Potapchuk Olha. Analysis of the effectiveness of the training system of future computer profile specialists for the application of digital technologies. Journal of Education, Health and Sport. 2024;58: 225-233. eISSN 2391-8306. https://dx.doi.org/10.12775/JEHS.2024.58.016 https://apcz.umk.pl/JEHS/article/view/50548 https://zenodo.org/records/11060074

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences). Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 20159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu; Nauki o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu; Naukow; Nauki o zdrowiu; Nauki

© The Authors 2024;

This article is published with open access at Licensee Open Journal Systems of Nicolaus Copernicus University in Torun, Poland

Open Access. This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author (s) and source are credited. This is an open access article licensed under the terms of the Creative Commons Attribution Non commercial license Share alike. (http://creativecommons.org/licenses/by-nc-sa/4.0/) which permits unrestricted, non commercial use, distribution and reproduction in any medium, provided the work is properly cited.

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 08.04.2024. Revised: 16.04.2024. Accepted: 29.04.2024. Published: 22.04.2024.

UDC 378.4:378.147

## ANALYSIS OF THE EFFECTIVENESS OF THE TRAINING SYSTEM OF FUTURE COMPUTER PROFILE SPECIALISTS FOR THE APPLICATION OF DIGITAL TECHNOLOGIES

#### **Olha Potapchuk**

#### Ternopil Volodymyr Hnatyuk National Pedagogical University

ORCID: 0000-0001-8041-0031; Ph.D.(Pedagogy), docent, docent of the Computer Technologies Department, doctoral student Ternopil (Ukraine); potapolga24@gmail.com

#### Abstract

The purpose of the article is to verify and justify the effectiveness of implementing an authorial system for preparing future computer professionals to apply digital technologies.

The methodological basis of the publication is methods of scientific analysis, pedagogical positions on the issues of preparing future computer professionals, implementation of an authorial system for preparing future computer professionals for the application of digital technologies.

The scientific novelty lies in highlighting the main results of the pedagogical experiment, which aimed to verify the effectiveness of the system for preparing future computer professionals for the application of digital technologies. The pedagogical

experiment was conducted in accordance with the main stages (diagnostic, formative, control), during each of which a series of tasks and research were carried out. The research hypothesis assumes that the quality of preparation of future computer professionals for the application of ICT in professional activities will improve by implementing organizational and pedagogical conditions, principles, approaches, content, forms, and methods laid down in the authorial system for preparing future computer professionals for the application of ICT. To substantiate the conclusions regarding the effectiveness of the content and methodology of the pedagogical experiment, statistical processing of the obtained data will be conducted.

It was found that EG students demonstrated significantly higher knowledge and skills in mastering and using modern ICT tools and instruments: 3D modeling technologies, including for graphic reconstruction; additive technologies; development of adaptive web resources; development and application of virtual and augmented reality applications; use of Smart technologies in education, and so on.

Conclusions. Summarizing the research results, we believe that the authorial system for preparing future computer professionals for the application of ICT in professional activities is effective and positively influences the formation of their readiness for professional activities in general.

# Keywords: digital technologies; training system; future computer professionals; pedagogical experiment.

**Statement of the problem.** Today, the development of society is characterized by a significant impact on it of digital technologies, which permeate all spheres of activity and create a global digital space. An integral part of these processes is the digitalization of education and its entry into the global digital educational space. This process is accompanied by significant changes in the pedagogical theory and practice of training future computer specialists [6, 7].

One of the ways to modernize the system of training future computer specialists is to develop its pedagogical model. The main goal of the process of pedagogical modelling is the study of the problem with the help of schematization of content and process characteristics within the defined goals. To achieve them and confirm the hypothesis, a pedagogical experiment was conducted. It provided for checking the effectiveness and expediency of implementing a system of training future computer specialists for the use of digital technologies in the educational process [3].

Conducting a pedagogical experiment makes it possible to establish connections between pedagogical processes that are related to the preparation of future computer specialists for the use of digital technologies, taking into account the effectiveness of the developed and introduced innovations in their educational process. Pedagogical experiment includes goals, conditions and a place in a holistic study, which result from a specially organized experimental and scientific search for influences [1, 9].

