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PREPARING FUTURE PHYSICS TEACHERS TO WORK IN A VIRTUAL LEARNING ENVIRONMENT

Manana D. Dammer (a), Marina G. Kovtunovich (b)*, Elena A. Leonova (c), Marina A. Korytova (d), Zemfira M. Bolshakova (e)
*Corresponding author

(a) Federal State Budgetary Educational Institution of Higher Education “South Ural State Humanitarian-Pedagogical University”, 454080 Lenin Ave. 69, Chelyabinsk , Russia, e-mail: dammermd@yandex.ru
(b) Religious Organization - Higher Theological Educational Organization of the Russian Orthodox Church “Saints Cyril and Methodius Institute for Postgraduate Studies”, 115035, Pyatnitskaya str., 4/2, p. 1, Moscow, Russia; Physics teacher, Private secondary school for gifted children "World of intelligence" 127055 Obraztsova, 11, 4, Moscow, Russia, e-mail: marinakovt@mail.ru
(c) Federal State Budgetary Educational Institution of Higher Education «South Ural State Humanitarian-Pedagogical University», 454080 Lenin Ave. 69, Chelyabinsk, Russia, e-mail: leonova@cspu.ru
(d) Federal State Autonomous Educational Institution of Higher Education South Ural State University (FGAOU VO "SUSU (NIU)"), 454080 Lenin Ave., 76, Chelyabinsk, Russia, e-mail: korytovama@susu.ru
(e) Federal State Budgetary Educational Institution of Higher Education «South Ural State Humanitarian-Pedagogical University», 454080 Lenin Ave. 69, Chelyabinsk, Russia, e-mail: zmb25@mail.ru

Abstract

Digital transformation of education poses new challenges in the preparation of future teachers, including teachers of physics. The basis of digital competence of teachers is digital skills, which are manifested in particular in the ability to apply electronic educational resources: training programs, simulators, computer models, etc., as well as a set of such tools - virtual learning environments. The preparation of a future physics teacher for the management of students' cognitive activity combines the work of a teacher at the same time in two directions. The first direction is the development by students of the features of the management process of the cognitive activity of schoolchildren. The second direction is the teaching students how to present the elements of content and how to master them in digital form by using ready-made or independently developed electronic educational resources. The implementation of productive technology by the teacher helps to improve the efficiency of preparing the future physics teacher for the management of the cognitive activity of students using digital educational resources. As a result, students embody their knowledge and skills in an educational product. This is a set of teaching and learning materials that is objectively new and significant for their future professional activity. The author of the article presents the experience of developing the content of training future physics teachers to manage learning and cognitive activity in a virtual learning environment which is based on modern ideas about the development of education.

Keywords: Electronic educational resources, virtual learning environment.

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1. Introduction

At present, the development of the digital economy in Russia has led to the need for a digital transformation of all aspects of human activity, including education. It is believed that the process of informatization of education, which began in the 90s last century, solved the tasks assigned to him. New features of computer technology allow us to solve new problems in the field of education. Network environments, artificial intelligence, big data processing bring the education system to a new level. There are different points of view on how informatization and digitalization of education correlate (Nikulina, 2018). We also believe that these are generations in the development of the education system. Consequently, it is necessary to consider the current stage in terms of the continuity of all developments which are made in the conditions of informatization. However, this should take into account the new requirements.

In the conditions of the digital world, in order to provide the fulfillment of production and other functions, the person and his methods of interaction with the world must change (Müller & Bostrom, 2016; Kupriyanovskiy et al., 2017). The characteristics of a person in a digital economy are measured by such characteristics as: “Digital competence”, “Digital literacy”, “Digital skills”.

Both Russian and foreign scientists have devoted their work to the problem of the formation of digital competencies (Liu & Sung, 2014; Sgurev & Piuri, 2018; Yachina & Fernandez, 2018).

One approach to a systematic process of effectively incorporating technology is to identify the skills that students need to master in order to support virtual skills or practices, such as digital collaboration (Kathleen, 2017). Shmakova (2013) dedicated her work to the problem of shaping the readiness of a future teacher for pedagogical creativity by means of information technologies, Fedotova (2015) indicates the importance of information technologies in the professional activities of a future teacher, Mayer (2018) has made the study of mathematical models of didactic systems on a computer, and Fross, Winnicka-Jasłowska, and Sempruch (2018) emphasizes that the activities associated with the use of the network and new forms of work creates new functional and spatial relationships and interactions university buildings.

