

Features of Using Information and Communication Technologies in the Educational Process: The Case of Mathematical Education

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Abstract: The relevance of our study is determined by the global transition to a digital economy, a knowledge-based society. Today, specialists with information and communication competencies (and a special role in their education belongs to mathematics) are becoming in high demand. In this regard, this paper is devoted to the theoretical justification and development of the methodology for using information and communication technologies (ICT) in teaching mathematics in the context of digitalization of education. The implementation of the methods of complex and comparative analysis allowed us to reveal aspects of using ICT in the process of teaching mathematics, as well as to present technologies of mixed learning based on ICT. The authors conclude that the use of ICT in mathematics helps to effectively increase students' motivation, to involve students in active cognitive activity, and to construct an individual educational trajectory. The results of experimental work confirm that the effectiveness of using ICT in teaching mathematics in higher education institutions depends on the educator's competence in the field of ICT.

1. Introduction

Today, deep changes are taking place in the education system due to the specifics of the development of modern society. Considering the changes taking place in modern society, we can note, on the one hand, the openness of society to import a variety of knowledge, ideas, and information, and on the other hand, the transition to universal digitalization. In the context of digitalization, the possession of information and communication competencies, the ability to manage knowledge, i.e., to search, identify, extract, evaluate, store and exchange information, is becoming increasingly popular [1; 2].

In the context of the ongoing transition to the information society, the requirements of the organization of the educational process are changing, the emphasis is shifting from "a person who knows" to "a person prepared for life." Today, the formation of ICT competence can not be carried out only within the framework of particular disciplines, and an integrated, interdisciplinary approach is needed. A special role in this process belongs to mathematics [4]. However, an analysis of the practice of implementing higher mathematical education shows that currently, the implementation of mathematical disciplines is focused on the transfer of ready-made knowledge, it is not able to prepare a person for life in the modern information society.

As demonstrated by the comparative analysis of these studies, which were presented to the interdisciplinary, integrative studies on the formation of the ICT competence, these competencies in the aspect of mathematics education practically are not present. In connection with the above, the problem of the organization of the educational process that contributes to the formation of ICT competencies in the framework of mathematical disciplines requires an in-depth and purposeful study, which is why the relevance of the work. The purpose of this study is the theoretical justification and development of the methodology for using information and communication technologies in teaching mathematics in the context of digitalization of education. The main objectives of this study are the following: (1) to identify options for

the use of ICT in the educational process on the basis of the analysis of works on the digital transformation of the field of professional education; 2) to develop and test blended learning technologies in teaching mathematics based on information and communication technologies.

2. Materials and Methods

The paper presents the main issues related to the use of information and communication technologies in teaching mathematics by reviewing the main research in this area. The theoretical part of the study was presented: the components of the information educational environment, the analysis of ICT cases in teaching mathematics. In the practical part of the work was presented blended learning technology, which was tested in the universities of the Baikal region. During the study, the authors employed the methods of complex analysis and comparative analysis of studies on the formation of ICT competence. These methods made it possible to identify the most productive approaches to solving the tasks posed in the study, to outline the most promising lines for conducting research and obtaining new scientific results.

3. Results

Consideration of the evolution of the world education system allows us to argue that modern education is characterized by the formation of a new educational information environment. Also, we observe the active use of mobile devices, applications, tablets, the development of training using educational games in various media, the emergence of personal, educational spaces (a collection of resources and content selected by students for independent work). The active use of ICT in the educational process requires new approaches from the teacher to its organization, which implies a change in the role of the teacher from a simple translator of knowledge to the designer of the educational process [12]. A modern teacher should not only teach but also be able to design, adapt, manage, and evaluate an educational environment that includes digital materials. The effectiveness of the integration of information technology in the real educational process will depend on the ability of the teacher to structure the learning environment in a new way to combine new technologies and new pedagogy – digital didactics [3].

Mathematics in high school is quite a difficult subject. Therefore, to ensure maximum effectiveness of training, the teacher needs to find the best combination of tools, teaching methods, and technologies.

All modern pedagogical technologies are informational, as the educational process is impossible without the exchange of information. Today, the term "information technology" refers to the accumulation, processing, presentation, and use of information by electronic means [6]. Information technologies are characterized by the environment in which they are implemented and the components that they contain (see Fig. 1).

Based on the above, the use of information technology in the study of mathematics, first of all, requires a highly trained teacher who not only knows these programs well and knows how to work with them but can also teach his students how to use them [11].

Information technologies in mathematics classes are attractive because they are aimed at developing the communicative abilities of students while making the teacher's work more productive [4].

The use of ICT allows the teacher to solve the following tasks: increasing motivation to study mathematical disciplines; involving students in active cognitive activity; implementing maximum visibility, due to the adjustment of images, animation, colorful presentation of the material; constructing an individual educational trajectory; implementing a comprehensive assessment of the formation of competencies.

