Regional trends in the implementation of artificial intelligence in the system of teacher training in distance learning during martial law

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Abstract. The study is devoted to analysing regional trends in introducing artificial intelligence (AI) into the in-service training system of teachers in the Kherson region of Ukraine in the context of distance learning during martial law. The study's originality lies in identifying specific regional features of the use of AI in the educational process in emergency conditions and developing targeted in-service training programmes adapted to the challenges of wartime. The study aims to identify effective ways to integrate artificial intelligence technologies into the teacher training system and develop their information and digital competence in distance learning. The research methodology included a comprehensive analysis of the regulatory framework, scientific and methodological literature, and a survey of teachers on their readiness for professional development in AI implementation. The study results revealed the main advantages (access to data-based resources, personalisation of the educational process, automation of assessment, creation of interactive learning environments, use of virtual assistants, etc.) and disadvantages (lack of teacher training, ethical issues and technical limitations) of using artificial intelligence in the educational process. Based on the study of AI tools, the content lines of the advanced training programmes "Artificial Intelligence in the Educational Process" and "Neural Networks in Education" of 30 hours (1 ECTS credit) were developed. The study's findings can serve as a basis for developing regional strategies for introducing AI into the educational process, including training, infrastructure development, and cooperation between educational institutions and technology companies.

Keywords: artificial intelligence, neural networks, digital competence of a teacher, teacher training, postgraduate education, pedagogical technologies, personalisation of learning

1. Introduction

Introducing artificial intelligence into the educational process is one of the key trends in the digital transformation of education worldwide. The use of AI in teacher training is particularly relevant, as it can significantly expand the opportunities for teachers' professional development and improve the efficiency of the educational process.

Under martial law in Ukraine, the system of postgraduate teacher education has faced unprecedented challenges regarding ensuring continuity of education and support for teachers' professional development in distance learning. This has led to the search for new approaches to the organisation of teacher training, among which the introduction of AI technologies occupies a special place.

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2. Literature review

A thorough analysis of the scientific literature demonstrates the growing interest in using artificial intelligence in the educational process, especially in the context of teacher training in distance learning during martial law. Given recent global crises and regional conflicts, this topic is becoming increasingly relevant.

The current state of research in artificial intelligence in education, educational data mining and learning analytics, historical elements, attempts to define goals, adopted methodologies and applications are presented in [7, 17]. The purpose of the article by Marienko, Semerikov and Markova [15] is to study the main problems that arise when using artificial intelligence in secondary education in Ukraine and to formulate prospects for the further use of artificial intelligence in education. The main components of AI literacy are also presented.

Studies of anxiety about artificial intelligence and teachers' attitudes towards machine learning are important [2, 9, 13, 22]. Their results show that teachers' anxiety about AI implementation varies significantly by region and level of prior technological training. According to the research, teachers have an ambivalent attitude towards machine learning technologies, ranging from enthusiasm to significant anxiety. The main factor contributing to AI-related anxiety is the fear of AI replacement and the impact on social life [9]. Secondary reasons have also been identified, such as uncontrolled growth of AI, privacy issues, misinformation and bias of AI, and problems with academic integrity. To address these, interdisciplinary solutions are being developed [13], offering insights into educational, technological, regulatory, and ethical recommendations.

The concept of "Teachers of the Future" introduced by Ismail et al. [10] addresses concerns about the potential for AI to replace teachers. The paper acknowledges the indispensable role of teachers in providing emotional and moral support and fostering critical thinking among students. The paper notes that strategies for preparing future teachers in the AI era include developing AI literacy, integrating AI into courses, promoting collaborative learning, providing professional development opportunities, and fostering positive attitudes towards AI.

Based on the analysis of modern research on adaptive learning systems, it can be argued that they are of particular value in crisis conditions and regions with limited access to education [24]. For example, Koutsantonis et al. [14] has identified the ability of such systems to provide personalised learning paths, work effectively in unstable Internet connections, and use culturally adapted learning materials.

Important in the context of current challenges is the research by Fernández-Herrero [6], which reveals the unique ability of adaptive systems to consider users' cognitive and emotional states in conditions of increased stress characteristic of martial law. This allows not only to maintain the continuity of the educational process but also to ensure its psychological relevance to the needs of students in extreme conditions, which significantly distinguishes such systems from traditional distance learning formats.

Ahmad et al. [1] explores the role of artificial intelligence applications in education to address modern challenges and promote modern learning methods.

Chen, Chen and Lin [5] argues that artificial intelligence in education has significantly improved administration, teaching, and learning by increasing efficiency, promoting student retention, and increasing curriculum personalisation.

According to Marienko, Semerikov and Markova [15], the introduction of AI into teacher training has a twofold impact: on the one hand, it transforms traditional teaching methods, and on the other hand, it creates new competencies that teachers need to work effectively in a crisis. AI technologies are changing the form and content

of education, with a particular emphasis on developing adaptability and resilience skills among teachers. Memarian and Doleck [16] note that the most significant transformation occurs in assessment and feedback methods.

