

Professional development of teachers in conditions of digital transformation of postgraduate pedagogical education

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Abstract

The digital transformation of society promotes changes in all spheres of life, including education. Digital and remote technologies for professional development are essential for those who combine study with work and already have professional experience. The critical aspects of the continuity of the educational process during crises and the creation of strategies for the effective implementation of digital tools in postgraduate pedagogical education are understanding the general strategy of the digital transformation of education in general and postgraduate pedagogical education in particular. To ensure the continuous professional development of teachers in today's conditions, it is necessary to consider the possibilities of digital transformation of postgraduate pedagogical education. The digital transformation strategy of postgraduate education is impossible without analysing the needs and requests of teachers in professional development using digital technologies and possibilities of postgraduate education, taking into account international experience. To determine teachers' professional development possibilities, the article presented the results of a survey of 1472 teachers of various specialities and different professional experiences and conducted interviews with focus groups of 72 teachers with a high level of digital competence and professional experience.

Keywords

digital transformation, postgraduate pedagogical education, teacher's professional development, information and educational environment.

1. Introduction

The modern world, particularly in the use of AI, is changing rapidly, and to be competitive, education systems must adapt to these changes. Digital transformation is necessary for updating education, which should ensure lifelong learning and teachers' adaptation to the changing conditions of the labour market according to the requirements of time and the conditions of the modern economy. Digital transformation should reduce or remove barriers to access to quality, flexible postgraduate education and ensure continuous professional development of teachers because of the ability to choose various training programs and use adaptive learning platforms from anywhere in the world at a convenient time and at your own pace. Researchers emphasise the development of Education 4.0 and Education 5.0. [1] conducted a systematic review of the concept of "Education 4.0" as a new educational system based on experience, which uses technology and meets the expectations of the modern world within the framework of personalised educational needs and concluded that compared to previous social constructs, we are talking about a digital society that is being formed, defined by a completely new perception of time and place and virtually unlimited access to information [2]. Education 5.0 refers to the fifth industrial revolution in education through the use of digital technologies to remove barriers to learning, improve learning methods and promote overall well-being. The critical requirements of Education 5.0 [3] are advanced technologies that make it possible and necessary to create a learner-centred environment that uses the latest technologies and learning methods, in particular, artificial intelligence, blockchain, virtual and augmented reality, which can enhance personalisation, engagement

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and to provide more comprehensive access to education, taking into account ethical aspects cite.

The digital transformation of postgraduate education is a complex and multifaceted process that requires a comprehensive approach and consideration of many factors. Essential aspects are preparing teachers to use the latest technologies, supporting continuous learning in crisis conditions, and developing strategies for effectively integrating digital tools into the educational process.

2. Literature review

Mergel et al. [4] conducted research based on interviews with experts, developing a detailed definition of digital transformation, highlighting its importance for educational institutions and determining how information systems can be integrated into educational institutions to support digital transformation.

The study of leadership in the conditions of digital transformation, organisational flexibility and digital transformation itself made it possible to determine that the training of educational leaders should ensure successful changes and adaptation of new technologies in educational institutions [5]. The intersection between teachers and artificial intelligence in education is another opportunity to improve the quality of teaching and reduce the burden on teachers. Still, it should become a mandatory condition for such cooperation and ethical training for educators and technologists to ensure the responsible use of AI in the educational process.

The European Digital Strategy aims to give Europe a leadership position in digital technologies, the development of the digital economy, the protection of citizens' data, and the support of digital infrastructure.

The main factors can determine the adoption of new technologies in education: to what extent users believe that the new technology will improve their work (Perceived Usefulness), to what extent ease their use of new technology (Perceived Ease of Use), general attitude towards using technology (Attitude Towards Using), intention to use technology in the future (Behavioural Intention to Use), social influences, organisational support and individual characteristics of users (External Variables). Scientists [6] investigated developing teachers' knowledge in integrating content, pedagogy and technology. They created the TRACK model, which is critical to understanding how teachers can effectively use technology in learning. Kaufmann [7] compared the adoption of artificial intelligence models by experienced and novice teachers and explored the factors influencing teachers' willingness to use new technologies in their work. In their bibliometric analysis, Phuong et al. [8] considered digital tools for distance learning, emphasising the importance of modern technologies to ensure the quality of learning in the distance format. Training and support of teachers and providing access to modern technologies are essential for quality teaching [9].