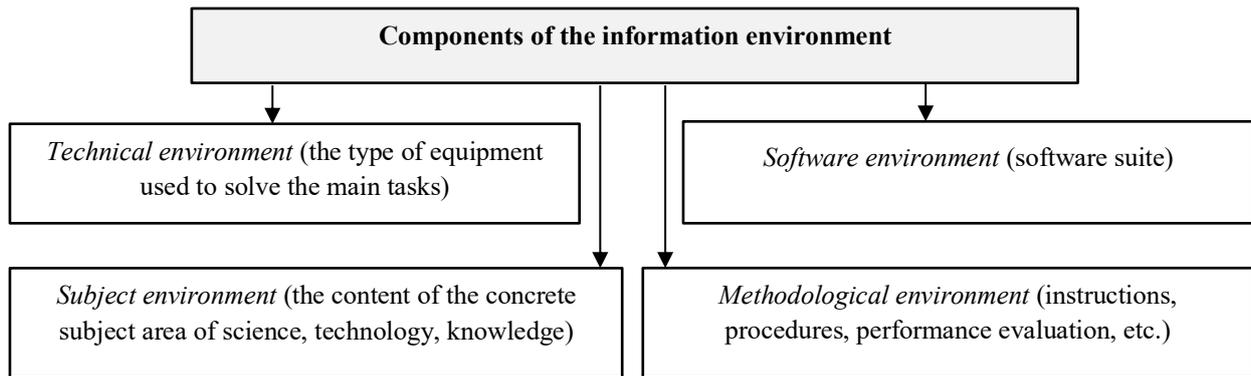


Fig. 1. Components of the information environment.

The use of information and communication technologies (ICT) changes the goals and content of training, new methods, and forms of training appear. The options for using ICT tools in the educational process that we are considering are presented in Fig. 2.

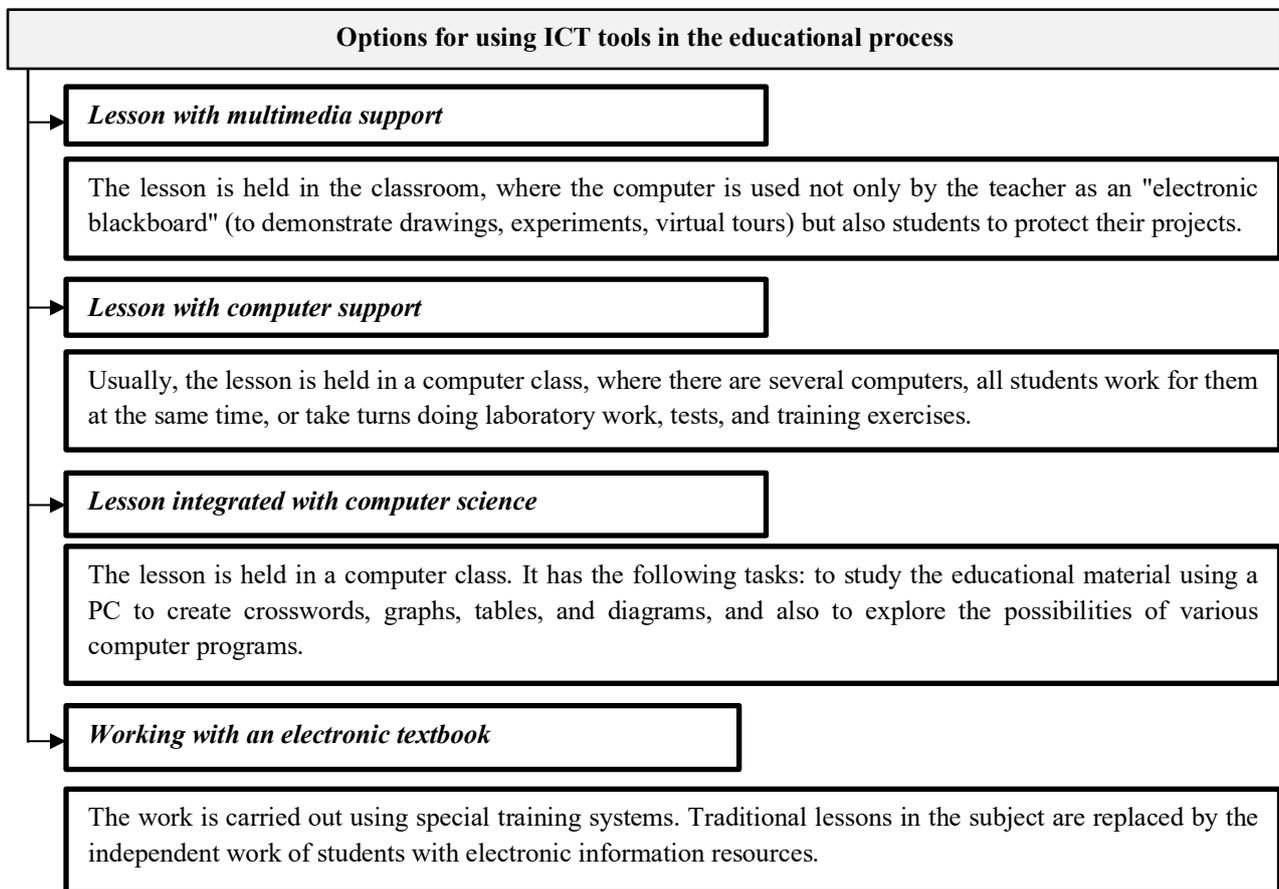


Fig. 2. Options for using ICT tools in the educational process.

