Development of digital competencies in immersive cloud-based educational environment

Serhiy O. Semerikov[1,2,3,4,5], Tetiana A. Vakaliuk[3,2,1,5], Iryna S. Mintii[6,2,1,3,7,5], Vita A. Hamaniuk[1,5], Olha V. Bondarenko[1,5], Pavlo P. Nechypurenko[1,5], Svitlana V. Shokaliuk[1,5] and Natalia V. Moiseienko[1]

[1]*Kryvyi Rih State Pedagogical University, 54 Universytetskyi Ave., Kryvyi Rih, 50086, Ukraine*
[2]*Institute for Digitalisation of Education of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine*
[3]*Zhytomyr Polytechnic State University, 103 Chudnivsyka Str., Zhytomyr, 10005, Ukraine*
[4]*Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine*
[5]*Academy of Cognitive and Natural Sciences, 54 Universytetskyi Ave., Kryvyi Rih, 50086, Ukraine*
[6]*University of Łódź, 68 Gabriela Narutowicza Str., 90-136 Łódź, Poland*
[7]*Lviv Polytechnic National University, 12 Stepana Bandery Str., Lviv, 79000, Ukraine*

Abstract

The development of digital competencies in higher education students is a key task for modern universities in the context of digital transformation of society. An effective means to achieve this goal is the use of an immersive cloud-based educational environment (ICBEE). This paper presents a model for using ICBEE in the formation of digital competencies, defines a system of digital competencies for future IT professionals and engineer-educators, and proposes a methodology for developing digital competencies in pre-service teachers using immersive technologies. The implementation of the proposed approaches will increase the level of digital competencies of higher education graduates and promote their successful professional self-realization in the digital society.

Keywords

digital competencies, immersive technologies, cloud-based educational environment, pre-service teachers, IT professionals

1. Introduction

The rapid development of digital technologies necessitates the formation of relevant competencies in higher education students to ensure their competitiveness in the labor market. An immersive cloud-based educational environment (ICBEE) opens up new opportunities for the development of digital skills through the use of virtual and augmented reality, 3D modeling, and cloud services [1, 2, 3].

This paper aims to substantiate the use of ICBEE for the development of digital competencies in higher education students. The objectives are: 1) to develop a model for using ICBEE in the formation of digital competencies; 2) to define the system of digital competencies for future IT professionals and

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semerikov@gmail.com (S. O. Semerikov); tetianavakaliuk@gmail.com (T. A. Vakaliuk); irina.mintiy@gmail.com (I. S. Mintii); vitana65@gmail.com (V. A. Hamaniuk); bondarenko.olga@kdpu.edu.ua (O. V. Bondarenko); acinonyxleo@gmail.com (P. P. Nechypurenko); shokalyuk@kdpu.edu.ua (S. V. Shokaliuk); n.v.moiseenko@gmail.com (N. V. Moiseienko)
https://acnsci.org/semerikov (S. O. Semerikov); https://acnsci.org/vakaliuk/ (T. A. Vakaliuk); https://acnsci.org/mintii (I. S. Mintii); https://kdpu.edu.ua/personal/vagamanuk.html (V. A. Hamaniuk); https://kdpu.edu.ua/personal/ovbondarenko.html (O. V. Bondarenko); https://acnsci.org/nechypurenko (P. P. Nechypurenko); https://kdpu.edu.ua/personal/svshokaliuk.html (S. V. Shokaliuk); https://kdpu.edu.ua/personal/nvmoiseienko.html (N. V. Moiseienko)
0000-0003-0789-0272 (S. O. Semerikov); 0000-0001-6825-4697 (T. A. Vakaliuk); 0000-0003-3586-4311 (I. S. Mintii); 0000-0002-3522-7673 (V. A. Hamaniuk); 0000-0003-2356-2674 (O. V. Bondarenko); 0000-0001-5397-6523 (P. P. Nechypurenko); 0000-0003-3774-1729 (S. V. Shokaliuk); 0000-0002-3559-6081 (N. V. Moiseienko)

engineer-educators; 3) to propose a methodology for developing digital competencies in pre-service teachers using immersive technologies.

2. Model of using ICBEE for development of digital competencies

Based on the analysis of recent studies [1, 4, 3], we propose a generalized model of using ICBEE for the development of digital competencies in higher education students of different specialties (figure 1).

