The impact of virtual learning environment on future teachers' professional competence in lifelong learning

El impacto del entorno de aprendizaje virtual en la competencia profesional de los futuros docentes en el aprendizaje permanente

Oksana Karabin
https://orcid.org/0000-0001-8759-948X
Associate Professor of the Department of Informatics and Methods of its Teaching, Faculty of Physics and Mathematics, Volodymyr Hnatiuk National Pedagogical University of Ternopil, Ternopil, Ukraine.

Tetiana Hladun
https://orcid.org/0000-0002-0231-1238
Associate Professor of the Department of General and Medical Psychology, Bogomolets National Medical University, Kyiv, Ukraine.

Viktoriia Romaniuk
https://orcid.org/0000-0002-3795-4081
Senior Lecturer of the Department of Foreign Languages, The National Defence University of Ukraine, Kyiv, Ukraine.

Anastasiia Vitchenko
https://orcid.org/0000-0003-3009-993X
Associate Professor of the Department of Foreign Languages and World Literature Teaching Methods, Faculty of Foreign Philology, Mykhailo Dragomanov State University of Ukraine, Kyiv, Ukraine.

Valerii Hrytsenko
https://orcid.org/0000-0001-5881-3491
Professor of the Department of Automation and Computer-Integrated Technologies, Bohdan Khmelnytsky National University of Cherkasy, Cherkasy, Ukraine.

Abstract

The study aimed to empirically test the impact of a virtual learning environment on the professional competence of future computer science teachers in lifelong learning by conducting a survey and comparing the professional competence of bachelor and master students, as well as their opinions on the impact of the virtual learning environment on future teachers' professional competence in lifelong learning. The surveying methods were cognitive, motivational, activity-based, and value-based. A survey of students found that a virtual learning environment has the most significant impact on the activity component of professional competence, and most students are motivated to use virtual learning environments to improve their professional competence. The survey of teaching staff revealed a positive attitude towards professional development through virtual learning environments, the prevalence among students of high and sufficient levels of professional competence and digital literacy. The obtained results can be used to

Oksana Karabin, Tetiana Hladun, Viktoriia Romaniuk, Anastasiia Vitchenko, Valerii Hrytsenko

adjust the virtual educational process of future teachers' professional training in the system of Ukrainian HEIs.

Keywords: academic staff, computer science teachers, HEIs, lifelong learning, professional development, students, virtual tools.

Resumen

El estudio tuvo como objetivo probar empíricamente el impacto de un entorno de aprendizaje virtual en la competencia profesional de los futuros profesores de informática en el aprendizaje permanente mediante la realización de una encuesta y la comparación de la competencia profesional de estudiantes de licenciatura y maestría, así como sus opiniones sobre el impacto del entorno de aprendizaje virtual sobre la competencia profesional de los futuros docentes en el aprendizaje permanente. Los métodos de encuesta fueron cognitivos, motivacionales, basados en actividades y basados en valores. Una encuesta entre estudiantes encontró que un entorno de aprendizaje virtual tiene el impacto más significativo en el componente de actividad de la competencia profesional, y la mayoría de los estudiantes están motivados para utilizar entornos de aprendizaje virtuales para mejorar su competencia profesional. La encuesta al profesorado reveló una actitud positiva hacia el desarrollo profesional a través de entornos virtuales de aprendizaje, la prevalencia entre los estudiantes de niveles altos y suficientes de competencia profesional y alfabetización digital. Los resultados obtenidos se pueden utilizar para ajustar el proceso educativo virtual de formación profesional de futuros docentes en el sistema de las IES de Ucrania.

Palabras clave: aprendizaje permanente, desarrollo profesional, docentes de informática, estudiantes, herramientas virtuales, IES, personal académico.

1. Introduction

Due to the continuous digitalisation of society and all spheres of human life and activity, the role of virtual environments in the educational process is increasing significantly. Moreover, virtualisation has enabled the educational system to respond adequately to the challenges posed by the global pandemic and the full-scale military invasion. However, the introduction of virtual platforms and digital tools into the educational process has increased the requirements for the teachers' professional competence in terms of improving digital skills, as the virtual space is dynamic today and requires constant changes from all its subjects. The above makes it necessary to empirically determine the impact of virtual learning environments on teachers in lifelong learning.

