, as it is the foundation of all sciences. They must realise their creative potential and apply the newly acquired knowledge in the form of scientific information to subsequently create technical, technological, or social innovations. For students, research work provides an opportunity to acquire or improve their knowledge based on the experiences of others, enhancing their strengths and correcting their weaknesses (Morgun *et al.*, 2021).

An essential mechanism that fosters the development of research skills and the formation of innovative knowledge is educational heuristics. As an educational method, heuristics ensures a gradual transition from organisational-search mechanisms of cognitive activity to the development of independent thinking and creative activity, i.e., "intuitive heuristics" (related to associative memory and the brain's ability to provide quick thinking and generate ideas based on perception, memory, and emotional mechanisms) and "heuristic programming" (which can be applied for the precise description of specific processes).

Pedagogical HEIs build students' research work based on the National Doctrine of Education Development, which clearly states the necessity of organically combining education and science, forming a modern worldview, and developing creative abilities and skills for independent scientific exploration, self-education, and personal self-realisation. It emphasises

the preparation of qualified professionals capable of creative work, professional development, mastering and implementing knowledge-intensive and information technologies, and competing successfully in the labor market (Decree of the President of Ukraine No. 347/2002, 2002).

The establishment of research activities for students in pedagogical higher educational institutions is also based on Order of the Cabinet of Ministers of Ukraine No. 286-r (2022). This document states that:

- The reform of the educational process in higher education is expected to result in “the creation of intellectual and innovative products and services by higher education institutions, which are implemented and provided in the real sector of the economy”;
- International educational and scientific cooperation is deemed relevant and necessary, where mechanisms for “integrating scientific and scientific-pedagogical staff into the global space” may be employed;
- A level of international scientific cooperation is anticipated such that by 2032, “the share of full-time scientific-pedagogical and scientific staff who will have 25% of scientific publications in specialised scientific publications of category “A”;
- Higher education institutions are required to ensure “the creation of conditions for the participation of higher education seekers in scientific research, the initiation and implementation of innovative projects”;
- The state stimulates “the support of cooperation between higher education institutions and research institutions, participation in the implementation of international scientific projects and programmes, primarily of the European Union”;
- The third stage of implementing the Strategy for the Development of Higher Education in Ukraine is characterised by “the expansion of links between education, science, and business, and integration into the global educational and scientific space...”.

The implementation of the norms specified in the above regulatory documents aims to create favourable conditions in pedagogical higher educational institutions for the development of creative thinking, the formation of a scientific worldview and erudition, and the expansion of research capabilities. Overall, this contributes to the quality training of future educators who are prepared, skilled, and capable of engaging in not only teaching but also scientific and creative activities.

■ Informational heuristics in research activities: Theory, practice, and educational aspects

The foundation of scientific activity is the mechanism of information search as a source for analysis, a basis for critical reflection on processes, and a stimulus for innovative actions. The process of searching for information that becomes the “starting point” in the system of scientific research can be categorised as “informational

heuristics”. Delving into the meaning of the term “informational heuristics”, it is important to highlight its multifaceted and ambiguous interpretations. One can agree with Z.V. Hipters (2008), who suggested that the term “heuristics” is associated with productive creative thinking aimed at resolving contradictions through the intuitive mechanisms of the human psyche.

Aiming to create a model for resolving contradictions and reaching a new level – an innovation – heuristics, as a process, is based on an informational component, which ensures either diligent work, a brilliant insight, or a complex process of creative thinking. Being a complex concept, informational heuristics is a combination of philosophical, psychological, cybernetic, and scientometric knowledge aimed at solving tasks for which personal experience is insufficient, and where the conditions surrounding the problem do not suggest a solution. A new activity strategy (the research process) includes a significant mechanism (informational heuristics), where knowledge of information theory, creative thinking skills, and intellectual capabilities are essential. Providing the opportunity to develop a person’s abilities for creative intellectual activity is one of the main tasks of modern higher education institutions (HEIs) in Ukraine.

In the information age, the development of cybernetics enables the creation of heuristic programming, which is applied in situations where a person can evaluate the results of a process but cannot describe it precisely. For this purpose, various heuristic programmes are created to model the process of solving specific tasks. Heuristic programmes have limited search capabilities due to technical limitations, such as the precision of execution and description, while “human heuristic abilities in some cases are still not subject to formalisation” (Dictionary of the Ukrainian language, 2013). Selective search is used, a motivational mechanism for action is activated, the psychology of thinking is engaged, and human intellect plays a role. In modern conditions, the skillful combination of human abilities and technological support is appropriate. The preparation of individuals to competently use technological resources is entrusted to various levels of educational processes.

In pedagogical HEIs, the following types of research activities for students are distinguished: academic research according to curricula and research within the framework of scientific work conducted by the faculty of departments. The result of students’ research work according to curricula includes activities related to solving problem-based tasks during seminars, laboratory, or practical classes; conducting independent research work; carrying out individual pedagogical or industrial tasks during internships, as pedagogical HEIs prepare specialists in professional education by specialisation; writing essays on topics for each educational component; and preparing for the defense of term papers and qualification projects. Through this direction of

academic research, which becomes more complex with each academic year and increases in depth of requirements, the process of scientific cognition is ensured, leading to the growth of self-realisation and pedagogical-scientific self-affirmation (Luhovyi *et al.*, 2021).

The process of scientific formation for future vocational education teachers is essential, as the result of the educational process in pedagogical higher education institutions (HEIs) should not only be the preparation of a qualified professional teacher but also a potential innovator in the industrial-professional sphere. Such an individual should be capable of transferring their skills, expertise, and knowledge to others and, through their creative activity, fostering the creative development of graduates from vocational and technical education institutions. The ability to work in a research-oriented mode from their time in pedagogical HEIs will enable young vocational education teachers to bring elements of scientific-practical and research-experimental activities into vocational and technical education. Every research paper or term project becomes a step in the professional development of the future vocational education teacher, both as a teacher and as a researcher.

Research activities of students outside the formal educational process contribute further to solidifying the high qualifications of future vocational education teachers. These research activities include subject-specific scientific research, participation in departmental work on state-funded or contract-based research topics, and conducting studies within the framework of collaboration between HEIs and vocational and technical education institutions. Particularly noteworthy is the involvement of students in student research centers and lecture associations, where the outcomes include organising student conferences, roundtables, and debates on problematic issues; setting up lecture series on research topics; and publishing a collection of student research papers (every semester). This activity fully complies with the norms outlined in the National Doctrine of Education Development (Decree of the President of Ukraine No. 347/2002, 2002) and the Strategy for the Development of Higher Education in Ukraine for 2022-2032 (Order of the Cabinet of Ministers of Ukraine No. 286-r, 2022). These documents confirm the unwavering direction of Ukrainian education towards the formation of human capital, where significant components are not only the ability to engage in innovative activities but also the capacity to defend one's creative achievements in any scientific discussion through heuristic dialogue.

Thus, one can speak of the importance of heuristic progressive learning forms in shaping a new societal communication system that meets the demands of the information society of the 21st century.

The foundation of research work for students is the skills embedded in the educational component of pedagogical higher education programmes – “Fundamentals

of Scientific Research and Academic Writing”. A fundamental skill in conducting research is the ability to search for and analyse information. Given the vast amounts of available information, it is essential to guide students in searching for relevant information, teaching them to properly evaluate, categorise, and rank the collected data. To achieve this, instructors offer a system for evaluating information that includes the following criteria: the novelty of the information, its reflection of significant contemporary issues, the reliability based on the trustworthiness of the source, the adequacy of the information through an analysis of the degree of hypothesis argumentation, the sufficiency determined by the volume of information needed to support the hypothesis, and the accessibility based on the ease of comprehension, speed of retrieval, and potential for dissemination. Through this process, students develop the “heuristic potential of research”, where cognitive tools and methods are combined to identify and solve the problem of selecting information for further scientific research.

Authors believe that even during the transition to an information society, students should be encouraged to use various types of information carriers – printed, electronic, audio, video; traditional and modern sources of information – libraries, websites of research institutions, professional publications, webinars, conferences, etc. It is clear that students increasingly rely on modern information sources (which offer speed, flexibility, and access to foreign resources, among other advantages). Therefore, it is the responsibility of HEI instructors to teach students to verify information from internet sources and to focus on peer-reviewed information from websites of academic institutions, professional electronic publications, and library websites.

In lecture sessions for the “Fundamentals of Scientific Research and Academic Writing” course, the use of informational systems such as Google Scholar, Google Book Search, World Digital Library, Open Library, and others is recommended. The importance of students' own informational resources is also highlighted, which not only allow the sharing of certain information but also foster the exchange of ideas and opinions (these platforms can serve as a basis for online surveys related to research activities). Additionally, students are encouraged to engage in collective work using Web 2.0 technologies (Blogger, Digg, Wetpaint, Wiki, Google Docs, etc.), which facilitate the collaborative creation of informational resources on a particular research problem through the joint interaction of multiple users (from different courses, faculties, or even different universities). Such collective work among students with a shared interest in a specific problem allows for the rapid formulation of hypotheses, a more comprehensive analysis of information, and the identification of models for solving the research problem.

However, the primary focus is on the individual preparation of students for research work: training

them in research methods and technologies, developing a research programme, familiarising them with the reporting forms for each stage of research, and guiding them through the process of presenting and defending their research results. Given the extensive global information resources available in the informational network, the authors' courses in "Fundamentals of Scientific Research and Academic Writing" teach students not only how to search for information but also how to use it effectively. By developing information search skills, students are taught to properly plan their search strategies and consciously create criteria for information selection; to accurately choose keywords while forming a search image for a document; and to focus on the thoughtful and holistic understanding of information, emphasising the importance of correct classification.

Through both collective and individual preparation for research activities, students are guided in refining their cognitive processes, aiding intellectual localisation, developing research skills, and reinforcing the ability to select appropriate research methods – these competencies are essential components of modern heuristic learning. The libraries of higher education institutions now ensure high-quality information selection by establishing automated library information systems (ALIS), retro-converting library collections, and creating electronic catalogues through digital technologies. Within the scope of the academic module "Fundamentals of Research and Academic Writing", the focus lies on teaching students effective research strategies, understood as a logical process grounded in source knowledge, and recording information that can serve as a foundation for future research. In other words, the course enables the use of bibliographic heuristics, defined by O.M. Zbanatska (2020) as the "basis of bibliographic search" – a methodology that encompasses search rules, output criteria, and the collaboration system between the researcher and the information retrieval system.

Knowledge of bibliographic source studies is crucial for student research, along with the ability to identify key characteristics for finding relevant bibliographic material and maintaining a consistent awareness of connections between the targeted source and academic or public references. These skills aim to make research swift and effective, instilling in students the understanding that only through dialectical-logical retrieval methods can success be achieved at one of the initial stages of scientific inquiry – identifying the search profile of a document as an information source. Upon forming the search profile, document retrieval can commence, facilitated by the ALIS currently in use across Ukrainian academic libraries.

Through sequential academic introduction and practical methodologies, students are trained to work with information products and the digital services offered by both university and other libraries. Class

sessions, followed by internship experiences, equip students with skills in using digital services and products, such as reference requests, document access from collections, and electronic document delivery; bibliographic information through indexes, databases, and reading lists; as well as factographic databases, reference materials, and dossiers. Given the increasing presence of online information products, working with library systems and various documents imparts skills beneficial for research, such as bibliographic, document, and factographic search methods.

Bibliographic search involves seeking document-related information, document search locates the document itself, and factographic search examines the document's content and information. O.M. Zbanatska (2019) suggests considering these processes as forming fields of study – bibliographic heuristics, document heuristics, and document-information heuristics (factographic heuristics).

Student attention is also directed toward library services that include text analysis (factographic, conceptographic, analytical): computer research, factographic dossiers, analytical reviews, digests, etc., which are essential in research activities. In seminars on "Fundamentals of Research and Academic Writing", text analysis skills are practiced and refined during library internships, assisting students in applying these skills effectively to their own research activities.

To acquire more extensive information during research activities, students are encouraged to keep track of virtual book exhibitions held by libraries. These exhibitions focus readers on collections within specific subject areas, with books or documents that can subsequently be ordered for review (via interlibrary loan or electronic document delivery services). Information presented in lectures on international interlibrary loans and document delivery services, such as The British Library Document Supply Centre (BLDSC), enables students, when necessary, to obtain this information for their own research purposes. Libraries in Ukrainian higher education institutions support such collaboration with international library networks and funds by preparing relevant permits and establishing electronic communication systems. Students make extensive use of the interlibrary loan system, becoming increasingly convinced of the power of Internet capabilities and digital transformations within the field of library services (Lobuzina, 2012).

