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# INTEGRATION OF DIGITAL TECHNOLOGIES INTO THE PROFESSIONAL DEVELOPMENT OF EDUCATORS: THE SLOVAKIAN EXPERIENCE

**Abstract.** Slovak Republic has accumulated significant experience in integrating digital technologies into the professional development of educators, and a systematic analysis of this experience could serve as a resource for modernising the Ukrainian system of postgraduate education. The aim of this article is to provide a theoretical analysis, systematisation and classification of digital technologies for professional development of educators in Slovakia and to justify a model for professional development of educators using digital technologies. General scientific methods such as analysis, classification and systematisation of the results of scientific publications, as well as content analysis of strategic and regulatory documents of the EU and the SR, were employed. The article highlights the results of national and international projects implemented at Comenius University in Bratislava, which are aimed at supporting the professional development of teachers in digital environment. Strategic and regulatory documents, project materials, methodological resources and practices developed within the framework of national and international initiatives have been analysed, with particular attention paid to the DiTEdu project and the digital professional development of educators. Based on the systematisation and comparative analysis of the identified practices, an original structural-functional model of professional development for educators using digital technologies has been developed, and a classification of the main types of digital tools used in the Slovak context has been proposed. The findings have made it possible to identify the key organisational, pedagogical and technological conditions for effective digital professional development, in particular personalised learning, blended formats, professional networking, learning using artificial intelligence, the development of digital competence and ongoing methodological support. Recommendations are proposed at the national, institutional and individual levels for Ukrainian postgraduate education regarding the implementation of the Slovak experience in the using of digital technologies in the professional development of educators.

**Keywords:** educators; teacher; professional development; digital literacy; digital resources; digital technologies.

## 1. INTRODUCTION

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**Statement of the problem.** The rapid development of digital technologies in the 21st century has brought about profound transformations in various spheres of public life, including the field of education. In the current context of global transformation, education is regarded as one of the key drivers of social progress and sustainable development for nations. The adoption by the UN in 2015 of the resolution 'Transforming our world: the 2030 Agenda for Sustainable Development' [1] outlined new global Sustainable Development Goals for humanity, among which Sustainable Development Goal 4 holds a special place, aimed at ensuring inclusive, equitable and quality education and promoting lifelong learning opportunities. The achievement of this goal is directly linked to improving the quality of training and continuous professional development for educators in higher education institutions [2].

In recent years, the international education community has been actively discussing these issues at global forums and conferences. In particular, the first regular mission of the Global Education Monitoring Report in 2018 in Brussels was dedicated assessing progress towards achieving educational goals in the context of the 2019 High-Level Political Forum on Sustainable Development. Subsequent international discussions have highlighted the role of education as a catalyst for social recovery, particularly in the wake of the pandemic.

The 2024 Global Education Summit [2] also marked an important milestone in the development of international educational partnerships, highlighting the strategic role of education in overcoming global crisises and ensuring inclusive development. In this context, a significant increase in the number of highly qualified teachers through the expansion of international cooperation in the field of teacher education takes on particular importance.

The educational landscape is undergoing significant transformations under the influence of digitalisation processes, which are changing traditional approaches to the professional formation and development of educators. The active introduction of distance and blended learning, digital educational platforms and artificial intelligence tools necessitates a review of the content and forms of professional development for educators [3].

Contemporary digitalisation of teachers' professional development is associated not merely with the transfer of traditional training activities into an online environment, but with the emergence of new models, technologies and pedagogical approaches. These include personalised and adaptive professional learning, microlearning and micro-credentials, digital professional portfolios, learning analytics, virtual professional learning communities, peer-to-peer digital collaboration, and the use of artificial intelligence to support learning, reflection and feedback. Such innovations contribute to the development of more flexible, continuous and individualised models of professional development, enabling educators to shape their own learning trajectories and combine formal, non-formal and informal learning. At the same time, their effective implementation requires appropriate digital competences, institutional support, quality assurance mechanisms, and new approaches to assessing professional learning outcomes. Consequently, the study of national practices in implementing such innovations is important for identifying effective and transferable solutions and determining the conditions for their adaptation to different educational contexts.

These developments are particularly significant for Ukraine, where the transformation of the educational landscape is taking place under conditions of war, the destruction of educational institutions, the mass displacement of children, and persistent security risks and restrictions. In this context, digital innovations in teachers' professional development are becoming not only instruments for modernising the educational environment, but also important mechanisms for ensuring the continuity and accessibility of postgraduate education, professional self-development, and peer interaction. Digital learning environments can also facilitate access to professional and psychosocial support for educators working under conditions of prolonged crisis. Therefore, the identification and adaptation of effective

international practices in the digital professional development of educators is of particular relevance to the Ukrainian educational context.

The Slovak Republic, as a European country neighbouring Ukraine and sharing a similar mindset, has accumulated significant practical experience in the implementation of digital technologies in the professional development of educators. A systematic analysis and scientific adaptation of the Slovak experience could become an important resource for the modernisation of the Ukrainian system of postgraduate education in the context of Europeanisation.

**Analysis of recent research and publications.** Research focusing on the role of the teacher and the enhancement of their professional competence is well-developed in global pedagogy (research on teachers/teacher education), as evidenced by a large number of publications.

In contemporary European academic discourse, considerable attention is also paid to understanding the phenomenon of digital platforms as a key factor in transformation of the educational environment. In particular, the study by M. Decuyper, E. Grimaldi and P. Landry presents a systematic analysis of the essential characteristics of digital platforms, which they interpret as a programmable digital architecture aimed at organising multi-level interaction between various actors: from individual users to corporate structures and state institutions [4]. The authors argue that the functioning of such platforms is based on integrated mechanisms for collection, algorithmic processing and dissemination of user data, which leads to profound changes in the structure of educational processes. As a result of their implementation, technological modernisation takes place, along with a conceptual rethinking of forms and methods of teaching, and the standardisation and adaptation of the educational process to the requirements of the digital society.