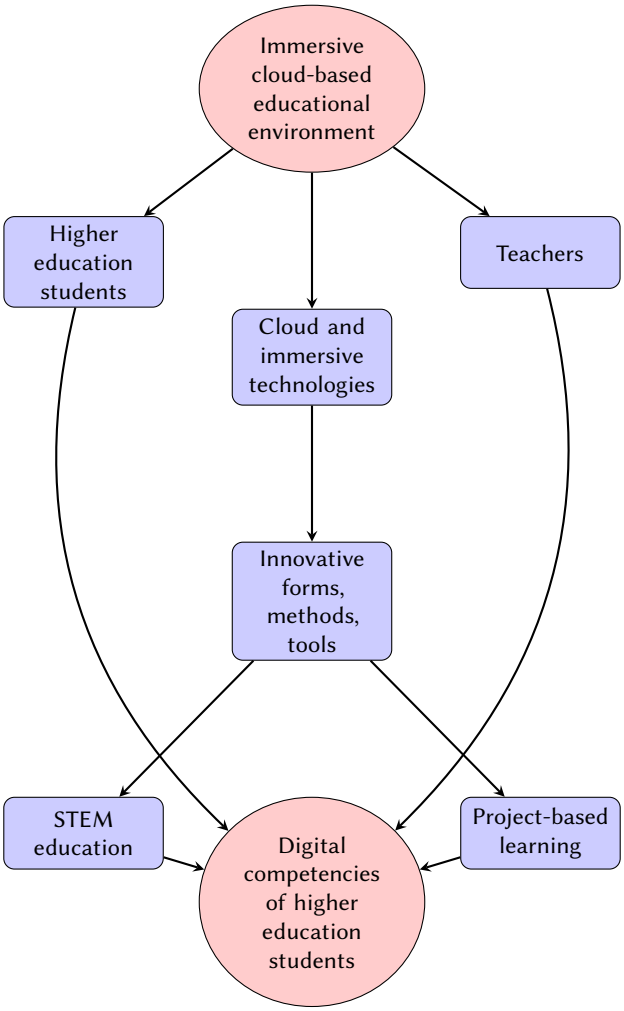

Figure 1: Model of using ICBEE for development of digital competencies in higher education students.

The model reflects the structure and relationships between the key components of ICBEE in the context of developing students' digital competencies. The central element is the ICBEE itself, which integrates technological, informational, and pedagogical aspects. The environment enables the interaction of the main actors of the educational process - students and teachers.

The technological basis of ICBEE consists of cloud platforms and services, as well as immersive technologies (virtual and augmented reality, 3D modeling, etc.). They create an innovative infrastructure for implementing personalized and practice-based learning.

Based on the synthesis of technological capabilities and modern pedagogical approaches, innovative forms, methods, and tools of students' learning activities are designed and implemented in ICBEE. This allows for active student participation in the educational process, development of research and project work skills, and organization of effective collaboration.

Studies show that STEM education and project-based learning approaches using ICBEE tools play a special role in developing digital competencies [1, 3]. They allow students to gain experience in solving

practical problems, develop critical thinking, teamwork, and project management skills.

The result of the systematic use of ICBEE is the development of a set of digital competencies in students, covering technological, information-analytical, communicative, and innovative aspects. The formation of these competencies is an important prerequisite for successful professional activity and lifelong learning in the context of the digital transformation of society.

3. System of digital competencies for IT professionals and engineer-educators

The system of digital competencies for future IT professionals should include both purely technological skills of working with hardware and software, as well as the ability to effectively communicate, collaborate, and manage projects using digital tools. Glazunova et al. [1] proposed a classification of soft skills for future IT specialists in 5 categories: personal effectiveness, communication, management, strategic, and information management skills. The authors developed a methodology for the formation of soft skills in future IT professionals, based on three stages: collective, course, and interdisciplinary. Each stage involves the implementation of different types of projects using cloud services, which contributes to the development of various components of soft skills.

For engineer-educators, it is important to develop both their own digital skills and methodological competencies for the use of digital technologies in the educational process. Among the components of teachers' digital competence for working in ICBEE, we can distinguish:

- ability to use cloud LMS to organize the learning process;
- skills to apply cloud tools for creating interactive content, communication, collaboration;
- ability to develop and apply VR simulations to build practical skills;
- skills to create AR applications to visualize learning material.

Figure 2 presents a generalized system of digital competencies for future IT professionals and engineer-educators. It includes technological, information-analytical, communicative, security, design, and methodological competencies, the development of which should be ensured during training using ICBEE.

The formation of these competencies requires a systematic approach and should be carried out throughout the entire period of students' study at the university. At the same time, it is worth applying blended learning forms that combine traditional methods with innovative practices based on the use of digital technologies.

4. Methodology for developing digital competencies in pre-service teachers using immersive technologies

The use of immersive technologies, such as virtual (VR) and augmented (AR) reality, opens up new opportunities for the formation of digital competencies in pre-service teachers. It allows creating realistic simulations of professional situations, visualizing abstract concepts, and providing interactive interaction with virtual objects.