Many researchers raise issues of school computerization and describes educational programs that students can use to work independently at home, consider the development of telecommunications networks and the preparation of projects to create the so-called the “global class”. The “Global Class” will provide access to various networks, which will allow the consumer to receive information from any corner of the planet, from any time period. The pedagogical possibilities of this approach are enormous. The Moscow government introduces a similar technology in Moscow schools. Research suggests that the integration of ICT into teaching moves in phases from the enrichment of existing practices towards more innovative teaching practices, enriching and transforming Russian educational practices (Light & Pierson, 2014).

The proliferation of digital technologies is raising the demand for general ICT skills (ICT - information and communication technologies). It changes ways of working and leads to increased demand for additional ICT skills. Such skill is impossible without introducing into the learning process, especially teachers, technologies which are designed to develop critical, systemic, scientific thinking.

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2. Problem Statement

The GEF of higher education in the field of “Pedagogical education” determines the universal and professional competencies that are formed by future teachers in the disciplines of the basic and variable part of the curriculum. To prepare a teacher of a new generation, it is necessary in the educational program to provide the formation of his digital skills and taking into account their complex nature.

Features of the formation of digital skills are also valid for the general education system. They are an important task which is solved by a physics teacher in the process of preparing and conducting a lesson. A modern lesson, as a rule, is conducted by using electronic educational resources: training programs, simulators, computer models, etc. The complex of such tools is a component of a virtual learning environment. The development of digital technologies contributes to a fairly rapid pace of improvement of electronic educational resources (ESM), and therefore the learning environment.

3. Research Questions

Virtual learning environment

Teaching in a virtual learning environment has great didactic opportunities. The inclusion of virtual physical demonstrations and interactive labs, electronic presentations and video materials, computer animations and static images in the learning process provide an improved perception of educational information by students.

The most important stage of the educational process is conducting a physical experiment that ensures the creation and methodology of cognitive activity, the formation of a creative approach aimed at obtaining knowledge.

The effectiveness of the training session depends on certain properties of the learning virtual environment. We note some important properties that in our opinion.

The development directions of the virtual learning environment are associated with the development of such properties as immersiveness and interactivity.

An important issue of study is that line, which erases the differences between the virtual environment and the material world. Immersiveness reflects the possibilities of attracting the subject of the educational process to the system of relations which is determined by the content of the environment. To achieve a high degree of immersiveness, so-called virtual reality systems, are used by.

Interactivity is a property of the virtual environment to be able to change or select the parameters of the physical bodies, processes, phenomena included in the system, as well as to be able to control the course of the experiment using the available system tools. The gamification of the learning environment is the introduction of game mechanics. Using of elements of gamification enthralls and motivates learners to acquire new knowledge.

In addition, the virtual environment makes it possible to use the modelling of physical processes as a way of learning activities and as a method of understanding physical reality. In this case, models can be material objects or mathematical, informational (visual-figurative, logical-semantic) systems of objects or signs. Modelling is aimed at the development of such mental activity processes as abstraction and concretization, which are inalienable properties of developed theoretical thinking (Kovtunovich, 2011).

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4. Purpose of the Study

Thus, the purpose of our study was to: design the content of the training of future physics teachers to manage learning and cognitive activity in a virtual learning environment.

In this case, we assume that the following factors should be taken into account:

formed digital skills of the future teacher should take into account the dynamism of the methods of the teacher in the conditions of digital transformation of education;

the use of electronic educational resources is based on the theory of the formation of scientific concepts in the learning process;

the development of a virtual learning environment is associated primarily with the development of such properties as: immersiveness and interactivity;

the formation of the future teacher is impossible without immersing him in the scientific environment and the formation of his scientific thinking.

To achieve this goal, we were assigned the following tasks:

The inclusion in the curriculum of the preparation of teachers of physics of the discipline "Information and Communication Technologies in Physical Education" (variable part) and the development of its content, taking into account all the above factors.