Research by Mintii and Semerikov [17] on the difference in the adoption of AI before, during, and after the COVID-19 pandemic, including regions with military conflicts, shows that the crisis has significantly accelerated the adoption of AI tools, but the sustainability of these changes remains an open question. Integrating AI into teacher training during martial law has generated new pedagogical approaches that combine technological efficiency with a humanistic approach, especially regarding psycho-emotional support for students [29].

Various aspects of professional development of teachers in the use of AI are considered by Shyshkina and Nosenko [27], Skrypka [28], Vorotnykova [31]. Jabali, Saeedi and Alawneh [11] emphasises the need for robust structures and professional development initiatives and the need to increase training and collaboration between educators and developers of AI technologies.

Kim, Lee and Cho [12] emphasises the importance of teacher training in the field of artificial intelligence; it considers the concept of "learning design" to support the collaboration of students and AI, which consists of the following components: (1) curriculum development; (2) interaction between the student and AI; (3) learning environments necessary for the development of students. It is assumed that students will develop collaboration with AI in three stages: (1) learning about AI, (2) learning from AI, and (3) learning together.

The possibilities of artificial intelligence tools to improve teaching in Ukraine under martial law are discussed by Momot and Lytvynenko [18]. In addition, the study examines the impact of the introduction of artificial intelligence tools on students' perceptions of social support in the context of the Leadership-Trust model.

An important observation is made by Topuzov and Alieksieieva [29], who found that in regions with martial law, AI systems are becoming key to ensuring the continuity of education.

2.1. International policies on the use and implementation of artificial intelligence in education

An analysis of international policies on using and implementing artificial intelligence in education shows significant progress in this direction.

Many international organisations and projects focus on introducing AI into the educational process, particularly on teacher training (table 1). The main areas of their work are

- curriculum development (creation of online courses, webinars, and other educational materials for teachers to help them learn the basics of AI and teach them how to use its tools in their professional activities);
- creating communities of teachers to share experiences, ideas and best practices of using AI in education;
- developing AI tools for education (creating software and applications that automate teachers' routine tasks, personalise learning, and improve interaction with students);
- research (studying the effectiveness of AI in education, developing new methods and approaches) [26].

Documents from organisations such as the Organisation for Economic Co-operation and Development (OECD), the European Commission, and UNESCO emphasise the importance of integrating AI into educational systems to improve learning and teaching [3]. UNESCO [30] also emphasises the need for ethical use of technology that meets

Table 1
International organisations aimed at introducing artificial intelligence into education, particularly in teacher training.

Logo	Name of the organisation	Initiatives
	UNESCO	The United Nations Educational, Scientific and Cultural Organisation is actively researching the impact of AI on education and developing recommendations for integrating AI into educational processes
	European Commission	Implements initiatives aimed at developing digital competencies, including the use of AI in education, and supports professional development programmes for teachers
	Organisation for Economic Co-operation and Development (OECD)	Conducts research and provides recommendations on the introduction of the latest technologies, including AI, into the educational systems of member states
	Microsoft Education	Offers resources and training for teachers on the use of AI in education, helping to integrate modern technologies into the educational process
	Google for Education	Develops tools and conducts training for educators on the effective use of AI in the classroom, promoting digital literacy

the principles of sustainable development and equal access to education. The OECD [20] offers recommendations on implementing AI to support personalised learning, which allows adapting educational programmes to the needs of students.

2.2. Regulatory and legal support and guidelines for the use of AI in education in Ukraine

Ukraine has developed the National Strategy for the Development of Artificial Intelligence for 2021-2030, which identifies the introduction of AI in research and education as one of the priority areas [19].

The strategy proposes an integrated approach that includes

- conducting research in the field of artificial intelligence;
- development of a regulatory framework in the field of artificial intelligence;
- training of qualified personnel and development of education.

The Ministry of Digital Transformation of Ukraine and the Ministry of Education and Science of Ukraine have proposed Instructional and Methodological Recommendations for the Introduction and Use of Artificial Intelligence Technologies in General Secondary Education Institutions based on international practices. These recommendations aim at the responsible use of AI in education, emphasising human rights and ethical standards [23].

Thus, international policies and national strategies demonstrate AI's growing role in education, emphasising the need to consider ethical aspects and ensure equal access to technology.

3. Defining the purpose and objectives of the study

Thus, the issue of teaching teachers the basics of artificial intelligence and neural networks in postgraduate education is relevant and timely.

Further study is needed on the possibilities of applying artificial intelligence in education and the educational needs of teachers on this topic, as well as the compliance of in-service training programmes for developing digital competence for teachers with the Digital Competence Framework for Ukrainian citizens. Researching these issues will help develop in-service training programmes and prepare teachers for the effective use of AI in the educational process.

The study aims to investigate regional trends in introducing artificial intelligence in in-service training programmes for teachers in the Kherson region of Ukraine who are trained in distance learning during martial law and to develop appropriate in-service training programmes.

