



DOI: 10.54919/physics/56.2024.146vf4

Methods of teaching secondary school students to solve algebraic equations and inequalities and their systems

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Abstract

Relevance. The relevance of this study is conditioned by the integral role of algebraic equations and inequalities in mathematics education, as well as the need for effective methods and approaches to their teaching at the secondary school level.

Purpose. The study aims to develop and appropriate methods for teaching secondary school students to solve algebraic equations and inequalities, including their systems, taking into account modern educational requirements and pedagogical approaches.

Methodology. In the course of the study, methods such as experimental research, questionnaire surveys, and statistical analysis of data were used.

Results. Because of the study, it was revealed that the innovative methodology for teaching the solution of algebraic equations and inequalities in secondary school had a positive impact on students' mastery of the material. The participants demonstrated a deeper understanding of algebraic concepts, increased independence in problem-solving, and developed critical thinking skills. They became more confident in analysing and interpreting problem conditions, identifying relationships between variables, and proposing adequate solutions. The new approach also improved students' motivation to study algebra and their academic performance, with increased interest and passion for the subject due to the interactive methods and practical tasks provided.

Suggested Citation:

Sansyzbayeva A, Daiyrbekov S, Berdaliyev D, Daiyrbekova G, Sansyzbayev A. Methods of teaching secondary school students to solve algebraic equations and inequalities and their systems. *Sci Herald Uzhhorod Univ Ser Phys.* 2024;(56):1464-1473. DOI: 10.54919/physics/56.2024.146vf4

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Conclusions. The study confirms the effectiveness of the innovative methodology in the contemporary educational context of mainstream schools. The practical significance of the study lies in providing mainstream schoolteachers with tools to successfully teach students algebraic equations and inequalities, contributing to the development of analytical thinking and mathematical competence.

Keywords: interactive lessons; visualization of mathematical concepts; individual progress; skill development.

Introduction

Modern education undoubtedly plays an important role in shaping future citizens with comprehensive knowledge and skills capable of successfully navigating a dynamic world. Mathematical competence, as one of the key components of education, ensures the development of analytical thinking, logic, abstract reasoning and the ability to solve complex problems. An important stage in the formation of mathematical competence is mastering the skills of solving algebraic equations, inequalities, and their systems. This skill not only develops the ability to analyse and draw logical conclusions, but also teaches students to apply mathematical tools to solve practical problems. In recent years, the emphasis on the development of mathematical competence has become more pronounced, and researchers and educators are striving to find effective teaching methods that would contribute to a better mastery of algebraic equations and inequalities in secondary school. This article directs attention to the analysis of teaching methods for solving algebraic equations, inequalities, and their systems presented in modern research.

Many publications have been devoted to the research of effective approaches to teaching algebraic equations and inequalities. However, despite this, some aspects of the methodology remain under-researched and require additional analysis.

It is worth emphasizing the study by R.E. Groth [1], which focuses on the development of evidence-based practices in mathematics teaching. The article analyses in detail the research and approaches to mathematics teaching that are based on scientific evidence, but the paper pays little attention to individual needs and the diversity of students' learning styles. Therefore, it is important to consider techniques that help to tailor learning to individual pupils. In addition, the paper does not consider which techniques promote the development of the ability to apply mathematical knowledge in everyday life.

It should also be noted in the work of D. Zulpukarova et al. [2], in which the authors point out the importance of developing pupils' creative activity in the process of learning mathematics. It is noted that the performance of creative tasks requires pupils not simply reproduction of information, but the manifestation of creative abilities because of the element of ambiguity in the tasks themselves. A creative task is the basis for the application of interactive teaching methods, and it is especially effective if it is practical and related to students' everyday lives. However, the article does not analyse how these methods can be adapted to different levels of students. Some tools or approaches may be more appropriate for certain groups of students rather than for all students in mainstream schools. In addition, this paper does not address the possible limitations and difficulties that teachers may encounter when using these tools in educational practice.