Carrying out a pedagogical experiment to determine the effect of the developed course on the level of digital skills of students.

5. Research Methods

To solve problem 1, we used the following research methods: analysis of pedagogical and methodical literature; modeling of various approaches and pedagogical situations; comparative analysis and synthesis of modern approaches to the formation of digital competencies of students and understanding of their own experience; designing new learning content.

To solve the problem 2, we used the following research methods: experimental training, pedagogical testing, analysis of the products of the activity (analysis of students' work), methods of mathematical statistics.

We conducted a study in the form of pedagogical testing. As a result of this study, 32 students who are future teachers of physics, and who are studying at the South Ural State Humanitarian-Pedagogical University in the direction of Teacher Education, undergraduate programs in «Physics, Mathematics» and «Physics. English».

6. Findings

The discipline “Information and Communication Technologies in Physical Education” refers to the variable part of the educational program. In order to study the discipline “Information and Communication Technologies in Physical Education”, competences are needed that are formed in the following disciplines of the educational program: physics, computer science, pedagogy, psychology, teaching and education methods.

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In the content of the discipline there are two sections: “Methodology of the formation of concepts in the school course of physics” and “Information and communication technologies in teaching physics in school”.

Testing students is aimed to mastering the techniques of using digital teaching materials in physics (Dammer, 2018). Identification of the level of formation of students' skills in the use of digital educational resources in the classroom is carried out with the help of test tasks, as well as case studies. We give examples.

Task 1. Watch the video «Communicating Soap Bubbles» (2017). Select the type of lesson corresponding to the didactic possibilities of the video, if it is «Represents a video message for an explanation of a physical phenomenon».

Lesson of learning a new material

Lesson of consolidation and improvement of knowledge and skills

Problem solving lesson

Lesson of repetition and systematization of knowledge

Task 2. Watch the video «Connected Soap Bubbles». Select the type of lesson that corresponds to the didactic possibilities of the video: «It is used to pose a problem before studying the topic «Surface tension of a liquid».

Lesson of learning a new material

Lesson of consolidation and improvement of knowledge and skills

Problem solving lesson

Lesson of repetition and systematization of knowledge

Task 3. Relate the hypothesis presented below, which is expressed when resolving a problem situation is based on the «Interconnecting soap bubbles» video, with the level of problematic nature.

The teacher suggests that the reason for this strange behavior of bubbles is the force acting on the free surface of the liquid. It, in turn, may depend on the type of fluid and the area of its free surface.

Task 4. Relate the hypothesis presented below, expressed in resolving the problem situation is based on the «Interconnecting soap bubbles» video, to the level of problematic nature.

Since the difference between communicating soap bubbles and communicating balloons lies only in their shell, the “strange” behavior of the soap bubbles must be associated precisely with the soap film. The reduction of the surface of the soap film indicates its “tense” state, i.e. about the action of some force. Consequently, the problem is to study the force acting on the surface of a soap solution or other liquids. Most likely, it depends on the free surface area and the type of liquid.

The teacher puts forward the problem and offers its own solution.

The teacher makes the problem, and the students find the solution.

The students independently put forward the problem and find its solution.

Task 5. Indicate the reasons prompting the teachers of physics to use the CRF.

Improving the process of teaching physics, raising the level of professional culture, moving from the role of teacher-translator to the role of teacher-tutor;

Poor provision of schools with textbooks, weak physical laboratory facilities;

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Possibility of conducting physics lessons in the computer science office, the inability to use visual aids on a printed basis;

Providing a support to students who are weak in physics but who have good computer skills.

Case task.

The test was conducted in 8th grade. The purpose was to determine the formation of students' ability to describe a physical phenomenon on the basis of a generalized response plan. The papers considered the phenomena of convection and heat conduction (according to the variants).

The results of the work analysis are clearly shown in Figure 01.