Total virtualisation of the educational space poses new challenges to the pedagogical community. They are professional mobility, a high level of mastery of digital innovations, readiness to work in a dynamic educational environment, and constant motivation to improve one's digital competence. A decade ago, the main thing for teachers was mastering the latest technologies, and today, the main thing is readiness for constant improvement of skills and abilities of rational use of digital innovations in a multi-format educational space: in face-to-face, mixed and distance learning formats. Digital innovations change quite dynamically. And if a modern teacher does not have time to master them, he will certainly face the problem of the inconsistency of the virtual tools he uses in pedagogical practice with the requests of education seekers. After all, in today's conditions, students are well versed in digital innovations and know how to use virtual educational opportunities properly. Therefore, for the virtual educational environment to function effectively, pedagogical workers must master digital innovations at a high level and use them rationally to solve educational tasks. This approach creates conditions for teachers' continuous professional development throughout their professional career. Therefore, it is quite fair to assume that the virtual educational environment has an effective influence on the professional growth of teachers.

2. Literature review

Scientific studies dwell on forming and developing future teachers' professional skills and competencies and confirm the importan ce of creating a virtual educational environment, identifying the challenges associated with changing the e-learning process, broadcasting engaging and interactive content to students, the need to bring the competencies of teachers and students in line with the requirements of the virtual educational environment, the importance of their readiness to work in a virtual academic format (Molotsi, 2020). Researchers emphasise the need to update teachers' digital competencies to meet the challenges of the twenty-first century (Caena & Redecker, 2019) and claim that the use of virtual educational tools is essential to improve self-efficacy and self-development and to educate students (Amhag et al., 2019).

The development of professional competence is often considered as a unity of self-identification, self-esteem, self-determination, self-management, and self-development and as a means of successful professional development (Torres et al., 2021). Professional self-development correlates with creating a personality's individual educational and professional trajectory (Kravchenko et al., 2021) and continuous professional growth in the sustainable development of education and science (Sydorenko et al., 2020). The importance of professional self-development is increasing in the context of lifelong learning and the creative self-realisation of specialists in any field of activity (Mushynska, 2018). Professional self-development is related to spiritual and moral behaviour, the development of the person's emotional and motivational sphere, self-analysis skills, and the analysis of human relationships (Yekimov et al., 2020). In times of social challenges and pandemic restrictions, it is essential to build a creative educational environment for professional self-development in the context of modern trends in digital education (Bashkireva et al., 2021). Researchers emphasise the significant role of self-education (Demchenko, 2019) and digital skills in developing future teachers' professional competence (Budnyk, 2021). All this confirms the complexity and multifacetedness of continuous professional training of future teachers (Kanibolotska, 2020), the dynamism of the "professional competence" concept (Koreneva & Kyryenko, 2023), and the determinism of a teacher's professional competence by modern information challenges (Voitovych, 2020).

Scientists stress the importance of a teacher's professional competence and digital competence as key to a teacher's professional development in lifelong learning (Henseruk, 2019). Future computer science teachers' digital competence includes information, media, communicative and technical competences. There is a clear correlation between the high level of a future computer science teacher's digital competence and the development of a teacher's professional competence in general, as it consolidates knowledge, skills and abilities to use digital technologies for the successful organisation of the educational process, critical evaluation of information resources, their correct use in teaching activities, and readiness to introduce technological innovations (Klieba, 2019). Forming professional competence in future computer science teachers requires their enthusiasm for using digital technologies in education (Skaskiv & Hlad, 2021). The academic component of this professional competence involves virtualising the educational environment to ensure the continuous acquisition, mastery, formation and development of future teachers' professional competences (Karabin & Gromiak, 2022). Students' professional competence is considered in the context of informatisation and computerisation of the educational process (Isyanov et al., 2020), the ability to plan their further professional development (Khasanov, 2022), the use of the latest digital platforms and tools for future teachers' professional training (Makhkamova, 2023).

Scientists claim that virtual learning environments benefit teachers' continuous professional development as they expand the use of formal and non-formal learning (Jafar et al., 2020).