M. Lindfors, F. Pettersson and A. D. Olofsson have demonstrated that modern educational institutions are engaged in an ongoing process of digitalisation. For teachers, digital competence – as one of their professional competencies – involves not only mastering digital technologies, but also preparing students to use them effectively [5].

F. Caena and C. Redecker found out that learning and teaching strategies must be changed and teachers need to update their competence profiles in line with the challenges of the 21st century [6]. Thus, digitalisation processes are significantly altering the nature of educational activities, as well as the methods of communication and interaction among participants in the educational process, which highlights the need to rethink the professional role of the teacher in a digital environment.

A significant contribution to research into the professional development of teachers at teacher training universities has been made by a team of researchers led by J. P. Carpenter. The researchers developed and tested a validated questionnaire for teachers to assess the effectiveness of professional development programmes. An analysis of the results of the empirical study revealed that formalised educational programmes have significant positive impact on the development of teachers' professional competencies, particularly in the area of digital technology use. It was found out that a significant proportion of respondents noted their own experience of participating in formal learning environments, which is linked to the acquisition of digital tools both within and outside educational institutions. At the same time, informal practices of interaction play an important role in professional development, particularly collegial support, which facilitates the direct mastery of digital technologies, as well as the indirect influence of the digital environment on raising teachers' awareness [7].

Consequently, researchers consider digital technologies as a powerful resource for implementing innovative educational solutions that can expand access to high quality and continuous learning for students. They create conditions for the free exchange of information and knowledge, and also promote active and meaningful participation in social and civic life.

In recent years, international researchers have focused on exploring the potential of meta-learning, artificial intelligence technologies and personalised learning as innovative approaches to organise knowledge acquisition processes.

J. P. Monteiro et al. [8] considers metacognition as a mechanism for the purposeful selection and algorithmisation of knowledge discovery procedures, the integration of basic machine learning models, and the optimisation of educational process management, in particular the overcoming of cognitive and systemic biases. The researchers place particular emphasis on the possibilities for the transfer of meta-knowledge between different subject areas, which ensures greater adaptability and effectiveness of the educational process. The application of meta-learning principles enables educators not only to master digital tools, but also to understand the logic behind their use, adapt teaching strategies to the changing conditions of the educational environment, and facilitate interdisciplinary knowledge transfer.

In their study, K. G. Srinivasi, M. Kourni and K. Sariti outline the evolution of artificial intelligence from computer-based technologies to integrated web-based intelligent education systems, as well as its subsequent integration with robotics and chatbot solutions to partially or fully replicate the functions of a teacher [9].

X. Zhang, J. Sun and Y. Deng demonstrate the significance of using artificial intelligence technologies to design a “smart” educational environment aimed at in-depth study of learning material, taking cultural context into account [10]. Thus, using of artificial intelligence technologies contributes to improving the effectiveness of assessing learning outcomes in line with the needs of learners and to overall improvement of the quality of the educational process.

The personalisation of the educational process, as noted by M. G. Gallego-Jiménez and A. García-Barrera, involves creating space for the expression of personal initiative, which enables a design, planning, implementation and evaluation of various components of learning [11]. In the context of the professional development of teaching and researching staff, personalised learning takes on particular significance, as it fosters the ability reflectively manages one’s own educational activities and enables the creation of individual educational pathways and the enhancement of the educational process through using of intelligent digital systems.

In this context, research into the potential for integrating digital technologies into teachers’ professional development takes on particular significance as a key factor in improving the quality of education. M. J. Nelson, R. Voitofer and S.-L. Cheng investigated the potential for integrating technology as a tool for managing the educational process within teacher training at a national level in the USA [12]. Based on the results of an empirical study, the researchers established that the level of teachers’ digital competence, as well as institutional support, are key factors in effective professional development.

At the same time, finding the optimal balance between technological innovations and the preservation of humanistic values in education remains a pressing challenge, which determines the scientific significance of pedagogical research. The professional development of teachers emerges as a necessary condition for improving the quality of the educational process, creating an innovative educational environment, and preparing competitive specialists for the modern labour market.

The academic works of I. Vorotnikova [13] and O. Stoika [14] explore current aspects of the digital transformation of teachers’ professional development in the context of integrating artificial intelligence technologies into the educational process.

The researchers emphasise that using artificial intelligence systems opens up new opportunities for personalising learning, automating the assessment of learning outcomes, creating interactive educational environments, and utilising virtual assistants in teaching practice. It is emphasised that the effective implementation of such technologies requires the

development of an appropriate level of digital competence among teachers, in particular understanding of the principles of how artificial intelligence works and its areas of application.

O. Sinekop, I. Litovchenko, Y. Lavrysh and V. Lukyanenko propose integrating ChatGPT into English language teaching, which enables the effective implementation of artificial intelligence tools in the language training of engineering students with the aim of improving the quality of their education [15]. The authors emphasise the need to adhere to the principles of academic integrity and encourage the creative use of artificial intelligence tools by both lecturers and students.

Worthy of attention is the analysis of the research results by a team of authors led by O. Spirin regarding the identification of the components of digital competence, on the basis of which a model for the development of digital competence among scientific and scientific-pedagogical staff in the field of educational sciences has been formulated [16]. The researchers argued that the digital competencies of these groups of staff should include proficiency in general and specialised software, cloud services, scientometric databases, social and academic networks, as well as artificial intelligence technologies.

In a study by V. Spivakovsky and co-authors, the experience of developing institutional policies on the use of artificial intelligence (AI) technologies in higher education institutions was summarised, specifically using the example of Kherson State University [17]. Domestic researchers justify the need for clear regulatory and ethical regulation of the application of AI tools in the educational process, teaching and scientific research, which contributes to the creation of an inclusive digital educational environment and improvement of the effectiveness of academic activities.