To achieve this goal, the following tasks were identified:

1. Analysis of the theoretical and methodological foundations of using artificial intelligence in the educational process.
2. Study of the regulatory framework and scientific and methodological literature on the use of AI in education.
3. Identification of the advantages and disadvantages of using artificial intelligence in the educational process of general secondary education.
4. Assessment of the teachers' readiness to use AI in their professional activities.
5. Analysis of existing AI tools and their potential for use in the educational process.
6. Development of proposals for improving teacher training programmes under the Digital Competence Framework for Citizens, considering the peculiarities of distance learning during martial law.
7. Creation of content lines for in-service training programmes for pedagogical staff "Artificial Intelligence in the Educational Process" and "Neural Networks in Education".
8. Providing recommendations for developing regional strategies for introducing AI into the educational process.

4. Methods

The study of regional trends in introducing artificial intelligence into the in-service teacher training system used a set of interrelated methods: empirical (observation, survey) and theoretical (analysis, generalisation, comparison). The pedagogical experiment was conducted using artificial intelligence platforms such as ChatGPT and other educational bots integrated into the teacher training system in the Kherson region. The study involved 186 teachers from various educational institutions in the region.

Scientific sources on introducing artificial intelligence into the educational process were reviewed during the theoretical analysis. The commenting and tagging functions were used to communicate with the participants. For example, participants could receive teacher comments through tags indicating their username, which simplified feedback and increased interaction in distance learning. To highlight the current trends in the use of artificial intelligence in education in the Kherson region, a survey of teachers was conducted using Google Forms. Quantitative and qualitative analysis methods were used to analyse the results.

To ensure the validity of the results, the research instrument was aligned with internationally recognised digital competence frameworks and reviewed by a panel of five domain experts. The sampling strategy ensured representation across demographic and professional categories, reflecting the diversity of educators in the

Kherson region. Data triangulation from national, international, and regional studies strengthened methodological consistency and external validity. Additionally, expert evaluation through structured feedback and content analysis confirmed the reliability and practical relevance of the developed programmes.

Thus, the study's results confirmed the effectiveness of introducing artificial intelligence into teacher training. Using artificial intelligence tools contributes to personalising learning, increasing teachers' motivation for self-development and optimising the learning process. Regional trends show positive dynamics in introducing innovative technologies in education, which is a promising area for further research and development.

5. Empirical studies of the introduction of artificial intelligence in the educational process: from the global to the regional level

The article analyses the data of studies conducted in the USA, Ukraine (at the national level), and the Kherson region (at the regional level). The study aims to identify general trends and features of AI use in education and determine the factors influencing teachers' readiness for innovation.

5.1. A study of US teachers' attitudes towards AI in education

In October 2023, Forbes Advisor surveyed 500 practising educators in the United States about their experiences with artificial intelligence in the classroom. The sample included a variety of teachers from different states with different backgrounds [8].

The survey results showed that American teachers believe artificial intelligence has positively impacted their work (figure 1).

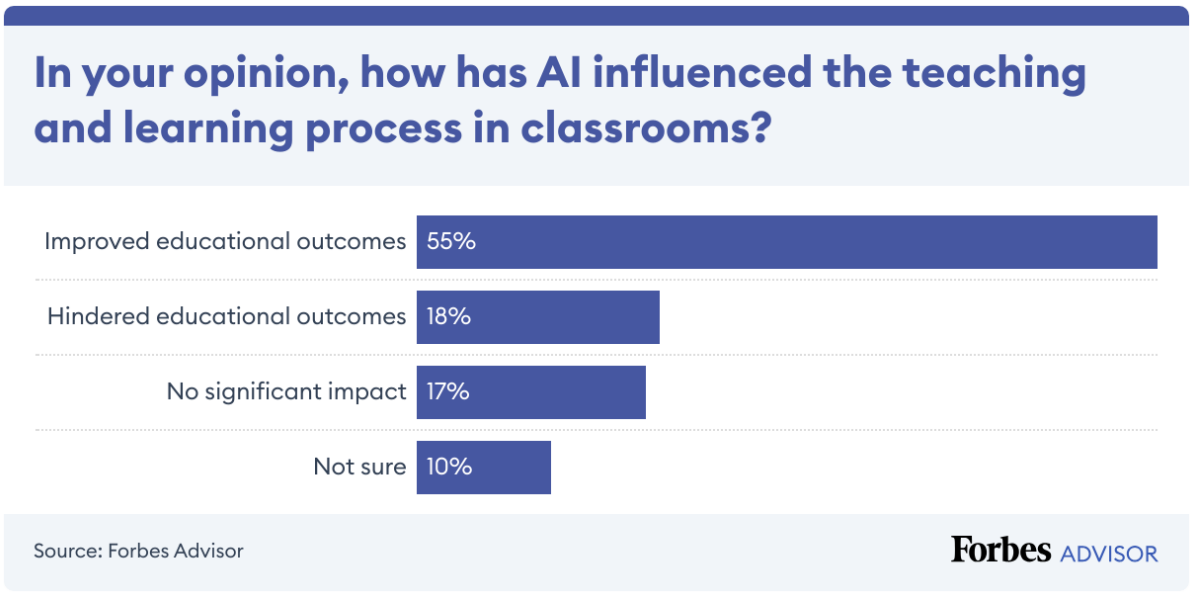

Figure 1: Survey of US teachers on the impact of artificial intelligence on the educational process.

