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On Using Information and Communication Technologies in Process of Mathematical Specialties Education

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Abstract. The study examines the pedagogical conditions for the use of information and communication technologies in the process of professional training of students of mathematical specialties. It is proved that the use of information and communication technologies in the educational process makes it possible to increase the indicators of the formation of students' professional competence. The analysis of the results of experimental studies made it possible to draw a conclusion about the advisability of using information and communication technologies for the formation of professional competence of students of mathematical specialties.

Keywords: Professional education · Mathematics · Information and communication technologies · Model · Process

1 Introduction

The worldwide pandemic of coronavirus infection has made the entire world community feel a new normality. The usual life has changed, and the importance of introducing information technology into all spheres of life has become evident. The forced digitalization has not spared the sphere of education [1]. Over the past half a year, the number of students affected by the closure of schools and universities in 138 countries has nearly quadrupled to reach 1.37 billion [2]. This means that over 3 out of 4 children and young people around the world are not able to attend educational institutions. The closure of educational institutions also affected nearly 60.2 million teachers [3].

Some countries closed schools completely for the first month of the pandemic and then adapted to accepted safety standards [4]. At the same time, in other educational institutions, they worked in the emergency mode, that is, only the children of those parents who worked during the quarantine could attend school or kindergarten: doctors,

sellers, police officers, firefighters, and the like [5]. Norway and Denmark reopened schools in April, about a month after the quarantine was closed, but initially only did so for younger children, leaving the high school distance learning. Israel reopened schools on May 3, first for smaller groups and subsequently for full classes. A month later, about 220 students and teachers were diagnosed with coronavirus infection there. Moreover, more than 100 infected were from one Jerusalem gymnasium.

On March 12, quarantine began in Ukraine, during which educational institutions were forced to switch to distance learning. In this mode, schools and universities worked until the end of the academic year.

However, the pandemic only accelerated the process of digitalization of the educational process, and trends in the transition of educational process to online have been observed for several years [6–8]. And now trends of digitalization not only in organization of educational process, but in Public Health [9–13], medical diagnostics [14–17], security [18–20], management [21–24], financial branch [25] and other spheres of human being are developed with high speed.

Although the coronavirus pandemic has become a catalyst for the digitalization of education in Ukraine, the urgent transfer of education to a distance format in a pandemic has significant differences from a properly planned online education. Educational organizations that are forced to work with students remotely in order to reduce the risks of the spread of coronavirus should be aware of this difference when assessing the effectiveness of the so-called “online learning” using distance learning technologies.

The professional activity of specialist mathematicians is complex, multifaceted and multifunctional. Professional functions require a high level of professionalism, professional skill, intellectual qualities and abilities, especially in modern conditions of the complication of tasks that are posed to future mathematicians. Taking this circumstance into account, the problem of increasing the level and quality of professional training of students of mathematical specialties is urgent [26].

The **aim of our research** is to consider and substantiate the organizational and pedagogical conditions for the use of information and communication technologies (ICT) for the formation of professional competence of students of mathematical specialties.

2 Current Researches Analysis

In the field of distance learning technologies, there is no uniformity of terminology. The conceptual apparatus in this area is in its infancy. The literature actively uses terms such as distance learning, distance education, Internet learning, distance learning technologies, they are used to describe the features of distance learning using modern information technologies.

The study analyzed the results published by the world’s leading scientists. The following concepts and theories were used as a theoretical basis:

- methodology for the introduction of information environments in the learning process of mathematics [27];

- general theory of the use of information and communication technologies in education [28];
- methodology for applying factor analysis to the study of the problem of knowledge quality [29];
- design of pedagogical systems [30].

In order to organize the process of teaching mathematics with using distance learning technologies, we highlight the goals of using ICT:

- satisfaction of the individual's need for education (lifelong learning technology);
- improving the quality of education through the introduction of modern technologies, in which targeted mediated or incompletely mediated interaction between the student and the teacher is carried out regardless of their location and distribution in time based on the use of telecommunications;
- strengthening the personal orientation of the learning process, intensifying the student's independent work;
- enhancement learning efficiency through the introduction of innovative educational technologies.
- free use by students of various information resources for the educational process at any convenient time;
- ensuring the advanced nature of the entire education system, its focus on disseminating knowledge among the population, raising its general educational and cultural level;
- creation of conditions for the application of the education quality control system.

In order to determine the requirements for the organization of the educational process using distance educational technologies, the characteristics of learning using ICT are given:

- separation of teaching and learning processes in time and space;
- the use of a modular principle, which involves dividing the subject into logically closed blocks, called modules, within which both the study of new material and control measures to check its mastery take place;
- extensive use of survey training, implemented through survey lectures, helping the student to create a holistic picture of the studied area of knowledge and activities;
- management of the student's independent work by means educational institution through curricula, specially prepared teaching and learning materials and special control procedures;
- mastering by the trainees of educational programs at the place of residence with the dominant of independent work, with periodic meetings of a group of students;
- creation of a special information and educational environment, including various educational products - from a working textbook to computer training programs, slide lectures and audio and video courses;
- the obligatory use of communication technologies for the transfer of knowledge, mediated, dialogue and interactive interaction of learning subjects and solving administrative problems.