The book is authored by J. Stigler and J. Hiebert [3] is a study aimed at analysing mathematics teaching methods in different countries to identify best practices and approaches. The focus of the paper is on international experiences in teaching mathematics and attempts to identify best practices that can be applied to improve education. The paper describes methods from different countries but does not always take into account the specific socio-cultural and educational context of each country. It is important to analyse which techniques can be successfully adapted to the specific conditions and needs of different educational systems.

The work of B. Kaskatayeva et al. [4] presents a study on the preparation of mathematics teachers and their readiness to develop students' mathematical culture at school. The study highlights the need to organize such a pre-service training of mathematics teachers, which would guide the development of their psychological and professional readiness to teach in schools, equip them with fundamental knowledge and skills in mathematics, correct educational methods and digital technologies applied according to the needs of the teaching process. The article presents a theoretical model for the training of future teachers of mathematics. However, the article does not analyse how the proposed model of teacher training takes into account the individual needs and diversity of students' abilities. Also, the article does not pay attention to the methods of assessing the success of student learning under the guidance of future teachers of mathematics.

It is also worth highlighting the work of L. Hrynevych et al. [5], who examine the problem of the quality of mathematics education in schools from the point of view of student's ability to apply the acquired knowledge of mathematics to solve practical problems. The article presents the results of a study involving 1849 schoolchildren. Examples of mathematical problems developed by the specialists of the Ukrainian Centre for Education Quality Assessment are given. Typical mistakes of pupils are analysed, as well as the most successful solutions. However, the article does not analyse the teaching methods used to develop pupils' ability to apply mathematical knowledge to practical situations. Also, the article does not analyse the use of innovative approaches or technologies in the process of teaching mathematics.

T. Mukina and H. Chun [6] analyses algebra teachers' beliefs and knowledge about teaching. The authors investigate how teachers' beliefs shape their teaching methods and how their subject knowledge influences their teaching practices. The purpose of the study is to find out how teachers' beliefs and their knowledge about algebra affect their decision-making in the educational process. The researchers used questionnaires and interviewing techniques to collect data by interviewing teachers from different educational institutions. However, apart from this, the article does not assess what teaching materials and

resources teachers use to teach algebra. This could be a key factor in their teaching methods. The article does not look at the specific pedagogies and tools teachers use when teaching algebra. The influence of cultural and contextual factors on teachers' beliefs and knowledge is not considered. Thus, the article does not offer specific recommendations or strategies for teachers and educational organizations to improve algebra teachers' knowledge and beliefs.

Against the background of these gaps in previous studies, this article aims to provide a comprehensive analysis of techniques for teaching secondary school students to solve algebraic equations, inequalities, and their systems. The problems of individual approach, use of modern technologies and adaptation of methods for different age groups require further study. This study is an important step towards improving pedagogical practice in the field of teaching algebraic equations and inequalities in secondary school and will help identify and propose new approaches to solving urgent problems that were left unsolved in previous studies.

Materials and Methods

This work, aimed at developing a new methodology for teaching secondary school students to solve algebraic equations and inequalities, as well as their systems, is based on the complex application of various methods of scientific knowledge, including also experimental research, questionnaires and statistical analysis of data.

An experimental study was conducted to evaluate the effectiveness of the developed Innovative methodology. In this study, an experimental design was used, which involved conducting student teaching using the developed methodology and comparing the effectiveness of the new teaching methodology with traditional methods. The study was conducted within several schools in the city of Almaty to provide a variety of data and to account for differences in educational practices. One of the schools was chosen as a base for the experiment. Specially designed educational materials, including textbooks, assignments, tests and practical tasks were used for the study. Visualization tools and interactive educational technologies were also used for more effective learning.