Researchers confirm the apparent correlation between the challenges of virtualisation of the educational process and the needs and interests of modern students, who increasingly use digital tools, virtual learning environments and social media (Lacka & Wong, 2021). But at the same time, it is inappropriate to overuse those virtual learning formats that were acceptable in the era of the global pandemic, as the impact of

virtual learning environments on students' achievement of higher education goals has not been studied yet (Lacka et al., 2020). However, despite this, the use of "smart" virtual learning environments (virtual reality; information, design, interactive, training, game-based and other learning) remains relevant for improving the quality of education and the new educational paradigm (Odrekhivskyy et al., 2019). Teaching staff worldwide use virtual educational platforms and immersive computer applications. Numerous surveys have confirmed students' satisfaction with new digital learning tools and their intention to participate in improving virtual products used in the educational process (Bogusevschi et al., 2020). At the same time, teachers' readiness to work with virtual educational platforms is a significant concern, as empirical research confirms the insufficient level of teachers' digital competence in the lifelong learning system, which hinders the promotion of a new way of teaching (Garzón Artacho et al., 2020). At the same time, students are dissatisfied with methodological approaches to teaching in a virtual learning environment. Scientists have proven the importance of using virtual educational platforms for future teachers' training. There is also growing concern about the quality of education in the context of its virtualisation. It is necessary to develop measures to improve the effectiveness of the virtual learning process, in particular for students to increase learning motivation and self-discipline to participate in online classes and for teachers to improve the system of formative assessment, introduce group activities (quizzes, competitions) to stimulate group exchanges and develop social skills (Dung, 2020).

The studies mentioned above focus on the advantages and disadvantages of introducing virtual platforms into the educational process and the importance of teachers and students' readiness to use virtual platforms to achieve academic goals. However, the impact of virtual learning environments on future teachers' professional competence in lifelong learning has not been adequately studied.

The study aims to empirically determine the impact of virtual learning environments on the professional competence of future computer science teachers in lifelong learning.

Research objectives:

– to determine the educational and qualification level of professional competence of future computer science teachers;
– to determine the impact of virtual learning environments on future teachers' professional competence in lifelong learning (through a survey);
– to conduct a survey of teaching staff in HEIs on the impact of virtual learning environments on the professional competence of future computer science teachers in lifelong learning;
– to make a comparative analysis of the level of professional competence of future computer science teachers in terms of students' educational qualification levels;
– to make a comparative analysis of the impact of virtual learning environments on the professional competence of future computer science teachers in the context of lifelong learning in terms of students' educational and qualification levels.

The research hypothesis is that virtual learning environments contribute to the growth of future computer science teachers' professional competence and motivate them to continue self-improvement.

3. Methods

a. Research design

The empirical testing included the following stages: preparatory, empirical, and final. At the preparatory stage, we formed a sample, selected research methods, and formulated the aim and objectives. At the empirical phase of the study, a survey of respondents was conducted on the impact of the virtual learning environment on the professional competence of future computer science teachers, diagnosing their level

of professional competence. The results were interpreted at the final stage, and conclusions were drawn. The pilot study was initiated by the scientific communities of Ukrainian higher education institutions: HEI 1, HEI 2, and HEI 3.

b. Sampling

In total, 140 future computer science teachers – bachelor and master students – aged 23 – 26 years – participated in the study. The reason for choosing students of different educational qualification levels is the need to identify students' focus on continuous education, which should increase with the achievement of the appropriate level of training. All students worked in the "Moodle" virtual environment.

The reasons for drawing such a sample are as follows:

1) Students' involvement in the use of virtual learning environments in the educational process;
2) students have a long experience of acquiring competences in a virtual learning environment;
3) students' readiness and ability to use the resources and tools of the virtual learning environment.

Fifty academic staff members aged 40 – 50 years, involved in training students of pedagogical specialities, participated in the study.

All participants gave their voluntary consent to participate in the survey. The study was conducted during extra-curricular time and did not interfere with HEIs' educational processes.

c. Research methods

The following methods were used in the study: diagnostics of future computer science teachers' professional competence, surveys, qualitative and quantitative analysis of the data, and comparative analysis.

The diagnostics of future computer science teachers' professional competence included a control test of students' knowledge, skills and abilities conducted by teachers of HEIs (the levels: high, sufficient, average, and low).

The study also involved determining the impact of virtual learning environments on the professional competence of future teachers in lifelong learning through a survey of students and teaching staff.

