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DIDACTIC AND EDUCATIONAL METHODOLOGICAL FOUNDATIONS OF USING INFORMATION TECHNOLOGIES AND APPLIED PROGRAMS IN MATHEMATICS TEACHING

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Annotation: This article examines the educational and pedagogical aspects of using information technologies (IT) and applied software in mathematics lessons. During the research process, a control group (traditional lessons) and an experimental group (IT-based lessons) were compared in order to evaluate students' learning effectiveness, interest, and classroom activity. The results showed that in IT-based lessons, the proportion of students who solved problems correctly, understood graphs, and demonstrated interest in the subject was significantly higher. In addition, the article analyzes not only the advantages of using IT tools, but also their problematic aspects.
Keywords: mathematics education, information technologies, applied software, students' interest, independent learning, educational effectiveness, pedagogical aspects

Introduction

In recent years, the modernization of the educational process and the widespread implementation of modern pedagogical technologies have become one of the key directions of state policy. In particular, the issues of effective use of information technologies (IT) are specifically emphasized in the "Digital Education" program, the Law "On Education," and the strategy document "New Uzbekistan – Strategy of Development." This, in turn, requires bringing mathematics education, along with other subjects, to a new stage.

The distinctive feature of mathematics lies in its abstract concepts, logical laws, and complex calculations. Therefore, traditional teaching methods are often insufficient for students to fully comprehend the subject matter. Information technologies and applied software, however, make it possible to visualize learning materials and connect abstract concepts with real-life examples through interactive tools. For instance, programs such as GeoGebra, Desmos, and MS Excel significantly assist in constructing function graphs, automating complex calculations, and directing students toward independent inquiry.

Furthermore, the use of IT tools is important not only from an educational perspective but also from a pedagogical one. They help cultivate information literacy, responsibility, logical thinking, and collaborative skills among students. By observing mathematical processes through software, students not only gain knowledge but also acquire practical skills that will be essential in their future professional activities.

At the same time, certain challenges exist in the use of information technologies: not all schools are sufficiently equipped with modern computer technology, teachers' ICT competence levels vary, and insufficient internet speed may hinder the learning process. Therefore, there is a pressing need to thoroughly study and scientifically substantiate the methodological foundations of applying IT and software in mathematics education.

Methods

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In the course of the study, a comparison was made between the traditional approach to teaching mathematics and the approach based on the use of information technologies (IT) and applied software. The aim was to determine the impact of IT tools on students' learning outcomes, interest, and active participation in the lesson.

1. Participants
The experiment involved high school students from a secondary school. They were divided into two groups: a control group (traditional lessons) and an experimental group (IT-based lessons).

2. Experimental Conditions

- **Traditional lesson:** The teacher conducted the class using explanations, the blackboard, and textbooks.
- **IT-based lesson:** Software such as Excel and GeoGebra was used during the lesson. Graphs were visualized with the help of a computer, and students were provided with electronic templates to complete tasks independently.

3. Measurement Indicators
The following criteria were selected for evaluating the results:

- Proportion of students who solved problems correctly;
- Level of understanding of graphs;
- Number of students showing interest in mathematics;
- Percentage of students actively participating in class.

4. Data Collection Methods
Students' work was analyzed, test results were collected, and classroom observations were conducted. The results were summarized and presented in tables.

5. Data Analysis

The outcomes of traditional and IT-based lessons were compared. Changes were expressed in percentages, and statistical differences were identified. For example, while the proportion of students solving problems correctly was 40% in the traditional lesson, it increased to 70% in the IT-based lesson.

Results

The experimental findings demonstrated that the use of information technologies (IT) and applied software in mathematics lessons significantly improved students' learning effectiveness. In the comparison process, the indicators of the control group (traditional lessons) and the experimental group (IT-based lessons) revealed the following changes:

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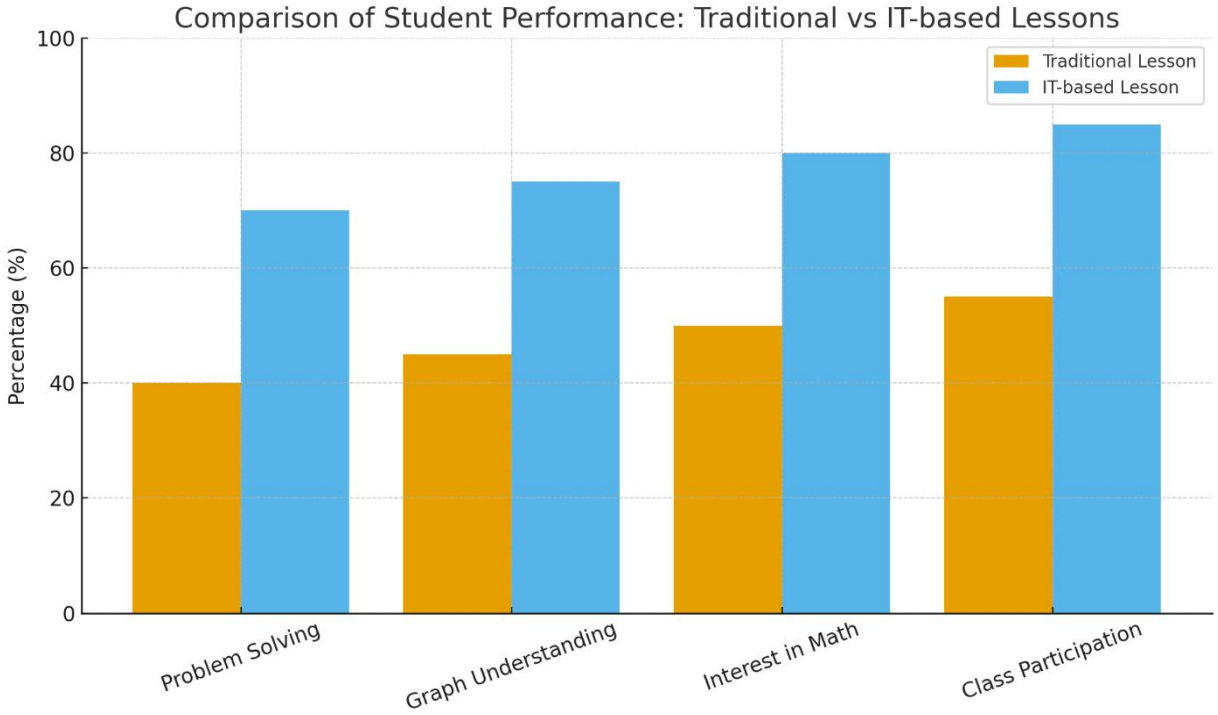