The study collected data on students' performance, including their grades and test scores, and assessed their level of understanding of algebraic concepts and their ability to apply them to solve problems. Also, in addition, during the experiment, data on the progress of learning was recorded, including lessons, practices, and assignments. Teachers who applied the developed methodology also provided data on the learning process and students' performance. To conduct the pilot study, a purposive sample was formed of secondary school students representing different age groups and levels of mathematical training of pupils in grades 5-9. The total number of participants was 200 people, who were randomly divided into two groups: experimental and control.

Statistical methods such as mean values; and correlation analysis were used to analyse the data. The mean value is used to calculate the average performance level of students in experimental and control groups. Comparison of mean values before and after the

implementation of the methodology helps to determine how the achievement changes because of the training. Correlation analysis was used to identify relationships between different variables, for example, between the level of comprehension and student performance. Graphs and data visualization were also used in the data analysis process. Graphs of students' performance in the experimental and control groups were used to visually compare the results before and after the training. This made it possible to see the changes in academic performance at a graphical level.

The sample was formed by randomly dividing the students into two groups: experimental and control. The participants in the experimental group received instruction using the innovative methodology developed, which included steps to solve algebraic equations and inequalities, applying a systematic approach and visualizing concepts through graphics and diagrams. They also participated in interactive lessons and hands-on activities designed to reinforce their understanding of the material. Students in the control group continued with the traditional methodology, which involved a more formal study of algebraic equations and inequalities, with no emphasis on interactive methods and visualization. The experiment was organized in several stages. To collect data, the first phase involved diagnosing students' initial level of knowledge and skills in algebraic equations and inequalities.

Then the training began, which included systematic study of theory, interactive lessons, practical tasks and games. At the end of the training, there was a control test of knowledge. Students in both groups took tests and solved problems that were similar to the diagnostic tasks conducted before the training. This allowed a comparison of their performance and understanding of algebraic concepts before and after the training. The data collected was analysed using statistical methods to compare the results before and after the implementation of the technique.

Thus, the combination of different methods of scientific cognition allowed comprehensive investigation of the effectiveness of the developed innovative teaching methodology and identifying its potential for the development of algebraic skills of secondary school students.

Results

In the modern educational context, the development of algebraic competence among secondary school students is of key importance for the formation of analytical thinking, logical skills and problem-solving abilities. The rapid development of educational technologies and the requirements for the adaptability of the educational process raises an important question about the development of an effective methodology for teaching the solution of algebraic equations, inequalities, and their systems. Therefore, this study aims to develop and validate a new methodology that promotes a deep understanding of algebraic concepts, the development of analytical thinking and the application of mathematics in real-life situations. The results of the study are presented based on theoretical analysis of existing approaches, experimental data and

approbation of the methodology in real conditions of the educational process.

The methodology developed in this article is called “Innovative”. It represents a comprehensive approach to teaching students’ algebraic equations, inequalities, and their systems, including a systematic approach focused on understanding and visualization of the material. The main idea of the Innovative Methodology is to conduct interactive lessons, practical exercises and games that facilitate the application of the acquired knowledge in practice. It promotes the development of not only technical skills, but also mathematical thinking, adaptability to solving complex problems and application of mathematics in everyday life.

The beginning of training, according to the developed Innovative Methodology, is based on the preliminary acquaintance of students with basic algebraic concepts such as variables, coefficients, equations, and inequalities. This stage is fundamental for the successful mastering of further skills in solving equations and inequalities. Visualization with graphs is used to enhance learning. Students master the skills of graphing equations and inequalities, which helps them to better understand algebraic relationships. They learn what a variable is, how it is used to represent unknown values, and what values coefficients can take in algebraic expressions. Using concrete examples, students see how variables and coefficients affect algebraic expressions and how changing their values changes the result. To reinforce the concepts of variables, coefficients, equations, and inequalities, students are provided with a variety of examples and hands-on activities. Pupils solve simple equations and inequalities, investigate their properties and see what solutions different types of equations and inequalities can have. This allows them to see the practical value of algebraic concepts and prepares them for the more advanced stages of the methodology.

