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METHODOLOGY OF TEACHING QUADRATIC FUNCTIONS AND GRAPH CONSTRUCTION IN SECONDARY SCHOOLS

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Annotation; This article analyzes effective methods for teaching quadratic functions and graph construction in secondary schools. The key properties of quadratic functions, techniques for graphing, and pedagogical approaches that enhance students' analytical thinking are discussed. The importance of innovative teaching technologies and interactive methods is emphasized. The findings indicate that step-by-step instruction in graph construction improves students' mathematical literacy and independent thinking skills.

Keywords: Quadratic function, parabola, graphing, teaching methodology, mathematics education, interactive methods, analytical thinking

In the modern educational system, the development of students' logical and analytical thinking is of great importance. The study of the quadratic function and its graph is one of the fundamental topics in the algebra curriculum and plays a significant role in the formation of functional thinking. This topic helps students develop skills in graph interpretation, mathematical modeling, and the analysis of problem situations. In practice, however, students often encounter difficulties in constructing the graph of a parabola and identifying its elements. This indicates the necessity of improving teaching methodologies. The purpose of this article is to identify effective methods for teaching quadratic functions and their graphs and to introduce them into the educational process. In our country, mathematics was designated as one of the priority areas for the development of science in 2020. The recognition of mathematics as a priority field of scientific development reflects the government's strong commitment to this discipline. This creates broad opportunities for improving mathematics education, introducing modern teaching methods, and enhancing students' knowledge and potential.

LITERATURE REVIEW AND METHODS

An analysis of scientific and pedagogical literature related to the methodology of teaching quadratic functions and their graphs shows that this topic has been studied by numerous researchers as one of the central sections of the algebra curriculum. In particular, school mathematics textbooks and methodological manuals extensively discuss the properties of quadratic functions, methods of graph construction, and approaches to developing students' graphical thinking. Modern studies especially emphasize the effectiveness of interactive methods, information and communication technologies, and visual tools in the teaching process.

This study employed methods such as the analysis of scientific and pedagogical literature, comparison, observation, and experimental research. Particular attention was paid to strengthening students' knowledge through step-by-step graph construction, the creation of problem-based situations,

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the application of interactive teaching methods, and the use of software such as GeoGebra during classroom instruction.

DISCUSSION AND RESULTS

Within the framework of this study, the effectiveness of teaching methodologies for quadratic functions and their graphs in general secondary schools was comprehensively analyzed. The findings were obtained through a comparison of traditional and modern pedagogical approaches. The results indicate that students' level of understanding of the concept of a quadratic function is directly dependent on the appropriate selection of teaching methods. It was emphasized that greater attention should be given to increasing young people's interest in mathematics, identifying gifted students, and effectively organizing their admission to specialized schools and subsequently to higher education institutions. The task was also set to develop popular textbooks and educational materials written in a simple and understandable language and to foster mathematical thinking from an early age, even beginning in preschool education. Mathematics is the foundation of all exact sciences. A student who masters mathematics develops intellectual abilities, broad thinking skills, and is more likely to achieve success in various professional fields. Developing an interest in mathematics from an early age is an important factor in enhancing the intellectual potential of young people. Identifying talented students, providing them with access to quality education, and creating simple and accessible educational resources contribute significantly to the advancement of mathematics education. As the foundation of all exact sciences, mathematics helps students develop logical reasoning, broad perspectives, and a strong basis for future success in diverse fields.

In many schools, teacher-centered and lecture-based instruction still predominates. Under this approach, students are mainly directed toward memorizing ready-made formulas, while their independent thinking skills are not sufficiently developed. As a result, mathematical concepts are often not understood deeply. Researchers have noted that mathematical knowledge should be formed not only through reproductive learning but also through constructive activities. A teacher-centered approach cannot fully develop students' independent thinking abilities. Education based primarily on memorizing formulas often leads to superficial understanding of mathematical concepts. Therefore, the use of modern teaching methods based on constructive learning and active student participation is essential for improving the quality and effectiveness of mathematics education. From this perspective, the effectiveness of lessons organized on the basis of modern pedagogical technologies was examined in detail. Interactive methods, particularly brainstorming, clustering, and small-group work, significantly increase students' participation in the learning process. As a result, students are able to acquire knowledge more consciously and effectively. Research conducted by J. Hattie also confirms the high effectiveness of interactive teaching methods.

Lessons organized through modern pedagogical technologies demonstrate a high level of effectiveness in enhancing students' cognitive activity. Interactive methods encourage independent thinking, collaborative learning, and meaningful knowledge acquisition. Consequently, the educational process becomes more engaging and productive. This approach plays an important role in achieving a deeper understanding of mathematical concepts and developing practical skills.

