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Modernization of future teachers' professional training: on the role of immersive technologies

Nataliia Bakhmat
Ph.D. hab. (Education), Professor at the Department of Elementary Education Theory and Methods, vice-dean of scientific activity of Pedagogical Faculty Kamianets-Podilskyi National Ivan Ohiienko University, Ohiienko street, 61, Kamianets-Podilskyi, Ukraine, 32302, bakhmat.nataliya@kpnu.edu.ua, bakhmat.nataliya@kpnu.edu.ua, https://orcid.org/0000-0002-5144-2517

Kateryna Kruty
Doctor of Pedagogical Sciences, Professor Department of Preschool Education Faculty of Pre-School and Primary School Named after Valentina Voloshina, Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, Ukraine, 21001, Vinnytsia, street Ostrozhskogo, 32, kateryna.krutii@vspu.edu.ua, https://orcid.org/0000-0001-5001-2331

Hanna Tolchieva
Associate Professor Academy of Management and Administration in Opole, 45-085 Opole ul. Mieczysława Niedziałkowskiego 18, Poland, asergeeva29@gmail.com https://orcid.org/0000-0001-7023-8194

Tamara Pushkarova
Doctor of Pedagogical Sciences, Professor, Head of the Project Activity Department Corresponding Member NAPS, Institute for Modernization of Education Content, 36 Vasylia Lypkivskoho Str., Kyiv, Ukraine, https://orcid.org/0000-0001-7611-9516

Abstract: Immersive technologies have shown effectiveness and relevance in the educational space. Global challenges of sociocultural nature have necessitated the use of innovative learning environments that have become an alternative to the traditional educational system. The research aims to analyze the status of immersive technologies in the teacher's professional skills cluster. The article aims to position immersive elements in practical in educational strategies in the short and long term, which specify the teacher's competencies required to organize the educational process using VR/AR/MR/XR. The methodology of the study is associated with the use of general scientific, scientific-pedagogical, and scientific-technological means that allow to analyze of the content and form of virtual reality elements in the process of their use in education. A promising direction of research is the consideration of the professional competencies of a teacher through the prism of the balance between the traditional face-to-face and innovative virtual format of education. Consequently, immersive

technologies become a relevant learning environment in the educational space, which leads to modernizing transformations in the preparation of professional competencies of the teacher, who must have appropriate digital skills to be able to organize the learning process in VR-format.

Keywords: immersive technologies, VR/AR/MR/XR, digital pedagogical competencies, pedagogical innovations, virtual learning environment.

Introduction

The growing role of technologization and informatization in all areas of social activity necessitates transformational processes in education. Innovations include all clusters of the educational space with the help of the latest technological solutions. One of the directions of ICT elements are immersive technologies, which promote the immersion of participants in the educational process in a virtual or mixed (virtual-real) form of organizing educational activity. The practical functioning of virtual learning environments requires an appropriate level of technological equipment and digital literacy of teachers and co-teachers. If the technological capabilities and digital literacy of applicants are mainly organizational and logistical parameters, digital pedagogical competencies have a predominantly educational and pedagogical dimension.

Research Problem

Immersive technologies are the optimal solution for the organization of the educational process in conditions of pandemic restrictions and the impossibility of organizing face-to-face education. However, when the security situation is stabilized, the pedagogical community will face the problem of coordinating the coexistence of traditional face-to-face learning and innovative virtual format. Reorientation of part of the learning environment into the virtual space is obvious since it has shown effectiveness. Under such conditions, the threats to human resources and risks associated with the need to promptly acquire appropriate digital skills to work in this learning environment are actualized. Consequently, teacher training programs should already take into account the need to develop the proper level of digital literacy. Working in a virtual environment requires a set of skills that form a synergistic effect of combining pedagogical skills & digital skills.

Research Focus

Focusing on VR/AR environment in education forms two main points of scientific and pedagogical research:

- analysis of the structure and specifics of the use of virtual technologies in the educational process, based on which the requirements and wishes of the level of digital literacy of the teacher, who will provide the educational process in VR/AR format are formed;

- comparative analysis of the relevance, feasibility, and effectiveness of face-to-face and virtual learning formats with an appropriate correlation of educational programs of teacher training (entering digital skills of working in a virtual educational environment into the matrix of competencies and their correlation with general soft skills and special digital skills).

Research Aim and Research Questions

The purpose of scientific research is to characterize the digital competencies of the teacher, which provide the ability to organize virtual learning environments by fundamental educational requirements. The article aims to justify the status of virtual reality elements and the prospects for the development

of this innovative environment in the educational space. Three main clusters of competencies responsible for the formation of skills in the virtual educational space are actualized for the teacher:

- organizational and logistical;
- educational and methodological;
- moral and attitudinal.