After successfully mastering basic algebraic concepts in the introduction phase, the Innovative Methodology provides a sequential deepening into more complex algebraic concepts. This stage is aimed at the gradual development of pupils’ skills in solving algebraic equations and inequalities. At this stage, students are introduced to arithmetic operations applied to algebraic expressions. They learn to add, subtract, multiply and divide algebraic expressions, applying the rules of bracket expansion and reduction of like terms. This allows them to manipulate and simplify algebraic expressions more freely before solving equations and inequalities. Next, students move on to solving linear and quadratic equations. They explore different solution methods, including the substitution method, the method of equating roots to zero and the use of the square trinomial. Students solve equations with one and two variables, learn to find roots and analyse possible solutions.

An important aspect of the developed Innovative Methodology is the systematic training of students in various methods of solving algebraic equations and inequalities. This stage involves organizing the learning process in such a way that pupils are able to consistently learn and understand the material, develop skills of solving equations and inequalities and apply them in practice. They learn various solution methods such as substitution, adding

similar terms, using addition equations, and other strategies. Lessons should be organized with an eye to the gradual complexity of the material. Beginning with basic concepts and equation-solving skills, students gradually progress to more complex scenarios, including systems of equations and inequalities. Systematic learning involves utilizing the knowledge and skills acquired in previous stages of the learning process. This allows pupils to gradually expand their mathematical baggage and move on with confidence. Lessons and assignments should be organized in such a way that pupils can follow logically from one topic to another. For example, start with simple linear equations and gradually move on to quadratic equations, systems of equations and inequalities.

It is important to consider the individual needs and levels of students. Some may learn basic concepts quickly and move on to more complex tasks, while others may require additional practice. Systematic teaching includes a variety of tasks that allow pupils to apply their knowledge in different contexts. These may include real-life tasks, puzzles, test questions, and other forms of activity. An important part of systematic teaching is analysing pupils’ errors. This allows for identifying weaknesses and adjusting one’s teaching for more effective learning.

Systematic teaching in this methodology promotes a deep understanding of algebraic equations and inequalities, the development of analytical and logical skills, as well as the ability to apply the acquired knowledge in practice. It helps students gradually master complex material and prepare for solving more difficult problems. The innovative methodology actively uses practical tasks and interactive teaching methods. Interactive methods play a key role in the developed methodology of teaching the solution of algebraic equations, inequalities, and their systems to secondary school students. These methods are aimed at active interaction of students, development of their analytical thinking, exchange of experience and joint problem-solving. Among these methods, it is possible to single out group discussions and joint problem-solving. Pupils divide into small groups and analyse complex problems together. In the process of discussion, they develop different approaches to the solution, share their thoughts and ideas. This allows students to see a variety of solution methods and enrich their experience.

Interactive games are also used, which are not only fun for students but also develop algebraic thinking. For example, the game “Algebraic Race” is an interactive method used during the deepening phase of algebraic concepts. This game aims to reinforce the skills of solving algebraic equations and inequalities through a competitive and interactive form of learning. The game is conducted in the classroom and is divided into several stages. At the initial stage, students are divided into groups and given tasks of varying difficulty depending on their level of preparation. The tasks include linear equations, quadratic equations and systems of equations. Each group is given a task with problems that they will have to solve in a limited amount of time. Participants begin solving the problems by sharing ideas and strategies with other members of their group. When solving equations and inequalities, they must apply the methods and techniques they have learnt, making the necessary algebraic transformations.

The key element of the game is not only the correct solution but also the speed of completion. At the end of the game, there is a discussion where pupils share their experiences and approaches to solving the problems. They also analyse mistakes and identify possible improvements in their methods. This phase allows learners to share their knowledge and experiences and draw attention to aspects they should improve [7; 8]. In addition, the sharing of experiences is equally important. Students share their problem-solving techniques with the rest of the class. This allows students to see a variety of approaches and strategies that can be applied to algebraic equations and inequalities.