A generalised analysis of domestic research reveals a contradiction between educators' growing interest in use of AI in educational activities and the insufficient coverage of this issue in professional development programmes, which highlights the need to modernise the content of professional development for teaching staff.

M. Antalová and L. Sejčová also analyse current trends in development of educational and psychological counselling in the digital age in Slovakia, particularly its role in supporting children, young people and teachers in the process of learning and socialisation [18]. The researchers emphasise the importance of interdisciplinary collaboration among specialists and implementation of innovative approaches in counselling practice. The research results highlight ways to modernise the system of educational and psychological support and its significance for development of postgraduate education in Slovakia.

Consequently, the issue of integrating digital technologies into professional development of educators is now a pressing concern, and there is therefore a need to define them.

**The research goal.** The purpose of the study is to conduct a theoretical analysis and systematisation of digital technologies for the professional development of educators, and to develop a structural-functional model of professional development of educators using digital technologies in the Slovak Republic. The study is important for summarising knowledge on the professional development of educators in European countries in the digital age and the possibilities for its implementation in Ukrainian postgraduate teacher education.

## 2. THE THEORETICAL BACKGROUNDS

The theoretical foundations of the research are the national programmes and strategies in the education sector of the Slovak Republic [19]–[22], the European Digital Competence Framework for Educators (DigCompEdu) [23], the conceptual principles of digital transformation in the education sector, and the socio-pedagogical foundations of adult

education, in particular andragogical, activity-based, competence-based and systemic approaches of learning.

The regulatory and legislative framework for digitalisation of education in the Slovak Republic is comprised of a set of strategic and policy documents aimed at modernising the educational system in line with the challenges of the digital society. A key role among these is played by the State Educational Programme for Basic Education (2023) [19], which defines the conceptual foundations of the curriculum and serves as the basis for development of educational institutions' syllabuses. Within the structure of this document, significant attention is paid to development of information and digital literacy among learners, reflecting the integration of digital technologies into the content of most academic subjects. The digital component is viewed as an interdisciplinary element of the educational process, ensuring the development of pupils' key competences in the modern information environment.

The strategic directions for the digital transformation of the education system are also outlined in the document Programme for the Informatisation of Education until 2030 (2024) [20], which defines the long-term policy for implementation of digital technologies in the field of education. Within the framework of this programme, emphasis is placed on overcoming structural problems related to the inadequate level of digital infrastructure and the limited digital competences of students and teachers.

An important guide for development of the population's digital competences is the National Digital Skills Strategy of the Slovak Republic and Action Plan for 2023–2026 (2022) [21], which aims to improve the level of digital literacy among various socio-demographic groups. Implementation of this strategy is driven by the need to improve the country's position in the context of digital development among European Union member states. The document sets out a range of measures to expand training for specialists in the field of information and communication technologies, and to develop the digital skills of young people and teach staff in educational institutions.

A key focus of state policy relates to ensuring a safe digital environment for children, as reflected in the National Concept for the Protection of Children in the Digital Space (2020) [22]. This document aims to prevent socio-pathological phenomena associated with using of digital technologies, as well as to systematise legislative mechanisms for protection of children's rights and safety in the digital environment.

An analysis of the regulatory and strategic documents governing the processes of digitalisation of education in the Slovak Republic demonstrates formation of a comprehensive state policy, the actions of which are aimed at developing the digital competences of educators and modernising the educational environment.

The regulatory and legislative framework for digitalisation of the Slovak education system provides the conceptual basis for studying innovative practices in the digitalisation of the professional development of educators in Slovakia.

## 3. RESEARCH METHODS

The article employs comprehensive, systematic methodological approaches combined with the principles of digital education and lifelong learning (openness, flexibility, accessibility, continuity, personalisation, and using of digital resources and platforms), which enable an analysis of the integration of digital technologies into professional development of educators. The research findings were summarised using general scientific research methods (analysis, classification and systematisation) and content analysis of academic publications and regulatory documents. The results of the theoretical analysis are systematised in the form of the author's model and summary tables.

The study concerns a broader range of educators as employees in the education sector

(teachers; methodologists; heads of educational institutions; employees of education management bodies; research and teach staff; specialists at professional development centers and other employees, whose activities are related to the education sector). The study was conducted over seven months during the 2025/2026 academic year as part of the research topic "Organisational and pedagogical support for university lecturers" the Department of Pedagogical Science Comenius University Bratislava within the framework of the national project "Digital transformation of education and schools" (DiTEdu).

## 4. FINDINGS

The professional practice of educators involves developing the ability to perform a wide range of professional functions, encompassing not only teaching and educational activities, but also organisation of the educational environment, using of innovative technologies, and effective interaction with those involved in the educational process. Modern teaching and educational researchers must be prepared for continuous professional development, lifelong learning and the ability to respond flexibly to changes in the educational and social spheres. Therefore, the training of future teachers and practising educators must be based on a combination of traditional pedagogical methods with modern teaching technologies, ensuring the development of their professional competence. An important aspect is a development of teamwork skills, critical thinking and self-reflection, which determines the effectiveness of pedagogical activity. Thus, the harmonious integration of innovative and classical approaches into the process of professional education contribute to the formation of a new generation of educators capable of successfully realising their potential in the dynamic educational environment.

In the current context of educational development, teachers must review and update their own professional competence profiles in line with the challenges of the 21st century. Teaching strategies require transformation, as do the competences that educators must develop in order to effectively foster the potential of learners in a digitalised society. 21st-century competences should be viewed as a necessary prerequisite for an individual's successful adaptation to the present and future social environment, which is actively shaped by technologies that are transforming the nature of work, communication and lifestyle. They focus both on the development of new skills and on the rethinking of traditional skills, ensuring that individuals are prepared for new ways of thinking, acting, using tools of work and living in a globalised world [23].