When asked whether they integrate artificial intelligence into their teaching to improve and optimise their teaching needs, teachers answered as follows: yes (60.0%), no (35.0%), not sure (4.0%), and do not want to say (1.0%). Thus, we can see that most US teachers integrate artificial intelligence tools into their teaching.

The most common tools used by educators are AI-based online games (51%), adaptive learning platforms (43%), automated assessment and feedback systems (41%),

chatbots for learning support (35%), intelligent tutoring systems (29%), other tools (5%), do not use AI at all (6%), not sure (3%).

However, along with the benefits of using artificial intelligence in the educational process, teachers also feel there are dangers. The question "What concerns do you have about the use of AI in education?" revealed that the biggest concerns are plagiarism in essays and written works of students (65%), reduced human interaction (62%), data privacy and security breaches (42%), teachers losing their jobs due to AI dominance (30%), unequal access to AI-based resources (30%), automation of routine tasks (23%), other (1%), no concerns (4%), not sure (1%).

The survey showed that US educators are optimistic about the potential of artificial intelligence in the classroom and understand the growing impact of AI on education.

5.2. All-Ukrainian study of the use of artificial intelligence in school education

In September-December 2023, an all-Ukrainian study of using artificial intelligence in school education was conducted. This study was initiated by the Projector Creative & Tech Institute and the Junior Academy of Sciences of Ukraine (JAS) with the support of the research company Factum Group. The study aimed to analyse the extent to which artificial intelligence and its capabilities are used in Ukrainian school education. The survey covered 1,747 teachers and 1,443 students from different regions of Ukraine, including those living abroad [33].

The survey areas included knowledge of artificial intelligence services, their use, and attitudes towards AI resources.

To summarise the survey results, it is worth noting that teachers are aware of artificial intelligence services (87% of respondents) and use them (69%) in the educational process. ChatGPT is the most well-known resource in the teacher community (76% know and 68% use), and AI tools from Na Urok (49% know and 35% use). Grammarly, Gemini (as of 2023, Google Bard), Midjourney, Stabble Diffusion, Notion AI, and others are much less used but well-known in the teacher community.

It is also worth noting that the majority of teachers and students receive information about AI services from social media (69%), educational materials (46%), friends and colleagues (35%), purposeful search (30%), and the press (24%).

Regarding the use of AI, most teachers say they have experience in using AI (76%) and are mostly satisfied with their experience (figure 2).

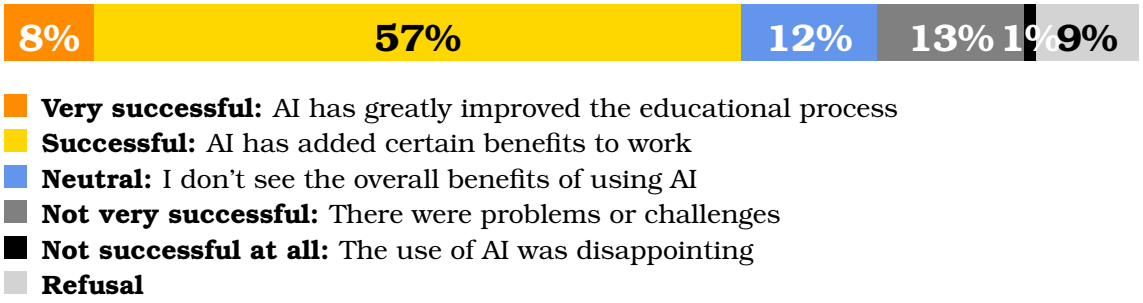

Figure 2: The degree of satisfaction of Ukrainian teachers with the experience of using AI in the educational process.

When analysing how AI is used in the work of teachers, teachers say that artificial intelligence will change the educational process in the coming years (54% of respondents). Teachers use AI to prepare for classes (44%), to prepare homework (30%), to conduct classes (online quizzes, interactive tasks, students' independent work with AI, etc.) (28%), to test students' knowledge (22%), and in extracurricular activities (to organise and conduct competitions, contests, use AI in clubs, etc.) (20%).

Teachers' opinions on using artificial intelligence in the educational process differ significantly. On the one hand, they recognise the potential benefits of this technology and its ability to optimise the learning process. On the other hand, many teachers are concerned about possible risks, such as limiting students' creative development, increasing the risk of academic integrity and unethical use of AI tools. Some teachers say they lack a deep understanding of how such technologies work, which raises concerns about possible mistakes in their use.

The issue of academic integrity in using AI is a particular concern for educators. Indeed, some students admit that they use AI to do their homework, but most say that these tools help them learn better and make the learning process more interesting and engaging. Students also desire to receive guidance from teachers on the ethical use of AI, to learn about its benefits and possible limitations, and to learn how to use these tools in their learning activities.

5.3. Study of AI application in educational institutions of Kherson region

In May-June 2024, a survey of teachers in the Kherson region was conducted to identify the real state of AI use in education and measure the current needs of teachers in using artificial intelligence tools in educational institutions. The survey involved 162 teachers of various subjects. Among them were 146 women (90.1%) and 16 men (9.9%). 62.3% of the respondents had more than 20 years of experience (101 people), 19.1% – from 11 to 20 years, 9.3% – from 6 to 10 years, 6.8% – from 3 to 5 years, 1.9% – from 1 to 3 years, 0.6% – up to 1 year.