As part of the Innovative Methodology developed, various role-plays are conducted where students can play the role of different mathematical variables, operations, and unknowns. This helps them to better understand algebraic relationships and rules. Among such games is the Role of Variables game: in this game, each student is assigned the role of a particular variable (e.g. x , y , z). The students' task is to solve equations and inequalities using their roles. Each variable can represent a different value, and students must work together to get the correct solution. In addition, the game "Problem-Solving in the Real World" can be used during instruction: in this game, students take on the roles of different characters facing real-life situations in which algebraic equations and inequalities need to be solved. For example, they can play the roles of buyers and sellers, solving equations to determine discounts or prices of goods [9].

The Innovative Teaching Methodology introduces interactive programmes that have great potential to enrich the teaching methodology of solving algebraic equations and inequalities, making the learning process more interesting, comprehensible and effective. Interactive learning platforms can be distinguished among such programmes. Modern online platforms and applications provide students with the opportunity to solve equations and inequalities interactively. They can visualize each step of the solution, provide hints and explanations, and offer a variety of tasks with varying degrees of difficulty. These programmes provide learners with interactive and dynamic tools to explore and solve algebraic problems [10].

Among such programmes, Algebrator can be highlighted. This programme provides learners with a visual representation of algebraic operations and concepts. Students can enter equations and inequalities and the programme will demonstrate the solution process step by step, including algebraic transformations and graphical representation of the results. This helps students to better understand the solution steps and visualize mathematical concepts [11].

The Desmos program is a graphing calculator that allows the graphing of functions, including algebraic equations and inequalities. Students can enter algebraic expressions and observe how the graph changes as parameters change. This helps them to better understand the relationship between algebraic expressions and graphs [12].

The Innovative Methodology also uses interactive tasks that allow students to actively engage with the material. For example, students may be presented with a task in which they must choose the correct algebraic expression or

equation based on a graphical representation. The use of interactive programmes in the Innovative Methodology for Teaching Algebraic Equations and Inequalities has several advantages. Firstly, such programmes make the learning process more interesting and engaging. Secondly, they allow visualizing mathematical concepts, which contributes to a better understanding of their essence. Third, interactive programmes allow students to explore the material independently, experiment with different parameters and deepen their understanding.

Suppose a teacher asks students to find the solution to an equation like " $x^2-3x-4=0$ ". Instead of using the traditional solution method, the teacher could ask the students to use the Algebrator programme. Students enter the equation into the program, and the program systematically demonstrates how to perform inverse algebraic operations to find the value of x . This allows students to visualize the solution process and better understand the steps to be taken. It is also possible to use educational games related to solving equations and inequalities that promote a deeper understanding of the material. These games allow students to apply knowledge in the context of a variety of situations. Equally useful is the development of virtual laboratories that allow students to experiment with different types of equations and inequalities, change the parameters and analyse the results. This promotes the development of analytical skills [13].

The use of interactive methods makes learning more engaging, activates students, and encourages them to develop a deeper understanding of algebraic concepts. These methods foster students' independence, critical thinking and communication skills, which is an important component of the developed methodology. Consequently, the developed Innovative Methodology is presented in the following stages:

1. Fundamentals of algebra and introduction to equations and inequalities. Purpose: To introduce the basic concepts of algebra and the fundamentals of equations and inequalities. In this step, students are introduced to the basics of algebra, the concept of variables and basic algebraic operations. It is important to visualize algebraic concepts through interactive software such as Desmos. Topic: Introduction to Variables. The teacher uses interactive demonstrations in Desmos to explain the concept of a variable and show basic mathematical operations with variables such as addition, subtraction, multiplication, and division. Students can see how changes in the values of variables affect the graphs of functions.