Let us summarise using of framework models of teachers' competences at different levels of the education system: at the micro-level, they contribute to the improvement of teacher training and the continuous professional development of teachers; at the meso-level, they enable the development of educational institutions through professional collaboration and the exchange of experience. At the macro level, such framework documents serve as a guide for ensuring the quality of teacher education and the professional activities of educators and researchers throughout their careers, whilst remaining open to adaptation in line with the institutional conditions of different countries and the further development of digital technologies.

Distance learning, or online learning, is a modern educational model that involves organising the educational process despite the physical distance between the teacher and the learners. Implementation of this format relies on using of various digital technologies that facilitate communication, interaction and support for the learning activities of those involved in the educational process.

Consequently, historically, distance education has been aimed primarily at individuals who, due to professional, social or geographical circumstances, were unable to participate in

traditional forms of learning. At the same time, the proliferation of online formats has significantly expanded access to training courses, contributing to greater flexibility and accessibility of various educational formats for teachers. Under these conditions, there is a growing need to integrate digital technologies into the system of professional development for educators, as the effective organisation of distance and blended learning formats requires educators and teachers to possess well-developed digital competences and the ability to use modern digital tools in educational practice.

In his analysis of the framework for digital competences among primary school teachers within the context of European educational initiatives, O. Dorozhovets demonstrates the comprehensive nature of the concept of digital competence as an individual's integral ability to apply digital technologies effectively, critically and responsibly in their professional practice [24]. In this interpretation, digital competence encompasses a broad spectrum of knowledge and skills, combining technical skills in using of digital tools and educational technologies with understanding of the social, ethical and cultural implications of their application. According to the researcher, this competence is of particular importance in the professional activities of primary school teachers, as it involves the ability to use online resources to search for and analyse educational information, organise the educational process, and communicate professionally with parents and colleagues. The author rightly argues that an important component of a teacher's digital competence is also a grasp of the basic principles of cybersecurity, which entails the ability to protect personal data, as well as to ensure the security and confidentiality of students' information in the digital educational environment.

The study by J. Fázik presents the results of the survey of representatives from five faculties at Comenius University in Bratislava (the Faculty of Philosophy, the Faculty of Natural Sciences, the Faculty of Mathematics, Physics and Informatics, the Faculty of Physical Education and Sport, and the Faculty of Evangelical Theology) regarding the information literacy of students on teacher training courses [25]. The researcher found that the ability to work with information, to locate necessary and relevant information sources, and to use them effectively when solving problems in professional and personal life is a competence that is currently valued in the labour market. Thus, digital competence is a key professional characteristic of the modern educator, as it ensures the effective organisation of the educational process and contributes to the all-round development of learners in a digital society. We consider a teacher's digital competence as an integrated professional ability to use digital technologies confidently, critically, safely and responsibly for educational activities, and for creating and solving professional tasks in the context of the digital transformation of education.

We present an overview of Comenius University in Bratislava's experience in organising professional development activities for teach and research staff using digital technologies in recent years.

At the university, one of the key areas of international research activity is "Information Methods and Tools for Supporting the Knowledge Society". Within this area, particular attention is paid to develop collaboration among lecturers in international and national projects aimed at the professional development of educators using digital technologies.

A prime example of such activity is the international teacher support project 'Educational Robotics for the Development of Computational Thinking in the Context of Blended Learning' (FERTILE) [26], implemented with the support of the European Commission. The project aims to support teachers in developing blended learning content by integrating simulators, remote collaboration and implementation of relevant innovations into educational practice. The integration of educational robotics into teachers' professional activities is linked to the development of their digital competences, which, in turn, contributes

to the personal development of learners. The current opportunities offered by the digital transformation of education create the conditions for a more in-depth exploration of the potential of such integration within a blended learning context.

The project's target audience comprises educators who use a blended learning approach, specifically teachers at various levels of education, as well as students, who study teaching qualifications. Between December 2023 and May 2024, pilot studies were conducted in Slovakia as part of the training provided to participants under the FERTILE programme. Over 70 people took part (lecturers and teachers who were undergoing training or are currently working in educational institutions), providing feedback on the results, structure and content of the training. The training materials developed as part of the project are available as open educational resources in English, Czech, Slovak, Greek and Spanish languages on the project's official website and on digital platforms, including the university's YouTube channel. The final phase of the project (June 2024 – January 2025) involved activities to disseminate the research findings among approximately 200 educators [26].

These events were based on a practice-oriented approach to promote the concept of "the teacher as a designer of the educational process" and provided participants with the opportunity to apply the FERTILE design methodology in their own professional practice. The format of these events was blended, combining face-to-face, synchronous and asynchronous forms of interaction. Ultimately, the project resulted in the creation of an online platform for the teaching community, which facilitates remote collaboration on planning the educational process, analysing educational artefacts, programming, and jointly designing educational solutions using simulators and empirical knowledge.

A particular interest is the results of the empirical study "Case study on the use of open IT tools at Comenius University in Bratislava", which were summarised in 2025 as part of implementation of the national project "National Information System for the Support of Scientific Research and Development – Access to Electronic Information Sources (NISPEZ V)" [27]. The main objective of the project and the survey of lecturers and students conducted within its framework was to examine the current situation regarding open IT tools at the university as teaching aids and digital resources available for use, and to develop a methodology by which their use can be tracked at a national level in other institutions and organisations in the academic and scientific spheres.