Let us analyse the main results of the experiment. When assessing their experience working with artificial intelligence technologies in education, teachers rate it at an average of 5.7 points (figure 3).

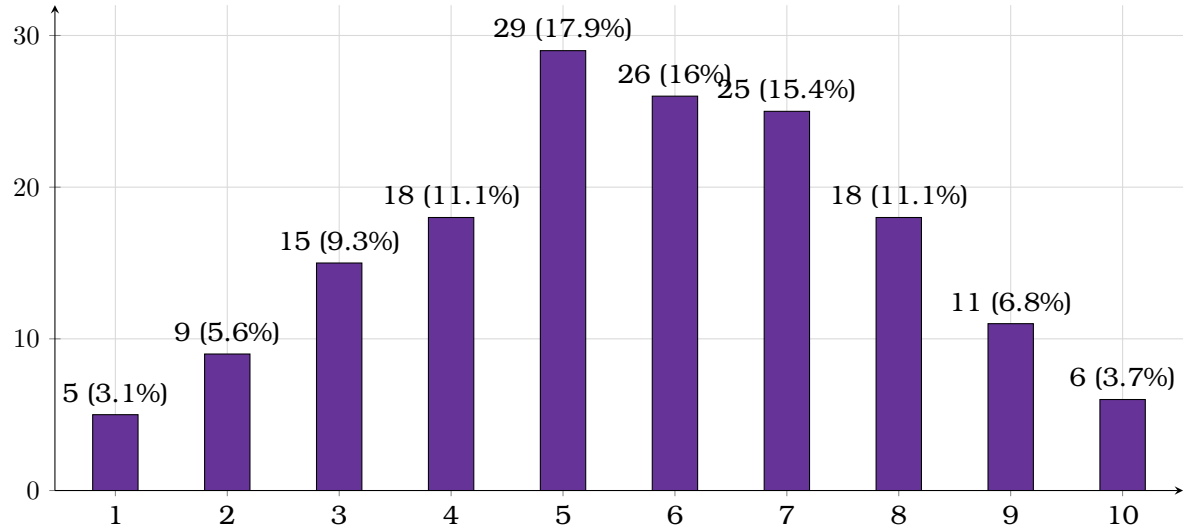

Figure 3: Assessment of own level of awareness in working with artificial intelligence technologies in education.

Answering the question "In what situations do students use artificial intelligence during their studies?", it was noted that they use it to answer tests/quizzes (52.5%), to prepare and present research results (57.4%), to prepare and present learning outcomes (44.4%), to translate texts (35.8%), and one per cent each of the following options: writing fairy tales, composing music, songs, writing texts, etc. Only 1% of teachers said that their students do not use AI.

Among the tools most often used by teachers in their work are ChatGPT, Gemini, Bing, Canva, Tome.app, Kazka.fun, Gamma, Adobe Firefly, Leonardo, Conker, Suno,

Lexica, Ideoram, D-ID, etc.

Regarding the frequency of AI use in the educational process, 37% of teachers said that they use it once or twice a month, 28.4% – once or twice a week, 12.3% – three or four times a week, and 6.2% of teachers use artificial intelligence every day. 16% of teachers said they do not use AI in education at all.

The largest number of educators (54.9%) use AI to increase students' motivation to learn, 45.7% use AI for self-study, 41.1% for creating educational and didactic materials, 40.7% for creating test tasks, 38.9% for searching, structuring, and summarising information on a topic in preparation for a lesson, 35.8% for organising students' learning activities using AI tools, and 23.5% for organising students' research and development or project activities. About 5% said they do not use AI at all.

The main problems that teachers face when using AI include imperfect skills in using AI (59.3%), the cost of AI tools (43.2%), a large number and rapid emergence of new AI tools, lack of performance/selection criteria for professional activities (35.8%), lack of methodological tools for teachers on the implementation of AI technologies in education (30.9%), inaccurate information insufficient image quality, etc. (25.9%), issues of assessing students' work performed with the use of AI tools (25.3%), organisational challenges (16%), lack of criteria for choosing an AI tool that meets the purpose of the lesson (15.4%), imperfect/limited functionality that does not meet the needs of the educational process (13.6%), ethical issues (9.9%).

Given the importance and trendiness of AI in education, teachers understand the need for training in artificial intelligence technologies. Therefore, 54.3% of them say they have been trained in AI, but 39.5% say they have never been trained in the use of AI tools, and even 2.5% of them said they have not been trained and do not need to be.

The most interesting AI-related area for the professional development of Kherson teachers was the creation of AI teaching materials; 81.5% of teachers noted the creation of AI teaching materials, 67.9% – AI lesson design, and 17.3% – AI ethics.

A separate question in the survey was dedicated to the challenges for teachers related to working in distance learning and during martial law. In such circumstances, artificial intelligence has become not just an innovation but a necessary tool to ensure the stability of the educational process. Teachers noted that in the context of martial law, constant communication, and power outages, AI tools help automate routine tasks, create interactive materials, quickly generate tasks, and even support students' psychological state by creating creative tasks.