In the context of the study, developing students' skills for effective online work, including information search strategies and critical information assessment, is essential. It is important to teach them library and informational heuristics to promote an understanding of various information resources, such as educational, scientific, regulatory, reference, and electronic libraries. Additionally, while performing independent tasks, students should become familiar with intellectual

property norms related to accessing electronic resources (Serhiyenko *et al.*, 2022).

Another important source of information for students' academic activities is the use of their university's electronic archives (repositories). Having gained worldwide recognition in the early 21st century as accumulators, systematisers, and disseminators of the digital scientific outputs of institutional staff and digitised documents of the legal entity itself, university repositories have transformed into indicators of institutional quality, conferring appropriate status and public significance.

Repositories guarantee open access to the research conducted within the university. This information is utilised by university students in their research activities. Students can observe the scientific achievements of the university's academic staff, track citation metrics of departmental researchers, access electronic versions of instructors' academic work, and consult directly with authors if they encounter difficulties in comprehending the researcher's ideas. This direct scientific communication between researcher and student on academic topics yields positive results for both parties, particularly for students as young researchers. Access to the repository fosters students' reading and research initiatives, expands their academic opportunities, and enhances scientific communication across various levels.

■ Conclusions

The conducted research underscores the critical role of informational heuristics in the contemporary scientific process, which integrates philosophical, psychological, and cybernetic aspects to enhance information search and analysis. This becomes particularly significant in the context of the rapid advancement of information and computer technologies, where the use of modern digital tools alongside traditional sources enables a comprehensive approach to solving complex problems. Informational heuristics, with its capacity to foster creative thinking and the discovery of new problem-solving models, is not a standalone science,

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yet it holds considerable potential for further in-depth research within a range of fundamental sciences.

Heuristics, including its various forms (informational, documentary, bibliographic, and archival), is linked to intellectual activity that incorporates elements of intuition and novelty. This fosters human innovation and is critically important for the formation of human capital in an era of transformations. Heuristic learning, based on information processing and the reinforcement of basic and specialised knowledge, prepares students for research activities. The complexity of this activity often lies in the search, analysis, and systematisation of information – essential skills developed in courses such as "Fundamentals of Research and Academic Writing".

The individual and collective preparation of students for research activities, particularly in the field of informational heuristics, is a key component of their professional competency. In the modern information society, continuous improvement of information processing methods is crucial for enhancing the quality of both scientific work and education. Automated library information systems also play an important role in scientific inquiry; thus, students must learn to effectively utilise both traditional and digital resources to uphold high standards in research work. Heuristic learning and informational heuristics, in general, have become primary mechanisms in the development of young researchers, which is essential for building an information society.

Prospective areas for further research include studying the impact of new information technologies on the efficiency of information search and analysis. Another important aspect is assessing the practical significance of different approaches to teaching heuristic skills across various professional fields.

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■ Conflict of Interest

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Інформаційна евристика як механізм забезпечення успіху в системі наукових досліджень студентів

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■ **Анотація.** Сучасні трансформаційні процеси, зумовлені швидким розвитком новітніх технологій, посилюють вимоги до якості людського капіталу, важливою складовою якої є науково-дослідна діяльність. Перед системою вищої освіти постає завдання не лише передачі знань, а й формування ключових дослідницьких навичок та вмінь у здобувачів. Інформаційна евристика, яка забезпечує оптимізацію процесів пошуку, обробки та інтерпретації наукової інформації, виступає інструментом для підвищення ефективності наукових досліджень студентів. Її застосування є необхідним для відповідності сучасним вимогам глобального освітнього середовища. Метою статті була репрезентація змістового наповнення механізму інформаційної евристики в різноманітних її проявах як гарантії забезпечення успіху у формуванні навичок науково-дослідницької діяльності здобувачів освіти педагогічних закладів вищої освіти (ЗВО), на прикладі досвіду викладання освітнього компоненту «Основи наукових досліджень та академічного письма». У ході дослідження заявленої проблеми було використано метод аналізу та синтезу, що забезпечило можливість узагальнити знання з проблематики: проаналізувавши види та форми науково-дослідницької діяльності студентства в педагогічних ЗВО за спеціальностями 015 «Професійна освіта (за спеціалізаціями), встановити відповідність здійснюваної такої діяльності нормам законодавства; розглянувши, відповідно до правових норм, процес набуття навичок науково-дослідницької діяльності здобувачами педагогічної освіти шляхом використання методів інформаційної евристики, визначити їх найбільше представлення в процесі викладання освітнього компоненту «Основи наукових досліджень та академічного письма»; проаналізувавши особливості продуктивного формування навичок науково-дослідницької діяльності в навчальному процесі, вказати на роль бібліотечної евристики в даному процесі та в формуванні навичок аналізу текстів. Результати дослідження можуть бути впроваджені в освітній процес для оптимізації викладання курсів з основ наукових досліджень, а також для підвищення ефективності викладання академічного письма

■ **Ключові слова:** інформація; методи пошуку; людський капітал; цифрові вміння; аналіз текстів; науково-дослідницькі навички здобувачів освіти; вміння працювати з відібраною інформацією



Pedagogical communication in practical training of future vocational education specialists: Process, implementations and outcomes

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■ **Abstract.** Professional-pedagogical communication, as a condition for developing communicative abilities and a form of psychological interaction between educators and learners during the educational process and practical training, is aimed at the comprehensive development of future professionals in vocational education and creating conditions for the realisation of their independent, professional, and creative abilities. The purpose of this research was to determine the main ways of organising practical training as one of the priority conditions for shaping pedagogical communication among future professionals in vocational education. A complex of methods including theoretical, systemic, analysis of practice program, and survey methods was employed to thoroughly explore the research topic. The study established that purposeful pedagogical guidance, methods of implementation and improvement of practical training, and enhancing the content of activities of future professionals in vocational education during practical training create conditions as an important factor for forming all components of professional-pedagogical communication of higher education students, perceiving themselves as vocational education educators. The research also analysed and summarised the experience of Ukrainian and foreign scholars regarding pedagogical-professional communication and ways to improve the practical training of future professionals in vocational education. It further synthesises the issues related to improving the organisation of pedagogical practice as one of the priority conditions for shaping professional-pedagogical communication of future professionals in vocational education in the specialty 015 Vocational Education (Occupational Safety, Transport). A set of pedagogical conditions is formulated. The practical significance of this work lies in the fact that the specified relevance, methods, formulated pedagogical conditions, and analysed the process of practical training by future professionals in vocational education, and conclusions as a whole can be utilised for: improving practical training programs in higher education institutions; introducing the educational component "Pedagogical Communication in Vocational Education" for higher education students of the specialty 015 Vocational Education (Occupational Safety, Transport)

■ **Keywords:** pedagogy; professional communication; competencies; educational process; practical training; higher education students; occupational safety

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■ Introduction

In the modern social environment, where knowledge and advanced technologies are developing at an unprecedented pace, the educational process should focus not only on acquiring basic knowledge but also on the formation of general and professional competencies, skills for independent acquisition of new knowledge, information, and professional communication, effectively applying them in practice. In the current period of higher education system reform in Ukraine, the important goal of educational institutions is to monitor the process of integrating education with science and industry, enhancing the role, responsibility, and significance of professionals, as well as ensuring the conformity of specialists' training to international standards. Special attention is paid to bridging the gap between the level of theoretical knowledge acquired by students in higher educational institutions and the practical skills necessary for their successful professional activities.

Meeting these requirements is possible by implementing practical training as an important component of the educational process, as a multifaceted, organic process of professional training of future professionals in vocational education, which allows synthesising theoretical knowledge and practical pedagogical experience for future teaching activities. I. Alimerko (2024), investigating the importance of practice for higher education students, pointed out that it is during practice that students can thoroughly examine the significance of theoretical issues and their application in practice, enabling them to envision their future profession in educational activities. The author noted that the main goal of practice is for the future specialist to gain a deeper understanding of their future professional activity.

Authors I. Adeel *et al.* (2023), A. Wanyu *et al.* (2024) in their works indicated that through artificial intelligence and the development of modern technologies and internet programs, higher education students can significantly more effectively develop and improve pedagogical, academic, and cognitive communication skills in practice. H. Henseruk & M. Boyko (2022), analysing organisational aspects to improve pedagogical practice, pointed out a number of effective factors, including the availability of high-quality educational and methodological support from departments, developed skills and abilities of students in applying teaching methods of professionally oriented subjects, their involvement in pedagogical research, as well as active support from mentors in students' adaptation to the conditions of professional activities during practice. Systematic control and objective evaluation of practice results are also important aspects. Authors agree with the researchers, as adherence to the listed factors will enhance the effectiveness of forming pedagogical communication in future professional activities.

In their studies, researchers N. Van Veggel *et al.* (2023) focused on the fact that during practice,

methodologists and practice supervisors are the drivers in the organisational machine that is a higher education institution. According to the authors, higher education students constantly develop leadership skills during their practice. It is precisely during practice that trainee students not only develop leadership qualities but also enhance their professional-pedagogical communication and competencies for future professional activities. As, in turn, by following the leader, each trainee student also tries to be a leader, thus, imitation occurs, which is one of the positive factors.

Using the research of I. Kamenska & O. Bokshyts (2022) on labour inspection as one of the main mechanisms to combat industrial injuries, higher education students during technological and pedagogical practice have the opportunity to identify certain shortcomings and prevent injuries in their future professional activities in the educational field. The authors' research is relevant because human health and life are a priority of universal values. M. Osborne *et al.* (2024), studying practice as an understanding of safety techniques, argued that it is during practice that higher education students acquire professional competencies, develop professional-pedagogical communication, and identify certain shortcomings in organisational and methodological approaches to practise implementation for their further improvement. According to the researchers, in addition to positive results in forming professional competencies and professional-pedagogical communication during practical training, more professional educational components should be added to educational programs for the professional training cycle and strengthen the knowledge and skills of future professionals in vocational education through multidisciplinary specialists working on the curriculum.

Contemporary competitive professionals must possess specialised skills and professional experience based on modern specialised knowledge in a particular field and a high level of professional competence, grounded in critical thinking and the ability to apply theoretical knowledge in practice, as well as adept communication at a professional level, as pedagogical communication is necessary for coordinating the behaviour of educational seekers in a group. Additionally, in modern realities, one of the priority requirements of potential employers is professional competence and professional communication. The aim of the article was to determine the role of pedagogical communication in the practical training of future professionals in vocational education for professional self-realisation, which can and should become one of the main results of Vocational Education (Occupational Safety, Transport).

■ Literature Review

Analysis of literary sources on pedagogical practice issues indicates the relevance of the studied topic by

scholars from various countries around the world. In their works, scholars have revealed questions of the methodological relationship between pedagogical-professional science and the practical activities of higher education seekers and the organisational-methodological principles of pedagogical practice. T. Belan (2011) emphasised that during pedagogical practice, there is intensive formation of students' professional competencies and skills, promoting the development of their creative independence and the ability to analyse pedagogical processes, as well as laying the foundation for an individual style of educational work and pedagogical mastery. In turn, Yu. Datsko (2009) pointed out that pedagogical practice not only contributes to the formation of future teachers' professional qualities but also serves as an important link between mastering modern methodological teaching technologies of speech communication and future pedagogical activities of university graduates.

Exploring the importance of practice in preparing future teachers, N. Kazanishena (2019) emphasised that it is during pedagogical practice that students acquire new types of professional activities, which, in turn, actively influence the formation of a complex of personality traits necessary for further pedagogical activities. I. Alimerko (2024) noted that professional practice is not just a simple exercise for students but also a profound test for theoretical issues and their application in practice, an attempt to recognise the profession in educational activities, indicating that practice is aimed not only at performing exercises but also at familiarising students with work tactics and learning strategies.

In her research, O. Oleksyuk (2005) noted that pedagogical practice in the system of professional training is a connecting link between theoretical material and the ability to use it in pedagogical activities. The system of pedagogical practice was formed on the basis of the principle of the comprehensive pedagogical training unity of theory and practice. Therefore, education in higher education was transformed into a process of implementing acquired knowledge in practice. Investigating pedagogical practice as a factor in the professional development of future teachers, L. Kravets (2012) emphasised that pedagogical practice is an important moment in forming self-assessment of professionally important qualities and self-awareness in the role of a future teacher. In her research, the scholar focused on various aspects of pedagogical practice, considering theoretical-methodological, historical-pedagogical, and scientific-methodical foundations of preparing future teachers. Additionally, she identified and characterised psycho-pedagogical conditions for improving students' pedagogical practice. Furthermore, the scientist scientifically substantiated socio-pedagogical aspects of the professional activity of a young teacher.