Such searches include: analysis of the activities of education seekers, questionnaires, testing, observations, conversations, creative tasks and professional tasks, which make it possible to collect information about the actual results of the educational process, based on the analysis of which to make a transition from traditional pedagogical influences to innovative ones, which are characterized in-depth knowledge of educational processes and development of practical recommendations.

Analysis of recent studies on the problem. The study of the problems of modernization of pedagogical systems, in particular, in the conditions of digitalization, requires a holistic approach, taking into account the dynamics and changes in the education system of Ukraine and the modern challenges of the digital life of society. The problem of analysis of modern pedagogical systems is actualized in the scientific discourse. Russian scientists V. Bykov, O. Spirin, O. Pinchuk [2], K. Kraus [4], N. Morse [5], O. Sypchenko [8] note that the effective development of modern pedagogical systems, the ability to choose and implement optimal educational trajectory depend on the possibility of digital transformation of educational institutions.

**The purpose of the article.** The purpose of the article is to verify and substantiate the effectiveness of the implementation of the author's system of training future specialists in the field of computer technology for the use of digital technologies.

The methodological basis of the publication is methods of scientific analysis, pedagogical positions on the issues of training future computer specialists, implementation of the author's system of training future computer specialists for the use of digital technologies.

**Outline of the main provisions.** The pedagogical experiment was carried out in accordance with the main stages, at each of which a number of tasks and researches were performed. At *the first (confirmatory) stage*, we establish the state of the studied pedagogical system through an experiment and determine the initial data for further research. The *formative stage* is accompanied by the development of a system of measures, which are aimed at forming in future specialists a computer profile of readiness for the use of digital technologies (DT) in professional activities and its implementation in the educational process.

*The control stage* of the pedagogical experiment provides for the determination of the level of readiness of the specified specialists for the use of DT in the future professional activity based on the results of the formative experiment. At all stages of the study, 359 students of the first (bachelor) level of education in the speciality 015 Professional education in the specialization 015.39 Digital technologies, 24 scientific and pedagogical employees of higher education institutions who teach educational components from the cycle of professional training and 8 stakeholders of educational programs of the specified speciality, based on which a pedagogical experiment was conducted.

Determining the readiness of future computer specialists to use digital technologies in their professional activities is an important stage of the pedagogical experiment aimed at establishing the actual state and effectiveness of the current pedagogical system [7]. The research concept and specifics of the development of a system for training future computer professionals for the use of digital technologies, the definition of its main components, the selection of the necessary approaches, methods, forms and means of their training depend on the results of the ascertainment stage, since all this is aimed at improving their educational process. Therefore, the purpose of conducting the ascertainment stage of the experiment is to reveal the level of formation of need-motivational, cognitive-content, activity-technological and reflective components according to the current system of their training. To diagnose the levels of formation of the specified components, we have implemented adapted methods for each of them.

The analysis of the results of the ascertainment stage of the pedagogical experiment proved that the majority of the surveyed students (68.6%) are at the reproductive and integrative levels (Fig. 1).



Fig. 1. Results of the ascertainment stage of the experiment

Professional skills and practical experience, which we investigated by determining the level of formation of the activity-technological and reflexive component, have sufficiently low indicators, although most respondents have the necessary knowledge about the possibilities of DT. In our opinion, this is caused by insufficient practical training of future computer specialists for the use of DT [6].

So, according to the results of the ascertaining stage of the pedagogical experiment, it was established that the traditional system of training future computer specialists does not meet the requirements of digitalization of education and the connection of theoretical knowledge of students with their professional duties. From this follows the task of modernizing the approaches, principles, methods and means of training the mentioned specialists at the level of development of modern DT, as well as forming a new content of their training.

Therefore, as a result of a multi-level analysis, a system of training future specialists in the computer profile for the use of digital technologies was developed, which was formed on the basis of the research concept in accordance with the modern conditions of digitization of education. The purpose of this stage of the experiment is to determine the effectiveness of the proposed system in the educational process of the experimental group of future computer specialists.

The hypothesis of the research consists in the assumption that the quality of training of future specialists in the computer profile for the use of IT in professional activities will improve by implementing organizational and pedagogical conditions, principles, approaches, content, forms and methods, which are the basis of the author's system of training future specialists in computer profile before DT application.