The survey found that, overall, more than 50 % of respondents indicated that they had previously encountered the concepts of open IT tools, open source, or open-source programming (all three terms were included in the wording of the question). A closer examination of the responses by type of activity revealed that the higher the respondents' level of education, the greater the likelihood of contact with open IT tools (undergraduate – 36 %, master's – 53 %, postgraduate – 67 %, staff – 63 %). When asked about specific open-source IT tools that students and staff use most frequently, the majority of respondents (110 out of 200) were unable to name any. The remaining responses covered a wide range of tools, including frequent answers such as "phone", "computer" (i.e. not even software tools) or MS Office, Google Workspace and other tools that are not available under public licences [27, p. 35]. The empirical study showed that the majority of respondents had previous experience of using open-source IT tools. It should be emphasised that the frequency of their use increases with higher levels of education. At the same time, knowledge of specific open-source tools proved to be limited, indicating a need for the systematic improvement of digital literacy among teachers and students. We will describe the experience of the Department of Pedagogy at the Faculty of Philosophy of Comenius University in Bratislava in participating in the national project Digital Transformation of Education and Schools (DiTEdu) (2024–2028) [28], which is being implemented with the support of the European Social Fund for Slovakia. The project partners are two leading universities: Pavol Jozef Šafárik University in Košice

and Comenius University in Bratislava, as well as the Ministry of Education, Research, Development and Youth of the Slovak Republic.

The aim of the project is to improve the quality, inclusivity and effectiveness of education and vocational training systems, as well as to enhance their alignment with labour market needs through the recognition of non-formal and informal learning outcomes, the development of key competences (particularly entrepreneurial and digital skills) and support for the implementation of dual models of vocational education and apprenticeships in less developed countries. The conceptual framework of the DiTEdu project is based on the provisions of the national strategic document Programme for the Informatisation of Education until 2030 [20], which sets out the long-term priorities for the digital modernisation of education and the creation of a comprehensive and sustainable system to support the digital transformation of educational institutions, involving the establishment of networking between educational institutions at national and regional levels.

As part of the project, particular attention is paid to ensuring continuous professional support for teachers through the organisation of training, methodological guidance and the provision of up-to-date educational resources in line with current trends in the development of digital education.

An important institutional component of the project is the establishment of the National Centre for the Digital Transformation of Education, whose activities involve coordinating research and educational initiatives in the field of the digitalisation of education. Experts from leading universities, including Pavol Jozef Šafárik University and Comenius University, as well as representatives of the academic community and educational practitioners, are involved in the implementation of research and educational activities.

During the seven-month research and training period at the Department of Pedagogy, Faculty of Philosophy, Comenius University in Bratislava, the authors systematically examined the Slovak experience of digital transformation in education within the framework of the DiTEdu national project. The research activities included the analysis of project documentation, strategic and methodological materials, educational resources, competency frameworks, analytical reports and recommendations developed within the project, with particular attention to approaches to teachers' continuous professional development and digital competence development. The authors also studied the structure and implementation mechanisms of the project's nine interconnected mini-projects, identifying the organisational, methodological and technological tools used to support digital transformation and professional learning. Particular emphasis was placed on analysing practices related to the adaptation of the DigCompEdu framework, the development of digital educational content, the functioning of professional networks, educational research, quality assurance and the provision of methodological support to educators. The collected and systematised materials were subsequently compared with the Ukrainian context in order to identify transferable practices, determine the conditions for their adaptation, and formulate evidence-based recommendations for the development of digital formats of teachers' postgraduate professional education in Ukraine.

In 2025–2026, the activities of school digital coordinators in Slovakia are being implemented as part of the national DiTEdu project and are aimed at providing systematic support for the digitalisation of the educational environment in general secondary schools. One of the key tools for training such specialists is the innovative 50-hour online course «Digital Transformation of Education and Schools», designed for primary and secondary school teachers who act as digital technology coordinators. The training aims to prepare teachers to implement practical steps to transform their educational institution into a school of digital excellence, capable of effectively preparing students for life in a digitalised society and the era of artificial intelligence.

An important component of the training course is familiarising teachers with digital competence assessment frameworks, in particular DigComp and DigCompEdu. Significant attention is also paid to the practical use of tools for self-assessing the digital readiness of schools and teachers, notably the SELFIE and SELFIE for Teachers platforms. Participants learn how to formulate strategic development goals for their educational institution using the SMART approach, which facilitates the effective planning and implementation of digital change within the institution. Furthermore, the course provides an introduction to modern digital technologies and tools that support implementation of constructivist approaches to learning. An important form of professional support for coordinators is the activities of the "Digital Coordinators' Club" professional community, which facilitates the creation of a national network for collaboration among teachers involved in the digital transformation of education. As part of the club's activities, thematic webinars are regularly held on topical aspects of the digitalisation of education, in particular the use of artificial intelligence technologies, ensuring cybersecurity and information security, the development of a modern educational environment, as well as the prevention of negative social phenomena associated with digitalisation. The webinars are delivered by experts from the National Centre for Digital Transformation of Education and representatives from universities.

During the initial implementation of the project, it was established that using of artificial intelligence tools in professional teaching practice is becoming particularly relevant in contemporary educational discourse. The results obtained have been presented by the leaders of the first mini-project in a specialised practical and methodological guide, "Guide to Artificial Intelligence Tools in Teaching Practice" [29]. The authors present artificial intelligence as one of the leading technologies of our time, which is rapidly being integrated into various spheres of public life, particularly the educational process. For educators, its application opens up new opportunities for personalising learning, adapting educational content to the individual needs of students, and enhancing the effectiveness of educational interaction. However, using of AI tools is accompanied by a number of challenges related to the ethical use of digital technologies, the reliability of information, and development of critical thinking among learners. The content of the guide is geared towards practical use by teachers for the purpose of creating teaching materials, summarising texts, generating questions and test tasks, language correction and translation [29].

Unlike traditional models of digital professional development for educator*s*, the Slovak approach involves integrating artificial intelligence tools not merely as auxiliary services for content creation, but as means of providing adaptive support for teachers' professional development. Using of generative AI models enables the personalisation of learning content, the automated creation of teaching materials, support for teachers' reflective practice, and optimisation of professional communication within the digital educational environment. Thus, the integration of AI tools into the educational process contributes to optimising teachers' lesson preparation, differentiating learning content, developing their own digital literacy, and fostering critical thinking among learners.