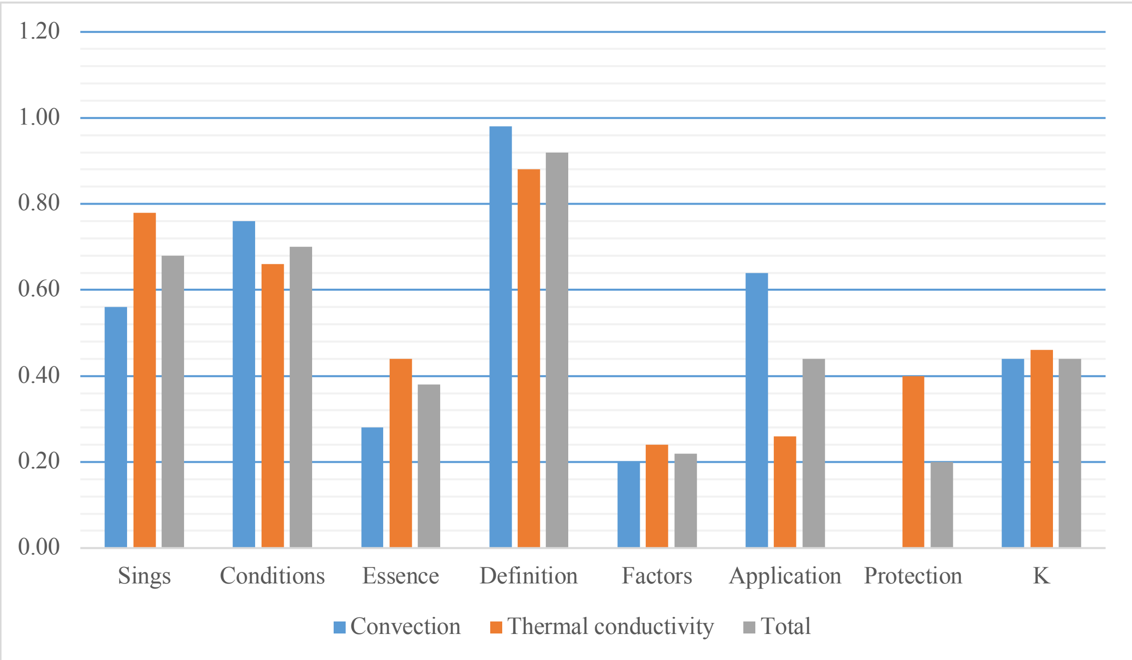

Figure 01. The results of the operational analysis of student work.

Operations: 1. Students described the external signs of the phenomenon. 2. Students described the conditions of occurrence of the phenomenon. 3. Students explained the essence of the phenomenon. 4. Students gave a definition of the phenomenon. 5. Students described the relationship of this phenomenon with others. 6. Students described the application of the phenomenon in practice. 7. Students cited examples of the harmful effects of the phenomenon and methods of protection against it.

According to this situation, the following tasks are proposed.

Task 6. Using the diagram, determine what the coefficient of completeness of the ability to describe a physical phenomenon is based on a generalized response plan.

Task 7. What are the two operations formed by the students the worst?

Task 8. Which operation is best for students?

Task 9. For what operation when describing the phenomenon of convection, the completeness of its implementation is equal to 0.28?

Task 10. Determine how many students wrote a test paper on the topic "thermal conductivity" if the number of students who correctly described the harmful effects of the phenomenon of thermal conductivity and methods of protection against it is 4.

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Task 11. Set the correspondence between the items of the generalized plan and their disclosure for the phenomenon of «convection».

Analysis of the research results: To confirm the significance of the proposed approaches, a pedagogical experiment was conducted, in which 4th year students took part in 2018 and 2019. Experimental and control groups were formed. The experimental group of students studied the course «Information and Communication Technologies in Physical Education» in 2018; in the control group, the methodological and information training of students was carried out only in the professional cycle disciplines. Students of both groups were offered the same tasks to test students for their knowledge of the use of digital teaching materials in physics; the content of the test is given above.