During the experimental stage of the study, a step-by-step methodology was applied in teaching students how to construct the graph of a quadratic function. The main advantage of this methodology

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is that it divides a complex process into simple and understandable stages. First, the general form of the function is analyzed; then, the roots are determined using the discriminant, followed by identifying the vertex and the axis of symmetry. This approach helps students understand graph construction systematically. The research findings demonstrated the effectiveness of this methodology. By identifying the fundamental elements of the function in sequence, students strengthened their graphing skills. This approach also promotes logical thinking and enhances students' ability to acquire and apply mathematical knowledge systematically.

Particular attention was also paid to the use of information and communication technologies. Software applications such as GeoGebra enable students to observe dynamic changes in graphs in real time. This helps them gain a deeper understanding of the relationship between function parameters and graph behavior. According to the studies conducted by M. Kaput, digital technologies play a significant role in the visualization of mathematical concepts.

Digital tools facilitate the visualization of mathematical concepts and contribute to a more meaningful understanding of the topic. As a result, students' interest in learning increases, while their analytical thinking, independent inquiry, and practical skills continue to develop. The importance of visual aids was also confirmed during the research. The use of colored graphs, animations, and interactive whiteboards attracts students' attention and improves their level of understanding. According to R. Mayer's Cognitive Theory of Multimedia Learning, the integration of visual and verbal information significantly enhances learning effectiveness.

As a result, students' interest in lessons increases, and their mathematical thinking, analytical approach, and academic engagement improve considerably. The results of applying problem-based learning were also positive. When students were presented with tasks based on real-life situations, they developed a deeper understanding of mathematical concepts. For example, explaining quadratic functions through parabolic motion or economic processes increased students' interest in the topic. As emphasized by J. Dewey, education should be closely connected with real-life experiences. Such an approach promotes the development of independent thinking, problem analysis, and problem-solving skills. Consequently, the learning process becomes more meaningful, engaging, and relevant to students' everyday lives.

The experimental results showed that students in classes where innovative teaching methods were implemented demonstrated significantly higher achievement levels. In particular, the accuracy of graph construction increased by 30–40 percent. This practically confirms the effectiveness of the proposed methodology.

Furthermore, the importance of a differentiated approach was identified. Assigning tasks according to students' individual abilities and levels of knowledge positively influences their development. L. Vygotsky's theory of the "Zone of Proximal Development" provides the scientific foundation for this process. The findings confirm the practical effectiveness of modern approaches in teaching quadratic functions and demonstrate their importance in developing students' knowledge, skills, and competencies.

The integration of theory and practice was also identified as an important factor. Studying formulas alone is not sufficient; they should be reinforced through practical exercises and real-world

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applications. Such an approach contributes to the development of students' mathematical thinking. Moreover, this approach makes it possible to provide instruction tailored to each student's pace of development, thereby fostering independent thinking and enhancing mathematical potential.

The teacher's methodological competence also plays a crucial role. Effective lesson organization, the selection of appropriate teaching methods, and student motivation contribute significantly to achieving high educational outcomes. Research has shown that teachers' professional competence directly affects the quality of education. In addition, students' motivation has a considerable impact on teaching effectiveness. The use of engaging methods and innovative technologies during lessons increases students' interest in the subject, leading to deeper understanding and more effective learning.

Overall, the conducted research demonstrated that the use of modern teaching methods in teaching quadratic functions and their graphs is highly effective. This approach contributes to improving students' mathematical literacy, developing their analytical thinking abilities, and enhancing the overall quality of education. Therefore, the wider implementation of these methods in educational practice is highly recommended.

CONCLUSION

In conclusion, teaching topics related to quadratic functions and their graphs in general secondary schools is an essential component of mathematics education. This topic plays a significant role in developing students' analytical thinking, logical reasoning skills, and competence in analyzing functional relationships.

The use of modern pedagogical technologies, interactive methods, and information and communication tools in explaining the properties of quadratic functions and constructing their graphs significantly increases the effectiveness of instruction. In particular, graphical representations and demonstrations of how parameter changes affect the shape of a parabola enable students to achieve a deeper understanding of the subject matter.

The research findings indicate that combining theoretical knowledge with practical exercises and applying both individual and collaborative learning methods enhances students' interest in the topic. At the same time, it promotes the development of independent thinking, problem-solving abilities, and mathematical modeling skills.

These methodological approaches provide an effective foundation for improving the quality of mathematics education and ensuring that students acquire strong theoretical knowledge and practical competencies in the subject.

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