The main challenges faced by teachers in such conditions were highlighted:

- Problems with access to stable Internet – 48.9%;
- Lack of technical equipment for organising distance learning – 42.7%;
- Psychological pressure and emotional burnout – 39.4%;
- The need to quickly master new technologies – 35.6%.

The majority of teachers (61.2%

- Quick creation of individualised tasks for students, taking into account their educational needs and level of training.
- Automation of checking homework and tests.
- Searching and summarising materials for lessons, including in conditions of limited access to textbooks.
- Development of interactive presentations and video lessons.
- Use of virtual assistants to support students in the learning process.

At the same time, teachers noted that using AI requires compliance with ethical standards. The main ethical challenges were highlighted:

- Evaluation of students' work performed using AI (45.3%).
- The threat of academic dishonesty on the part of students (38.7%).
- Insufficient understanding by teachers of the ethical boundaries of using AI in education (21.4%).

Based on the data obtained, it can be concluded that a comprehensive programme of professional development for teachers in the Kherson region on the use of artificial intelligence is necessary. Such a programme should include both theoretical training and practical classes and consider the specific conditions of distance learning during martial law.

5.4. Research analysis and regional trends

Summarising the results of international (USA), national (all-Ukrainian) and regional (Kherson region) studies allows us to identify both common features and unique peculiarities of the introduction of artificial intelligence in the educational sphere. Thus, among the common features inherent in all three levels is teachers' high interest in using AI to support the educational process, especially in creating digital content. ChatGPT is widely used, as are other adaptive learning platforms. At the same time, in all three cases, there are concerns about the ethical use of AI, data security, and threats to academic integrity.

The differences relate primarily to the conditions of implementation. In the US, the spread of AI is accompanied by the availability of technical infrastructure, sustainable digital education policies, and access to systematic teacher training. Ukraine has significant potential at the national level, but limited resources, lack of teaching materials, and unequal access to digital technologies hamper its implementation. In contrast, the Kherson region demonstrates a unique situation: despite the challenging conditions of war, limited technical facilities, and constant risks of communication disruptions, teachers are highly motivated to use AI and actively engage in specialised training.

The regional trends identified in the study allow us to outline the peculiarities of AI implementation in the context of long-term distance learning, unstable environment, and psychological stress:

- growing demand for practice-oriented programmes adapted to martial law conditions;
- awareness of the potential of AI as a tool to support the continuity of the educational process;
- the emphasis of the pedagogical community on ethical standards and the need to build digital integrity.

The obtained results confirm the feasibility of applying regionally sensitive approaches to integrating artificial intelligence into the system of teacher in-service training, especially in crisis conditions.

6. Development of advanced training programmes for teachers of Kherson region in the field of AI based on digital competence frameworks

The European frameworks DigComp 2.2 and DigCompEdu (European Framework for Digital Competences of Citizens and Teachers), as well as P21 (American Partnership for 21st Century Learning), provide teachers and researchers with recommendations for developing digital competencies necessary for the effective use of AI in the educational process [4].

Ukraine has developed a Digital Competence Framework for Citizens and a draft Digital Competence Framework for Educators. The 2023 version of the Digital Competence Framework for Ukrainian Citizens (DigComp UA 2.2) considers new opportunities for using artificial intelligence. The Framework provides examples of AI application in 20 digital competence components out of 30 existing ones, covering almost all areas of digital competence, namely Information Literacy (C1), Digital Content Creation (C2), Digital Communication and Interaction (C3), Safety in the Digital Environment (C4), Problem-Solving (C5) [25].

An analysis of existing teacher training programmes has shown that they do not fully meet the current requirements for teachers' digital competence. In particular, no AI modules are an integral part of the Digital Competence Framework. Therefore, the Kherson Academy of Continuing Education has developed in-service training programmes for teachers, "Neural Networks in Education" and "Artificial Intelligence in the Educational Process" for full-time and distance learning (30 hours / 1 ECTS credit).

The courses "Neural Networks in Education" and "Artificial Intelligence in the Educational Process" were specially adapted to the conditions of distance learning in the territories of hostilities caused by martial law and consider the challenges teachers face. The courses' flexible format and practical orientation help teachers effectively use artificial intelligence to organise the learning process in the face of uncertainty.

The main features of the courses are:

- Adapting to distance learning in the face of uncertainty. All course materials are available online, and classes are conducted in synchronous and asynchronous formats, allowing teachers to study even in communication or power outages. The course materials include video lectures, interactive assignments and recorded webinars for further study.
- Supporting the continuity of the educational process. The courses teach educators how to use AI to create learning materials that students can complete offline and tools that provide access to learning in crises.
- Practice-oriented. Course participants create tasks that can be immediately applied in the educational process.
- Flexibility and individualisation of learning. Courses allow teachers to adapt materials to the needs of a specific audience, including students with different levels of training and different technical conditions. This is especially important in distance learning when students are in different environments.
- Preparation for work under martial law. The course programmes consider the specifics of working in wartime and teach teachers how to create tasks available in any format, use limited resources effectively, and provide psychological support to students through interactive content.
- Addressing the ethics of AI use. The classes specifically address academic integrity, data privacy, and the ethics of using artificial intelligence. Teachers are also given methodological tools to ensure academic integrity in the classroom.
- Focus on interactivity. The courses teach teachers how to create interactive tasks that keep students' attention and engage them in learning. AI allows generating adapted tests, presentations, videos, and creative tasks even with minimal training.
- Innovative approach to learning. The final result of the courses is developing a project – a training session in the discipline taught by the teacher.
- Monitoring and support for teachers. During the training, participants receive constant feedback from teachers and discuss successful cases of AI implementation in the educational process.