On the basis of the formative stage of the experiment, we have gained experience: formation of a system of training future specialists of the computer profile for the use of DT in professional activities, taking into account prognostic provisions; scientific and experimental verification of the effectiveness of the conceptual principles of the use of modern digital technologies in the educational process of future computer specialists; determination of the diagnostic system for the effectiveness of training future computer specialists for the use of digital technologies; development of scientific and methodological support for pedagogical experiment; statistical analysis of the results of control sections. The generalized results of the formative stage of the pedagogical experiment are presented in fig. 2.

229



Fig. 2. Results of the formative stage of the experiment

At the final stage of the pedagogical experiment, a control stage was foreseen, which involved statistical processing of the experiment results and substantiation of the conclusions regarding the effectiveness of the proposed system of training future specialists of the computer profile for the use of DT in professional activities. Therefore, in order to justify the conclusions regarding the effectiveness of the content and the method of conducting the pedagogical experiment, we will carry out statistical processing of the obtained data. A comparison of two empirical distributions was made according to Pearson's  $\chi$ 2-criterion to confirm the research hypothesis.

According to the theory of the null hypothesis  $(H_0)$ , the differences between the distributions of the levels of success and the quality of knowledge regarding the use of DT among students of CG and EG are statistically unreliable.

That is,  $H_0: \overline{x}_1 = \overline{x}_2$ , where

 $\overline{X}_1$  – arithmetic mean value of points in CG,

 $\overline{x}_2$  – arithmetic mean value of points in EG.

The alternative hypothesis (Na) is that the differences between the distributions of the level of success and the quality of knowledge regarding the use of DT among students of CG and EG are statistically reliable. That is, the author's system of training future specialists in the computer profile for the use of CT is more effective than the traditional system of their training:  $H_1: \bar{x}_1 < \bar{x}_2$ .

So, to test the hypothesis, we will find the value of Pearson's  $\chi^2$ -criterion using formula (1), taking into account that in our study the samples are random and independent.

$$\chi^2 = \frac{1}{n_1 * n_2} \sum_{i=1}^n \frac{(n_1 * Q_{2i} - n_2 * Q_{1i})^2}{Q_{1i} + Q_{2i}} , \qquad (1)$$

where n1 - number of students in CG;

n2 – number of students in EG;

Q1i (i=1, 2, 3, 4) – the number of students in CG that belong to the corresponding levels ("conceptual-illustrative", "reproductive", "integrative", "creative");

Q2i (i=1, 2, 3, 4) – the number of students in EG, which belong to the respective levels.

From the table of values of  $\chi^2$  for the level of significance  $\alpha$ =0.05 and the number of degrees of freedom v=1, we determine the critical value of statistics. To do this, we will use the statistical functions of the MS Excel table editor by setting the necessary parameters. According to the results of calculations, we will get the number  $\chi^2_{cr} = 3,841$ .

Calculation of the  $\chi^2$  criterion after conducting the formative stage of the experiment showed that  $\chi^2_{emp}(8.290) > \chi^2_{cr}(3.841)$  at all stages of testing the statistical significance of the study. This proves that the control and experimental samples have significant differences. Therefore, we have grounds for rejecting the null hypothesis and accepting the alternative one.

The training of students of EG education during the formative stage of the pedagogical experiment was carried out in accordance with the proposed system. Therefore, we believe that this contributed to the achievement of high results.

EG students demonstrated significantly higher knowledge in mastering and being able to use modern means and tools of DT: technologies of three-dimensional design of objects of various complexity, including for graphic reconstruction using parallax methods; production of models by means of additive technologies; development of adaptive web resources and their application in the educational field; development and application of virtual and augmented reality applications; use of Smart-technologies in education (Smart-TV, interactive whiteboards, immersive technologies, interactive applications of online platforms, etc.); Internet of Things technologies, programming skills, etc.