2. Fundamentals of solving equations and inequalities. Purpose: Students learn to solve equations and inequalities with one variable. In this stage, students learn how to solve equations and inequalities with one variable and use interactive problems to practice. Topic: Solving Linear Equations. The teacher explains the steps of solving equations, such as transformations to isolate a variable. Pupils solve interactive problems in Desmos where they can change the values of variables and observe how this affects the solution. Role-play: Pupils can take on roles in equations, e.g. "If x is your age and y is my age, which equation does this represent?"

3. Extending solving skills. Purpose: Looking at more complex equations and inequalities, including systems and absolute values. Topic: Solving systems of

equations. In this stage, students consider more complex equations and inequalities, including systems and absolute values. The teacher shows how to graphically find the intersection points of systems of equations using Desmos. Students solve systems of linear equations in Desmos using interactive graphs to find the points of intersection.

4. Systems of Equations and Inequalities. Purpose: To deepen knowledge of systems of equations and inequalities and to apply them to real-life situations. Topic: Role-play. At this stage, pupils deepen their knowledge of systems of equations and inequalities. Pupils participate in a role-play where each of them represents an equation or inequality. Their task is to cooperate and find solutions to the system to solve a particular situation.

5. Practising and testing knowledge. Purpose: To repeat and consolidate the skills learnt. Topic: Practising solving equations and inequalities. In this stage, students complete a variety of problems to solve equations and inequalities of varying Algebraic complexity to reinforce their skills. Starting with basic linear equations and gradually moving on to equations with fractions, quadratic equations and equations with absolute values. Competitions and games: pupils can take part in maths competitions, solving equations and inequalities in a limited amount of time.

6. Applying knowledge to real-life situations. Purpose: In this stage, pupils will apply their algebraic skills to solve real-life problems and situations. Topic: Solving problems in real life. Projects and Investigations: Students can choose a topic that interests them most and conduct an investigation using algebraic methods. For example, investigating the relationship between the amount of time spent and performance in sports, and economic research. Solving real-world problems: students can create budgets for their families, considering income and expenses, and considering investment options. Working with data: analysing data and creating graphs using algebraic techniques. This may include statistical analysis of data, and forecasting. At this stage, the emphasis is on applying algebraic knowledge to real-life situations, which helps students to see the practical value of the learning material and its applicability to their future lives. Approbation of the methodology plays an important role in confirming its effectiveness and adaptation to real

educational conditions. This stage includes practical testing of the methodology on students of different ages and levels of training.

To test the effectiveness of the innovative methodology developed in this study, a pilot study was conducted. Students were divided into experimental and control groups. The experimental group received training using the developed methodology, and the control group used traditional teaching methods. Analysis of the results showed that students in the experimental group demonstrated a higher level of understanding of algebraic concepts, and the ability to solve equations and inequalities and apply them to solve complex problems. The control group showed fewer good results. The results of this experiment allow concluding the achievement of the set goals and the effectiveness of using the developed Innovative methodology. In the course of approbation, it was revealed that the use of interactive methods, structured approach and the use of modern technologies contribute to more successful learning of the material. Pupils became more confident in solving algebraic equations and inequalities and were able to apply the acquired knowledge in practice.

The results of the study also indicate that students who were taught using the Innovative Methodology showed a significant improvement in their academic performance compared to traditional teaching methods. They were more successful in solving algebraic problems, demonstrated a deeper understanding of the material, and were more confident in applying algebraic methods to a variety of problems. A comparison of average test scores before and after the training showed that the level of knowledge and skills in solving algebraic equations and inequalities increased significantly in the experimental group. For example, the average test score before the training was 60% and after the training, it increased to 85% (Figure 1). Students in the experimental group demonstrated higher practical skills in solving algebraic problems. They successfully applied the learnt methods to solve a variety of equations and inequalities in different contexts. For example, students successfully solved problems involving time, distance, and other real-world situations using algebraic models.