Vakaliuk et al. [3] substantiated the need to form digital competence of future foreign language teachers as an important component of their professional competence. To achieve this goal, the structural components of digital competence (motivational, content, operational-activity, and personal-reflexive) were determined, as well as criteria and indicators of its formation. The authors proved the effectiveness of using game simulators as a means of forming digital competence in future foreign language teachers.

Nechypurenko et al. [2] explored the possibilities of using augmented reality tools in the process of forming research competencies in pre-service science and mathematics teachers. The authors proposed a model for using digital tools in the training of future chemistry teachers, developed and tested a system of research tasks using mobile AR applications.

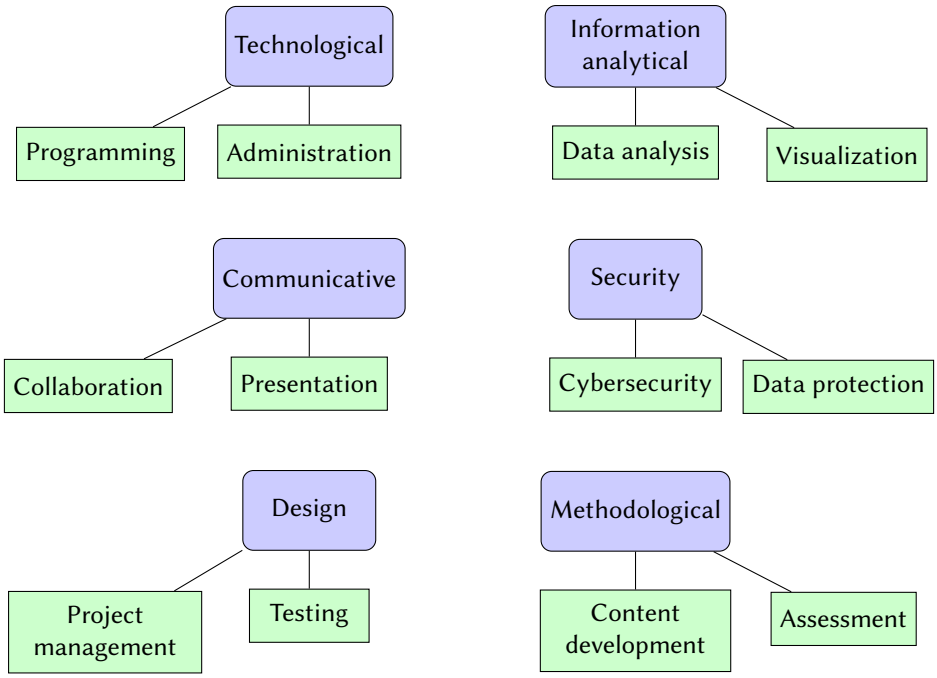

Figure 2: System of digital competencies for IT professionals and engineer-educators.

The methodology for developing digital competencies in pre-service teachers using immersive technologies should be based on the following provisions:

- application of immersive technologies to create interactive learning materials, visualize objects of study, and conduct virtual experiments [2];
- development of skills in designing and developing one's own VR/AR applications to support the teaching of specific disciplines;
- systematic use of immersive tools for the implementation of educational, quasi-professional, and professional activities of pre-service teachers;
- ensuring psychological and pedagogical conditions for the effective use of immersive technologies in the educational process (taking into account individual characteristics, gradual immersion, prevention of cognitive overload, etc.).

Based on these provisions, we propose a structural-functional model of the methodology for developing digital competencies in pre-service teachers using immersive technologies (Figure 3).

Immersive technologies have significant potential to improve the content of pre-service teacher training. Their implementation requires updating curricula to take into account the capabilities of VR/AR for visualizing school discipline material, modeling pedagogical situations, conducting psychological and pedagogical research, etc.

The implementation of the methodology involves the systematic use of immersive technology tools in the classroom and extracurricular work of students. These can be virtual reality glasses or helmets, augmented reality applications for mobile devices, specialized 3D object modeling programs, etc. The choice of specific tools is determined by the specifics of academic disciplines, material and technical, and organizational capabilities of the educational institution.