Table 2
Content lines of teacher training programmes in accordance with the Digital Competence Framework for Ukrainian citizens (DigComp UA 2.2) [25].

Competences of the teacher (according to the digital competence framework)	**Topics of the professional development programme for teachers "Neural Networks in Education"**	**Topics of the teacher training programme "Artificial intelligence in the educational process"**	**Training content/activities**
C0. Fundamentals of computer literacy	Artificial intelligence in education: its role in education and ways to use it	Introduction to artificial intelligence in education	Basic concepts and capabilities of AI in the context of learning
C1. Information literacy, ability to work with data	Text generation using neural networks: principles and practical guidance. Neural networks for creating tests	Personalised learning with the help of artificial intelligence. Assessment and analysis of learning outcomes using artificial intelligence	Learning how to create individualised curricula for each student using analytical data and AI capabilities. Consideration of tools that help to conduct objective assessment and analysis of learning outcomes using AI
C2. Creating digital content	Creating presentations, images, educational videos and audio recordings using neural networks. Neural networks for generating educational content	Creation of digital learning resources using AI	Practical skills in the development and adaptation of e-textbooks, tasks, and tests using AI tools to improve learning efficiency
C3. Communication and interaction in the digital society	The problem of the ethics of using artificial intelligence in education	Ethical aspects of the use of artificial intelligence in education	Discussion of ethical issues and challenges related to the use of artificial intelligence in the educational process and finding ways to solve them
C4. Safety in the digital environment	Children's safety on the Internet	Interactivity and engagement using artificial intelligence	Developing interactive tasks and learning scenarios using AI capabilities to engage students and create an immersive learning environment
C5. Problem solving in the digital environment and lifelong learning	Using chatbots ChatGPT, Gemini, and Microsoft Bing in the work of a teacher. Using neural networks to enhance students' cognitive activity	Benefits of digital transformation in education. Innovative approaches to teaching using artificial intelligence	Real examples of successful AI implementation in the educational process. Research of advanced methods and practices of using AI to create innovative learning strategies and approaches

- Providing emotional support. The courses include modules aimed at overcoming stress in students and teachers through interactive and creative content created using AI.

In 2024, 28 people completed the above courses under the "Neural Networks in Education" program and 56 people (2 groups of 28) under the "Artificial Intelligence in

Education process" program. The total number of teachers who have completed these courses is 84.

Analysing the feedback from the participants after completing the courses, teachers note that their professional competence has "increased significantly" (53.6%), "increased" (39.3%), "increased slightly" (3.6%), and "remained unchanged" (1.8%).

The most relevant topics for teachers were the creation of a personalised environment using artificial intelligence, the creation of digital learning resources using artificial intelligence, interactivity and engagement using artificial intelligence, and ethical issues of using AI in education.

Answering the question "How interesting were the practical tasks and trainings at the in-service training courses?", teachers scored 4.8 on a 5-point scale. The score for the usefulness of the courses for teachers was 4.75, and the comfort of the amount of training material was 4.9.

Thus, analysing the feedback from the in-service training courses, we can conclude that they contributed to improving the participants' digital competence and deepened their knowledge and understanding of artificial intelligence and its specific use in the educational process.

In addition to taking individual courses on the use of artificial intelligence in education, Kherson teachers have the opportunity to participate in webinars on the digitalisation of education and methods of teaching specific subjects [21, 32]. In 2024, over 2000 teachers from Kherson and other regions of Ukraine attended such events. The most popular events were

- a regional scientific and practical seminar for primary school teachers on the topic "Workshop on the use of artificial intelligence: personal assistant to the teacher",
- scientific and practical online seminar "Modern online tools for creating interactive exercises" for language teachers,
- an educational and methodological online seminar "Artificial Intelligence in Physical Education Lessons: Use Can't Be Prohibited",
- scientific and practical online seminar "Using artificial intelligence tools in foreign literature lessons",
- regional scientific and methodological online seminar for chemistry teachers on the topic "Differentiated approach to planning a modern lesson in the course "Chemistry"",
- an online training seminar for art teachers on "Effective visualisation tools in the lessons of the integrated course "Art"", etc.

Another area of artificial intelligence implementation is research and experimentation based on general secondary education institutions in the region. The research and experimental sites are Kherson Lyceum No. 1 of the Kherson City Council (the topic of the experiment: "Formation of research skills of pupils of grades 5-7 in STEM education") and Kherson secondary school No. 41 of Kherson City Council (the topic of the experiment: "Formation of a digital educational environment to improve the quality of education in a general secondary education institution"). Experimental activities in the region's educational institutions demonstrate a significant potential for integrating AI into the educational process. For example, as part of the experiment, Kherson Lyceum No. 1 created an interactive STEM platform that allows students to develop research skills through virtual laboratories and simulations. In turn, in Kherson Secondary School No. 41, the introduction of a digital educational environment has contributed to a significant improvement in the quality of educational services,

particularly through the development of electronic curricula, interactive resources and the use of virtual assistants for students.