According to modern researches, studies of the learning process cannot be proven if they were not subject to experimental verification. In pedagogy, the leading role in the organization of experimental verification of the effectiveness and appropriateness of theoretical provisions is assigned to the pedagogical experiment is a complex method of hypothesis testing, organized by a systemic process.

3 Results

The concept of efficiency is not clearly defined, since efficiency is an evaluation category that is related to the ratio of the value of the result to the value of the cost. By the effectiveness of the formation of professional competence of students of mathematical specialties by means of ICT, we mean qualitative and quantitative improvements in the performance indicators of students in the experimental groups in comparison with the control ones. In our opinion, the purpose of the study allows us to implement the cost-effective concept of determining the didactic effectiveness of organizational and pedagogical conditions: a positive increase in the result obtained relative to the previous result, taking into account the time, technical and psychophysical costs (the effect of the teacher's work, the achievement of pre-predicted learning goals for students).

In the process of research, we tried to prove that an effective methodology for the formation of professional competence of students of mathematical specialties should be based on the implementation of certain organizational and pedagogical conditions for the use of ICT tools.

The results of experimental learning using innovative professionally oriented teaching methods based on ICT in the study of vocational training disciplines confirmed the hypothesis of our research, which is the assumption that the formation of professional competence of students of mathematical specialties by means of ICT is provided by increasing their motivation in vocational training and translation of vocational training. competence in the subjective need and the purpose of the upcoming activity. The effectiveness of this process can be much higher if, when studying disciplines of the cycle of professional (professionally oriented) and special training, the implementation of certain organizational and pedagogical conditions is ensured. Let's consider and justify them in more detail.

The provision of didactic design, construction and implementation of professionally oriented ICT tools (electronic educational and methodological complexes, electronic textbooks, multimedia training courses, virtual laboratories, technical equipment) is based on modeling the professional activities of students of mathematical specialties, taking into account the qualification requirements for graduates.

In terms of informatization, it is necessary to consider the problems associated, firstly, with insufficient staffing of educational institutions with technical support, and, secondly, with imperfection, inadequacy of professionally oriented software for educational purposes. The second problem is characterized by a relatively weak development of instrumental and technological means used in the preparation of students of mathematical specialties, which is typical for the domestic programming industry as a whole.

Our research has confirmed that in order to solve the indicated problems of using ICT tools in the formation of professional competence of students of mathematical specialties, it is necessary to create the appropriate conditions:

- to provide the educational process with appropriate technical equipment, create and ensure the functioning of the internal network;
- to develop and introduce electronic manuals, electronic educational and methodological complexes that provide the formation of professional knowledge of students of mathematical specialties according to the principles of differentiation, individualization of training;
- to build the educational process using innovative technologies based on integrated methods, by introducing modern ICT (modular, distance learning, mobile learning, working on the Internet, etc.);
- to organize a system of advanced training for teachers in the field of ICT.

One of the promising ways to solve the second of these problems, it is advisable, in our opinion, to consider the development and implementation of professionally oriented ICT tools in the educational process.

Professional training of students of mathematical specialties is carried out in the following areas: classroom teaching technologies (multimedia educational complexes of disciplines, multimedia lecture hall), telecommunication and library technologies.

Learning using ICT tools cannot replace a human teacher, but it can not only supplement and improve the teacher's work, but also in some areas where independence, creative thinking develops, in general, it plays a unique role that we cannot now realize fully.

Using ICT in the educational process:

- helps to increase the interest of students, enhance the motivation of learning;
- provides opportunities for using various ways of presenting information;
- allows you to actively involve students in the educational process, focuses their attention on the most important aspects of the material;
- organizes psychologically calm work;
- allows you to use during classes significant amounts of information (information networks, databases, etc.);
- requires continuous professional development of teaching staff, appropriate equipment and improved methodological and software.

The development and implementation of electronic educational and methodological complexes, including electronic training courses, computer testing systems, video demonstrations, etc., allows:

- to submit educational information in various forms;
- to initiate the processes of assimilation of knowledge, acquisition of skills and abilities of educational or professional activity;
- to implement repetition and control of learning outcomes effectively;
- to intensify cognitive activity;
- to form and develop certain types of activities.

To conduct a formative experiment in the disciplines of the mathematical cycle of professional training, we have developed multimedia electronic complexes that contain large volumes of demonstration material based on new pedagogical teaching technologies, adapted to teaching in a telecommunication network.