Ukraine has adopted several documents that regulate and regulate the processes of digital transformation: Concept for Developing the Digital Economy and Society of Ukraine for 2018-2020, Strategy for the Development of Digital Skills and Digital Rights of Citizens until 2025, Law of Ukraine on the Basic Principles of Cybersecurity in Ukraine (2017), Concept for the Development of E-Governance in Ukraine (2017), Law of Ukraine on Electronic Trust Services (2017), National Informatization Program (2008, updated in 2020), Law of Ukraine on Open Data (2015, updated in 2020).

Ukrainian researchers emphasise the importance of digital transformation of education in crisis conditions and the importance of digital skills during crises [10]. The experience of digital transformation of secondary education in Ukraine during the war showed [11] that in crisis conditions, it is very important to adapt digital tools to support continuous learning. It has been proven that the quality of teaching in natural and mathematical disciplines depends on teachers' attitudes toward digital transformation and the level of digital transformation in educational institutions. Morse et al. [12] reviewed the effectiveness of training managers in e-learning, emphasising the importance of designing training programs and evaluating their effectiveness in supporting digital transformation.

Researchers point to obstacles to the digital transformation of education: resistance to change, digital skills gap, unstructured data and lack of an implementation strategy. It is crucial to have a plan for the digital transformation of this or that educational link as a whole and each institution [2] and consider

critical success factors for the effective implementation of the “Education 4.0” strategy and provide recommendations on the integration of technologies into the educational process to ensure quality education. Most of the research concerns the digital transformation of higher education [13, 1], which is essential in the context of the development of higher pedagogical education because this is where the research activity of future teachers is formed in the conditions of digitalisation, teachers are trained for professional activities, practical recommendations are provided for the successful integration of technologies into the educational process [14]. We must emphasise that higher education prepares a competitive specialist for several years, and postgraduate pedagogical education should be anticipatory and ensure the teacher’s professional development under the development of society and science throughout his professional life (almost 30 years).

Researchers have not paid attention to the digital transformation of postgraduate education and its opportunities for teacher professional development, particularly the study of the digital transformation strategy of postgraduate education.

Research questions or hypothesis: digital transformation of postgraduate pedagogical education will ensure an individual trajectory of professional development of teachers The purpose of the study: to reveal the possibilities of professional development of teachers in the conditions of digital transformation of postgraduate education

Objectives of the study.

- To analyse the needs and requests of teachers in professional development using digital technologies and attitudes towards the digital transformation of postgraduate education;
- To build a strategy for the digital transformation of postgraduate pedagogical education for the professional development of teachers. settings.

3. Methodology

To collect data, a survey was conducted among 1472 teachers of various specialities and interviews with 72 teachers with much experience and a high level of digital competence. The survey was conducted online with the anonymity of participants and content questions about the qualification levels of teachers and their competencies, determined by views on effective methods in postgraduate education. The data were analysed using statistical methods to assess the main trends and challenges and build a strategy for the digital transformation of postgraduate education for the continuous professional development of teachers. The focus group of teachers with experience using digital technologies and a high level of digital competence was formed by speciality based on the analysis of their pedagogical activities and the desire to contribute to the digital transformation of education. Participants of focus groups (up to 9 participants in one group) expressed their forecasts regarding the digital transformation of education and substantiated their opinions. The participants’ opinions were summarised, and critical forecasts were highlighted, with which each focus group became familiar. Forecasts were built based on previous ones until there were no changes in individual forecasts. The results of the survey of different groups of teachers were processed using statistical methods.

Description of research plan and methods This study used theoretical methods: literature analysis for building hypotheses and developing the study’s theoretical basis, defining the problem to be solved, and empirical methods, a qualitative approach using interviews and focus groups as data collection methods and statistical methods for processing the results. The study was conducted based on a sample of teachers.