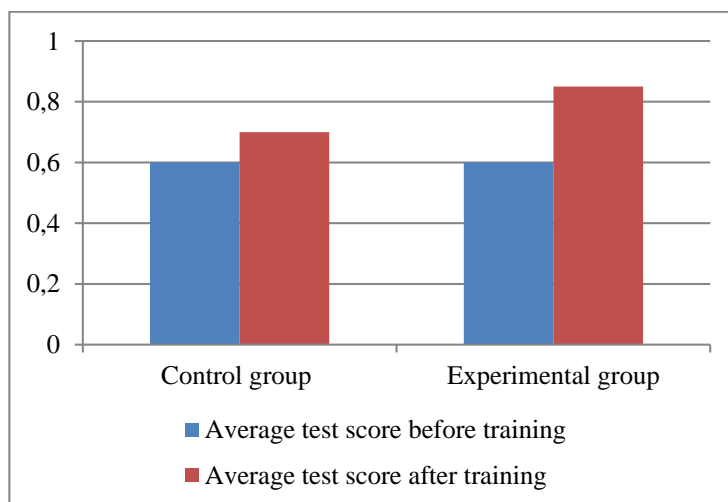


Figure 1. Learning results of the experimental and control groups

The experimental group showed higher activity and motivation of students. They showed more interest in the subject, and actively participated in games, discussions and practical lessons. This confirms the effectiveness of game and interactive methods used in the methodology. As part of the experiment, a test including a variety of algebraic problems of different complexity was conducted. Pupils from the experimental group showed a higher percentage of correct answers compared to the control group. For example, when solving complex tasks of finding roots of equations of the second degree, 80% of pupils from the experimental group successfully coped with the task, whereas in the control group, this indicator was only 45%. Thus, the results of the experimental study confirmed the effectiveness of the developed Innovative method of teaching students to solve algebraic equations and inequalities. Pupils of the experimental group demonstrated higher performance, versatile practical skills and greater motivation to study the subject.

Based on the results of the experimental study, it is possible to conclude that the developed Innovative methodology of teaching secondary school students to solve algebraic equations and inequalities and their systems demonstrates high efficiency. It promotes a deeper understanding of the material, improvement of academic results, development of algebraic thinking and successful overcoming of difficulties. The developed methodology has high practical significance for educational practice. Its application can contribute to the improvement of student's academic performance, development of algebraic thinking and skills of independent solution of complex problems. The methodology can be introduced into the secondary school curricula to optimize the process of teaching mathematics.

Discussion

Analysing the obtained results and comparing them with other authors' research in the field of teaching methods for teaching secondary school students to solve algebraic equations and inequality is an important step to identifying unique aspects of the developed methodology, as well as to determine similarities and differences with other approaches. The Innovative Methodology is a comprehensive approach to teaching students algebraic equations, inequalities, and their systems, including a systematic approach focused on understanding and visualizing the material.

One of the key aspects of the Innovative Methodology is the sequential deepening of algebraic concepts, starting with basic concepts and gradually moving to more complex ones. Analysing the results of the work of M. Shahi et al. [14], there are several points in common with this study. Both studies confirm the importance of using interactive teaching methods to achieve better results. The Innovative Methodology developed focuses on the use of educational games and interactive programmes to increase students' interest and motivation. This aspect is also present in the aforementioned work, where it is emphasized that students are more interested and actively engage with the material with interactive methods. However, the Innovative Methodology developed emphasizes systematic learning that involves a systematic and sequential deepening of algebraic concepts. This

allows students to master the material in greater depth and in a more sequential manner, which contributes to a better mastery of their equations and inequalities. In contrast, the study by the researchers rather focuses on comparative analyses of different teaching methods, evaluating their effectiveness without delving into the specifics of systematic learning.