The respondents were surveyed using Google Forms, based on the author's questionnaire of bachelor and master graduate students of pedagogical specialities. The questionnaire included 16 questions in four blocks: cognitive, motivational, activity-based, and value-based (Table 1).

Table 1.

The structure of the author's questionnaire to determine the impact of virtual learning environments on future teachers' professional competence in lifelong learning

Blocks	Diagnostic Method
Cognitive	Respondents' orientation towards expanding their knowledge on the use of virtual learning environments for professional self-development
Motivational	desire to use the virtual learning environments for professional development
Activity-based	positive experience of using virtual learning environments for professional development
Value-based	formation of a positive value attitude to the use of learning environments for professional development

Source: author's development.

To determine the impact of virtual learning environments on future teachers' professional competence in lifelong learning, we surveyed teaching staff, whom we asked to rate with a score from 1 to 12 the following diagnostic indicators of students: formation of professional competence, digital literacy, readiness to use virtual learning environments for self-development, understanding of the need for continuous professional development, positive attitude to professional development through virtual learning environments.

The primary data was recorded in the Excel spreadsheet processor. Statistical processing of the research results was carried out using Spearman's rank correlation coefficient. Cronbach's analysis (with Cronbach's alpha value – 0.8) was used to determine the reliability of the author's questionnaire.

4. Results and discussion

The data on the diagnostics of future computer science teachers' professional competence are shown in Figure 1. As can be seen from Figure 1, a higher level of professional competence was found among master students, which indicates their higher readiness for professional development in the framework of lifelong learning.
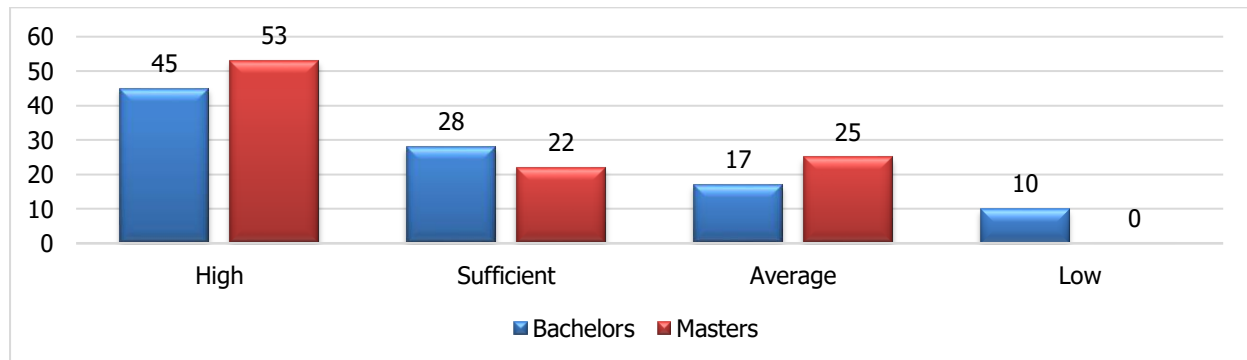

Figure 1. Professional competence of future computer science teachers, %.
Source: author's development.

The survey results of all respondents in percentage terms for each block of the questionnaire are summarised in Table 2.

Table 2.

Averaged data on the impact of virtual learning environments on the professional competence of future computer science teachers in the framework of lifelong learning (%)

Categories of respondents	Blocks of the questionnaire				Mean value
	Cognitive	*Motivational*	*Activity-based*	*Value-based*	
Bachelor students of HEI 1	60	70	69	65	66,0
Master students of HEI 1	40,5	80	87	70	69,4
Bachelor students of HEI 2	55	74	89	67	71,3
Master students of HEI 2	47,3	56	76	56,3	58,9
Bachelor students of HEI 3	34,1	67	69	45	53,8
Master students of HEI 3	45	54	65	43,9	52,0
Mean value	47,0	66,8	75,8	57,9	61,9

Source: author's development.

As can be seen from Table 2, virtual learning environments have the most significant impact on the activity-based component of students' professional competence. This indicates that most respondents have positive experiences using virtual learning environments to develop their professional competence and are motivated to improve it. However, the students lack the knowledge, skills and abilities to use all the possible advantages of virtual educational space in the context of lifelong learning. This is also the reason for insufficient readiness to use virtual learning environments to improve future teachers' professional competence.