3.1. Data collection process

They took part in the survey 1472 teachers of various specialities: natural sciences (20.97%), mathematics (12.3%), foreign language (6.3%), computer science (6.03%), technology (2.7%), Ukrainian language and literature (4.79%), history (3%) of primary school teachers (6.7%) and 37.21% of teachers (physical education, art, teacher organisers, etc.), which emphasises the consideration thoughts teachers of

various specialities regarding their professional development. The largest share of participants (56.1%) has the highest qualification level, of which 19.4% are Methodology teachers and 21.4% are senior teachers. Teachers of the first category are 11.2%, teachers of the second category are 11.2%, and specialists are 7.1%. Teachers with different teaching experiences took part in the survey: more than 20 years – 47.50%, from 10 to 20 years – 28.64%, up to 10 years – 22.03%, up to 1 year – 1.83%, which allowed to take into account different teachers' experience.

Data were collected through interviews, focus groups, and online teacher surveys. Each teacher was interviewed individually, allowing for detailed information.

4. Results

4.1. The needs and requests of teachers in professional development with the use of digital technologies and attitudes towards the digital transformation of postgraduate education

Digital technologies allow educators to quickly update educational materials with the latest advances in science and technology, guaranteeing teachers the opportunity to obtain up-to-date knowledge that meets the modern requirements of the labour market and the needs of society.

Let us consider teachers' requests regarding the digital transformation of postgraduate teacher's education, ensuring continuous professional development, based on a survey of 1,472 teachers in 2024. Almost half of the participants have extensive teaching experience (over 20 years— 47.50%, from 10 to 20 years: 28.64%; up to 10 years—22.03%, up to 1 year—1.83%), which emphasises the importance of further professional development for teachers with different levels of experience. To the question "What motivated you to increase the level of professionalism in the chosen topic?" most of the answers related to the relevance of the topic (58.31%), interest in learning new things (48.72%), the possibility of choosing the desired distance form of professional development (37.92%), free courses (34.0%), the availability of experience and this topic (33.10%), recommendations colleagues (18.43%), authority of the teacher (6.31%).

Face-to-face education is the most effective and desirable (average score of 4.43). Still, teachers also chose the mixed form of education (average score of 4.41) and the distance form of education (average score of 4.23), which indicates a generally positive assessment of all forms of education (figure 1).

The answer is, "Is it necessary to use coaching, including electronic coaching, in professional development?" 43.4% of teachers answered positively, 1.7% determined that yes, but 37.2% hesitated to answer under certain conditions, and only 17.7% said that it was unnecessary. Instead, in 2017, the percentage of positive responses regarding using e-coaching was 10% [15].

It can be concluded that the digital transformation of society and education is increasing teachers' desire to receive personalised postgraduate education with consulting and coaching. Surveys showed a medium to high level of digital competence among teachers (67.45%), their desire to master new digital tools for professional development, including AI technologies (74.23%) and motivation for continuous professional development using digital technologies (89.35%).

Most participants (almost 70%) give distance learning the highest rating (5), and 24.78% of participants gave a rating of 4, indicating that many participants consider this form of learning very effective. When evaluating the disadvantages and advantages of remote advanced training synchronously and asynchronously with active and passive participation, the participants determined the effectiveness of the synchronous training form in webinars (figure 2). Seventy-two teachers who have a high level of digital competence (64.7% of participants have scores of 9 and 10 on a 10-point scale) and significant work experience (88.24% – more than 20 years, from 10 to 20 years) participated in the focus group survey – 5.88%) and a high level of qualification (teacher of the highest category – 47.06%, title of "methodology teacher" – 29.41%, teacher of the highest category, title of "senior teacher" – 23.53%) and motivated to digital transformation of education.

