PROBLEMS IN TEACHING MATHEMATICS AND INFORMATICS IN GENERAL EDUCATION INSTITUTIONS AND METHODS FOR SOLVING THEM

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Abstract. This article analyzes the main challenges in teaching mathematics and computer science in general education schools. Students' low performance, methodological and pedagogical difficulties, as well as the insufficient infrastructure and resources of schools are examined. Scientifically-based solutions are proposed, including problem-based learning, project-based methods, gamification, visualization, and continuous professional development for teachers. The research results contribute to the development of students' logical and analytical thinking skills, enhance the interactivity and effectiveness of lessons, and improve performance in national and international assessments.

Keywords: mathematics, computer science, teaching methodology, challenges, interactive learning, problem-based learning, gamification, STEAM.

Introduction

Today, improving the effectiveness of teaching mathematics and informatics in general education institutions has become one of the most urgent issues of the education system. In an era of rapidly developing information and communication technologies and digital transformation, fostering students' logical thinking, analytical skills, and ability to use modern technologies is a key priority. At the same time,

various pedagogical and organizational challenges faced by teachers, as well as difficulties that arise during the learning process, may hinder the achievement of subject objectives.

In addition, educational infrastructure and methodological support play a significant role. Research on mathematics textbooks and teaching methods in Uzbekistan shows that textbooks mainly emphasize mechanical exercises and algorithmic solutions, while logical reasoning and creative approaches are applied less frequently. Furthermore, digital infrastructure, information resources, and teacher preparedness are still insufficient.

Thus, the main problems in teaching mathematics and informatics—low international performance, methodological and organizational challenges, and insufficient infrastructure—negatively affect the overall quality of education. Therefore, the purpose of this study is to conduct a scientific and practical analysis aimed at identifying key issues in the teaching of mathematics and informatics in general education institutions, examining their underlying causes, and developing recommendations for addressing them.

The findings of this research may contribute to improving teachers' professional practice, optimizing the learning process, and increasing students' motivation. Moreover, it may support the integration of subjects, the use of modern technologies, and the implementation of practice-oriented teaching methods within the school education system.

1. Low Student Performance

Currently, students in Uzbekistan demonstrate comparatively low results in mathematics and informatics in both national and international assessments. According to the TIMSS 2023 report, 8th-grade students scored 421 points in mathematics and ranked 32nd out of 44 countries. Fourth-grade students scored 443 points, placing 50th. Based on PISA 2022 data, the mathematical literacy of 15-year-olds is significantly below the international average: 364 points compared to the average of 472. These

results indicate shortcomings in developing students' logical reasoning, analytical thinking, and practical skills.

Problem Analysis:

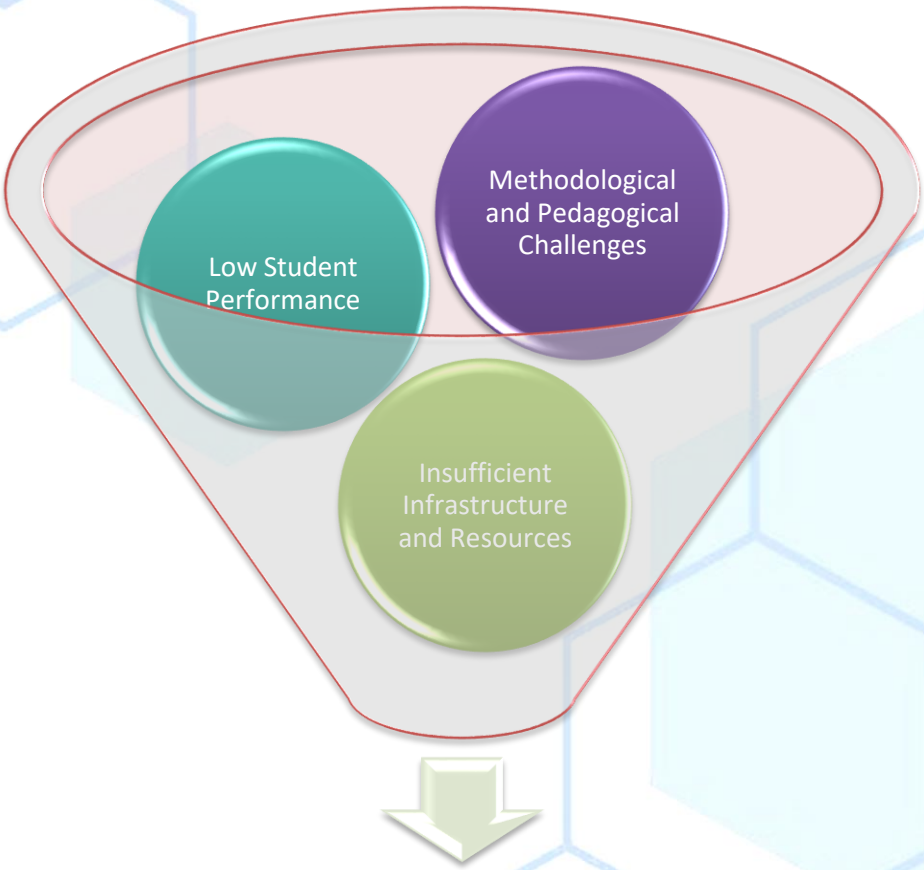
One of the main causes of low performance is the excessive focus on theoretical knowledge and the lack of practical application. Many students memorize formulas and algorithms but struggle to apply them to real-world problems. In informatics as well, students do not receive sufficient practice in coding and algorithmic problem-solving.