Such scholars as I. Kamenska *et al.* (2023), M. Osborne *et al.* (2024) in their scientific works investigating

mechanisms for combating occupational injuries and safety techniques noted that practical training plays an important role in studying safety disciplines and consolidating knowledge in practice to reduce injuries during future professional activities. Scholars emphasised that increasing practice hours for future education professionals will bring positive changes in reducing occupational injuries. N. Onyshchenko (2021a) devoted much attention to ways of modernising pedagogical practice, highlighting practical directions for practice development: the first direction – modernisation of practice is coordinated with modern state regulatory documents, the second direction – modernisation of practice is legislatively coordinated in accordance with the “Concept of training specialists in dual form of education”, the third direction – modernisation of practice involves bringing professional training of future teachers closer to the real conditions of future pedagogical activities based on active application of contextual learning.

T. Desyatov (2019), studying pedagogical education in Japan, highlighted the weaknesses in the pedagogical practice of educational seekers, indicating that the practical component is too small (2-4 weeks) and remains a weak point in Japanese pedagogical education. The analysis of literary sources testifies that Ukrainian scholars actively research topics related to pedagogical communication in the practical training of future professionals in vocational education. Authors in their works highlight the tendency to increase the duration of practice hours, intensify attention to methodological aspects of organising practice, as well as conducting and recognising the leading role in the professional training of future professionals in vocational education because it is during practice that pedagogical and professional-pedagogical communication is formed.

Authors N. Oliinyk (2004), M. Zabrotskyi (2009), I. Kamenska *et al.* (2023) pointed out that professional communication is an important factor in the professional identity of future professionals in vocational education, which is acquired, developed, and improved during practice. O. Novak *et al.* (2019), studying the formation of managerial competencies in graduate students, indicated that they directly depend on pedagogical communication of higher education seekers, which is best acquired during practice where seekers are in conditions close to real ones. L. Savenkova (2005) in her works indicated that preparing future teachers for professional communication is a quite relevant problem of modern psychological and pedagogical science and practice. Solving this problem is one of the directions in educating a new generation of pedagogical personnel, as envisaged by the reform of education in the Ukrainian state. In turn, A. Wanyu *et al.* (2024) in their research considered the consequences for developing policies and pedagogies in universities in developing teaching and assessment methods that meet the positions and needs of students in academic communication.

Thus, research in the field of practical training of future professionals in various fields of education indicates the general importance of this aspect for their professional training. Pedagogical practice plays a critical role in shaping students' professional competencies and skills. Researchers emphasised that it is during practice that students have the opportunity to develop creative independence, analyse pedagogical processes, and establish their own work style. Additionally, it is noted that pedagogical practice is an important component in mastering modern methodological teaching technologies and speech communication, which significantly affect the future pedagogical activities of future teachers. Attention to the practice process as a profound test and acquaintance of students with various aspects of professional activity is important, allowing them to effectively implement theoretical knowledge into practical reality.

■ Materials and Methods

The study employed a complex of methods: theoretical – analysis (retrospective, comparative) of pedagogical literature and generalisation and classification of scientific data in pedagogical sources; systematic (targeted observation of the interrelation and interaction of pedagogical communication in the practical training of future education professionals); analysis of pedagogical practice programs to clarify the state of professional training of future education professionals in the process of practice; survey method.

Using the theoretical research method, analysing scientific sources, a number of Ukrainian and foreign scholars who focused on strengthening ties with stakeholders, employers, on improving programs of all types of practice, and on activating the research work of future professionals in vocational education during practice were highlighted. Modern approaches to organising practice were outlined, the main feature of which is the desire to take into account national and international traditions and achievements close to real conditions of pedagogical activities of future professionals in Vocational Education (Occupational Safety, Transport). Using the systematic method in scientific research, the significance and development of pedagogical communication in practical training of future professionals in vocational education were systematised.

During the study, a survey was conducted in the form of a questionnaire, in which respondents were asked the following questions: whether there is enough time for practice; whether they would like to have more hours for practice; whether the review of the process of types of practice by supervisors is sufficient; whether the formed practice plans, requirements for the goals and objectives of practice suit them; whether the provision of pedagogical practices with educational and methodological materials is sufficient; whether the emphasis on organisational aspects rather than methodological ones is appropriate; whether it is correct that

the practitioner usually acts within the limits set by the practice base administration, which affects the manifestations of their independence and initiative; whether the level of professional-pedagogical communication for practice is sufficient; whether the summary of pedagogical practice is conducted at an appropriate level.

This survey allowed identifying a number of shortcomings in the organisation and conduct of practices. The survey involved 183 respondents of the daily and correspondence forms of study of the Faculty of Technological and Mathematical Education, specialising in 015 Vocational Education (Occupational Safety), who responded to the questions posed. All study participants were informed of its purpose and content, and they gave their consent to participate (American Sociological Association Code of Ethics, 1997). Additionally, confidentiality and anonymity of responses were guaranteed, and the collected data were used solely for scientific purposes and were not disclosed to third parties.

■ Results and Discussion

Pedagogical communication is a technique for implementing the professional activities of future vocational education teachers (occupational safety, transport), the skill of which should be based, on one hand, on special professional knowledge and diverse professional skills, and on the other hand, on the ability to skilfully exchange information with all participants of the educational process, achieving mutual understanding.

O. Fentsyk (2019) noted that pedagogical communication is a process of interaction between a teacher and students aimed at exchanging information, regulating pedagogical relations, and creating a positive psychological climate and emotional contact. This process is carried out using various communication tools. In her research, the author identified the main characteristics of pedagogical communication, such as its conduct in the conditions of the educational process; the application of an individual, personality-oriented, and humanistic approach to communication both with each individual student and with the group as a whole; basing on social-psychological interaction, which includes the participation of a teacher and one or more groups of students; observance of ethical principles of interaction between participants in the educational process; and orientation towards the processes of personal development and self-realisation of each student.

N. Volkova (2006) defined professional-pedagogical communication as a system of interaction of a teacher using various means of information transmission, which includes both verbal and non-verbal means, as well as computer communication. Its purpose is information exchange, modelling and management of the communication process, as well as regulation of pedagogical relations. The components of professional-pedagogical communicativeness are: a constant need for interaction with participants in the educational process

in various spheres; interaction of general human and professional aspects of communicativeness; emotional satisfaction at each stage of communication; possession of skills and abilities for communication; desire to improve communicative skills.

In her own research, N. Oliinyk (2004) also identified verbal and non-verbal communications for the development of pedagogical communication. She pointed out that professional-pedagogical strategies and tactics have a significant impact on education seekers, emphasising that the leading personality traits for pedagogical activity are: communicativeness, perceptual abilities, dynamism of personality, emotional stability, and creativity. The author's views are agreed with, as professional-pedagogical communication in practical training creates favourable conditions for the development of motivation of practitioner-learners, professional activities, development of their personality, ensures a favourable psycho-pedagogical climate, and allows maximising the use of personal and professional excellence in the educational process.

In the educational space, pedagogical communication simultaneously realises communicative and interactive functions. It can have different characters: informational, innovative, contact, motivational, coordination, and remote, in modern realities combining the interaction of all participants in the educational process. Pedagogical communication serves as an important factor in professional identity and covers all areas of pedagogical activity.

The success of pedagogical communication in practical training of future professionals in vocational education depends on whether the practitioner-learner can establish communicative relationships with the audience, classmates, students of vocational and

technical education institutions, supervisors of practice bases, methodologists, administration of educational institutions, etc., whether they are interested in the presented material for further activity, whether they can encourage cooperation and dialogue, whether they can manage attention, anticipate and resolve conflicts. It should be noted that communicative skills, combined with professional competencies of future professionals in vocational education, produce a solid foundation for shaping pedagogical activity.

T. Desyatov (2019) and N. Onyshchenko (2021b) noted that it is precisely in practice that future professionals in vocational education acquire professional competencies, pedagogical communication skills, activate understanding of the laws and principles of teaching and upbringing, learn to independently define the purpose and objectives of the educational process, learn to plan professional-pedagogical activities, analyse and forecast educational activities, collect methodological material for their future pedagogical-professional activities, demonstrate their creative abilities and potential in organising and conducting educational events.

At the Hryhorii Skovoroda University in Pereiaslav, at the Faculty of Technological and Mathematical Education, specialising in 015 Vocational Education (Occupational Safety), the organisation of practical training for students takes into account the specifics of vocational education and is carried out in accordance with the Regulations "On the Conduct of Practice of Higher Education Students at Hryhorii Skovoroda University in Pereiaslav (with amendments and additions)", developed, in turn, in accordance with the Regulations "On the Organisation of the Educational Process", the content of practice is determined by practice programs according to their types (Table 1-2).

Table 1. Types of internships for first-level higher education students in specialty 015 Vocational Education (Occupational Safety)

Practice Title	Year	Group	Semester	Duration	Assessment	Departments providing internship
Introductory practice	2	OP-2	IV	6 weeks	Pass	Department of Theory and Methodology of Vocational Training
Technological practice	3	OP-3	VI	4 weeks	Pass	Department of Theory and Methodology of Vocational Training
Pedagogical practice	4	OP-4	VIII	6 weeks	Pass	Departments: Theory and Methodology of Vocational Training, General Pedagogy and Pedagogy of Higher Education; Psychology

Source: developed by the authors based on Educational and professional program "Professional Education (Occupational Safety)" training specialist of the first (bachelor's) level of higher education in specialty 015 Professional Education (Occupational Safety) field of knowledge 01 Education/Pedagogy (2023), Educational and professional program "Professional Education (Occupational Safety)" training of a specialist of the second (master's) level of higher education in specialty 015 Professional Education (Occupational Safety) field of knowledge 01 Education/Pedagogy (2023)

Table 2. Types of internships for second-level higher education students in specialty 015 Vocational Education (Occupational Safety) for the 2022 academic year

Practice Title	Year	Group	Semester	Duration	Assessment	Departments providing internship
Production, research practice	1	OP-1PM	I	6 weeks	Pass	Department of Theory and Methodology of Vocational Training
Pedagogical practice	2	OP-2PM	III	8 weeks	Pass	Departments: Theory and Methodology of Vocational Training, General Pedagogy and Pedagogy of Higher Education; Psychology

Source: developed by the authors based on Regulation on the organisation of the educational process at Hryhorii Skovoroda University in Pereyaslav (2023), Regulation on the practice of students of higher education at Hryhorii Skovoroda University in Pereyaslav (with changes and additions) (2023)

The internship programs are developed by the academic staff of the department and the internship supervisor from the Department of Theory and Methodology of Vocational Training, in accordance with the curriculum of the educational program for training specialists at the respective level of higher education. The internship programs are discussed at department meetings, coordinated with the program coordinator, the academic council of the university, and approved by the vice-rector for academic affairs. The programs are developed for the duration of the curriculum for each level of higher education separately and are updated annually before the start of the new academic year. The regulations, internship programs, and educational-methodical literature developed by the academic staff and the internship supervisor from the Department of Theory and Methodology of Vocational Training are posted for higher education students in specialty 015 Vocational Education (Occupational Safety) on the department's website and on the Moodle platform.

The internship programs include a list of main issues that students of higher education institutions should independently study in the conditions of a specific professional (professional-technical) educational institution; determining the terms of individual tasks, as well as collecting factual materials for the preparation of scientific projects; understanding, transforming, and mastering the information obtained during the study and during the internship; willingness to apply the acquired knowledge in practice; organisation by the teacher of independent, conscious, rational, and ef-

fective activities of future specialists in the field of vocational education to master educational information, apply it, and consolidate it in practice (Borodiyenko *et al.*, 2023).

In seeking effective ways to implement practical training for future specialists in Vocational Education (Occupational Safety, Transport), it is worth noting a number of shortcomings identified in its implementation. In their research, L. Kravets (2012) and N. Onyshchenko (2021b) pointed out obstacles encountered during internships: insufficient provision of the process of forming practical skills and abilities during pedagogical practice; insufficient and unsatisfactory readiness and attitude of the trainee-practitioner to the preparation and completion of practical activities; lack of time allocated for the internship, unstable supervision over the internship process by the administration and supervisors; insufficient provision of pedagogical internships with educational and methodological materials that would contribute to the development and improvement of the professional competencies of future specialists in vocational education.

Thus, the authors indicated delays in the organisation of internships such as systematicness, consistency, and shortcomings in methodological-technological support for internships. Agreement is reached with the authors regarding the identified shortcomings, some of which were confirmed during a survey of higher education students at the Faculty of Technological and Mathematical Education, specialty 015 Vocational Education (Occupational Safety) (Table 3).