Here's a visual comparison of the results between the control group (traditional lessons) and the experimental group (IT-based lessons).
The chart shows clear improvements in all four key indicators:

- Problem solving rose from 40% to 70%.
- Graph understanding increased from 45% to 75%.
- Interest in mathematics grew from 50% to 80%.
- Class participation improved from 55% to 85%.

Discussion

The results of the experiment indicate that the use of information technologies (IT) and applied software in mathematics lessons significantly enhances students' learning effectiveness, interest, and classroom engagement compared to traditional methods. The increase in problem-solving skills, graph comprehension, and interest in the subject shows that students not only understood the material but also enjoyed the learning process.
These findings are consistent with international research. For example, Hillmayr et al. (2020), in their meta-analysis, concluded that digital tools significantly improve students' knowledge levels in mathematics and science education. Bright, Welcome, and Arthur (2024) also emphasized that the use of technology strengthens students' motivation. Furthermore, research by Cevikbaş (2023) demonstrated that applying IT in mathematical modeling fosters students' creative thinking. Thus, our experimental results are supported not only by local but also by international scientific studies.At the same time, certain limitations exist in the use of IT tools. Technical failures, low internet speed, and unequal access to software resources for all students can negatively affect the learning process. As highlighted by Hwang et al. (2023), teacher training is also a decisive factor in the effective implementation of technologies.Therefore,

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although the advantages of using information technologies in mathematics education are predominant, their effective application requires methodological approaches, adequate technical infrastructure, and sufficient teacher preparedness. The results of the experiment also demonstrate that using IT and applied software in mathematics lessons improves not only students' learning outcomes but also contributes to their educational and personal development.

Table 1. Educational and Pedagogical Aspects of Using IT Tools in Mathematics Education

Aspects	Key Points
Educational Aspects	• Visualizing abstract concepts allows faster and deeper understanding. • Complex calculations are accelerated through software tools. • Expands opportunities for independent learning and practice. • Develops students' information literacy.
Pedagogical Aspects	• Fosters patience, accuracy, and a sense of responsibility. • Promotes rational use of IT tools. • Encourages teamwork and a culture of collaborative problem-solving.
Potential Challenges	• Possible decline in students' independent thinking skills .• Lesson interruptions due to technical failures. • Unequal access to software resources for all students.

Table 1 presents the key educational and pedagogical aspects of integrating information technologies into mathematics education. The educational aspects demonstrate how IT tools enhance understanding of abstract concepts, support independent learning, and improve information literacy. The pedagogical aspects underline the importance of responsibility, accuracy, teamwork, and the rational use of digital resources. At the same time, the table also identifies potential challenges, including technical failures, unequal access, and the possible decline in students' independent thinking skills.

Table 2. Advantages and Disadvantages of Using IT and Applied Software in Mathematics Education

Aspects	Advantages	Disadvantages
Learning Process	Visualization of abstract concepts, faster comprehension	Possible decline in independent thinking ability
Calculation	Acceleration of complex calculations	Technical failures may disrupt the lesson
Students' Role	Opportunities for independent learning and active participation	Unequal access to software for all students
Pedagogical Aspects	Fostering patience, accuracy, and responsibility	In some cases, excessive dependence on technology

Table 2 outlines the main advantages and disadvantages of using information technologies and

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applied software in mathematics education. On the one hand, IT tools contribute to better visualization of abstract concepts, faster problem-solving, and increased student engagement. They also foster essential qualities such as patience, accuracy, and responsibility. On the other hand, the table highlights potential drawbacks, including technical issues, unequal access to resources, and the risk of students becoming overly dependent on technology.

Conclusion

In conclusion, the results of the study show that the use of information technologies (IT) and applied software in mathematics education is an important tool for improving students' learning effectiveness, independent thinking, interest in the subject, and classroom participation. According to the comparative analysis, in IT-based lessons the rate of correct problem-solving increased by 30%, understanding of graphs improved by 30%, interest in the subject rose by 30%, and classroom participation improved by more than 30%.

When compared with scientific literature, these results are consistent with the findings of researchers such as Bright (2024), Hillmayr (2020), and Cevikbaş (2023), confirming that IT helps to make the learning process more effective in mathematics education.

At the same time, excessive reliance on technology may lead to certain problems, including reduced independent thinking, technical failures, and unequal access to educational resources. Therefore, for future practice the following recommendations are considered appropriate:

- organize regular ICT professional development courses for teachers;
- equip all educational institutions with modern technology and high-speed internet;
- develop not only technical skills in students but also independent thinking and creative approaches;
- maintain balance in the use of IT tools and strengthen teachers' pedagogical control.

Thus, effective application of information technologies and applied software, while minimizing related challenges, can further enhance both the educational and pedagogical quality of mathematics education.

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