Another contributing factor is low motivation and limited interest in the subjects. Monotonous lessons, a focus on rote tasks and testing, and the absence of real-life applications reduce students' engagement.

Scientifically Based Solutions (Figure 2)

- **Implementation of Project-Based Learning (PBL).** This approach offers students real-life problem-solving tasks, reinforcing theoretical knowledge and developing logical and analytical thinking. For example, economic calculations in mathematics or designing a simple robot algorithm in informatics help enhance practical skills.
- **Laboratory sessions and project work.** Applying the "learning by doing" principle through mathematical projects or coding assignments enables students to develop deeper conceptual understanding and independent problem-solving abilities.
- **Gamification of lessons.** Integrating game elements, such as mathematical quizzes or coding competitions, increases student interest. Visuals—diagrams, graphs, and animations—help combine theoretical and practical learning.
- **Differentiated instruction.** Assignments and projects should consider individual differences. Advanced students may be given more challenging tasks, while additional support can be provided for students at a lower proficiency level.

- **Continuous assessment and feedback.** Regular evaluation helps identify learning gaps. Online tests and interactive platforms enable rapid feedback, enhancing students' self-assessment abilities.



Main problems

Figure 1

Result:

When these solutions are systematically implemented, students demonstrate significant improvement not only in theoretical knowledge but also in practical skills. Moreover, logical reasoning, creative thinking, and independent problem-solving abilities develop more effectively, which contributes to higher performance in both international and national assessments.

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2. Methodological and Pedagogical Challenges

In general education schools, the methodological and pedagogical difficulties encountered in teaching mathematics and computer science considerably affect students' ability to master these subjects in depth. Although current textbooks and methodological manuals provide extensive theoretical material, they lack sufficient real-life examples, practical tasks, and exercises that develop logical thinking. As a result, students tend to memorize information mechanically but face difficulties applying it in practical situations. This leads to the underdevelopment of higher-order thinking skills in the learning process—such as analysis, comparison, generalization, and creative problem-solving.

Furthermore, the methodological preparedness of teachers is also considered a significant issue. Many educators are unable to consistently and effectively utilize modern teaching technologies, interactive methods, the STEAM approach, gamification, and project-based learning. One of the main reasons for this is that teacher training courses are often theoretical in nature, and practical training is insufficiently organized. In the field of computer science, the uneven level of teachers' proficiency in programming languages, algorithmic thinking, and digital technologies negatively affects the quality and content of lessons.