We conducted a comparative analysis of bachelor and master students regarding the impact of virtual learning environments on the professional competence of future computer science teachers in the framework of lifelong learning (Figure 2).
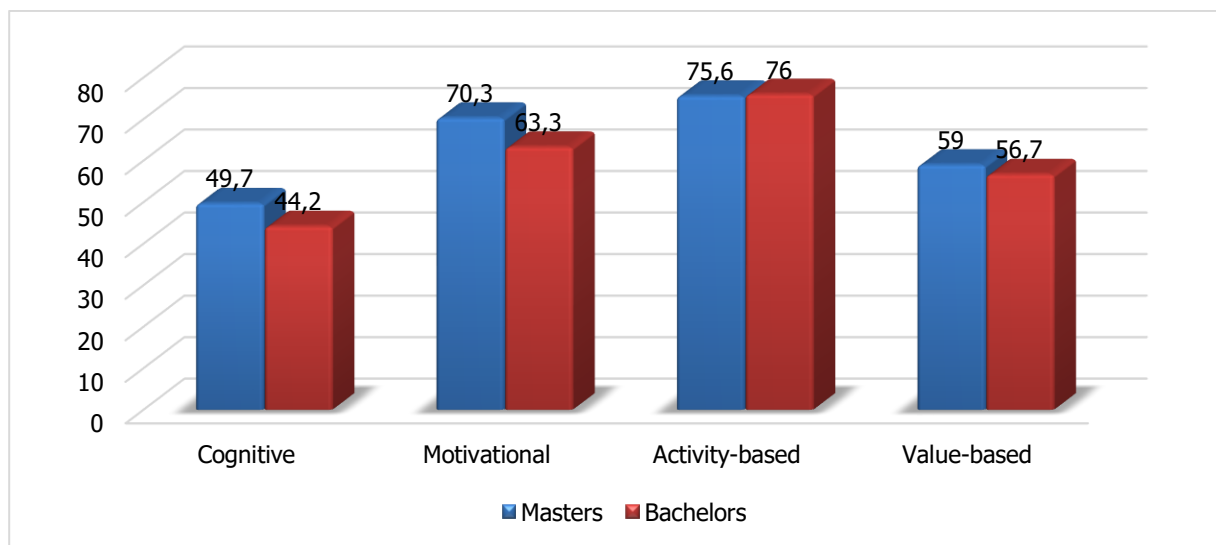

Figure 2. Comparative analysis of the survey of masters and bachelors on the impact of virtual learning environments on the professional competence of future computer science teachers in lifelong learning, % **Source:** author's development.

As can be seen from Figure 2, master students have slightly higher scores than bachelor students. This indicates that masters, compared to bachelors, have:

- a more pronounced focus on deepening the knowledge of virtual learning environments for professional self-development;
- more examples of positive experiences of using virtual learning environments for professional development;
- a more pronounced positive attitude towards using learning environments for professional development.

They are also more likely to use the resources of virtual learning environments for professional development.

Based on the data in Table 3, it can be argued that most teaching staff note future teachers' positive attitude towards professional development through virtual learning environments. More than half of the surveyed report the prevalence of high and sufficient levels of professional competence, digital literacy, and understanding of the need for continuous professional development in students. At the same time, students have an average level of readiness to use virtual learning environments for self-development, which may be due to the lack of effective models for using virtual tools for professional growth.

Table 3.

The results of the survey of teaching staff on the impact of virtual learning environments on the professional competence of future computer science teachers in lifelong learning (%)

Diagnostic methods	Levels				Mean value
	High	*Suffi cien t*	*Aver age*	*Low*	
Formation of professional competence	54	46	0	0	25
Digital literacy	68	22	20	0	27,5
Readiness to use virtual learning environments for self-development	22	28	50	0	25
Understanding the need for continuous professional development	62	28	10	0	25
Positive attitude to professional development through virtual learning environments	78	22	0	0	25
Mean value	56,8	29,2	16	0	25,5

Source: author's development.

The study makes it possible to identify the main directions for improving the use of virtual educational environments to develop the professional competence of future computer science teachers in lifelong learning:

- creating conditions for expanding students' knowledge base on the use of virtual learning environments for professional self-development;
- increasing the level of readiness to use virtual learning environments to improve the professional competence of future computer science teachers;
- forming a base of positive experience in using virtual learning environments for the professional development of future computer science teachers;
- creating consulting platforms for future computer science teachers on the use of virtual learning environments for professional self-development.