Research Methodology

General Background

The methodological basis for the study of teacher training for the use of immersive technologies is a system of general scientific methods at the theoretical and empirical level. The attempt to analyze the level of digital literacy allows you to determine the availability of skills necessary to carry out pedagogical activities in a virtual learning environment. Systematization and comparative analysis allows for determining the balance in the system of professional competencies of a teacher between fundamental, flexible, and digital skills. The synergetic methodology defines the peculiarities of interaction between digital and purely pedagogical competencies. Note that the success factor of the digitalization of education is interdisciplinary cooperation (Hein et al., 2021). This necessitates the use of synergetic principles of interaction between science, information, and technology in shaping the teacher's digital competencies.

An important methodological tool in contemporary scientific-pedagogical discourse is learning analytics. Studies of this methodology attempt to determine how contributions to learning analytics differ from those in related fields that also center around educational data (Baker et al., 2021). For virtual reality research, this approach is more effective than traditional general-scientific analytic methods because it identifies specifically the pedagogical aspects of innovative digital technologies.

Immersive technologies in education are quite actively studied by a variety of scientific methodological studies. In particular, due to the formation of behavioral inferences a significant increase in the level of engagement during immersion in a virtual learning system is noted (Bogacz et al., 2021).

Virtual environment results are based on comparative media studies (Buchner et al., 2021). Data are collected using the NASA Task Loading Index (Nasa TLX), which is the most commonly used virtual technology measurement tool in the United States. Particular emphasis is placed on the cognitive load in the actualization of virtual environments in education. The collected data becomes a good theoretical and methodological basis for the development of digital literacy programs for educators and their preparation for working in the virtual environment.

Separate analytic studies have been conducted to develop mechanisms of emotion regulation through posture, voice, and attention that constitute virtual learning environments (Kazemitabar et al., 2021). Designs for Learning (DFL), a research methodology focused on the practical dimension of the educator's activities, provides a response to learning contradictions that arise during the use of immersive technologies (Åkerfeldt & Åberg, 2021). Educator responsiveness to potential difficulties is an important element in enhancing the effectiveness of virtual learning environments. (Dibek, 2021).

Sample / Participants / Group

The participants of the study are positioned educators who are in the process of acquiring digital skills to work in a virtual environment or who are planning to master these elements of digital literacy. It is still difficult to identify the cohort of pedagogical specialists who can be considered qualified to

work in the virtual educational space. The situation is even more complicated with the specialists capable of navigating the educational and methodological nuances of pedagogical activity in virtual space. It should be noted that in the short term the tendency to attract external specialists in virtual reality, who will teach teachers the principles of working in this new environment, will continue. This approach will make it possible to form a cluster of pedagogical specialists, who will have not just the skills to work in virtual space, but an appropriate qualification level of training. This will allow further development of theoretical-methodological and substantive-practical recommendations for the global use of VR/AR in the educational system.

Instrument and Procedures

To realize the digital skills an educator must master, let us first outline the main virtual tools and formats of this type of reality. Key formats of immersive technologies in education: VR (virtual reality), AR (augmented reality), MR (mixed reality), XR (augmented reality).

The tools of virtual reality used in the educational space can include:

- virtual laboratories or other environments for experimental activities;
- theoretically-oriented elements of the virtual environment in the format of an electronic distance learning environment;
- simulation centers, systems, or individual simulation objects, which are used as a means of enhancing the traditional format of the educational process;
- the concept of a virtual educational institution - in which organizational, logistical, and socio-cultural components are virtualized in addition to the educational element;
- educational-methodical content of game character in a virtual format;
- programs, applications, services - which are used to achieve pedagogical goals through the virtual dimension.

Augmented reality allows educator and co-educators to form their idea of the reality of individual elements by viewing them in the virtual dimension of 3D objects using a computer or smartphone. Virtual reality allows the participants of the educational process to immerse themselves in the simulated by their own efforts world of 3D-views with the help of appropriate technological equipment (Ntaba & Jantjies, 2021).

Research Results

Sociocultural development determines the potential ability of the educational system to introduce innovative elements into its system. Virtual reality has already moved beyond the confines of research laboratories and is beginning to integrate into the spheres of social activity. The level of development of VR has reached the point where these technologies have reached mass production and can be presented not only as a prototype but also fully provide an educational environment in a particular case (provide a virtual learning environment, form the technological basis for a separate course or training).

At the same time, in the socio-cultural dimension, conditions must form or a certain event of a global scale must occur, which will be a direct factor that will determine the need to include VR in the educational space. Such a factor was the COVID-19 pandemic and further restrictions that directly affected the traditional format of the educational process. The pandemic created a real educational crisis, while at the same time becoming a unique challenge for educational institutions around the world (Pears et al., 2020). The educational community had to respond to the threats provoked by the impossibility of face-to-face learning. Innovative elements have transformed from potential educational

formats into actual learning environments. The immersive elements got their share of the crisis educational space.