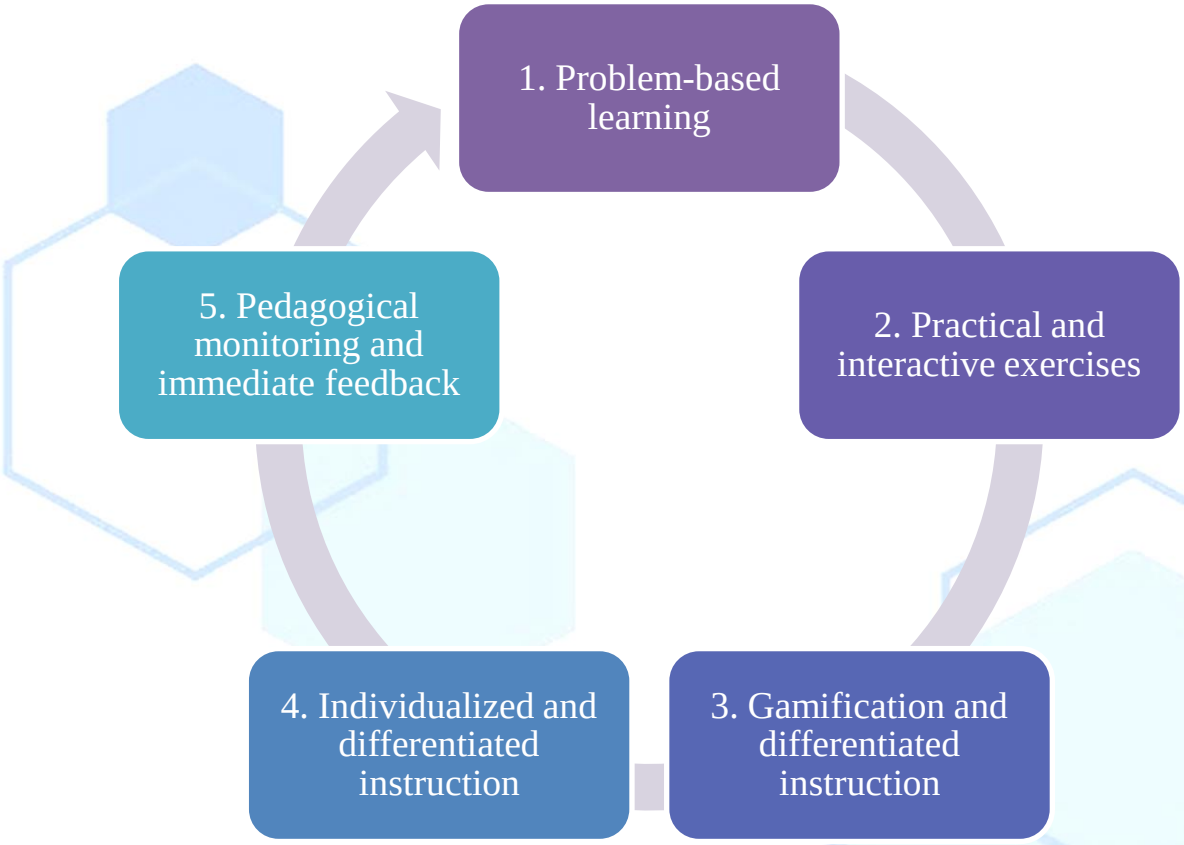

Figure 2

Another major methodological challenge is that many classes are still conducted using traditional, teacher-centered approaches. In such settings, students remain passive listeners, with limited opportunities for collaboration, discussion, argumentation, and justification of their ideas. When learners are not active participants in the lesson, teaching effectiveness decreases, and independent thinking skills fail to develop.

To address these issues, it is essential to integrate modern approaches into the teaching process. The implementation of problem-based learning enables students to explore real-life situations independently, analyze problems, develop solutions, and justify their opinions scientifically. In addition, project-based learning allows students to study concepts in an integrated manner, understand the interconnection between mathematics and computer science, and demonstrate their knowledge through practical tasks. The use of gamification elements enhances motivation through competition and

rewards. Employing tools such as graphs, simulators, algorithm visualizers, GeoGebra, and similar technologies helps students grasp abstract concepts more concretely.

Overall, the presence of methodological and pedagogical difficulties reduces the effectiveness of teaching mathematics and computer science. Systematic implementation of modern teaching methods, continuous methodological support for teachers, and organizing interactive lessons serve as the most effective ways to address these issues.

3. Insufficient Infrastructure and Resources

One of the major problems in teaching mathematics and computer science in general education schools is the lack of modern infrastructure and learning resources. Many schools have limited or outdated computer labs, low internet speed, and insufficient electronic learning materials. This complicates the use of interactive methods during lessons and hinders the development of students' practical skills. Additionally, teachers are often unable to abandon traditional methods because the existing infrastructure does not support the use of modern technologies.

Scientific analysis shows that the lack of technological resources decreases student motivation and leads to a passive learning experience. When students cannot use interactive platforms, visualization tools, or practical activities, their understanding of subjects and ability to independently develop solutions weakens. Moreover, insufficient digital resources make individual and differentiated instruction more difficult.

Several scientifically grounded solutions can be proposed to address this issue. First, computer labs in schools should be modernized and provided with stable internet access. The introduction of electronic textbooks, virtual laboratories, and online exercise and testing platforms will allow students to learn subjects interactively. Additionally, enhancing teachers' digital literacy is essential. Organizing online training, practical seminars in programming, and mentorship programs will help teachers master technology and apply modern teaching methods effectively.

Overall, insufficient infrastructure and resources present a significant barrier to effective teaching of mathematics and computer science. Addressing this issue through scientific and systematic measures will enhance students' practical skills, increase interactivity during lessons, and support deeper subject mastery.

Conclusion

In conclusion, the problems encountered in teaching mathematics and computer science in general education schools — low student performance, methodological and pedagogical difficulties, and insufficient infrastructure and resources — significantly reduce the effectiveness of the education process. Students' low outcomes in international and national assessments are explained by excessive emphasis on theoretical knowledge and insufficient practical skills. Lessons often remain passive and teacher-centered, preventing students from developing independent thinking, analytical skills, and creative approaches. Methodological challenges are associated with limited application of modern interactive methods, project-based learning, and the STEAM approach, as well as inconsistencies in teachers' methodological preparedness.

Effective solutions to these issues include implementing problem-based learning, project-based approaches, gamification, and visualization techniques in the teaching process. Problem-based learning teaches students to solve real-life problems; project-based learning enhances comprehensive understanding and interdisciplinary connections; and gamification and visualization make lessons engaging and interactive, increasing motivation and deep comprehension. Furthermore, continuous professional development for teachers through practical seminars, training programs, and mentorship systems will help integrate new methods into real classroom practice. Addressing infrastructure and resource shortages by establishing modern computer labs, ensuring stable internet access, and introducing electronic textbooks and online learning platforms is also crucial.

Overall, systematic implementation of these scientifically grounded solutions will significantly improve students' knowledge and skills in mathematics and computer

science, make the learning process more interactive and effective, and foster logical reasoning, creativity, and independent problem-solving abilities. This, in turn, will enhance educational quality in schools, strengthen teachers' pedagogical capacity, and improve students' performance in both international and national assessments.

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