The following measures can be proposed to improve the use of virtual educational environments for the development of future computer science teachers' professional competence in lifelong learning:

1. Involvement of students in choosing different virtual educational environments to improve their professional competence.
2. Use of various virtual educational environment tools in the professional training of future computer science teachers.
3. Involvement of students in creating virtual didactic content for educational environments.
4. Avoidance of monotony in a virtual educational environment when conducting classes and monitoring learning achievements.
5. Motivation of academic staff to improve the methodology of organising students' work in the virtual educational environment.

Scientists (Henseruk, 2019; Kanibolotska, 2020) have identified the importance of using virtual educational environments in the professional competence development of future computer science teachers in lifelong learning. Researchers also emphasise the need to use virtual instruments in the training of students and the readiness of teachers and students to work in the new virtual format of an interactive learning environment to be on par with their peers worldwide. Empirical research proves the convenience and speed of using educational content in the virtual space and the role of virtual tools in developing digital skills (Molotsi, 2020). Researchers note the impact of virtual learning environments on learners' career development (Caena & Redecker, 2019). A survey of teachers in Swedish educational institutions stated the systematic need for teachers and students to improve digital skills in the context of education virtualisation and the need for adequate scientific and methodological support for creating digital teaching and learning environments (Amhag et al., 2019). While noting the predominantly positive impact of virtual learning environments on the educational process, scholars identify problems that can hinder CPD because, without a vibrant online learning community, any constructive CPD requests cannot be met (Toole, 2019). However, it is necessary to avoid excessive use of virtual tools, so it is inappropriate to rely exclusively on digital, virtual instruments in the educational process (Pererva et al., 2020). The students' intention to participate in developing and improving existing virtual learning environments used by HEIs has been empirically proven (Bogusevschi et al., 2020). At the same time, some studies have revealed students' dissatisfaction with the methodology of using virtual learning environments, which raises the need to pay special attention to training teachers to use virtual educational platforms, as students believe that teachers lack knowledge of using graphic editors, video editors, computer graphics editors, and the perfect use of planning, monitoring and control procedures. Research by the University of Granada proved the need for additional and thorough study of the opinions of students and teachers on the use of virtual learning environments (Pererva et al., 2020), which was implemented in our research.

However, most studies focus on the advantages and disadvantages of using virtual learning environments in developing future teachers' professional competence in lifelong learning.

Our research is distinguished by a comprehensive approach to studying students' opinions and the parameters for assessing the impact of virtual learning environments on future teachers' professional competence, which we offered to students (cognitive, motivational, activity-based, and value-based blocks of the survey) and teachers (formation of professional competence, digital literacy, readiness to use virtual learning environments for self-development, understanding of the need for continuous professional development, positive attitude to raising professional level through virtual learning environments).

Our research is essential due to studying the influence of virtual learning environments on future teachers' professional competence in lifelong learning.

The research gives grounds for developing future teachers' professional competence in the virtual learning space in lifelong learning.

5. Conclusions

The introduction of virtual learning environments into the professional training of future computer science teachers has necessitated the study of the impact of this environment on the professional competence of future teachers in lifelong learning. Virtual learning environments have been proven to affect future teachers' professional competence. After all, they motivate students to use virtual learning environments for professional self-development. Working in virtual learning environments allows students to gain positive experience and form a positive attitude towards using learning environments for professional development. Virtual learning environments also positively impact the formation of professional competence, digital literacy, readiness to use virtual learning environments for self-development, understanding of the need for continuous professional development, and a positive attitude towards professional development through virtual learning environments.

The research results confirm the hypothesis that virtual learning environments contribute to the growth of future teachers' professional competence and motivate them to improve continuously.

Further scientific research may focus on various models for developing future teachers' professional competence in virtual and lifelong learning. Of particular empirical interest may be determining the parameters of a productive, rationally organised virtual learning environment as an essential component of future teachers' professional development.