An analysis of the projects described above has revealed that they implement complementary areas of professional development for educators in a digital society: the FERTILE project focuses on the practical implementation of digital technologies and robotics in the educational process; NISPEZ V provides an analytical study of the level of digital resource usage; DiTEdu establishes a systematic infrastructure for the digital transformation of education through institutional support, the training of digital coordinators, and the development of professional communities.

The effectiveness of these projects is demonstrated by the combination of teaching, research and networking activities, the creation of open educational resources, the implementation of digital platforms, and focusing on the continuous professional

development of teaching and academic staff. At the same time, the results of the NISPEZ V project revealed a gap between general experience in using digital technologies and in-depth knowledge of specific digital tools, highlighting the need for systematic support for the development of teachers' digital competence.

It is for this reason that the synthesis of the experience gained from these projects formed the basis for the development by the authors of a structural-functional model of professional development for educators using digital technologies (Fig. 1), which integrates organisational and managerial, technological and competence-based, networking and communication, analytical and diagnostic, innovative and research-based, and outcome-oriented components.

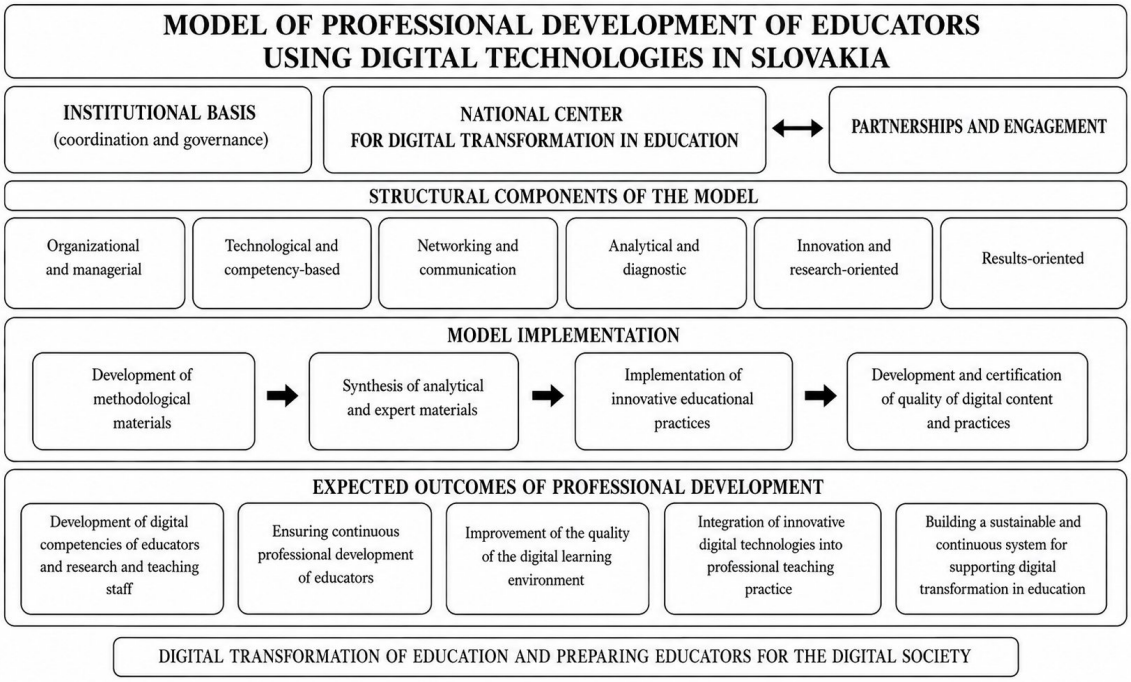


*Fig. 1. Structural-functional model of professional development of educators using digital technologies*
*Source: author modeling created using ChatGPT by [20;26;27;28;29]*

The organisational and management component involves the training and professional support of school digital coordinators as key figures in implementation of digital technologies in Slovak educational institutions. The technological and competence component focuses on adapting the European framework for teachers' digital competences, DigCompEdu and developing the digital competence of teaching and research staff. It also includes the creation of digital educational content, the implementation of innovative educational practices, usage of digital platforms, blended learning and digital educational resources. The networking and a communication component of the model facilitates the functioning of professional digital communities for collaboration between educational institutions, government bodies, civil society organisations and the academic community, with the aim of disseminating best practices in the digitalisation of education. The analytical and diagnostic component of the model involves using of digital tools for monitoring and evaluating teachers' professional development, in particular the SELFIE and SELFIE for Teachers platforms, digital systems for collecting educational data, learning analytics tools and electronic means of self-assessment of digital competence.

Implementation of this component ensures the personalisation of teachers' professional

development based on an analysis of their teaching activities and the results of monitoring carried out by the educational institution. The innovation and research component involves conducting educational research, preparing analytical materials, and developing standards and recommendations for implementation of the state policy on the digital transformation of education. This component of the model is implemented through the testing of new educational approaches, the certification of digital content quality, and the introduction of «schools of digital excellence» models. The outcomes component is aimed at establishing a sustainable system to support the digital transformation of education, developing teachers' digital competence, ensuring continuous professional development and self-development, improving the quality of the digital educational environment, and integrating innovative digital technologies into the professional activities of teaching and research staff.

Implementation of the model involves the creation of teaching materials, preparation of analytical and expert reports, and development of standards and recommendations for introduction of digital innovations in the educational environment. The expected outcomes include the establishment of sustainable and consistent support for the professional development of teaching and academic staff in the digital society. Thus, the developed and substantiated structural-functional model is a holistic system of interrelated structural components that define the organisational foundations, content, implementation mechanisms and expected outcomes of the professional development of teaching and research staff in the context of the digital transformation of education.

It should be emphasised that drawing on Slovakia's positive experience is of practical significance for modernising Ukraine's postgraduate teacher education system and strengthening its integration into the European educational area.