Table 3. Survey results regarding internship experience of future vocational education specialists

No.	Survey questions for higher education candidates	Response indicators, %	
		Yes	No
1.	Do you lack time for completing the internship?	58	42
2.	Would you like to have more hours for the internship?	100	-
3.	Is there sufficient supervision of the pedagogical internship process by supervisors?	42	58
4.	Do the structured internship plans and requirements for internship goals and tasks satisfy you?	70	30
5.	Is there adequate provision of educational-methodical materials for pedagogical internships that contribute to the development and improvement of the skills and abilities of higher education candidates?	55	45
6.	Are organisational aspects emphasised more than methodological ones?	20	80
7.	Is it correct that trainee-practitioners usually operate within the limits set by the practice base administration, affecting your independence and initiative?	15	85

Table 3. Continued

No.	Survey questions for higher education candidates	Response indicators, %	
		Yes	No
8.	Is your level of professional-pedagogical communication sufficient for completing the internship?	25	75
9.	Is the conclusion of the pedagogical internship conducted at an adequate level?	50	50

Source: developed by the authors

The survey results align with the research conducted by L. Kravets (2012), N. Onyshchenko (2021a), H. Henseruk (2022), and other scholars regarding the need to adhere to a range of effective factors in conducting internships. They serve as evidence that future specialists in vocational education are dissatisfied with a certain structure of practical training. Undoubtedly, these survey results are key indicators for departments to further improve the internship process, update educational programs (goals and objectives), actively involving employers who emphasise the need for pedagogical staff in vocational (vocational-technical) educational institutions, stakeholders, and higher education candidates, update educational materials that contribute to the development and improvement of the skills and abilities of higher education candidates. Based on the survey, to further improve pedagogical communication, it is necessary to increase the hours for all types of internships, allowing future specialists in Vocational Education (Occupational Safety, Transport) to professionally shape and develop both professional competencies and professional-pedagogical communication. Improve the quality of supervision over the internship process by supervisors and methodologists from internship bases and institutions. Also, with the aim of improving the conditions for conducting internships, as one of the main conditions for the formation of pedagogical communication, it is relevant to introduce the educational component "Pedagogical Communication in Vocational Education" into the educational-vocational program for specialty 015 Vocational Education (Occupational Safety). The educational component will allow future specialists in vocational education to thoroughly familiarise themselves with professional terminology and use it in professional communication, express their professional thoughts and emotions at a professional-pedagogical level; increase opportunities for self-realisation; mobilise personal potential and reveal hidden talents, contributing to the solution of many pedagogical problems in future professional activities. Identified gaps in previous theories direct towards a reasonable concept for research and the creation of new ways of implementing pedagogical communication in practical training.

Besides, T. Desyatov (2019) noted that during the period of pedagogical internship, when there is an active process of professional activity by higher education candidates under the pedagogical guidance of instructors, the transformation of professionally

significant knowledge into skills and abilities takes place. The author indicated that such an approach not only allows tracing the dynamics of the formation of professional-pedagogical communication but also reveals the results of internship supervision. Important ways of implementing the internship process include the interaction of university instructors and teachers of vocational education in professional (professional-technical) educational institutions. In their joint work, they practise a frontal strategy for organising the internship depending on its goals, the content of the course being studied by higher education candidates, expected outcomes, forms of control, etc. Methodologists from departments are appointed to supervise the internship, as well as teachers from vocational education institutions, who have certain responsibilities. Professional department methodologists work with future specialists in vocational education systematically throughout the entire internship period. It is worth noting that strengthening the role of methodologists in guiding the internship of future specialists in vocational education significantly changes the course of the internship. While in daily contact with trainees, methodologists effectively orient and adjust their activities; demonstrate examples of pedagogical activity and pedagogical communication, regularly advise higher education candidates on the organisation of the educational process.

In the conditions of martial law, higher education institutions conduct the educational process using a blended learning format, which combines face-to-face and distance learning models. Methodological recommendations for organising and conducting internships were developed at Hryhorii Skovoroda University in Pereiaslav, and individual tasks were updated to support the system of practical training for future specialists in vocational education. The scientific and pedagogical staff of the Department of Theory and Methodology of Vocational Education, for the continuous development of professional-pedagogical communication during the internship, using new information technologies, organise meetings in the format of video conferences on Zoom, Teams, Skype platforms. Trainees of practice groups, internship supervisors, and methodologists from internship bases, heads of cyclical commissions, and department heads participate in conference meetings. The process of practical training for higher education candidates is carried out in various forms both offline and online, as safety conditions

during air raids and wartime must be observed. Internship supervisors, together with stakeholders and train-

ees, constantly select the best didactic internet resources and applications (Fig. 1).

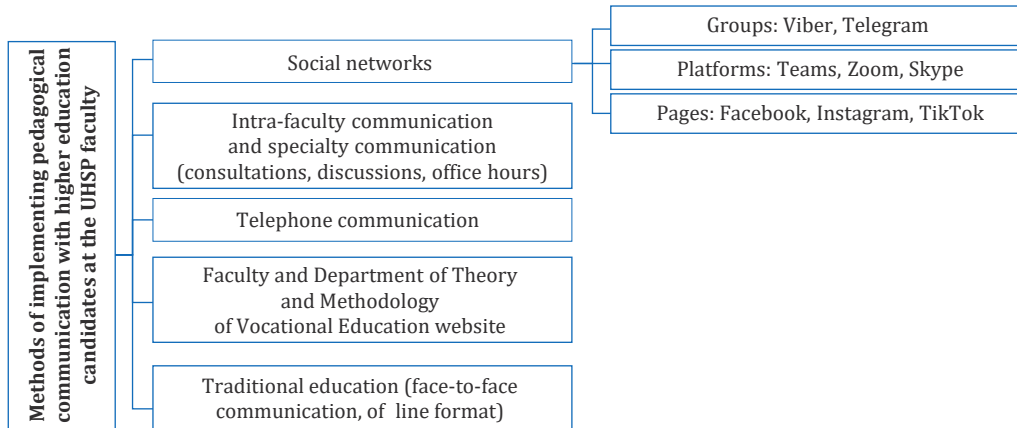


Figure 1. Communication methods of the Department of Theory and Methodology of Vocational Education with higher education candidates of specialty 015 Vocational Education (Occupational Safety)

Source: developed by the authors

Based on the analysis of educational and professional programs, regulations on internship and on organisation of educational process of the Faculty of Technological and Mathematical Education of Hryhorii Skovoroda University in Pereiaslav, relying on student-centeredness, survey results, modern aspects of cooperation with stakeholders, as a necessary condition for high-quality practical training of future professionals in vocational education, directors of state vocational and technical education institutions “Pereiaslav-Khmelnytskyi Vocational Education Centre” and “Boryspil Vocational Lyceum”, as well as a higher

education candidate of specialty 015 Vocational Education (Occupational Safety) at the master’s level, who was a member of the working group, the opportunities for second (master’s) degree higher education candidates were expanded in the form of three types of internships, namely: research, production, and pedagogical internships. It should be noted that specialty 015 Vocational Education (Occupational Safety) at the second (master’s) degree of higher education had two types of internships: production research and pedagogical, as well as underwent production internship at enterprises at the choice of higher education candidates (Fig. 2).

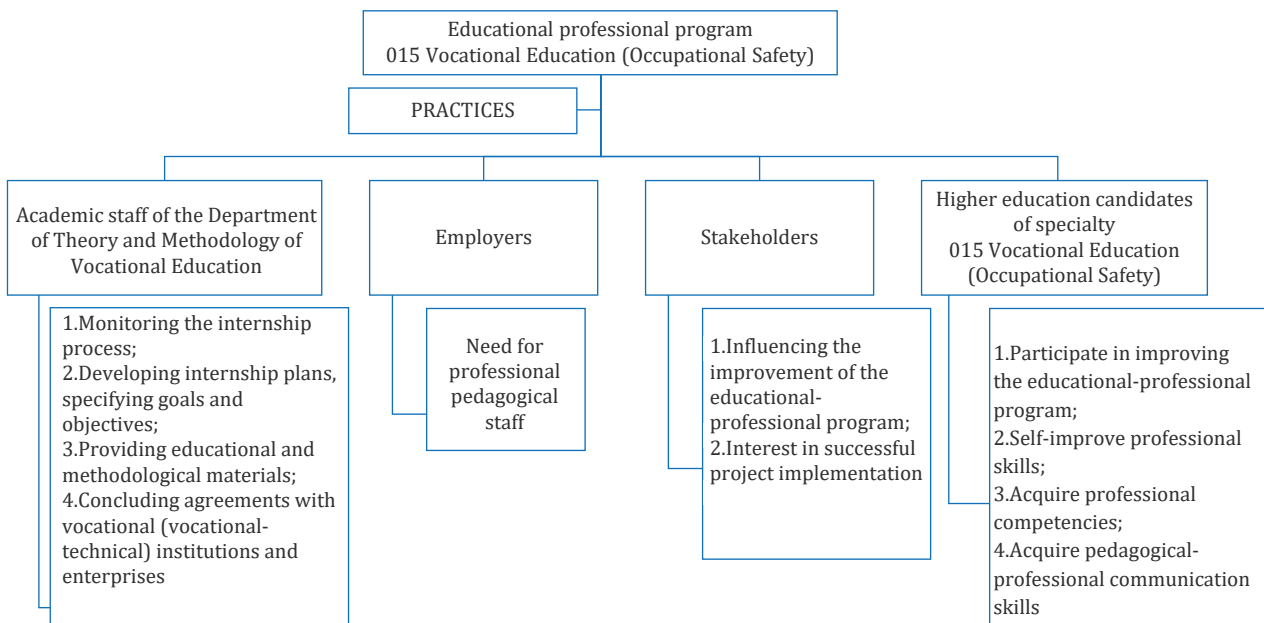


Figure 2. Paths of implementing improvements in practical training of higher education candidates of specialty 015 Vocational Education (Occupational Safety)

Source: developed by the authors

Therefore, it is important to create conditions for future vocational education specialists to achieve success and satisfaction from the process and results of pedagogical activities during all types of internships. This will ensure positive conditions for the formation of professional-pedagogical communication, activating their further comprehensive personal development in future professional activities.

■ Conclusions

Thus, pedagogical communication is one of the important factors in the practical training of future specialists in professional education, covering all spheres of pedagogical activity. The main ways of implementing the formation of pedagogical communication during internships depend on the communicative capabilities of educational institution administrations, educators, practice supervisors, and methodologists, their skill in establishing contact with student trainees, their ability to promote the practice of conducting educational sessions; quality provision of educational and methodological materials (improvement of internship programs, “Regulations on the Conduct of Internships for Higher Education Candidates of Hryhorii Skovoroda University in Pereiaslav”); organisation of systematic internship management; involvement of interns in professional-pedagogical research; ability to stimulate future specialists in Vocational Education (Occupational Safety, Transport) towards further activities; ability to structure industry relations between employers and higher education institutions to acquire professional-pedagogical communication and professional competencies by future specialists in professional education.

To ensure proper professional-pedagogical communication in practical training, the authors proposed a model for improving the paths of implementing practical training of higher education candidates in specialty 015 Vocational Education (Occupational Safety); weaknesses are highlighted on the basis of which it is necessary to improve the principles of interaction between Ukrainian higher education institutions and practice bases, as well as forms and methods of organisation. Despite the proposed clear list of ways to implement practical training of future specialists in Vocational Education (Occupational Safety, Transport), for further effective professional-

pedagogical formation of professional competencies and communications, it is deemed necessary to introduce into the educational-professional program of specialty 015 Vocational Education (Occupational Safety, Transport) a compulsory educational component of the professional training cycle “Pedagogical Communication in Vocational Education”; increase the number of hours for studying disciplines of the professional training cycle and disciplines of professional orientation, in particular, for further effective formation of pedagogical communication in future professional-pedagogical activities.

It is necessary to constantly analyse the level of training of future specialists in Vocational Education (Occupational Safety, Transport), their professional skills and abilities during practical training. This will allow predicting and timely determining their level of proficiency in various types of professional activities; development of self-improvement and consolidation of skills for practical and scientific activities; formation of the ability to transform theoretical knowledge gained in the educational process into professional functions; ability to solve complex specialised tasks and practical problems in vocational education and production activities; continuous deepening and consolidation of theoretical knowledge and practical skills in the specialty, formation of professional competencies and professional-pedagogical communications. The conducted research does not exhaust all aspects of the stated problem. Prospective research could focus on the significance of artificial intelligence in shaping professional-pedagogical communication in practical training of future specialists in Vocational Education (Occupational Safety, Transport).

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■ Conflict of Interest

None.