6. Bibliographic references

Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher Educators' Use of Digital Tools and Needs for Digital Competence in Higher Education. *Journal of Digital Learning in Teacher Education, 35*(4), 1-18. https://doi.org/10.1080/21532974.2019.1646169

Bashkireva, T., Bashkireva, A., Morozov, A., Kuraev, A., & Nebrodovskaya-Mazur, E. (2021). Problems of Professional Self-Development Among Undergraduates in the Digital Space, Identified During the COVID-19 Pandemic. *SHS Web of Conferences, 93*, 01018. https://doi.org/10.1051/shsconf/20219301018

Bogusevschi, D., Muntean, C. H., & Muntean, G.-M. (2020). Teaching and Learning Physics using 3D Virtual Learning Environment: A Case Study of Combined Virtual Reality and Virtual Laboratory in Secondary School. *Journal of Computers in Mathematics and Science Teaching, 39*(1), 5-18. Retrieved from https://www.learntechlib.org/p/210965/

Budnyk, O. (2021). Development of digital competence of future teachers in the new Ukrainian school. In: *Innovative educational technologies in the New Ukrainian School* (pp. 22-34). Retrieved from https://acortar.link/wROjZ7

Caena F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st-century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education, 54*, 356-369. https://doi.org/10.1111/ejed.12345

Celik, B., & Kara, S. (2022). Students' perceptions of the general english proficiency test: A study on Tishk International University students in Erbil, Iraq. *Amazonia Investiga, 11*(59), 10-20. https://doi.org/10.34069/AI/2022.59.11.1

Demchenko, Yu. (2019). Self-education competence – indispensable component of professional competence (activity) of a would-be teacher. *Topical Issues of the Humanities, 23*(1), 154-159. https://doi.org/10.24919/2308-4863.1/23.166160

Dung, D. (2020). The Advantages and Disadvantages of Virtual Learning. *IOSR Journal of Research & Method in Education, 10*(3), 45-48. https://doi.org/10.9790/7388-1003054548

Garzón Artacho, E., Martínez, T. S., Ortega Martin, J. L., Marin Marin, J. A., & Gomez Garcia, G. (2020). Teacher Training in Lifelong Learning – The Importance of Digital Competence in the

Encouragement of Teaching Innovation. *Sustainability, 12*(7), 2852. https://doi.org/10.3390/su12072852

Henseruk, H. (2019). Digital competence as one of the professionally important competencies of future teachers. *Open educational e-environment of modern University, 6*, 8-16. Retrieved from https://acortar.link/ujHGE6

Isyanov, R., Rustamov, K., Rustamova, N., & Sharifhodjaeva, H. (2020). Formation of ICT competence of future teachers in the classes of general physics. *Journal of Critical Reviews, 7*(5), 235-239. Retrieved from https://acortar.link/nvMEWy

Jafar, D. S. A., Saud, M. S., Hamid, M. Z. A., Suhairom, N., Hisham, M. H. M., & Zaid, Y. H. (2020). TVET Teacher Professional Competency Framework in Industry 4.0 Era. *Universal Journal of Educational Research, 8*(5), 1969 - 1979. https://doi.org/10.13189/ujer.2020.080534

Kanibolotska, O. (2020). Current state of life-learning professional training of foreign language teachers in the modern society. *Topical Issues of the Humanities, 29*(2), 200-205. Retrieved from https://acortar.link/xqEfce

Karabin, O. Y., & Hromiak, M. I. (2022). The main factors of formation of professional competence of future computer science teachers in the process of professional training. *Modern Digital Technologies and Innovative Teaching Methods: Experience, Trends, Perspectives, 9*, 107-109. Retrieved from http://dspace.tnpu.edu.ua/bitstream/123456789/27560/3/karabin_Gromjak.pdf

Khasanov, A. R. (2022). Development of information competence of future informatics teachers as a pedagogical problem. *Texas Journal of Engineering and Technology, 15,* 78-84. Retrieved from https://zienjournals.com/index.php/tjet/article/view/3038

Klieba, A. I. (2019). Digital competence of future computer science teachers of higher education. *Scientific Journal of M.P. Dragomanov National Pedagogical University, 72*(1), 223-226. https://doi.org/10.31392/NPU-nc.series5.2020.72-1.49

Koreneva, I., & Kyryienko, O. (2023). Historical and retrospective analysis of the formation of the teacher's professional competence. In: *The 12th International scientific and practical conference "Modern research in world science"* (pp. 486-492). Lviv: SPC "Sci-conf.com.ua". Retrieved from https://acortar.link/sEYC8F