“The growing advances and technical readiness of these systems have paved the way for a new generation and category of simulation-based simulations and experiences for vocational education, training, and operations that are relatively cheaper, more engaging, smaller, and more accessible than traditional configurations. While the concept of using VR, AR, and MR technologies for professional education and operations is not new, their recent development and distribution now allow for practical implementation and application in the real world” (Mallam et al., 2019).

When we look more deeply into the problems of the effectiveness of immersive technologies in education, we should notice the economic effect of such innovative forms. If we consider the training of specialists in high-tech industries, it should be noted that the creation of simulators to reproduce real-world conditions is expensive and difficult to maintain. If we replace this environment with elements of virtual reality, however, we get the right conditions at a relatively low cost. Immersive technologies are able to provide a certain proportion of the organization of a practical learning environment that simulates real conditions for the acquisition of professional skills and experience.

Among the practical benefits of a virtual learning environment are the following: a sense of place, scale, and presence. Each of these elements is achieved through digital and technological elements. At the same time, the teacher's role is to channel these resources in a way that makes it possible to realize pedagogical goals. Using immersive technologies exclusively for the emotional satisfaction of participants or simply to enhance traditional pedagogical presentation in the future will not be appropriate, because a quality virtual environment of pedagogical direction is rather complicated in organizational and logistical design, so the goals and principles of such a format of pedagogical activity should be clearly defined.

Here there is a problem of the verification of the status of immersive technologies and the appropriate training of teachers for their effective use in the educational process (see Fig. 1).

Fig. 1. Positioning immersive technologies in the learning space.



Source: authors' own development.

Based on the status of immersive technologies, the principles of digital literacy of a teacher and ways of its implementation in practical and educational activities are formed. When creating a separate virtual learning environment, the teacher coordinates pedagogical and digital competencies. When virtual reality acts as an auxiliary element of the traditional teaching format, fundamental pedagogical competencies act as a dominant component in relation to digital skills, which play an auxiliary role.

Immersive technologies refer to the Industrial Revolution 4.0 (IR 4.0), where every segment of social activity is developed with the goal of producing a positive outcome (Khan et al., 2021). Virtual reality technologies are justifiably given revolutionary status. Consequently, there is the same cardinally revolutionary need to transform the process of professional teacher training.

Among the most common educational and methodological manifestations and mercurial technologies we note:

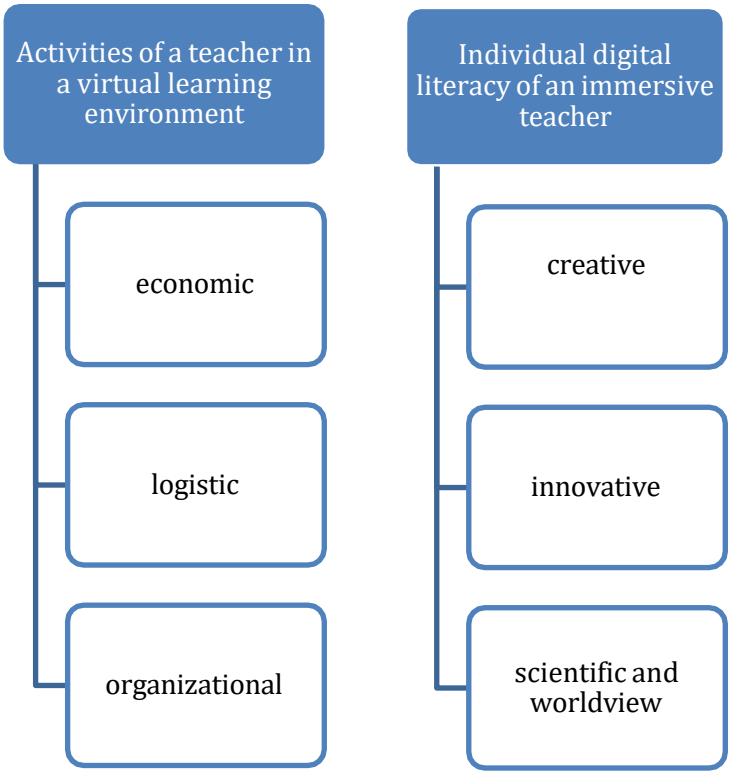
- computer simulation, which involves the implementation of dynamic activity thanks to computer programs based on precise mathematical algorithms or models. Simulation in this case has either graphic or animated expression;
- deep learning is related to the content, understanding, and analysis of the material presented in a virtual dimension;
- 3D games teach content with the characteristics of three-dimensional graphics, which creates a sense of immersion in a virtual world while maintaining a realistic image (Zheng & Greenberg, 2020);
- virtual excursions that fully convey the atmosphere of the respective environment through the translation of natural or sociocultural realities (Klippel et al., 2019).