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Педагогічна комунікація у практичній підготовці майбутніх фахівців професійної освіти: процес, реалізація та підсумки

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■ **Анотація.** Професійно-педагогічна комунікація як умова розвитку комунікативних можливостей, як форма психологічної взаємодії педагога зі здобувачами освіти під час освітнього процесу та під час практичної підготовки спрямована на всебічний розвиток майбутніх фахівців професійної освіти, на створення умов для реалізації їх самостійних, фахових та творчих здібностей. Метою наукової роботи було визначення основних шляхів організації практики як однієї з пріоритетних умов формування педагогічної комунікації майбутніх фахівців професійної освіти. У ході наукового дослідження використано комплекс методів: теоретичні, системний, метод аналізу програм практик та метод анкетування, які надали можливість детально розкрити досліджувану тематику. У статті було встановлено, що цілеспрямоване педагогічне керівництво, шляхи реалізації та удосконалення практики, поліпшення змісту діяльності майбутніх фахівців професійної освіти у процесі проходження практики створюють умови важливого чинника для формування всіх компонентів професійно-педагогічної комунікації здобувачів вищої освіти, сприйняття себе в ролі педагога професійної освіти. Проаналізовано й узагальнено досвід українських і зарубіжних науковців щодо педагогічно-професійної комунікації й шляхів удосконалення практики майбутніх фахівців професійної освіти. Узагальнено питання покращення процесу організації педагогічної практики як однієї з пріоритетних умов формування професійно-педагогічної комунікації майбутніх фахівців професійної освіти спеціальності 015 Професійна освіта (охорона праці, транспорт): введення в освітньо-професійну програму освітнього компоненту «Педагогічна комунікація в професійній освіті», збільшення годин практик, взаємопраця з роботодавцями, стейкхолдерами, випускниками, що працюють за фахом та здобувачами вищої освіти зокрема. Сформульовано комплекс педагогічних умов. Практична цінність роботи полягає в тому, що зазначені актуальність, методи, сформовані педагогічні умови та проаналізований процес проходження практики майбутніми фахівцями професійної освіти і висновки загалом можуть бути використанні для: удосконалення програм практик в закладі вищої освіти; введення освітнього компоненту «Педагогічна комунікація в професійній освіті» для здобувачів вищої освіти спеціальності 015 Професійна освіта (охорона праці, транспорт)

■ **Ключові слова:** педагогіка; професійне спілкування; компетентності; освітній процес; практика; здобувачі вищої освіти; охорона праці



Innovative models of vocational education: A symbiosis of artificial intelligence, neuropedagogy, and the competency-based approach

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■ **Abstract.** The modern world establishes new demands in education, necessitating innovative approaches to professional training. Integrating artificial intelligence, neuropedagogy, and the competency-based approach emerges as a cornerstone for creating effective vocational education models. This study aimed to develop and test innovative models that combine the capabilities of artificial intelligence (including smart robotics) with neuropedagogical competency-based strategies to enhance the effectiveness of vocational education. The research methodology encompassed an analysis of contemporary literature and practices, the development of experimental models integrating artificial intelligence into the educational process, and empirical investigations in educational institutions. Analysis, synthesis, modelling, observation, and experimentation methods were employed. The proposed innovative models include personalised learning platforms with adaptive algorithms, intelligent systems for analysing learners' emotional states, virtual environments and gamified simulations, as well as robotic automated assessment and reporting systems in vocational education. The integration of artificial intelligence into neuropedagogical processes facilitates personalised learning, enhances learners' motivation, and fosters the development of critical thinking. Artificial intelligence enables the creation of adaptive educational platforms that cater to the individual characteristics and needs of learners. Its implementation also automates routine tasks for educators, allowing them to focus on the creative aspects of the educational process. The findings highlight the significance of integrating artificial intelligence into vocational education as a means to enhance its competitiveness. Given the dynamic advancement of technologies, future research is expected to explore immersive neurointerfaces for developing engaging interactive learning environments, as well as the ethical considerations surrounding the use of artificial intelligence in education, with an emphasis on critical thinking. The results of the study are of practical value for the development of innovative educational technologies and approaches that meet the contemporary demands of the labour market and the expectations of progressive youth

■ **Keywords:** personalised learning; adaptive algorithms; individual learning trajectories; virtual environments; robotic automated assessment; critical thinking; vocational training

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■ Introduction

The realm of vocational education is rapidly evolving, combining cutting-edge technologies with a profound understanding of human learning. The integration of artificial intelligence (AI), neuropedagogy, and the competency-based approach unveils new possibilities for preparing future professionals. AI functions as a personal mentor through personalised learning platforms and adaptive algorithms, ensuring that each learner receives education tailored to their pace and needs. Robotics and virtual simulations provide realistic environments for hands-on experience, while intelligent systems analyse learners' emotional states, adjusting the educational process and sustaining motivation. Neuropedagogy harnesses the brain's potential by leveraging insights into its functioning, while neuropedagogical approaches make learning both engaging and effective. Various regions of the brain are activated, facilitating improved comprehension and retention of material. The competency-based approach focuses on developing practical skills and knowledge required for specific fields, shaping practitioners equipped to tackle the challenges of a competitive labour market. Modern vocational education, a strategically significant area supported by the Ministry of Education and Science of Ukraine, demands innovative approaches. The synergy of AI, neuropedagogy, and the competency-based approach leads to the development of symbiotic learning models. These models optimise educational processes, enhance learning outcomes, and cultivate essential competencies among vocational education learners (Pidubna *et al.*, 2023).

Research in this field focuses on developing and testing innovative models that personalise the learning experience. According to R. Zhoga (2024), AI algorithms analyse data about learners, tailoring educational programmes and materials to their individual needs, learning pace, and information processing styles. V. Mykhailets (2023) emphasised that neuropedagogical methods, based on insights into brain function, make learning more engaging and captivating, enhancing learners' motivation and active participation. T. Luhova (2021) explored the use of gamification, virtual environments, and simulations combined with AI systems, enabling learners to apply knowledge in practice while developing critical thinking and problem-solving skills. O. Bazeliuk (2021) highlighted that AI systems automate routine tasks, such as marking assignments and assessing knowledge, freeing educators to focus on the more creative and strategic aspects of the educational process.

A significant portion of contemporary vocational education methods relies on the use of advanced technologies. Analysing existing theoretical sources, including prior research, provides a foundation for developing innovative vocational education models. This process involves designing new approaches and empirically testing various educational models. The study of I. Yildiz *et*

al. (2021) demonstrated that gamification significantly enhances learner motivation, forming the basis for incorporating game elements into personalised learning platforms. L. Sharma & M. Srivastava (2019) emphasised the importance of motivating educators to adopt technologies, highlighting the need to foster a competency-based approach among teaching professionals. Research by A. Rakhmanina *et al.* (2022) revealed the substantial potential of robotics in developing critical thinking and practical skills, which contributed to the inclusion of robotic automated assessment systems in model design. M.S. Ramirez-Montoya *et al.* (2021) stressed the necessity of integrating innovative technologies into educational practices, shaping the strategy for developing four distinct models.

S. Lytvynova & N. Soroko (2022) highlighted the advantages of immersive technologies, which have become a foundation for creating effective virtual learning environments. N. Grigorieva *et al.* (2021) emphasised the importance of leveraging international experience in education, facilitating the adaptation of best practices to the Ukrainian educational system. O. Petrovych *et al.* (2022) underscored the significance of neuropedagogical approaches, which serve as the basis for developing effective teaching methods. L. Lysiak (2020) stressed the necessity of continuous monitoring of educational innovations, an essential component in model development. S. Fedko (2023) explored the emerging field of neuropsychology in learning, emphasising its importance for integration into vocational education. L. Elouafi *et al.* (2021) confirmed the positive impact of neuropedagogical methods on the educational process, while N. Bilozhko (2021) analysed teaching quality in the context of educational internationalisation, focusing on innovative teaching methods.

According to T. Semigina & Yu. Rashkevych (2023), the effectiveness of innovative models is assessed through methods of systems analysis, pedagogical experimentation, and statistical forecasting. Research findings confirm that the integration of artificial intelligence, neuropedagogy, and a competency-based approach leads to personalised learning, where learners acquire knowledge and skills that align with their individual needs and goals; increased motivation, as learning becomes more engaging and exciting, leading to heightened interest and engagement among learners; the development of critical thinking, specifically the ability to apply knowledge in practice, solve problems, and make informed decisions; and improved learning outcomes, manifested in better material retention, increased knowledge and skill levels among learners.

Regarding the competency-based approach, it does not require a separate model, as it should be integrated into all four proposed models. For instance, personalised learning platforms can be designed to foster the development of specific competencies, virtual

environments can simulate real workplace scenarios, and robotic assessment systems can evaluate not only knowledge but also the skills necessary for success in a particular field or profession. The study aimed to develop and implement new educational models that leverage the potential of artificial intelligence and robotics in integration with neuropedagogical approaches, enhancing the learning process and fostering the development of professional competencies among learners. The research intended to evaluate the effectiveness of these models through practical trials in real educational settings, addressing the needs of a competitive labour market, mitigating the consequences of the war in Ukraine, and supporting the establishment of a newly European-integrated Ukrainian state.

■ Materials and Methods

The research methodology is grounded in a systemic approach encompassing both theoretical and empirical methods. Theoretical methods include the analysis and synthesis of contemporary scientific approaches, comparative analysis of methods and models employed in various countries, and the modelling of new approaches. These approaches incorporate personalised learning platforms, intelligent systems for emotional state analysis, virtual environments, gamified simulations, and automated assessment systems. The research drawn on a broad source base, including contemporary scientific publications, national and international regulatory frameworks, and analytical reports on the use of artificial intelligence and innovative technologies in education. Key methods of scientific inquiry employed in the study include the analysis and synthesis of the literature, comparative analysis of the effectiveness of various innovative teaching methods, modelling experimental educational frameworks, and testing these models in real-world settings. At the theoretical level, the model development process relied on SWOT analysis and illustrative schematic synthesis of contemporary theoretical concepts such as artificial intelligence, neuropedagogy, and the competency-based approach in vocational education. This approach facilitated the identification of the core aspects of each concept and their potential for integration into the educational process. At the empirical level, the study involved the implementation of personalised learning platforms, intelligent systems for analysing pupils' emotional states, the creation of virtual learning environments, gamified simulations, and the application of automated assessment systems for evaluating educational outcomes. The empirical investigations were designed to collect quantitative and qualitative data on the effectiveness of these approaches in improving the quality of learning and developing learners' professional competencies.

Experiments using virtual learning environments (VLEs) were conducted to assess their impact on pupils' motivation and engagement, providing valuable

insights into the effectiveness of these innovative methods. As part of the experiments, several diverse VLEs were created, incorporating interactive lessons, virtual laboratories, and simulation games. Students had the opportunity to immerse themselves in a virtual environment where they completed tasks, interacted with virtual objects, and collaborated with other participants. The experiments involved the preparation and configuration of VLEs, including content creation, the development of interactive elements, and the setup of feedback systems. The integration of VLEs into the educational process included embedding virtual environments into regular lessons, where students were assigned tasks to complete within the VLE. This approach allowed them to apply theoretical knowledge in practice. Data collection and analysis during the experiment involved both quantitative and qualitative methods, such as surveys, interviews, observations, and automated data collection systems. These data were used to assess students' behaviour, activity, motivation levels, and engagement. Based on the collected data, a detailed analysis of the effectiveness of the VLEs was conducted. The experiment was carried out following the Declaration of Helsinki (2013). The results showed that the use of virtual environments contributed to increased student motivation, active participation in the learning process, and the development of collaborative skills. Students demonstrated a higher level of interest in learning, achieved better results in task completion, and showed greater engagement. Based on the results obtained, recommendations were developed for the continued use and integration of VLEs into the educational process. These recommendations included specific strategies and approaches that could enhance the effectiveness and quality of the learning process through the use of virtual learning environments.

■ Results and Discussion

The war in Ukraine has served as a catalyst for re-evaluating many aspects of life, including education. The destruction of infrastructure, loss of lives, and mass displacement of people have had a detrimental effect on the availability of a qualified workforce in the country. Outdated teaching methods are increasingly inadequate to meet the dynamic demands of the modern labour market and the challenges of the contemporary world. This situation underscores an urgent need for innovative models based on the principles of personalisation, efficiency, practicality, and accessibility. According to Yu. Boychuk & A. Boyarska-Khomenko (2023), a comprehensive approach to modernising infrastructure and ensuring stable funding is essential to address these issues. However, contrary to this view, the authors of this study argue that the integration of artificial intelligence, neuropedagogy, and the competency-based approach offers a more flexible and effective solution for vocational education. The integration and synergy

of these methodologies enable the creation of personalised educational platforms, adaptive algorithms, and intelligent systems capable of dynamically responding to the evolving demands of the labour market. This ensures more effective and practical learning outcomes.