Kravchenko, L., Bilyk, N., Onipko, V., Plachynda, T., & Zavitrenko, A. (2021). Professional Mobility of the Manager of a Secondary Education Institution as the Basis of Their Self-Development. *Revista Romaneasca pentru Educatie Multidimensionala, 13*(1), 417-430. https://doi.org/10.18662/rrem/13.1/379

Lacka, E., & Wong, T., & Haddoud, M. (2020). Can digital technologies improve students' efficiency? Exploring the role of Virtual Learning Environment and Social Media use in Higher Education. *Computers & Education, 163*, 104099. https://doi.org/10.1016/j.compedu.2020.104099

Lacka, E., & Wong, T. C. (2021). Examining the impact of digital technologies on students' higher education outcomes: the case of the virtual learning environment and social media. *Studies in Higher Education, 46*(8), 1621-1634. https://doi.org/10.1080/03075079.2019.1698533

Makhkamova, D. X. (2023). The advantages of using the possibilities of infographics in the work of future informatics and information technology teachers. *Open Access Repository, 9*(3), 291-298. https://doi.org/10.17605/OSF.IO/K4UWE

Molotsi, A. R. (2020). The university staff experience using a virtual learning environment as a platform for e-learning. *Journal of Educational Technology & Online learning, 3*(2), 133-151. https://doi.org/10.31681/jetol.690917

Mushynska, N. (2018). Means of future economists' professional self-development in the educational process of foreign language studying. Economics. *Ecology. Socium, 2*(3), 45-56. https://doi.org/10.31520/2616-7107/2018.2.3-5

Odrekhivskyy, M., Pasichnyk, V., Rzheuskyi, A., Andrunyk, V., Nazaruk, M., Kunanets, O., & Tabachyshyn, D. (2019). Problems of the Intelligent Virtual Learning Environment Development. *MoMLeT, 2019*, 359-369. Retrieved from https://ceur-ws.org/Vol-2386/paper27.pdf

Pererva, V., Lavrentieva, O., Lakomova, O., Zavalniuk, O., & Tolmachev, S. (2020). Environment in the process of organising the future teachers' terminological work by specialty. In: Kiv, A. E. & Shyshkina M. P. (Eds.), *Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019)* (pp. 321-346). Kryvyi Rih. Retrieved from http://ceur-ws.org/Vol-2643/paper19.pdf

Skaskiv, H. M., & Hlad, N. I. (2021). Structural components of the computer science teacher's digital competence. *Modern Digital Technologies and Innovative Teaching Methods: Experience, Trends, Perspectives, 8*, 229-231. Retrieved from http://dspace.tnpu.edu.ua/bitstream/123456789/23517/1/Skaskiv1.pdf

Sydorenko, V. V., Yermolenko, A. B., Lukiianchuk, A. M., Denysova, A. V., & Kharagirlo, V. Ye. (2020). Platform "Profosvita" as innovative educational and digital environment for specialists' professional development. *Educação & Formação, 5*(3), 1-17. https://doi.org/10.25053/redufor.v5i15set/dez.3097

Toole, C. (2019). "Networked Learning Communities – The Benefits for Continuing Professional Development of Virtual Learning Environment Teachers" A Critical Literature Review. *Irish Journal of Technology Enhanced Learning, 4*(1), 48-67.

Torres, M., Acal, C., Honrani, E., & Estrada, M. (2021). Impact on the Virtual Learning Environment Due to COVID-19. *Sustainability, 13*, 582. https://doi.org/10.3390/su13020582

Voitovych, I. (2020). *Preparation of future teachers for the use of information and communication technologies in professional activities*. Departments of the Ternopil National Pedagogical University named after Volodymyr Hnatyuk. Retrieved from http://dspace.tnpu.edu.ua/bitstream/123456789/20828/1/monografia.pdf

Yekimov, S., Getmanets, G., Miroshnik, L., Sosnina, T., Havrylenko, A., Vasylieva, N., Zymivets, N., & Bondarenko, Z. (2020). Some problems of humanitarian training of future specialistsin pedagogical specialties using interactive technologies. *Journal of Physics: Conference Series,* 1691, 012221. https://doi.org/10.1088/1742-6596/1691/1/012221