An electronic textbook is a tool that integrates the main forms of the educational process, such as the presentation of theoretical material, elements of consolidation and control of the assimilation of the material using all the advantages of ICT. The main tasks that are set for such a textbook are the development of the skills of independent experiments, the accumulation of experience in managing modern software and hardware resources, the study and practical development of methods for processing the experimental results obtained. The solution of these problems contributes to the creative development and increase of the educational activity of students, the development of real technology, they will be used by them at the place of service.

The formative experiment was carried out on the basis of the communal institution “Lutsk educational complex No. 26 of the Lutsk city council of the Volyn region”. We used ICT elements, which contain large volumes of demonstration material based on new pedagogical teaching technologies, adapted to teaching in telecommunication networks in the process of studying mathematical disciplines.

The results of approbation of the electronic textbooks developed by us allow us to draw the following conclusions:

- the use in such textbooks of a structured functional communication environment that ensures the perception and assimilation of information as a whole (as the perception of an image). The analysis of statistical data shows that the use of an electronic textbook increases the perception of educational material by 45.7%, and assimilation – by 31.6%;
- research of the operation of power plants by means of ICT through the use of a wide range of virtual measuring instruments and mathematical research methods increases the reliability of the results obtained, forms the ability to work with measuring devices (by 29.8%), contributes to the development of students’ creative abilities (by 22.4%);
- electronic textbooks can be used in the distance education system, subject to the creation and development of an educational information environment in an educational institution;
- the development of electronic textbooks allows attracting students and teachers who do not have sufficient programming experience to work.

Building an educational process using ICT based on professionally oriented technologies in order to form skills and abilities allows you to make optimal decisions or offer options for solving them in real conditions.

The strategy of innovative learning changes primarily the goals of educational activities. The goal of transferring information in the field of specific disciplines is replaced by the goal of developing students by expanding the existing volume of knowledge and the scope of their cognitive activity. This implies:

- determination of the current level of student development;
- the need for motivation to continue learning;

- the use of developmental teaching methods allows not only transferring new knowledge, but also simultaneously teaching methods, techniques, and self-education skills.

The role positions of the teacher and the student change, the nature of the organization of educational activities.

By activating the educational process through the use of professionally oriented ICT tools, it is possible to solve a complex of didactic and methodological problems, to carry out individual training, motivation, development of thinking and creative abilities of students. The structure of an interactive learning system should develop the cognitive functions of students and at the same time adapt to their needs. Interactive (computer) dialogue provides communication between two partners - an educational tool (computer) and a student. Thus, using the classical provisions of didactics, the introduction of interactive learning technologies based on ICT introduces significant changes not only in practice, but also in theory.

It can be concluded that it is possible and advisable to use ICT tools to support a complex of different types of learning activities, but at the same time it is necessary to adhere to clear boundaries of their use, so that, on the one hand, they facilitate the learning activities of students, and on the other hand, so that they provide the identification of conceptual scientific provisions and guaranteed the possibility of their assimilation.

Practical recommendations for professional training of students for the use of ICT tools:

- conducting training sessions on the basics of ICT application;
- introduction of a topic that reveals the features of the use of computer and other information tools in the educational process;
- mastering by students the method of independent work;
- obligatory preliminary psychological work with students before using new ICT tools.

Certain organizational and pedagogical conditions and principles of interaction in the educational process of the participants in the experimental work made it possible to develop a model of the future specialist's readiness to be included in professional activity. The model includes three structural elements - educational competence, subject-personal competence, motivational orientation, each of which has its own content. These elements were considered in two aspects: from the standpoint of personal readiness and professional readiness.

Educational competence at the level of personal readiness includes professional, general cultural and humanistic components, as well as communication skills, creativity, a system of in-depth knowledge and skills. At the level of professional readiness, these are professional knowledge, skills and abilities to perform functional duties, the ability to creative activity.

Subject-personal competence at the level of personal readiness is considered by us as an adequate self-assessment of physical, mental and creative development, and at the level of professional readiness - as a self-assessment of professionally significant personality traits, the ability to self-regulate work capacity, and self-control in

professional activity. Motivational orientation is considered at the level of personal readiness as broad cognitive interests, value-semantic orientations, and at the level of professional readiness – as sustainability of professional choice, professional orientation, development of professional qualities.

4 Conclusions

Full and timely fulfillment of all organizational and pedagogical conditions justified above can contribute to the formation of professional competence by means of ICT among students of mathematical specialties. The analysis of the results of experimental studies made it possible to conclude that it is advisable to use ICT tools for the formation of professional competence of students of mathematical specialties, since, firstly, it has been experimentally proved that the use of ICT in the educational process makes it possible to increase the indicators of the formation of students' professional competence, and secondly, to activate them cognitive activity, to increase the stimulating and motivational component of the educational process.

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