A theoretical analysis of national and international educational projects, digital platforms and professional development practices for teachers has enabled the creation of an original classification of digital technologies and digital tools used in the professional development of teaching and academic staff in the Slovak Republic (Table 1).

The proposed classification enables identification of functional areas for using of digital technologies in the professional development of educators and their impact on development of digital competence, professional networking, adaptive learning and digital transformation of the educational environment. The author's systematisation of digital technologies for professional development of educators in the Slovak Republic demonstrates the systematic nature of the digital transformation of teachers' professional development, encompassing the development of digital competences, the integration of AI technologies, usage of blended learning, digital platforms, professional communities and self-assessment tools. The proposed classification enables the identification of functional areas for using of digital technologies in the professional development of educators and their impact on the development of digital competence, professional networking, adaptive learning and the digital transformation of the educational environment.

*Table 1*

**Digital technologies in professional development of Slovak educators**

| Digital technology / tool | Content and areas of application | Significance for teachers' professional development | Impact on the digital transformation of education |
|---|---|---|---|
| Diagnostic and analytical technologies | | | |
| European Digital Competence Frameworks (DigComp, DigCompEdu) | Using of tools for assessing and developing teachers' digital competence. | Ensuring the systematic development of teachers' digital literacy. | Learning analytics. Competence-based digital transformation Personalised learning. |
| Digital self-assessment platforms (SELFIE, SELFIE for Teachers) | Self-assessment of the digital readiness of educational institutions | Supporting professional reflection and planning for professional | |

| | | | |
|---|---|---|---|
| | and teachers. | development and self-development. | |
| Educational and communication technologies | | | |
| Blended learning technologies and learning management systems (LMS) | A combination of face-to-face, distance and digital learning formats, the use of simulators and remote collaboration. | Ensuring the flexibility of vocational training and readiness to work in a digital learning environment | Personalised learning Data-driven education |
| Open-source IT tools, cloud services and digital platforms (Google Workspace, Microsoft 365, Open Source) | Development of educational content and organisation of professional activities | Expanding access to digital resources. Ensuring the digitisation of teaching materials and educational content | Data-driven management |
| Online courses on the digital transformation of education; webinars and online lectures. | Training of school digital coordinators as part of the DiTEdu project | Building teachers' readiness to implement digital transformation in educational institutions. | Personalised learning |
| Innovative and STEM-oriented technologies | | | |
| Educational robotics | Used for modelling real-world processes and solving practical problems | Promotes the development of STEM skills, programming. | Innovation in STEM education |
| Adaptive and intelligent technologies | | | |
| Artificial intelligence technologies (ChatGPT, Grammarly, Google SlidesAI). Conversational AI models. | Usage of AI tools to create educational content, tests and simulate learning scenarios. | Improving the effectiveness of teaching, fostering creativity, critical thinking and interactive engagement | Adaptive learning |
| Network and professional technologies | | | |
| Online communication tools (Google Meet, Telegram, Zoom) | The role of the "Digital Coordinators' Club" as a professional support network. | Ensuring continuous professional development and professional networking . | Digital collaboration |
| Digital security technologies | | | |
| Digital cybersecurity technologies | Raising awareness among educators about information and cybersecurity issues. | Fostering safe digital behaviour and a culture of data protection in the educational environment | Secure digital educational environment |

The author's systematisation of digital technologies for the professional development of educators in the Slovak Republic demonstrates the systematic nature of the digital transformation of teachers' professional development, encompassing the development of digital competences, the integration of AI technologies, usage of blended learning, digital platforms, professional communities and self-assessment tools. Using these digital technologies contributes to improve the quality of teachers' professional training, development of the innovative pedagogical practice, and the creation of a sustainable digital educational environment in line with current European trends in the digitalisation of education.

Recommendations are provided on how to support the professional development of educators in using digital technologies. Table 2 has been compiled based on the results of the content analysis.

*Table 2*

**Recommendations for enhancing the professional development of educators**

| Levels | Content |
|---|---|
| At the national level | Establish national platforms for professional collaboration among teachers, expand access to open educational resources, and introduce innovative models for professional development with the support of international programmes, in particular initiatives by the European Commission. Facilitate the development of networking between |

| | |
|---|---|
| | educational institutions and foster professional communities of teachers to exchange innovative practices in digital learning. Organise cooperation between educational institutions and research bodies and centres for the digital transformation of education, and involve teachers in research-based educational initiatives. It is advisable to establish a mechanism for the evaluation and certification of digital educational resources, e-courses and teaching materials used in postgraduate teacher training. |
| At the institutional level (for educational establishments) | To implement a systematic model of digital transformation for educational institutions, involving the integration of digital technologies into the educational process, the introduction of blended and distance learning, and the creation of individual professional development pathways for teachers, alongside the development of their digital competences in line with the European Digital Competence Framework. Integrate the outcomes of teachers' non-formal learning into the professional development system by recognising acquired competences and disseminating best European educational practices. |
| At the individual level (for educators) | Systematically integrate modern digital technologies into their own professional practice, in particular by using educational platforms such as Moodle and Google Classroom, video conferencing services such as Zoom, and interactive assessment tools, selecting them in accordance with learning objectives. Develop competencies in using digital educational resources, as well as compliance with personal data protection and copyright regulations. Create professional online communities of educators for the exchange of experience, the organisation of webinars, consultations, mentoring and the joint development of educational content. |

Ultimately, the effective professional development of educators requires the systematic integration of digital technologies into the educational process. An important component of this development is supporting from international and national state institutions. At the same time, teachers must have motivation and opportunities to participate in professional communities, scientific and methodological events, and digital educational networks with the aim of constantly updating their knowledge, improving the quality of education, and fostering critical thinking among learners.