The authors of this research proposed four key models that impact the learning and assessment processes of learners. The first model involves personalised learning platforms with adaptive algorithms, learners' students to learn at their own pace and focus on individual needs. These platforms enhance the efficiency of knowledge acquisition and the overall quality of education. The second model introduces intelligent systems for analysing the emotional state of learners, allowing educators to adjust the educational process to align with the emotional needs of learners while considering the ethical implications of data collection. The third model incorporates virtual environments and gamified simulations, offering practical experience

without real-world risks by creating realistic conditions for professional activities. However, their implementation requires significant financial investment. The fourth model includes robotic automated systems for assessment and reporting, simplifying the evaluation process and providing accurate records of learner achievements while reducing reliance on technology. The implementation of these models significantly influences the quality and accessibility of vocational education in Ukraine.

I. MODEL OF A PERSONALISED LEARNING PLATFORM WITH ADAPTIVE ALGORITHMS

The personalised learning platform model, featuring adaptive algorithms (Fig. 1), has been specifically designed to meet contemporary demands for vocational education and incorporates identified key factors. The modelling process for this platform involved several stages, ensuring optimal efficiency and utility for learners.

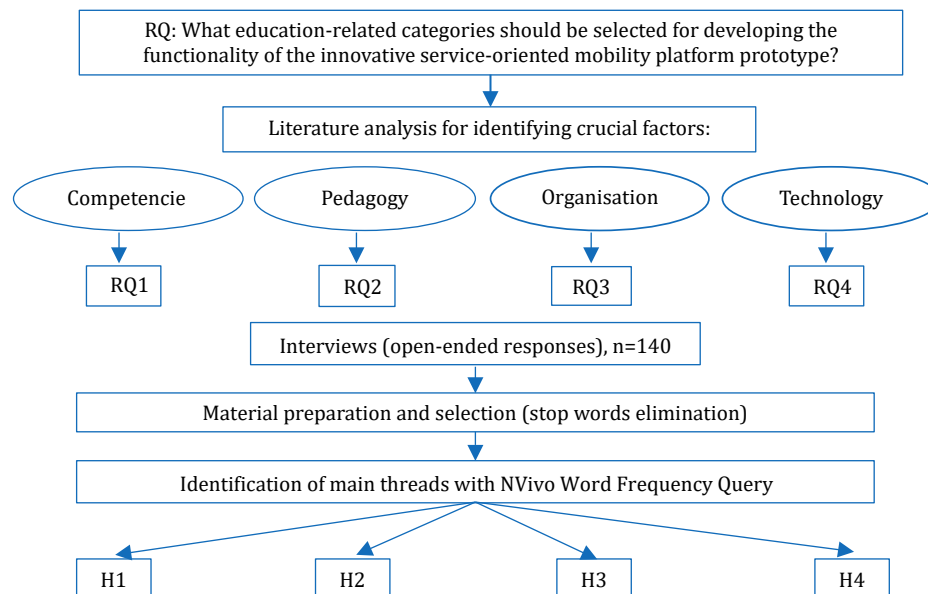


Figure 1. Implementation of the NVivo Word Frequency Query Platform in personalised vocational learning

Source: created by the authors

NVivo Word Frequency Query is a powerful tool for analysing unstructured data, including text documents, interviews, audio, and video recordings. The Word Frequency Query function in NVivo enables the analysis of textual data to determine the frequency of specific words or phrases within a dataset. The word frequency analysis counts the occurrences of particular words in selected text or texts. This approach aids in identifying central themes or keywords critical to specific research. Data visualisation can be presented as tables, charts, or word clouds. According to P. Mykytenko & O. Halytskyi (2021), word clouds are a popular visualisation technique, representing the most frequently used words in larger fonts, while less frequent words

are displayed in smaller fonts. The effectiveness of word clouds may vary depending on the context and purpose of the visualisation. This highlights the potential for discussions on the optimal use of various visualisation methods tailored to different types of data and audiences.

When filtering and excluding words, queries are configured to remove common or irrelevant terms, known as "stop words", such as conjunctions and prepositions. This process ensures greater focus on significant terms. Alongside frequency analysis, NVivo also examines the context in which these words appear, providing insights into how key terms are utilised within texts. The application of the NVivo Word Frequency Query is beneficial

in social sciences, educational research, marketing, and other professional fields. It facilitates the identification of core themes, understanding of trends in textual data, and supports theoretical analysis. The modelling process consisted of several stages. The initial phase involved a detailed literature review, which identified the key factors to be considered in designing the platform model. The authors of this study concentrated on four primary categories: competencies (RQ1), pedagogy (RQ2), organisation (RQ3), and technology (RQ4).

This stage established the theoretical foundation and identified existing approaches and methods that could be integrated into the new model. The subsequent step involved conducting 140 interviews with experts and educators, who provided open-ended responses regarding the needs and requirements for the platform. These interviews offered an in-depth understanding of specific demands and preferences that needed to be considered in the platform's design. The responses gathered from the interviews were instrumental in understanding the practical aspects and needs in the field of vocational education, forming the basis for the following research phases. After data collection, rigorous preparation and selection of materials were undertaken, including the removal of stop words to ensure data quality for further analysis. This process enabled the refinement of material for the subsequent stages of development. The cleaned data ensured the accuracy and relevance of the analysis results, which is critical for building an effective platform. Identification of key information flows was conducted using the NVivo Word Frequency Query (Mitcheltree, 2021), which helped determine the most significant themes and categories for inclusion in the platform's functionality. The

use of NVivo facilitated a systematic approach to text data analysis, highlighting key terms and themes most relevant to platform development. This phase guided the platform design towards the most crucial aspects of vocational learning, ensuring alignment with the needs and expectations of end users.

As a result of the conducted research, a prototype of an innovative service-oriented mobility platform was developed. This prototype effectively integrates artificial intelligence, neuropedagogy, and the competency-based approach into vocational education. It provides a personalised learning experience with adaptive algorithms, facilitating the development of essential skills and competencies for learners. Thus, NVivo Word Frequency Query is recommended as a powerful tool for analysing textual data, aiding educators in identifying key terms and themes relevant to further pedagogical research. This tool is particularly useful for examining unstructured data across various professional domains. Its use enables the systematic organisation and visualisation of data, which is crucial for developing effective educational programmes and approaches. Overall, NVivo Word Frequency Query proves to be an invaluable resource for educators working with large volumes of text data, allowing the identification of key terms and themes important to their research. It provides deep insights into the content and structure of textual data, supporting a more accurate and informed analysis of educational needs and trends. To evaluate the personalised learning platform model with adaptive algorithms, which offers a flexible and efficient approach to vocational learning while accounting for the individual characteristics of each learner, conducting a SWOT analysis was deemed appropriate (Table 1).

Table 1. SWOT analysis of the personalised learning platform model with adaptive algorithms in the context of a competency-based approach to vocational education

Strengths	Weaknesses
The platform tailors the educational process to the individual needs of each learner, considering their knowledge, skills, experience, and learning styles	High costs associated with the development and implementation of a personalised platform
Interactive teaching methods and personalised content make learning more engaging and motivating for learners	Developing adaptive algorithms and personalised content is complex and labour-intensive
Adaptive algorithms assist learners in better mastering educational material by focusing on their strengths and weaknesses	Effective platform operation requires large volumes of data on learners and their academic performance
The personalised platform enables learners to assimilate educational content more quickly, improving overall learning outcomes	Adaptive algorithms may be biased if the data they are based on is not representative
The platform supports learners to develop the essential competencies for successful professional performance	Learners may require additional support when using the personalised platform

Table 1. Continued

Opportunities	Threats
The personalised platform facilitates the integration of a competency-based approach in vocational education, focusing on developing competencies rather than merely acquiring knowledge	Rapid technological advancements may render personalised platforms obsolete
Customisation of education for diverse groups of learners with varying needs and goals	Risk of misuse of data for unethical purposes
The platform can support informal education and self-directed learning, helping learners develop competencies throughout their lives	Learners or educators may resist or lack the skills to use personalised platforms effectively
Data collection on learners' competencies can improve teaching and assessment processes	Learners and educators may not receive adequate support when working with the personalised platform
The personalised platform enhances learners' competencies for professional success, boosting their competitiveness in the labour market	Development and implementation of personalised platforms may face insufficient funding from governments, educational institutions, or private investors

Source: created by the authors

This analysis revealed that the model of a personalised learning platform with adaptive algorithms offers significant strengths and opportunities that should be leveraged to enhance the quality of vocational education. However, it also presents certain weaknesses and threats that require attention to maximise its effectiveness. Recommendations include: reducing development and implementation costs; improving data availability; providing adequate support for learners and educators; conducting further research; promoting collaboration among government bodies, educational institutions, the private sector, and civil society to support the development and implementation of personalised platforms.

The implementation of personalised platforms has a profound impact on vocational education, making it more individualised, effective, and aligned with the demands of the modern labour market. According to research by O. Bilier *et al.* (2023), innovative educational technologies, including neuropedagogy, play a critical role. The authors emphasise that such technologies significantly enhance the quality of education by adapting learning materials to the individual needs of learners. This approach fosters deeper knowledge acquisition and better preparation for the requirements of labour market. This study highlights that the effectiveness of innovative technologies in vocational education can vary depending on the context and the methods of implementation, raising questions about the optimal approach to modernising the educational process. It is essential to recognise and address potential challenges associated with this model to ensure it is applied ethically and responsibly. In addition to considering knowledge, skills,

and learning styles, attention must also be paid to learners' emotional states, as these factors significantly influence motivation, engagement, and learning outcomes.

II. MODEL OF INTELLIGENT SYSTEMS FOR ANALYSING THE EMOTIONAL STATE OF LEARNERS IN VOCATIONAL EDUCATION

This model integrates the emotional state of learners into the vocational learning process. By employing emotion recognition technologies, the system identifies learners' emotional reactions to educational materials and adjusts the content to align with their needs. According to G. Dermott *et al.* (2023), affective computing is utilised to adapt the learning process in real-time. Their research supports the notion that artificial intelligence analyses emotional data collected from learners and modifies educational videos, interactive tasks, and other resources to suit the emotional state of each participant.

The model offers several advantages. Firstly, it enables the personalisation of vocational learning through the use of affective computing and emotional analysis, which fosters motivation and engagement. Secondly, effective knowledge acquisition is achieved through the use of video and a theoretical framework (Fig. 2), which helps structure and visualise the learning material. Thirdly, video content based on real-world professional scenarios provides learners with the opportunity to gain practical experience in a safe and controlled environment. Finally, by considering the emotional state of learners, the model creates a comfortable and motivating learning environment, which helps reduce stress and enhance learning outcomes.

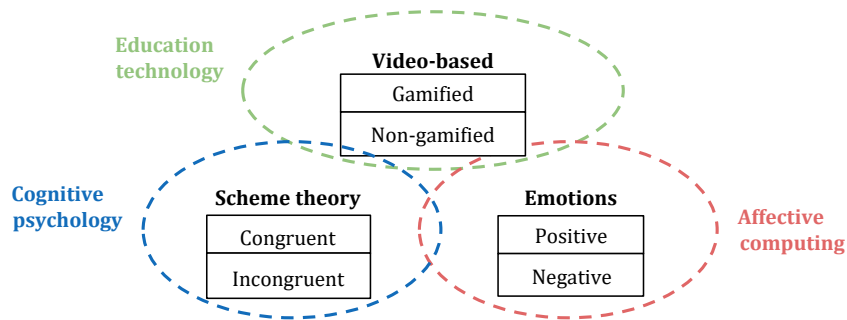


Figure 2. Symbiosis of the utilised video, emotional analysis, and the theoretical framework

Source: created by the authors

The model of intelligent systems for analysing the emotional state of vocational education learners introduces a range of innovative approaches to create a personalised and effective educational environment. It integrates video-based learning, scheme theory, emotion analysis (Emotions), and affective computing to establish a tailored and efficient learning process. Video-based learning employs educational video materials designed around calculated professional scenarios and simulations of real working conditions.

According to K. Zavalko (2022) and T. Nikulochkina *et al.* (2022), video provides both visual and auditory representations of the learning material, facilitating better retention of information and the development of practical skills. In this study, scheme theory, proposed for structuring learning content and organising knowledge, opens up new opportunities. It enables learners to easily navigate the material, understand the connections between general concepts, and effectively absorb new information. Thus, both approaches can play an important role in enhancing the learning process, depending on the context and characteristics of the educational programme, and they provide grounds for further discussion on the optimal use of various methods of visualisation and content structuring.