Effective forms and methods of implementing the methodology are:

- immersive lectures using VR to demonstrate phenomena, model processes;
- laboratory work using AR/VR applications to acquire practical skills;
- students' implementation of individual and group projects to create their own immersive educational resources;

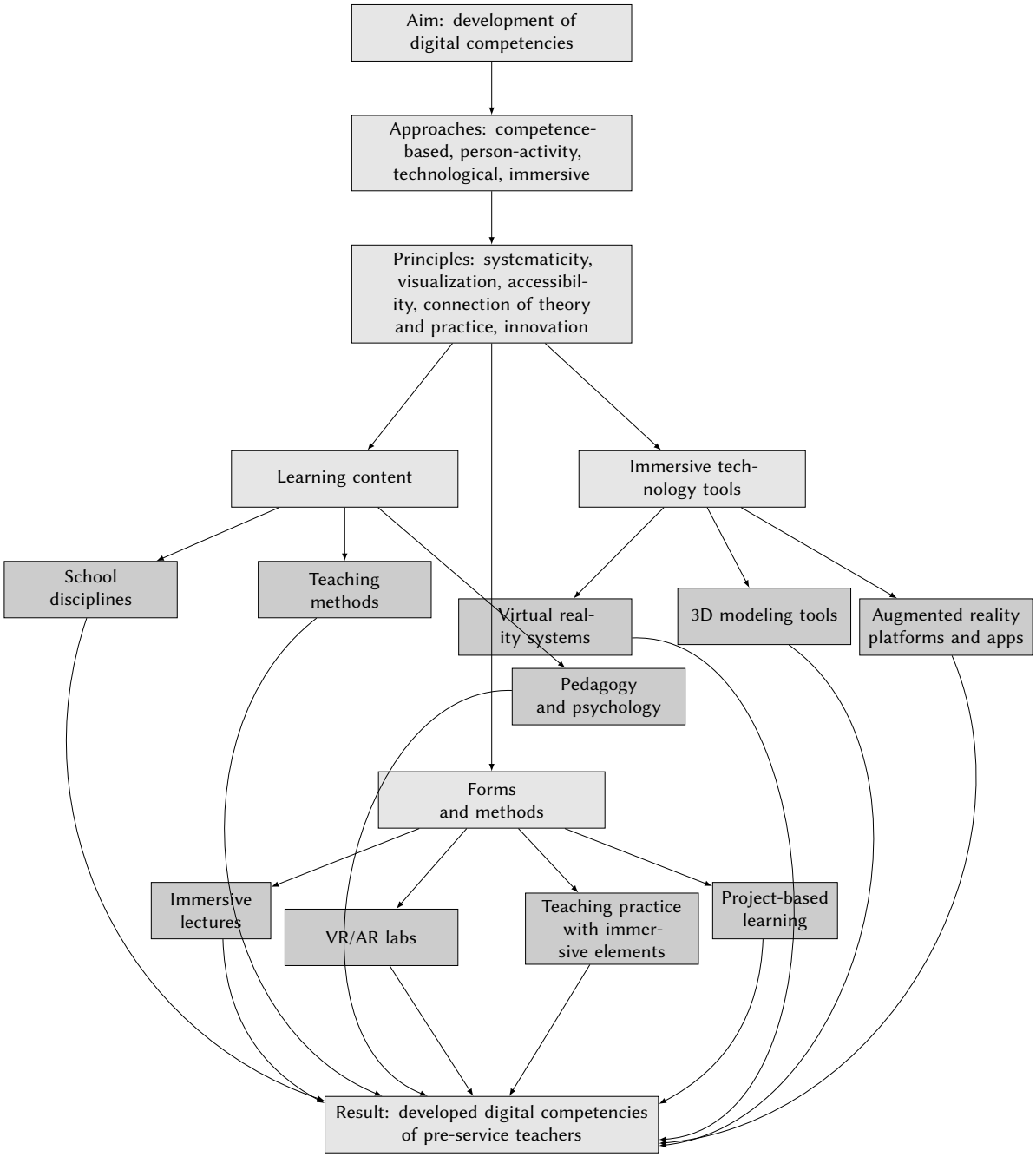

Figure 3: Structural-functional model of the methodology for developing digital competencies in pre-service teachers using immersive technologies.

- organization of pedagogical practice with elements of immersive technologies application in the real educational process of the school.

The expected result of the methodology implementation is the developed digital competencies of pre-service teachers, which integrate technological literacy, the ability to effectively use and create immersive content, and readiness to apply innovations in future professional activities.

5. Conclusion

The use of an immersive cloud-based educational environment opens up new opportunities for the development of digital competencies in higher education students. The proposed model reflects the

conceptual vision of integrating the benefits of cloud and immersive technologies into a single high-tech educational environment to develop students' digital competencies.

The defined system of digital competencies for future IT professionals and engineer-educators covers technological, communicative, project, methodological, and other aspects, the formation of which should be ensured by means of ICBEE.

The methodology for developing digital competencies in pre-service teachers using immersive technologies involves updating the content of their training, the systematic use of VR/AR tools, and the implementation of innovative forms and teaching methods. This will significantly increase the level of digital competencies of future teachers, promote the formation of innovative thinking and readiness to use immersive technologies in the modern school educational process.

Further research should be aimed at the experimental verification of the effectiveness of the proposed model and methodology, the development of specific methods for using ICBEE tools in the training of specialists in various fields.

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