Their survey results showed that the main functions of the information and educational environment in postgraduate education are to provide access to current professional development programs in digital

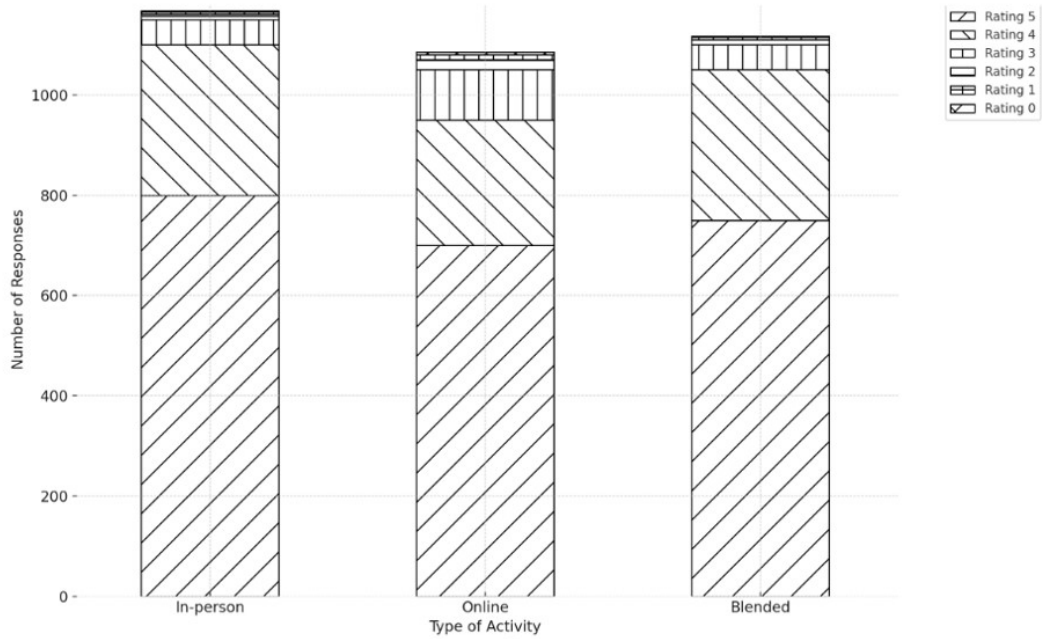


Figure 1: Choice of an effective form of professional education development by survey participants.

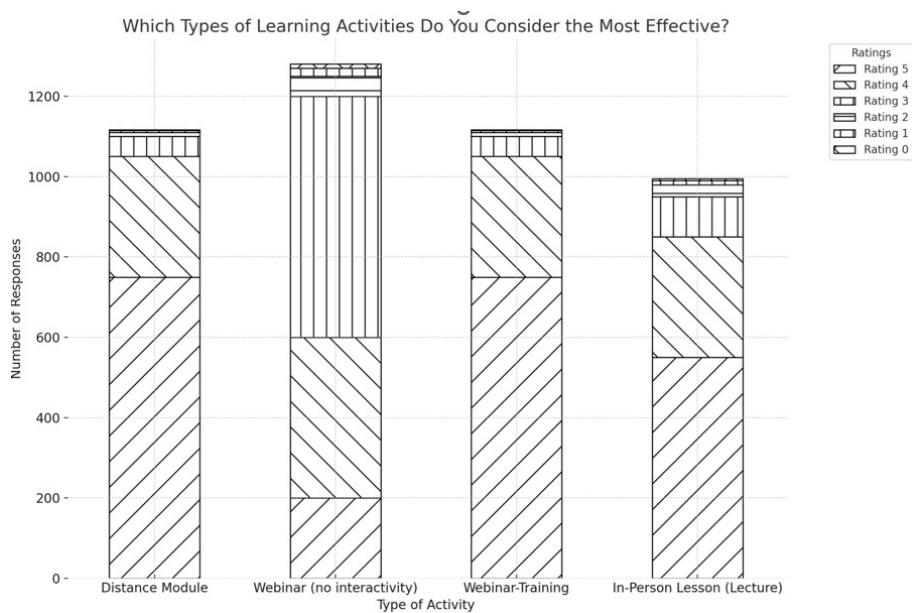


Figure 2: Choice of an effective activity for professional education development by survey participants.

format and to create professional online networks and communities to support and develop teachers.