The model of intelligent systems for analysing the emotional state of learners opens up new possibilities in the field of personalised learning, considering both

the cognitive and emotional aspects of the learning process. This model uses artificial intelligence to analyse the emotional state by employing various methods, such as the analysis of facial expressions, body language, tone of voice, and physiological data, to determine the learner's emotional condition. The use of this model involves providing feedback to learners on how their emotions affect their learning, as well as dynamically adapting the learning process to their emotional state. For example, in the case of anxiety, according to N. Ilyashenko & A. Rosokhata (2023), the system may offer additional resources or adjust the pace of learning, thereby supporting the learner's emotional well-being. This model enhances motivation and engagement in the learning process, improves material retention, and supports learners' emotional health. Adapting the learning process to the emotional state of the learners makes education more personalised and effective, helping them achieve their learning goals and become more competitive in the job market.

The competency-based approach permeates each of the models discussed, including the model of intelligent systems for analysing emotional state, and ensures a synergistic effect from their interaction. An important aspect is the examination of the strengths and weaknesses of this model, as well as the opportunities and threats it may face during implementation, which is reflected in the SWOT analysis (Table 2).

Table 2. SWOT analysis of the intelligent systems for analysing the emotional state of learners in vocational education within the context of the competency-based approach

Strengths	Weaknesses
Intelligent systems analyse learners' emotions more objectively than humans, who may be prone to biases. This helps educators provide learners with more accurate and impartial feedback on their work	The need for large volumes of data and powerful computational resources to process emotional reactions, as well as substantial computational power for data analysis
Emotion analysis helps educators better understand how emotions affect learners' perception of the material, motivation, engagement, and overall learning outcomes	Emotion analysis systems can sometimes make errors, leading to incorrect conclusions about learners' emotional states. It is essential to use these systems ethically, respecting learners' privacy and rights
Based on emotion analysis, the learning process is personalised, offering individual tasks, support, and teaching methods that align with learners' emotional states and needs	Emotional reactions can vary depending on culture, context, and personal characteristics. Emotion analysis systems must be adapted to these differences to ensure accuracy and ethical use
Emotion analysis helps educators identify learners who need additional motivation and/or support, enhancing their engagement in the learning process	Developing, implementing, and maintaining emotion analysis systems can be costly, which may limit their availability for a wider range of educational institutions

Table 2. Continued

Opportunities	Threats
The increasing popularity of personalised learning and the use of artificial intelligence is driving demand for emotion analysis systems for learners	Some learners and educators may not be ready for their emotions to be analysed by computer systems
The rapid development of machine learning and artificial intelligence technologies is improving the accuracy, reliability, and ethical standards of emotion analysis systems	Misuse of data on the emotional state of learners for unethical purposes, potentially harming learners
Support from governments, educational institutions, and the private sector in terms of funding for the development, implementation, and research of emotion analysis systems	The lack of standards and regulations governing the development and implementation of such systems

Source: created by the authors

Table 2 illustrates how the model of intelligent systems for analysing the emotional state of learners integrates various aspects of a competency-based approach, thereby creating a strong foundation for building modern vocational education. This approach is particularly important in the context of overcoming the challenges of the war in Ukraine, as it contributes to the development of vocational education as a strategically important direction. It helps not only to improve the quality of education but also to provide emotional support to learners, which is a key factor in their success and resilience.

The model of intelligent systems for analysing the emotional state of learners offers a new approach to personalised learning that takes into account not only cognitive but also emotional aspects of learning. Using artificial intelligence, the system analyses facial expressions, body language, tone of voice, and physiological data to determine learners' emotional states. Based on the analysis of emotional states, the system provides learners with feedback on how their emotions affect their learning. The system dynamically adapts the educational process, taking into account the emotional state of learners. For example, if a participant feels anxious, the system may offer them additional resources or adjust the pace of learning. The emotional well-being of learners is supported, their motivation and engagement are increased, learning is individualised, and leads to better retention of the material (Melnyk & Petryk, 2022).

Thus, the model of intelligent systems for analysing the emotional state of learners is an innovative approach to personalised learning that helps learners learn better, achieve their goals, and become more competitive in the job market (Szókök *et al.*, 2023). It uses artificial intelligence to analyse learners' emotional states, helping them to better absorb material, be more motivated, and improve their emotional well-being. Moreover, as argued by T. Kramarenko *et al.* (2023), it is also important to create learning conditions for learners that promote their engagement, motivation, and practical application of knowledge.

The model of virtual environments and gamified simulations complements the previous two models by offering learners interactive and engaging virtual environments in the form of simulations of real-world professional scenarios, where learners can apply their

knowledge and skills in practice. Gamified elements, such as the use of game mechanics like points, badges, and leaderboards, make learning more interesting and motivating. A personalised experience, tailored to the individual needs and emotional state of each learner, ensures an optimal learning experience.

III. THE MODEL OF VIRTUAL ENVIRONMENTS AND GAMIFIED SIMULATIONS

According to N. Folomieieva *et al.* (2024), the use of virtual environments and gamified simulations in Ukrainian vocational education represents a novel innovative approach. These technologies offer significant potential for improving the effectiveness and outcomes of learning. However, their successful implementation requires attention to technical, methodological, and organisational aspects, as well as consideration of potential challenges related to the availability of technical resources and the training of pedagogical staff.

Virtual spaces are created that simulate real-world professional environments such as laboratories, hospitals, factories, offices, and so on. Interactive simulations are developed that allow learners to apply their knowledge and skills in practice, make decisions, solve problems, and receive feedback. The system adapts to the individual needs and emotional state of each learner, ensuring an optimal learning experience (Fig. 3).

The schema illustrates a multi layered architecture of the process of creating gamified educational videos. The data used to create e-learning videos consists of video files recorded from webcams, video conferences, and digital (virtual) participants. The content layer contains e-learning video materials created using the data. Video materials can be either gamified or non-gamified, and can also have different levels of complexity. Another layer uses artificial intelligence to detect emotions and create a congruence model. Artificial intelligence is also used to adapt content to individual user needs. Educators and educational discipline developers create curricula and courses, as well as develop educational materials. Policymakers O. Sagan (2023) and R. Nacional (2024) apply rules and regulations that govern the use of the e-learning video material system. Overall, the e-learning video material system is a powerful tool that should be used to create a personalised and engaging learning experience.

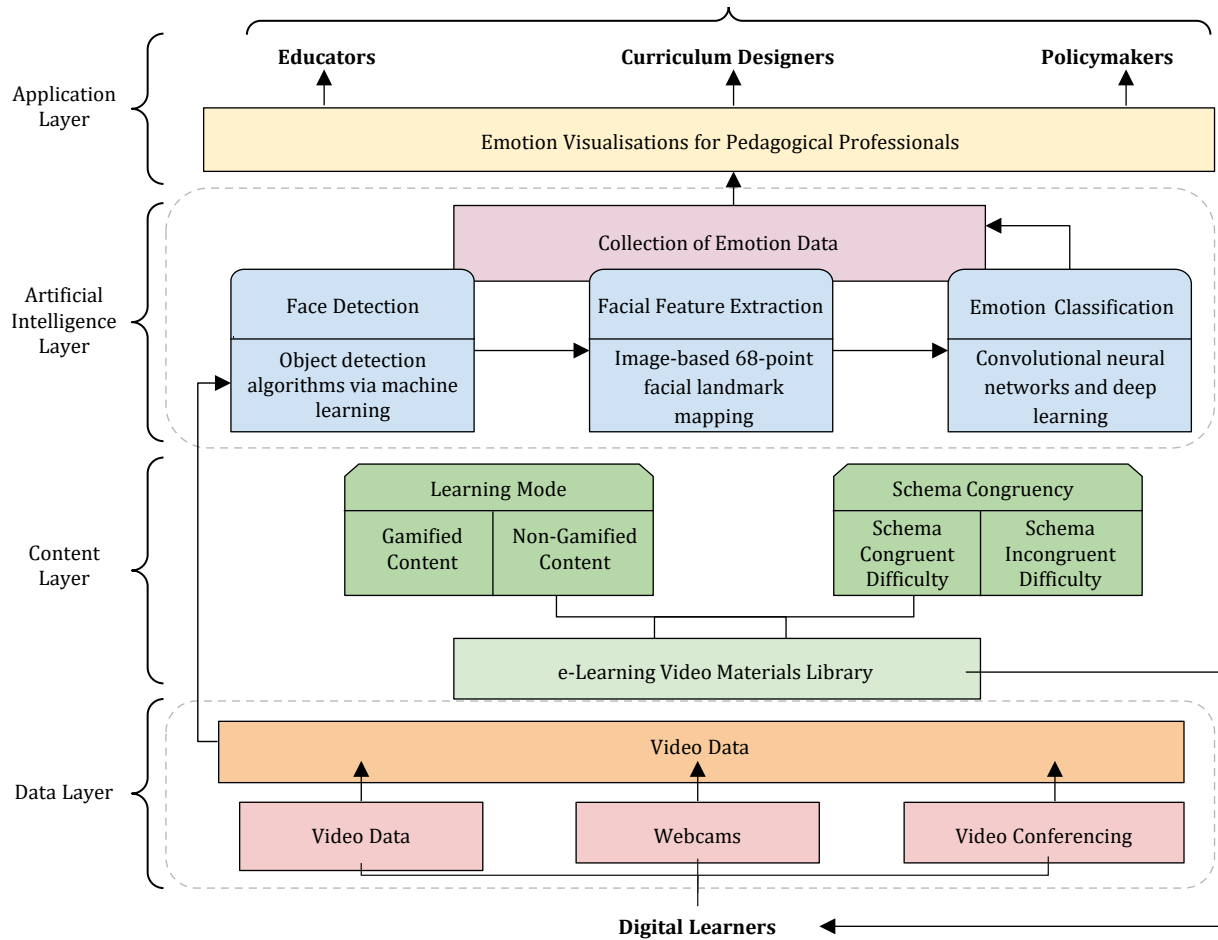


Figure 3. Layers of the e-learning video materials system

Source: created by the authors

The use of e-learning video material systems offers numerous opportunities for vocational education. According to O. Bazeliuk (2023), the system personalises content, facilitating individualised learning for each user. The presence of both gamified and non-gamified materials makes the learning process more engaging and varied. However, it is important to consider that collecting data on user progress and

providing feedback may require significant computational resources, limiting the system's accessibility to a wide range of users. Thus, while the system has the potential to enhance the effectiveness of professional training, its use requires careful planning and consideration of various aspects related to ensuring the quality and accessibility of educational services (Table 3).

Table 3. SWOT analysis of the virtual environments and gamified simulations model in the context of the competency-based approach to vocational education

Strengths	Weaknesses
Virtual environments and gamified simulations make learning more engaging and immersive, leading to increased learner involvement and motivation	High cost of developing and implementing virtual environments and gamified simulations
Virtual environments and gamified simulations help learners develop problem-solving, critical thinking, and decision-making skills	Learners and educators often need technical skills to work with virtual environments and gamified simulations
Virtual environments and gamified simulations allow learners to experiment and make mistakes safely, helping them better understand the material	Virtual environments and gamified simulations must be carefully designed to be effective and align with learning objectives
Virtual environments and gamified simulations make learning more accessible to learners who cannot attend inperson classes	Technical issues may arise when working with virtual environments and gamified simulations, potentially disrupting the learning process
Virtual environments and gamified simulations help learners develop collaboration and teamwork skills	Virtual environments and gamified simulations need to be adapted to different learning styles to be effective for all learners

Table 3. Continued

Opportunities	Threats
Growing interest in using technology in education	Some learners and educators may not be ready to use virtual environments and gamified simulations
Development of virtual and augmented reality technologies makes virtual environments and gamified simulations more realistic and engaging	Misuse of virtual environments for malicious purposes, such as spreading disinformation and/or propaganda
Governments and educational institutions may allocate funding for the development and implementation of virtual environments and gamified simulations	Lack of standards and regulations for the development and use of virtual environments and gamified simulations, which may lead to compatibility and ethical issues

Source: created by the authors

The SWOT analysis has confirmed the hypothesis that this model contributes to a better understanding of knowledge and the development of practical skills through interactive and motivating learning methods. At the same time, the competency-based approach, which permeates this model, ensures that the learning process corresponds to the real needs of the labour market and prepares competitive specialists. The e-learning video material system has the potential to revolutionise professional training, as it uses artificial intelligence to adapt content to individual user needs; can be used to create both gamified and non-gamified learning materials; can be used to restore user progress and provide them with feedback; and can be used to create personalised learning plans.

Through interactivity, gamification, and visual appeal, vocational learning becomes more engaging and motivating for learners. The practical application of knowledge in virtual simulations contributes to a better understanding and retention of information. Learners have the opportunity to develop practical skills necessary for successful professional careers, such as decision-making, teamwork, and problem-solving. Virtual simulations allow learners to feel more confident and better prepared for real-world professional challenges. However, in addition to interactive learning, it is important to provide an objective and transparent assessment system that allows for the evaluation of learners' knowledge and skills and provides them with feedback on their own progress.