In addition to these measures, an important step in introducing artificial intelligence into education is creating specialised platforms and projects to support teachers' professional development. For example, the Kherson Academy of Continuing Education hosts an online hub for teachers that combines resources dedicated to digitalising the educational process, innovative teaching methods, and integrating AI into curricula.

The focus on developing teachers' information and digital competence is also implemented through the organisation of training, during which teachers learn how to use artificial intelligence tools such as ChatGPT, Canva, D-ID, Tome.app, Kazka.fun, and others. In 2024, more than 150 teachers took certified courses on "Creating Interactive Lessons Using AI" and "Academic Integrity in the Context of Artificial Intelligence". In the context of martial law, special attention is paid to developing recommendations for teachers on using AI in distance learning. These recommendations include:

- Creating personalised tasks for students based on their level of knowledge.
- Automation of checking and grading work to reduce teachers' workload.
- Developing interactive tasks and tests using content generation platforms.

Regional trends in introducing artificial intelligence in the in-service teacher training system in Kherson demonstrate the readiness of educators to adapt to new conditions and challenges. In the context of martial law, the introduction of AI ensures the continuity of the educational process and improves the quality of education. Developing teachers' information and digital competence and creating innovative educational platforms are key areas that shape the future of education in the region.

7. Conclusions

The study provided a comprehensive analysis of the regional dynamics of artificial intelligence integration into the in-service teacher training system in the Kherson region under the exceptional circumstances of martial law. The findings highlight both the transformative potential of AI technologies in supporting educational continuity during crisis conditions and the critical need for context-sensitive approaches to their implementation.

Theoretical analysis of the normative-legal framework and scientific-methodological literature enabled the identification and classification of the core benefits of AI integration in the educational process. These include expanded access to data-driven digital resources, the personalisation of learning pathways, automation of formative and summative assessments, the development of interactive and adaptive learning environments, and the deployment of virtual assistants to facilitate communication and feedback. However, these advantages are counterbalanced by systemic challenges, particularly the insufficient preparedness of educators for AI integration, ethical concerns related to privacy and algorithmic transparency, and infrastructural and technical limitations—especially acute under wartime conditions.

Empirical data from the regional survey reveal a high level of motivation and readiness among teachers to improve their information and digital competence, clearly recognising the relevance of AI tools to enhance pedagogical effectiveness. This demonstrates not only the teaching community's receptivity to technological innovation but also the urgent need for structured professional development initiatives tailored to the specific challenges faced by educators in conflict-affected regions.

In response to this demand, two modular distance learning programs were designed and implemented – "Artificial Intelligence in the Educational Process" and "Neural Networks in Education" – each comprising 30 hours (1 ECTS credit). These programmes

combine theoretical foundations with practical applications of AI in education and are designed to function effectively under remote instruction, technological disruption, and psychological stress. Their structure and content reflect modern pedagogical priorities, including adaptability, interactivity, and ethical responsibility.

Comparative analysis of global (USA), national (Ukraine), and regional (Kherson region) trends demonstrates both shared tendencies and distinct local features. While all levels show growing interest in AI and concerns regarding ethics and academic integrity, the Kherson region stands out due to its teachers' resilience, commitment, and willingness to engage with AI tools despite persistent infrastructural and security-related barriers. These regional trends underscore the need for differentiated, context-aware strategies in teacher training.

Based on the research outcomes, the following strategic directions for regional AI integration in teacher professional development are proposed:

- Development of regionally adapted training programmes, focusing on practical, application-oriented skills that address the realities of distance learning during emergencies;
- Investment in digital infrastructure and connectivity, ensuring equitable access to AI tools and platforms across all educational institutions;
- Strengthening ethical frameworks and digital integrity standards, including the promotion of responsible AI use in teaching and assessment;
- Fostering partnerships between educational institutions and technology providers to ensure sustainable implementation and continuous innovation.

In conclusion, successful AI implementation in teacher training systems, particularly under crisis conditions, requires an integrated approach that combines pedagogical relevance, technological feasibility, and regional specificity. The experience of the Kherson region illustrates the potential for leveraging AI to support educational resilience and offers a model for other regions facing similar challenges. The results of the study can serve as a foundation for the development of regional and national strategies that promote the ethical, effective, and sustainable integration of AI in education.

Future research should focus on evaluating the long-term impact of AI-integrated professional development programmes on teacher performance, student learning outcomes, and institutional digital transformation in crisis and post-crisis contexts. Particular attention should be paid to developing adaptive models of AI implementation that consider regional differences, teachers' psychological resilience, and evolving ethical standards. In addition, interdisciplinary studies involving educational science, data science and crisis management could provide a more holistic understanding of how AI can support sustainable and equitable education systems under extreme conditions.

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