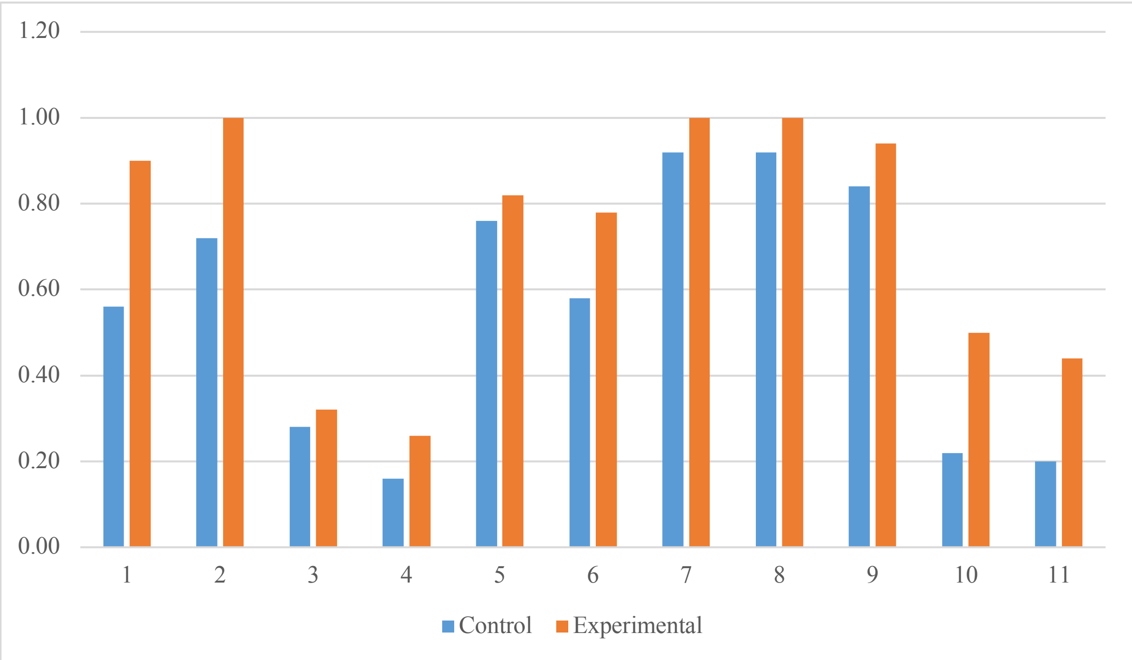

Figure 02. The results of pedagogical testing of students.

In Figure 02 the results of pedagogical testing of students is presented. The analysis of the diagram shows that the students of the experimental group, on the whole, performed the test tasks better. They were showing a higher level of knowledge of methodological skills in applying digital educational resources in their activities. At the same time, it is impossible not to note the fact that the students of the experimental and control groups equally coped with different tasks, i.e. equally good, or equally bad. It can be said that the «shape of the experimental curve» is the same in both groups. Here, the role is played by the specificity of individual tasks. So, for example, students coped with tasks №№ 1, 2, 5, 6, 7, 8, 9 better than with the others. They correlated the didactic possibilities of the viewed video with the types of lessons. However, the completeness of the answers of students in the control group was below the permissible level. The situation is similar with the fifth task, reflecting the expediency of using digital resources. In tasks №№ 6–9, it was necessary to simply make readout along the axis of the diagram, and the students coped with it. But equally difficult for students of both groups were issues related to problem-based learning (№№ 3, 4). It should be noted that the methodology of problem-based teaching physics has traditionally caused difficulties for students of very different levels of training. For example, at the All-Russian Olympiad on the theory and methodology of teaching physics, in which the best students of the country participate, the problem-based learning always causes difficulties for students, both in the ways of posing the problem and the ways of solving it.

The quality of the tenth and eleventh test assignments shows a lack of proficiency in the method of elementwise and operational analysis of student work. But here, the students of the experimental group distinguished themselves for the better too. And the further development of this skill is assumed in the performance of final qualifying work.

7. Conclusion

Let as to sum up the results. We can say that the strategy of methodical preparation of the future teacher of physics implemented by us in the course of the course on choosing has justified itself. It turned out to be appropriate and the technology of productive learning, which is implemented in the classroom. After completing the course, each student had an educational kit which is developed by him on a specific topic of the school physics course. This course contains a system of digital resources and assignments to them for the formation of physical concepts, working with a computer model of a physical phenomenon, performing a virtual laboratory work, etc.

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