IV. MODEL OF ROBOTIC AUTOMATED ASSESSMENT AND REPORTING SYSTEMS IN VOCATIONAL EDUCATION

A model of robotic automated assessment and reporting systems in vocational education serves as a complement to previous models, offering objective and unbiased evaluation. The use of computer algorithms and automated systems minimises human error and ensures a more objective and impartial assessment of learners' knowledge and skills. Fast and efficient assessment automates the professional learning process, significantly reducing the time required to check assignments and provide feedback. Detailed analysis and reporting, i.e., the generation of detailed reports

on learners' learning outcomes, are used to track their progress, identify strengths and weaknesses, and make informed decisions about further professional development.

Personalised feedback helps learners better understand their mistakes and improve the competencies required for professional development. This approach fosters a deeper understanding of the material, develops independent thinking, and increases motivation to learn. The symbiosis of all four models creates a comprehensive and flexible system of vocational education that combines a competency-based approach to interactive learning with objective assessment and personalised feedback. This allows for the integration of various teaching methods and technologies, ensuring the all-round development of learners and improving the quality of the educational process. This helps learners better acquire learning material, develop practical skills, critical thinking, and also receive an objective assessment of their knowledge and skills. As a result, they can achieve success in their professional careers, be better prepared for the challenges of the modern labour market, and gain a competitive advantage.

The study (Fig. 4) was conducted over a six-week period and involved 18 participants in the anthropomorphic robot group and 19 participants in the traditional education group. According to M. Mihai & D. Mapheto (2024), the anthropomorphic robot method used to facilitate interaction between participants and an anthropomorphic robot teaching them rules and tasks represents a significant step towards interactive learning. The robot employed various teaching methods, including visual cues, audio instructions, and tactile feedback, contributing to increased engagement and effectiveness of the learning process. However, research by S. Prasad Bhatt (2021) and Yu. Cui & H. Zhang (2021) indicate a need for further research into the optimal use of anthropomorphic robots in educational settings, especially considering the individual characteristics of students and pedagogical tasks. Thus, the introduction of anthropomorphic robots into the educational process opens up a field for discussion regarding their impact and effectiveness, requiring a competency-based approach and further research.

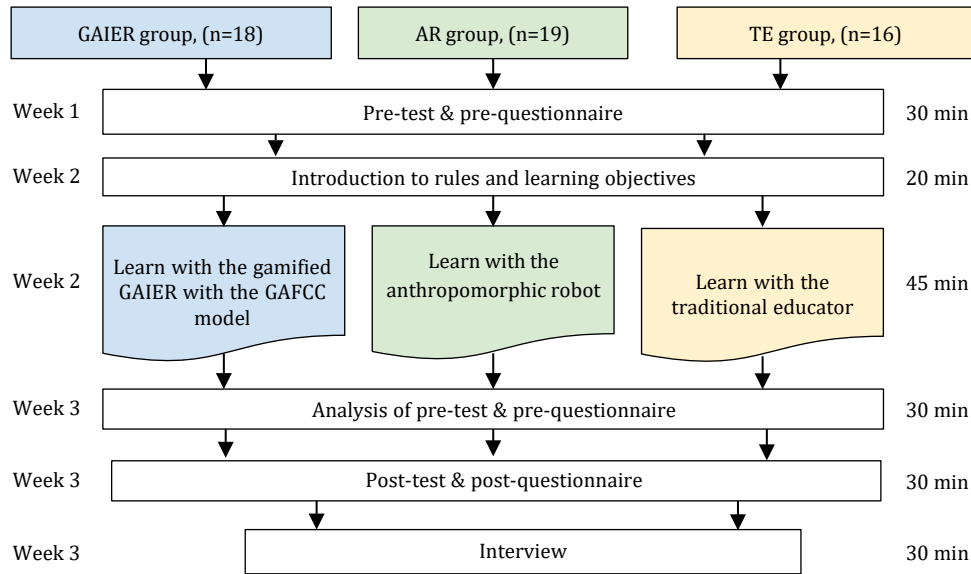


Figure 4. Comparison of the effectiveness of anthropomorphic robots and traditional education

Source: created by the authors

The traditional education method involved participants receiving instructions from a human educator. The educator used various teaching methods such as lectures, demonstrations, and practical exercises. The study evaluated the effectiveness of the two teaching methods using the following measures: pre-test and post-test, where participants completed tests before and after the study to assess their knowledge of the rules and tasks; interviews, where participants took part in interviews after the study to share their experiences of learning with an anthropomorphic robot or a traditional educator. The results of the study showed that the anthropomorphic robot method was more effective than the traditional education method. Participants in the anthropomorphic robot group performed better on the post-test and gave more positive feedback

about their learning experience. The authors of this study suggest that the anthropomorphic robot method was more effective because it provided greater interactivity and engagement among participants (participants in the anthropomorphic robot group were more involved in the learning process and had the opportunity to actively interact with the robot). At the same time, O. Dushchenko (2021) and R.A.Z. El Islami *et al.* (2022) highlighted that the robot provided participants with more personalised and timely feedback, contributing to better material acquisition. In the context of the growing use of intelligent robots in the educational process, the presence of potential threats and advantages of this model necessitated a SWOT analysis (Table 4) of the robotic automated assessment and reporting model in vocational education.

Table 4. SWOT analysis of the robotic automated assessment and reporting systems model in vocational education in the context of the competency-based approach

Strengths	Weaknesses
Robotic assessment systems are objective and unbiased	Large volumes of data on learner performance are required for effective operation of robotic assessment systems, along with powerful computational resources for processing
Robotic assessment systems are personalised for each learner, which promotes a better understanding of the material	Robotic assessment systems can make errors, leading to inaccurate grading and unfair treatment of learners. Ethical use of these systems, and respecting learners' rights, are essential
Robotic assessment systems significantly reduce the time required for assessment, freeing up educators' time for other tasks	The need to adapt to various learning styles and assessment formats
Learners have 24/7 access to their grades and feedback, helping them better understand their progress	The development, implementation, and maintenance of robotic assessment systems are costly, limiting their availability to a wide range of educational institutions
Opportunities	Threats
Artificial intelligence is becoming an increasingly popular tool in education, leading to higher demand for robotic assessment systems	Some learners and educators may not be ready for their learning outcomes to be assessed by computer systems

Table 4. Continued

Opportunities	Threats
Rapid development of digital technologies will improve the accuracy, reliability, and ethics of robotic assessment systems	Data on learners' results could be misused, leading to negative consequences for learners
Support from governments, educational institutions, and the private sector in the form of funding for the development, implementation, and research of robotic assessment systems	The lack of unified standards for the development and use of robotic assessment systems could lead to compatibility and ethical issues
Integration with other systems, such as Learning Management Systems (LMS) and e-portfolio systems	Potential negative impact on the emotional well-being of learners

Source: created by the authors

According to the conducted SWOT analysis, this model has demonstrated significant potential in improving the quality of vocational education and has proven the sufficient effectiveness of anthropomorphic robots as tools for vocational learning. Anthropomorphic robots can be used to complement traditional teaching methods or to provide training in cases where traditional teaching methods are not viable. A common concept for all four models is their potential to improve vocational education through the integration of technologies that facilitate personalised learning, increase efficiency, and provide access to knowledge and assessments at any time. Each model demonstrates strengths in the form of objectivity of assessment and time saving but requires attention to challenges such as the need for large amounts of data and ethical considerations. For the further successful implementation of these models, it is important to develop standards and promote their compatibility with existing educational practices.

■ Conclusions

Innovative models of vocational education play a pivotal role in Ukraine's strategic development, particularly in the context of overcoming the challenges of military aggression. All four models: personalised learning platforms with adaptive algorithms, intelligent systems for analysing the emotional state of learners, virtual environments and gamified simulations, and robotic automated assessment and reporting systems – form a powerful synergistic symbiosis permeated by a competency-based approach. Each of these models independently increases the efficiency and personalisation of learning, and their combination creates an exceptionally strong complex educational process. This allows for consideration of both cognitive and emotional aspects of learning, adaptation of the material to the individual needs of learners, and ensuring constant support and feedback.

The competency-based approach, which is not a separate element but permeates each model, allows for the creation of a learning environment focused on developing the key competencies required for the modern labour market. Personalised learning platforms with adaptive algorithms use data on the individual needs

and characteristics of each learner, allowing for the creation of individualised learning trajectories. This contributes to the development of both professional and general competencies, such as critical thinking, creativity, and the ability to work in a team. Intelligent systems for analysing the emotional state of learners not only help to adapt the learning process to the emotional needs of students but also support the development of emotional intelligence, which is an important element of the competency-based approach.

Virtual environments and gamified simulations create opportunities to acquire practical experience in conditions that closely resemble real-world professional situations. This allows learners to develop practical skills and competencies in a safe environment, contributing to better preparation for real-world challenges in the workplace. Gamified elements, such as game-based tasks and simulations, increase learner motivation and engagement, positively influencing the learning process and the development of professional competencies. Robotic automated assessment and reporting systems ensure objective and fair assessment of learners' knowledge and skills, which is essential in shaping a competency-based approach. Research has confirmed the great potential of integrating artificial intelligence, neuropedagogy, and a competency-based approach, which improve the quality of learning and develop professional skills. The implementation of such approaches is a strategic priority for the development of Ukraine's education systems, which meet the challenges of the modern labour market.

The strategic importance of such a comprehensive approach to vocational education is particularly relevant in the context of overcoming the challenges of military aggression in Ukraine. Innovative models, permeated by a competency-based approach, ensure not only a high level of professional training but also support the emotional well-being of learners, which is critically important in difficult circumstances. This integrated approach helps to create a resilient and competitive vocational education system capable of effectively responding to the challenges and needs of the modern labour market, contributing to the recovery and

development of Ukraine's economy. Future research includes the creation of digital interfaces for interactive immersive vocational education environments, which will allow for further increasing the quality of education and preparing learners for real-world professional challenges. Thus, the implementation of these models is not only an educational but also a strategically important step for Ukraine's future.

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■ Conflict of Interest

There is none.

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Інноваційні моделі професійної освіти: симбіоз штучного інтелекту, нейропедагогіки та компетентнісного підходу

Євген Кузнєцов

Аспірант

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■ **Анотація.** Сучасний світ диктує нові правила освіти, вимагаючи інноваційних підходів до підготовки фахівців. Інтеграція штучного інтелекту, нейропедагогіки та компетентнісного підходу стає ключем до створення ефективних моделей професійної освіти. Метою дослідження були розроблення й апробація інноваційних моделей, які поєднують можливості штучного інтелекту (зокрема смарт-робототехніки) з нейропедагогічними компетентнісними підходами, для підвищення результативності професійної освіти. Методологія дослідження базувалася на аналізованні сучасної літератури та практик, розробці експериментальних моделей інтеграції штучного інтелекту до навчального процесу, а також на проведенні емпіричних досліджень у закладах освіти. У дослідженні використано методи аналізу, синтезу, моделювання, спостереження й експерименту. У якості інноваційних моделей запропоновано персоналізовані навчальні платформи з адаптивними алгоритмами, інтелектуальні системи аналізування емоційного стану здобувачів освіти, віртуальні середовища та гейміфіковані симуляції, а також роботизовано-автоматизовані системи оцінювання та звітності в професійній освіті. Інтеграція штучного інтелекту до нейропедагогічних процесів сприяє персоналізації навчання, підвищенню мотивації здобувачів освіти та розвитку їх критичного мислення. Використання штучного інтелекту дозволяє створити адаптивні освітні платформи, які враховують індивідуальні особливості та потреби здобувачів освіти. Впровадження штучного інтелекту сприяє автоматизації рутинних завдань викладачів, що дозволяє їм зосередитися на креативних аспектах освітнього процесу. Висновки дослідження підкреслюють значущість інтеграції штучного інтелекту до професійної освіти як засобу підвищення її конкурентоспроможності. З огляду на динамічний розвиток технологій очікується, що в майбутньому будуть досліджені як імерсійні нейроінтерфейси для створення захоплюючих інтерактивних навчальних середовищ, так і етичні аспекти використання штучного інтелекту в освіті з урахуванням критичного мислення. Результати дослідження мають практичне значення для розроблення нових освітніх технологій і підходів, що відповідають сучасним вимогам ринку праці та потребам прогресивної молоді

■ **Ключові слова:** персоналізація навчання; адаптивні алгоритми; індивідуальні освітні траєкторії; віртуальні середовища; роботизовано-автоматизоване оцінювання; критичне мислення, професійна підготовка

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