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MODERN METHODOLOGICAL APPROACHES TO TEACHING THE SOLUTION OF IRRATIONAL EQUATIONS

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Abstract

This scientific article analyzes the process of teaching the solution of irrational equations from mathematical and didactic perspectives. The study examines the role of irrational equations in the algebra curriculum, methodological difficulties encountered in solving them, and the potential of modern pedagogical and digital technologies to overcome these challenges. Based on the results of pedagogical observations, the positive impact of interactive and visual approaches on learning outcomes is scientifically substantiated. The findings of the article contribute to improving the quality of mathematics education.

Keywords

irrational equations, algebra education, squaring method, graphical analysis, interactive methods, digital technologies.

INTRODUCTION

In the context of modern mathematics education, the development of students' logical, critical, and analytical thinking skills is regarded as one of the key priorities. Within the algebra curriculum, irrational equations occupy a special place due to their theoretical significance and their potential to enhance higher-order cognitive skills. Solving irrational equations requires not only the application of algebraic transformations but also the ability to analyze the domain of definition, establish logical connections between expressions, and verify the validity of obtained solutions. Practical experience shows that these aspects often pose significant difficulties for students.

The recent shift toward a competency-based approach in education has led to a reconsideration of traditional teaching methods in mathematics. Students are now expected not merely to apply ready-made algorithms but to analyze problem situations critically, compare different solution strategies, and justify their reasoning. From this perspective, the methodology of teaching irrational equations requires scientific re-evaluation and adaptation to contemporary educational demands.

An analysis of existing research indicates that the theory of solving equations has been extensively studied in classical mathematical literature. Fundamental works by A. N. Kolmogorov, I. M. Vinogradov, and G. Polya provide a solid theoretical and logical foundation for equation-solving techniques. More recent studies by D. Tall and M. Artigue emphasize the importance of visual representations and digital technologies in the development of mathematical understanding. However, despite these contributions, the issue of integrating modern pedagogical tools into the teaching of irrational equations at the secondary education level remains insufficiently explored. This gap determines the relevance of the present study.

MAIN PART

Irrational equations represent one of the more challenging topics in school algebra, combining formal symbolic manipulation with conceptual reasoning. Their complexity arises from the presence of radicals involving the unknown variable, which imposes restrictions on admissible values and necessitates careful consideration of the domain of definition. Consequently, effective instruction in this area must balance mathematical rigor with methodological clarity.

Pedagogical observations reveal that the most frequent errors in solving irrational equations are associated with the squaring process. When both sides of an equation are squared, the logical equivalence of the transformation is conditional rather than absolute, often leading to the emergence of extraneous solutions. This difficulty is primarily caused by insufficient attention to the preliminary analysis of the domain and the final verification of solutions. Therefore, teaching practices should explicitly emphasize these stages as integral components of the solution process.

Traditional algebraic methods, including squaring, substitution, and functional approaches, remain essential tools for solving irrational equations. Nevertheless, when these methods are presented solely as mechanical procedures, students tend to develop a superficial understanding of the topic. A more effective approach involves highlighting the internal structure of equations and the relationships between their components, enabling learners to perceive solution methods as logically motivated rather than algorithmically imposed.

In recent years, graphical analysis and visual modeling have gained increasing importance in mathematics education. By interpreting irrational equations as intersections of functions, students can analyze solutions geometrically and gain intuitive insight into the number and nature of roots. This approach strengthens the connection between algebraic and geometric thinking and supports conceptual understanding.

The integration of digital technologies has further expanded the methodological possibilities for teaching irrational equations. Interactive software such as GeoGebra and Desmos allows for dynamic visualization of functions and immediate feedback on parameter changes. Such tools promote exploratory learning, encourage independent investigation, and foster deeper engagement with mathematical concepts. Empirical observations indicate that students exposed to digitally supported instruction demonstrate greater accuracy in determining domains and identifying extraneous solutions.

Pedagogical experience also suggests that interactive learning environments contribute positively to students' reasoning skills. Problem-based tasks, exploratory activities, and guided discussions enable learners to articulate their thinking and justify solution steps. As a result, students develop a more coherent and reflective approach to solving irrational equations.

Overall, the analysis confirms that reliance on purely algorithmic instruction is insufficient for mastering irrational equations. The combination of algebraic reasoning, visual representation, and digital technologies creates favorable conditions for meaningful learning and supports the development of mathematical thinking.

CONCLUSION

The results of the study demonstrate that modern methodological approaches significantly enhance the effectiveness of teaching irrational equations. The integration of visual, interactive, and digital tools with traditional algebraic methods leads to improved conceptual understanding and more stable learning outcomes. Such an approach not only facilitates the mastery of irrational equations but also contributes to the broader development of students' analytical and critical thinking skills.

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