The respondents highlighted the following main perspectives on development information and the educational environment of post-graduate teacher education: providing access to current professional development programs (17.65%), monitoring teacher requests and creating adaptive professional development programs (11.76%), developing professional online communities and networks (11.76%). Simultaneously, the quality of content, interactivity of learning and availability of resources remain critical factors in the effectiveness of using the information and educational environment (41.17%). To further improve the informational and academic environment of postgraduate pedagogical education, according to teachers, it is necessary to focus on improving their support (tutoring), which was indicated by 29.35% of respondents, improving qualifications and supporting professional networks (11.76% of

responses), attracting experienced teachers as authors of professional development courses (17.65% of reactions).

4.2. Model of educational policy of digital transformation of postgraduate pedagogical education

The results of the survey of the focus groups of teachers made it possible to identify the necessary directions for the digital transformation of postgraduate pedagogical education: in the management of postgraduate education and organisation of the educational process, teaching and learning, professional development of postgraduate education teachers and teachers, resource provision.

To develop the educational policy of digital transformation of post-graduate teacher education, the results of teacher surveys, literature analysis, and tools and Intel, which consists of materials arranged according to the educational policy development process model, were used [16].

Components of such tools.

- Forecasting the future. Formation of a common vision ;
- Develop a strategic plan to create a roadmap for realising the vision, focused on the next five years. Select some strategic levers that can be used to implement change. Plan to use these levers to join the efforts of interested participants to implement transformational changes;
- Management plan and resource provision;
- Evaluation and adjustment of phase 1 “Prediction of the future”;

The first phase. Let us consider forecasting the future and forming a common vision. At the state level, it is possible to single out trends regarding the vision of strategies related to the development of postgraduate education to ensure the professional development of teachers: anti-corruption reform, provision of services in electronic form to citizens, decentralisation and reform of public administration, promotion of Ukraine’s interests in the global information space, digital transformation for economic and social development within the framework of public-private partnership, reducing the gap in digital technologies and increasing their availability, reforming the education sector, the need to eliminate inequality between rural and urban communities in providing quality education. The strategy is based on the vision of the future landmarks to which we strive: the economy is built on the use of our resources and engagement with the latest technologies, work under martial law and post-war recovery, education has a proactive nature, a high percentage of middle-class people (60%) a single information space, e-government, e-services, e-democracy.

Implementation of national vision strategies at the level of the Institute of Postgraduate Pedagogical Education: digital transformation, individualisation of continuous professional development of teachers, creation of an information and educational environment for professional development of teachers, internship, personalised training, preservation of the mission, development of corporate culture, traditions, improvement of communication between participants of the educational process, using AI.

Development of education: increasing the availability of quality, competitive education for citizens of Ukraine by the requirements of innovative sustainable development of society, economy, and every citizen; ensuring the personal development of a person according to his abilities and needs based on lifelong learning. Critical areas of educational policy: modernisation of the structure, content and organisation of the educational process based on the competence approach, personalised training, reorientation of the content of education for sustainable development; creation and provision of opportunities for the implementation of various educational models and methods for teachers working in educational institutions of different types and forms of ownership, multiple forms and means of obtaining an education; cooperation with educational institutions, training centres on the creation of a joint informational and educational environment for the professional development of teachers; ensuring availability and continuity of education throughout life; ensuring monitoring of the education system, raising the social status of teachers; development of human resources (personnel) and the creation of a knowledge society.

Among the tasks of postgraduate pedagogical education which must be resolved, the main ones are the formation of the content of training based on the target direction and job duties of specialists, professional standards, previously acquired education, work experience, individual interests and needs; the use of modern technologies, which provide for differentiation, individualisation, the introduction of various forms of professional development, including without leaving work; development and continuous improvement of the content of postgraduate education, and at the state level – decentralisation of management bodies and autonomous institutions, which will be able (forced) to make decisions and bear responsibility for them to ensure continuous professional development of the teacher or lose him as a customer of services in connection with the development of competition among institutions of postgraduate pedagogical education and various organisations, training centres. A digital transformation policy for teacher professional development is impossible without considering teachers' motivation and educational institutions' needs, which school leaders determine, the possibilities of postgraduate pedagogical education, and the availability of consulting and coaching assistance for educators.