It should also be noted that the scientific and pedagogical workers who were involved in the pedagogical experiment began to practice more new approaches and methods of teaching using DT tools, in particular for the organization of classes in a mixed format (auditory classes with online streaming, for students studying in distance form) use interactive boards to explain new material, which makes the lesson more interesting and accessible for all participants of the educational process; augmented reality applications and virtual glasses are used for visualization when explaining new educational material; to attract students to scientific and research activities, specialized web resources are used for the organization and presentation of research results, etc.

**Conclusions.** Therefore, we believe that the author's system of training future specialists in the computer profile for the use of DT in professional activities is effective and has a positive effect on the formation of their readiness for professional activities in general. The conducted pedagogical experiment confirmed the hypothesis of the research: the quality of training of future specialists in the computer profile will increase under the condition of the implementation of a scientifically based system containing goals and objectives, for the achievement of which specific content, forms, methods and means of training are used, as well as criteria and indicators of their verification effectiveness, and this will contribute to increasing the level of readiness of future computer professionals to use digital technologies in their professional activities. The analysis of the results of the pedagogical experiment indicates an increase in the quality of training of future computer specialists when using the author's system, and, therefore, its effectiveness.

We see **the prospects for further research** in the modernization of educational programs for the training of future specialists in the speciality 015 Professional education of the specialization 015.39 Digital technologies in accordance with the proposed system of training future specialists in the computer profile for the use of digital technologies in professional activities.

### References

1. Arthur Jr. W., Bennett Jr. W., Edens P. S., Bell S. T. (2003). Effectiveness of training in organizations: a meta-analysis of design and evaluation features. Journal of Applied psychology, 88(2), 234.

2. Bykov, V., Spirin, O., & Pinchuk, O. (2020). *Suchasni zavdannya tsyfrovoyi transformatsiyi osvity* [Modern tasks of digital transformation of education]. UNESCO Chair Journal "Lifelong Professional Education in the XXI Century", (1), pp. 27-36. [in Ukrainian].

3. Kolosnichenko M. V., Yezhova O., Pashkevich K., Kolosnichenko O. V., & Ostapenko N. (2021). The use of modern digital technologies in the design and technology VET in Ukraine. Journal of Technical Education and Training (JTET).

4. Kraus K. M. (2018). *Imperatyvy formuvannya tsyfrovoyi osvity v Ukrayini* [Imperatives of the formation of digital education in Ukraine]. Doctoral dissertation, Kyyiv: KUBH, 512 p. [in Ukrainian].

5. Morze N., Kucherovs'ka V., & Smyrnova-Trybul's'ka YE. (2020). *Samootsinyuvannya rivnya tsyfrovizatsiyi osvitn'oho zakladu za umov transformatsiyi seredn'oyi osvity* [Self-assessment of the level of digitalization of an educational institution under the conditions of transformation of secondary education]. Elektronne naukove fakhove vydannya "Vidkryte osvitnye e-seredovyshche suchasnoho universytetu", (8), pp. 72-87.

6. Potapchuk O. (2022). *Suchasni vymohy tsyfrovoho suspil'stva do fakhivtsiv komp"yuternoho profilyu* [Modern requirements of the digital society for computer specialists]. Bulletin of the Cherkasy National University named after Bohdan Khmelnytskyi. Series: Pedagogical sciences. 2022. No. 4. P. 78-82. [in Ukrainian].

7. Potapchuk, O. (2023). Current trends in the development of pedagogical systems of Ukraine in the conditions of digitalization of society. Journal of Education, Health and Sport, 13(1), 300-309.

8. Sypchenko, O. (2021). *Tsyfrovizatsiya vyshchoyi osvity yak vazhlyva vymoha chasu* [Digitization of higher education as an important requirement of the time]. Drukuyet'sya za ukhvaloyu Vchenoyi rady Chernivets'koho natsional'noho universytetu imeni Yuriya Fed'kovycha (protokol № 7 vid 30 chervnya 2021 roku) REDAKTSIYNA KOLEHIYA, 276 p. [in Ukrainian].

9. Sysoyeva S.O., Krystopchuk T.YE. (2013). *Metodolohiya naukovopedahohichnykh doslidzhen'* [Methodology of scientific and pedagogical research: a textbook]: pidruchnyk. Rivne: Volyns'ki oberehy, 2013. 360 s. [in Ukrainian].