There are various options for the application of information technology in the study of mathematics both in lectures and in practical classes [4; 9]. However, recently, teachers have been paying increasing attention to blended learning [7], which, based on ICT, is changing the role of both teacher and student.

The leading technologies of blended learning include:

- Mobile learning, which is based on different types of mobile applications (universal (dictionaries, guides, lectures, MOOC)), test, game, subject (task books, keys to tasks, atlases, USE, and BSE preparation applications));

- BYOD (Bring Your Own Device). In this technology, the workplace of students is created through the use of personal devices of students, in order to access information resources.
- "Flipped learning." In this technology, this is the acquaintance with training materials and its study is transferred from the lesson in the audience to independent work, through the use of ICTs (watching videos, electronic textbooks, etc.), and in the classroom, there is a discussion and solution of problems encountered during independent study;
- "Park lesson" is learning outside the classroom. During such training, for example, in mathematics, it is possible to make measurements and calculations on the ground, to get an idea of geometric shapes, etc. using mobile applications;
- Gamification. The basis of this technology is the application of application software approaches typical of computer games, which is used to attract users to the solution of applied problems. The methods of this technology provide constant feedback from the user, dynamic adjustment of user behavior, and, as a result, the rapid development of all the functionality of the application.

The use of blended learning provides several advantages, which include the following: the choice of network tools for work, the efficiency of work, open access to results, in-depth study, a differentiated approach to training, the development of information culture. Students using mobile devices will be able to access educational materials anywhere and perform the same tasks as on a wired network.

As an example, we will reveal in more detail the activities of a mathematics teacher using the technology of "flipped learning." In order to design a lesson on the technology of flipped training, it is necessary to determine the resources and specifics of the teacher's activity, which includes two stages.

At the first stage, in order to prepare students to perform independent work on a selected topic, before the start of the lesson, the teacher needs:

- Creating a resource directory (make a list of URLs of recommended ICT resources and tools (services));
- Determining the way to create an educational environment (content broadcasting, organize networking);
- Listing the main activities of students (information retrieval, information and cognitive, educational, training and research, analytical, experimental, productive, etc.), her character (individual work, work in groups, etc.);
- Describing the predicted knowledge gaps, difficulties in developing skills, etc., the elimination and overcoming of which must be paid attention to the lesson.

At the second stage, to organize the work of students in the lesson on this topic, the teacher must:

- Determine the main forms of work and types of activities of students in the lesson;
- Create an interactive worksheet that includes tasks to choose from for students
- Create an interactive test (for example using a Google form);
- Create an educational screencast – a digital video recording of the information displayed on a computer screen, accompanied by voice comments (not web- or video cameras are used to create screencasts, but special software such as CamStudio or Jing). Moreover, with the provision of the possibility of using the created educational screencast when repeating and fixing material, reflection.
- Create a "board of tasks" – a system of tasks for the independent solution and subsequent posting on the teacher's website or the forum of the university's electronic educational environment.

The results of practical work allow arguing that the proposed technology is effective not only for its aesthetic appeal. It also contributes to the activation of different channels of perception of students, thereby realizing the principles of accessibility and visibility (the use of animation, sound, videos, and hyperlinks). The use of modeling tasks when students experiment by working with the slider, see the changes directly on

the monitor screen, allows them to solve not typical mathematical problems, but to experiment, which contributes to their involvement in the educational process.

4. Discussion

The effectiveness of the use of ICT in teaching mathematics in higher education depends, according to many researchers, on the competence of the teacher in the field of ICT [5; 8; 10]. The last one is determined by

- technological literacy, i.e., possession of basic skills in working with digital technologies, an ability to select and use software, web content, and use ICTs to improve their skills;
- The ability to manage information, i.e., to identify, develop, save, and transmit information; to use open digital tools designed specifically for a specific subject area; to have skills in developing learning resources and educational environments based on ICT.

The teacher, in the conditions of the modern information society, is becoming a vital link in the educational system, which is tasked with preparing a person who is able to navigate in the information environment and generate new knowledge.

5. Conclusion

In conclusion, we note that the use of ICT and blended learning in mathematics classes, in our opinion, is most effective in increasing the motivation of students, introducing new material, demonstrating mathematical models, modeling, practicing certain skills, knowledge control, organization of research activities of students.

The use of blended learning provides benefits that will be considered as part of further research. Also, in the framework of further research, it is planned to write a textbook devoted to certain aspects of the use of ICT in mathematical education. We will pay special attention to the subject and methodological components of the information environment.

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