The second phase – “Strategic plan development”, includes directions organised to support step-by-step implementation, namely: the creation of a long-term plan, search for levers of influence, coordination of interested participants, and development of strategies. Combining the results of changes in various system components is necessary for the digital transformation of postgraduate pedagogical education. This should be done by institutes of post-graduate pedagogical education, which have gained various experiences in ICT policy and professional development of teachers in conditions of digitalisation, and all interested participants. Considering the above, we will develop a strategic plan for the digital transformation of postgraduate education, which will encourage the implementation of educational policy in the next five years.

Strategic plan of digital transformation of postgraduate pedagogical education.

Leadership management of postgraduate education and organisation of the educational process:

- distribution and expansion of the network of digital educational platforms for the professional development of teachers using constantly updated content ;
- development of a national platform for management postgraduate pedagogical education with AI integration to analyse data and predict training needs for optimisation processes and to increase their efficiency;
- implementation of a system of individual online registration for courses and placement of e-portfolios of teachers on the platform for the creation of data banks and improving the exchange of information between teachers and administration;
- the use of AI to analyse and monitor the effectiveness of courses and the individual progress of teachers and determine their training needs, which helps in data-based decision-making, which improves the management and planning of educational processes;

Professional development of postgraduate teachers and teachers

- soft skills and hard skills, development of critical thinking, analytical, technical communication skills of teachers, project management skills [17];
- development of digital competencies of teachers [18];
- personalised professional development and learning: using AI to create individual professional development trajectories based on learning data analysis, using AI-based adaptive learning systems to improve motivation and learning outcomes [19]; introducing virtual assistants to support teachers in training and professional development. AI assistants can provide round-the-clock support and consulting, which positively affects the effectiveness of training;
- involvement of teachers in international projects and internship programs organised both in a face-to-face format and using AI platforms to improve teaching quality and develop professional skills [20];

Teaching and learning:

- Use of AI to monitor professional development needs and adapt training programs to respond to changes on time and ensure the relevance of training programs;
- using various forms of professional development, mobile immersive technologies, micro-learning and ensuring synchronisation of data between different devices such as phones, tablets and computers for convenience and continuity of learning, allowing teachers to have constant access to the necessary materials [20] regardless of their location using cloud-based services;
- introduction of electronic coaching and mentoring using AI to support and advise teachers to increase the effectiveness of teaching and support of teachers [15, 11];
- individual and group programs: development of individual and group educational and professional programs for various forms of education, including creating and supporting massive open online courses (MOOC) using AI technologies for adaptive learning. Studies confirm that MOOCs with the integration of AI contribute to improving access to quality education and increasing the level of knowledge among teachers;
- creation of digital etiquette of cooperation and communication and use of cloud technologies to share experiences and create joint online learning programs based on connectivist theory;
- with the creation of adaptive training programs and improvement of the assessment system using AI and implementation of formative assessment and self-assessment; implementing adaptive programs using AI to analyse teachers' needs and progress. Studies confirm that adaptive learning systems increase student motivation and success;
- for constant monitoring of the quality of education and the effectiveness of educational programs: AI can ensure high quality of education and timely correction of programs, using AI for formative assessment, self-assessment and expert assessment of professional development programs for objectivity and transparency of assessment ;
- introduction of a teacher certification system with automatic monitoring and evaluation to promote changes in the content of postgraduate pedagogical education;
- peer review: evaluation of professional development programs by teachers on platforms and sites and improving the quality of education through research and evaluation using AI;
- for automatic assessment of achievement results, which contributes to the objectivity and efficiency of knowledge assessment [21];
- to research changes in the system of postgraduate pedagogical education and the introduction of innovative technologies. Data analytics based on AI helps to make informed decisions and implement innovations;
- ensuring data security and content quality (plagiarism check), safety and efficiency of management of educational resources;

Resource support:

- development of digital infrastructure of educational institutions;
- availability of e-education managers;
- providing access to educational resources;
- development of repositories in educational institutions, libraries, open electronic educational resources and electronic textbooks;
- use of cloud services, individual educational e-offices, and e-methodical centres.