The active integration of digital technologies into teachers' professional development raises a number of debatable issues regarding their educational, ethical and social impact. First and foremost, there is the challenge of maintaining a balance between usage of digital tools and the preservation of direct interpersonal interaction among participants in the educational process. Furthermore, particular attention must be paid to foster a responsible attitude among teachers towards using digital technologies as a tool to support the teaching process, rather than as a complete replacement for pedagogical interaction. An important topic of academic debate is adherence to the principles of academic integrity in the context of the widespread use of digital resources and automated services for creating educational content.

The ethical aspects of introducing digital technologies into the professional development of educators are also a matter of debate. The analysis of the ethics of using digital footprint data in education, as presented by researchers [30], allows us to conclude that the confidentiality of information regarding learners' results is critically important, as its improper use or disclosure may negatively impact a teacher's reputation. At the same time, it is emphasised that the mass collection and centralisation of data pose significant risks to privacy and highlight the issue of determining ownership of this data.

## CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The digitalisation of the professional development of educators in the context of the current challenges facing the Ukrainian education sector is becoming a key factor in ensuring the continuity of postgraduate training and the adaptation of teaching and research activities to social and technological changes. The experience of the Slovak Republic demonstrates the

effectiveness of systematically integrating digital technologies into teachers' professional development, which could serve as a useful guide for modernising postgraduate education in Ukraine. A theoretical analysis of European practices demonstrates the importance of integrating educational robotics, blended learning formats and open-source IT tools for the development of teachers' digital competences. It has been established that teachers' digital competence is based not only on skills in the application of digital tools, but also on an understanding of the social, ethical and cultural aspects of using digital technologies. As a result of studying and describing the content of projects implemented at Comenius University in Bratislava, a structural-functional model of professional development for educators using digital technologies in the Slovak Republic has been developed and justified. This model is based on the integration of digital platforms for professional interaction, educational data analytics tools, artificial intelligence technologies and online professional communities. The practical significance of the study lies in the possibility of using the proposed model to modernise the system of postgraduate teacher education in Ukraine in the context of the digital transformation of the educational environment.

The digital technologies for the professional development of Slovak educators described in the projects have been summarised and classified. It has been established that the effectiveness of this development is ensured by a combination of blended learning technologies, artificial intelligence, robotics, digital monitoring of educators' professional competences, the activities of school digital coordinators, and using of adaptive digital resources in the process of self-education.

The integration of artificial intelligence tools into teaching practice opens up new opportunities for personalising learning, enhancing the effectiveness of educational interaction, and developing critical thinking skills among both teachers and learners. Organisational support – in particular through the creation of professional communities, national platforms, and systematic guided training and self-directed learning for educators –ensures their sustained professional development. The effectiveness of this development requires a combination of state support, teachers' participation in scientific and methodological activities, and personal motivation to actively use digital resources. Particular attention must be paid to upholding academic integrity and cybersecurity provisions. The integration of digital technologies into the professional development of educators facilitates the adaptation of educational practices to the conditions of a digital society, ensures the improvement of educational quality and the formation of a new digital environment.

The potential for implementing Slovak experience is outlined in recommendations at the national, institutional and individual levels. The integration of digital technologies, which provide access to the latest educational resources, online courses and professional communities, optimises the professional development of educators and ensures an improvement in the quality of education.

The growing needs to ensure high-quality professional development for educators in the context of the digital transformation of education determines the social significance of this research. The effective integration of digital technologies contributes to improving the quality of educational activities, developing teachers' digital competence, ensuring access to continuing education, and fostering an innovative educational environment.

Further research should focus on empirically testing the proposed structural-functional model and assessing the effectiveness of specific digital technologies in the Ukrainian context.

## GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

ChatGPT was used in this text to construct a structural-functional model.

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## CONFLICT OF INTEREST

There are no conflicts of interest

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## ІНТЕГРАЦІЯ ЦИФРОВИХ ТЕХНОЛОГІЙ У ПРОФЕСІЙНИЙ РОЗВИТОК ОСВІТЯН: ДОСВІД СЛОВАЧЧИНИ

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**Анотація.** Словаччина має значний досвід інтеграції цифрових технологій у професійний розвиток освітян, системний аналіз якого може слугувати ресурсом для модернізації української системи післядипломної освіти. Метою статті є теоретичний аналіз, систематизація і класифікація цифрових технологій професійного розвитку освітян у Словацькій Республіці та обґрунтування структурно-функціональної моделі професійного розвитку освітян засобами цифрових технологій. Використано такі загальнонаукові методи як аналіз, класифікація і систематизація результатів наукових публікацій та контент-аналізу стратегічних і нормативних документів ЄС, Словацької Республіки. Установлено, що використання цифрових технологій виступає не лише інструментом модернізації освітнього середовища, а й засобом забезпечення професійного вдосконалення, неперервної самоосвіти та психоемоційної підтримки педагогів, що актуалізує потребу в ефективності використання інноваційних європейських практик професійного розвитку. У статті висвітлюються результати національних та міжнародних проєктів, реалізованих в Університеті Коменського в Братиславі, що спрямовані на підтримку професійного розвитку вчителів у цифровому середовищі. Проаналізовані стратегічні та нормативно-правові документи, матеріали проєктів, методологічні ресурси та практики, що розроблені в межах національних і міжнародних ініціатив, приділено особливу увагу проєкту DiTEdu та цифровому професійному розвитку освітян. На основі систематизації та порівняльного аналізу виявлених практик розроблено оригінальну структурно-функціональну модель професійного розвитку освітян з використанням цифрових технологій та запропоновано класифікацію основних типів цифрових інструментів, що застосовуються в словацькому контексті. Отримані результати дозволили виявити ключові організаційні, педагогічні та технологічні умови ефективного професійного розвитку, зокрема персоналізоване навчання, змішані формати, професійне мережування, навчання з використанням штучного інтелекту. Запропоновано рекомендації на державному, інституційному та індивідуальному рівнях для українських закладів післядипломної освіти.

**Ключові слова:** освітяни; педагог; професійний розвиток; цифрова компетентність; цифрові ресурси; цифрові технології.

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