Discussion

Häfner (2020) cautions that educators should not perceive virtual learning environments only as fascinating technology, but, above all, to shape the conditions for achieving learning outcomes. For a long time, virtual reality has been associated with the sphere of entertainment and leisure, which has led to the formation of corresponding stereotypes in society. Therefore, the teacher should take into account this socio-cultural positioning of immersive technologies. Before organizing a virtual learning environment, a kind of clarification for education applicants regarding the purpose and principles of this space should be made, noting the priority of the learning goal.

The formation of professional digital competencies of a teacher to ensure the proper organization of a virtual learning environment includes two main clusters (see Fig. 2).

Fig. 2. Segments of digital competencies of a teacher for immersive educational technologies.



Source: authors' own development.

Scientific and pedagogical discourse expects a rather complicated analytical process regarding the further status of immersive technologies in education. It should be understood that in the global dimension, the educational space has expanded its arsenal of potential learning environments. At the same time, the quantitative indicators of the educational system have not actually changed. Therefore, after the crisis manifestations in education due to pandemic constraints are over, the teaching community will face contradictions that will point to such aspects:

- організація педагогом віртуального навчального середовища за відсутності належних digital skills, що було прийнятним за кризових умов в період пандемії, однак буде неприйнятним при утвердженні імерсивних технологій як фундаментального освітнього кластеру, який вимагатиме чітких компетенцій від педагога;

- change in the status of the teacher, who delegates part of his/her professional activity to artificial intelligence and virtual mechanisms, at the same time losing part of his/her influence on co-educators, reorienting his/her activity from mentoring to moderating and requiring new skills to implement these changes;
- staffing and organizational decisions that will affect the quantity and quality of educational institutions and will require educators to have and continually confirm the level of individual digital literacy that will enable effective pedagogical activities using the virtual format.

Significant attention is paid to the moral and psychological aspect of the teacher's preparation for the conditions of activity in a virtual learning environment. This cluster of competencies is also important along with elements of digital literacy.

"Immersive technologies have the potential to overcome physical limitations and virtually transfer experiences to the field, such as the classroom. However, little is known about the features of immersive technologies that contribute to successful situated learning. Immersive technologies enable embodied experiences by simulating natural embodied interactions through an egocentric user

perspective. In addition, they allow for out-of-reality experiences by integrating contextual information that cannot be provided in actual field sites." (Zhao & Klippel, 2019).

In fact, moral and psychological resilience is the key to the effective performance of the moderator function of the educator in the learning process in a virtual environment. What complicates the educator's work in such an environment is the need to adhere to pedagogical principles of operation and to constantly correlate them with digital competencies.

Moral and moral standards become relevant in the formation of digital competencies of the teacher because thanks to ethical constants the balance between technologization and human dimensionality is preserved. Moral elements must be considered when introducing innovative technological formats such as virtual environments, shaping the notion of cultural intelligence (Gokalp, 2021). Furthermore, the use of artificial intelligence in the educational system requires responsible initiatives to establish ethics and privacy (Zhang & Aslan, 2021).

In addition, aspects such as the feasibility of virtualization of learning are being brought up to date. The prominence and massiveness of the virtual world leads to the absolutization of its dimensions, which negatively affects the intended educational purpose when the virtual format is applied in the educational system. Situations of unjustified immersion into the virtual environment, contributing to the achievement of educational goals, are possible. Therefore, an important aspect of the modernization of professional training of teachers of the future is a critical approach, which will exclude the possibility of absolutization of digital mastery and haphazard use of virtual learning systems.

The teacher's acquisition of digital competencies greatly enhances his or her overall professional development. Immersive technologies are an innovative approach to learning, so the teacher's ability to master relevant skills and the ability to integrate learning activities into a new learning environment indicate the development of flexible skills such as agility, mobility, adaptability, interdisciplinarity (Whewell et al., 2021).

Conclusions and Implications

Consequently, immersive technologies represent a promising trend in the educational space, as they form a number of advantages in the practical dimension of the educational process organization. Among the key positive manifestations of the virtual environment, we should note the accessibility and mobility of education, which have become especially relevant in the period of pandemic restrictions. In order to ensure the organization of virtual learning, teachers almost urgently began to master immersive technologies and implement them in practical educational activities. If we consider further prospects of VR/AR/MR/XR elements in the educational system, we should talk about the expediency of creating appropriate programs or trainings for teachers, which will form the relevant digital competencies.

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