The third phase is “Management Plan + Resource Support”. In the management plan, we must define the areas of activity and responsibility for implementing the programs that introduce the implementation of the educational policy on the digital transformation of postgraduate pedagogical education. The budget should include the following categories of costs: initial costs, which include ensuring the development of digital infrastructure (hardware and software), teacher training, maintenance (installation of hardware, payment of IT specialists, etc.); costs for the provision of services, that will be provided by third parties (outsourcing). To set up the digital infrastructure, educational institutions should also decide what tools can be used free of charge and which need funding.

The fourth phase. Evaluation and adjustment. The materials of the “Assessment and Adjustment” phase are intended to help in the development of a monitoring and evaluation plan; determination of progress measurement criteria; drawing up a schedule of periodic inspections to track success and identify problems that can be measured quantitatively: based on the analysis of documents (work plan of post-graduate pedagogical education institutes, programs and forms of teacher training); the results of a questionnaire regarding teachers’ satisfaction with professional development courses; introduction of ICT by teachers in their professional activities; teacher training courses in ICT; availability of each teacher’s individual professional development route; openness and accessibility platform for professional development; the availability of individual and group educational and professional programs and their variability for different groups of teachers (by speciality, seniority, needs); measurement of digital and AI competence of teachers, monitoring general secondary education.

The main problems and limitations of the developed strategy are the presence of restrictions on financial support for the development of the digital infrastructure of educational institutions in wartime conditions, including post-graduate pedagogical education institutions; different level of training, digital competence and motivation of teachers of postgraduate pedagogical education and teachers for the digital transformation of education; lack of electricity, access to high-speed Internet in martial law conditions [22]; lack of recommendations on the digital transformation of education at the state level (including on the use of AI).

5. Conclusions

Digital technologies contribute to automating many educational institutions’ processes, allowing for more effective management, reduced costs, and increased decision-making efficiency. Thanks to data analysis and the use of adaptive learning systems, it is possible to create individual learning trajectories for each teacher, considering their needs and training level. Digital platforms allow the creation of communities of interest, which promotes social integration and the exchange of experiences between teachers and professionals from different fields.

The survey showed that teachers are highly motivated to use digital technologies for professional development. The digital transformation of postgraduate education is critical for ensuring the competitiveness and adaptability of educational institutions in today’s world. This strategy aims to create conditions for integrating digital technologies in all aspects of postgraduate education, improve the quality of education, and train specialists to work in the digital economy. The strategy’s primary goal is to create an innovative and effective post-graduate education system that meets modern society’s and the economy’s needs, ensuring access to quality education and developing digital competencies among students and teachers. The main directions of the digital transformation of postgraduate pedagogical education for the professional development of teachers, which were confirmed by teachers’ surveys:

- Infrastructural support for digital transformation: development of modern digital infrastructure in educational institutions, provision of access to high-speed Internet and modern digital tools for learning, implementation of cloud services for data storage and processing.
- Personalised and adaptive learning: the use of adaptive learning platforms to individualise the learning process, the development of training programs that consider the individual needs and capabilities of teachers, and the use of data analytics to monitor progress and adapt learning trajectories.
- Professional development of teachers: organisation of training and courses for teachers on using modern digital technologies, support of teachers in developing digital skills and implementing innovative teaching methods, and creation of communities for sharing experiences and best practices.
- Innovations in educational programs and teaching methods: integration of modern technologies, such as artificial intelligence, machine learning, and virtual and augmented reality, into the educational process, development of interactive and gamified educational materials, use of simulations and virtual laboratories for practical training.

The digital transformation strategy of postgraduate education will contribute to improving its quality, continuous professional development of teachers, developing digital competencies among the educational process participants, and ensuring the competitiveness of educational institutions in the modern digital world. Implementing digital technologies in all aspects of the educational process will help create an innovative and effective learning environment that meets the requirements of the times. Further research is required for the introduction of management plans and resource provision for the introduction of the educational policy of digital transformation of postgraduate pedagogical education for the professional development of teachers based on the integration of resources of institutes of postgraduate pedagogical education, the development of educational and professional training programs for teachers who work with teachers, the creation of single information and educational environment for professional development teachers.

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