During the development of the Innovative Methodology, special attention was paid to interactive teaching methods. The authors of the study S.H. Alijonov et al. [15] also deal with the problem of using interactive methods in teaching mathematics. They analyse the effectiveness of such methods in classroom activities and identify their positive impact on students' engagement and interest in the subject. The study also emphasizes the importance of introducing interactive methods to enhance the quality of learning. The work of N. Rakhmankulova and S. Mirzanazarova [16] also focuses on the use of interactive methods of teaching mathematics. The authors examine various aspects of this method, including its impact on students' motivation and understanding. The study focuses on the design and use of interactive tasks that promote the participation of all learners and develop their critical thinking.

By comparing the results of the current study with those of S.H. Alijonov et al. [15] as well as N. Rakhmankulova and S. Mirzanazarova [16], it is possible to identify common trends and key aspects. Firstly, all three studies confirm the effectiveness of using interactive methods in teaching mathematics. They increase students' interest in the subject, enhance their participation and develop their critical thinking skills. Secondly, each of the studies emphasizes the importance of individualizing learning. S.H. Alijonov et al. [15] focus on adapting interactive methods to the needs of each student. N. Rakhmankulova and S. Mirzanazarova [16] emphasize the importance of creating tasks that promote the active involvement of all students, regardless of their characteristics. However, there are also differences between the studies. Thus, the conducted research focuses on the development of a comprehensive methodology for teaching the solution of algebraic equations and inequalities using interactive methods and educational games. This allows effectively combining theoretical material with practical skills and developing students as active participants in the learning process. While the authors' research considers a wider range of interactive methods.

Analysing the work of R. Banerjee and K. Subramaniam [17], it can be noted that like this study, this work has the objectives of improving the teaching of algebraic concepts. However, Innovative Methodology focuses on developing an integrated approach that includes the use of interactive methods, learning games and a systematic approach, whereas the study by the researchers describes an evolutionary approach to teaching elementary algebra. This emphasizes the uniqueness of the developed methodology in the context of current pedagogical methods. Both studies emphasize the importance of engaging students' interest and motivation in the learning process. The study in developing the Innovative Approach also found that the use of educational games and interactive methods promoted greater student participation

in lessons, which is in line with the findings of the researchers.

Comparing the results of this work with the study of M. Kaplar et al. [18], it is possible to identify certain similarities and differences. Both studies confirm the importance of using interactive methods in education. In the work of the researchers also examines the impact of interactive educational materials on students' mathematical thinking. These general findings indicate that interactive teaching methods have the potential to improve the educational process in mathematics. However, there are differences in the methodology and emphasis of the studies. For example, the researchers emphasize different types of mathematical thinking and its development with interactive educational materials.

The current study also looked at different aspects of mathematical thinking, but the emphasis was on its relationship to solving algebraic equations and inequalities. It is also worth noting that in this paper, the research was conducted in different contexts and with different samples of students, which may influence the results. Regarding practical relevance, both studies emphasize the importance of using interactive methods and educational materials in mathematics teaching. These methods can be applied in educational settings to improve the quality of mathematics education. This also implies that educators and developers of educational materials should pay attention to the integration of interactive components into curricula.

The work of C. Walkington and M.L. Bernacki [19] aimed to investigate the impact of individualization of algebra learning in an intelligent educational system. The authors analysed the results of using an individualized teaching methodology and identified moderators of the impact of this methodology on learning outcomes. By comparing the main aspects of the innovative methodology with the study of these authors, several common aspects can be identified. Both studies sought to effectively teach algebra using innovative methods. Both emphasized the importance of personalizing learning and adapting to individual student interests and needs.

The study by A.Y. Algani [20] aims to investigate innovative methods of teaching mathematics and their application in schools. The author analyses what innovative approaches are used in educational institutions and evaluates their effectiveness. Analysing the authors' findings, it can be seen that the focus of their study is to examine what specific innovative methods are used in schools. Whereas, this study concentrates on developing and testing a comprehensive methodology for teaching the solution of algebraic equations and inequalities using interactive methods. This aspect makes the study more specialized and focused on the practical implementation of the methodology. In addition, during the current study, an experiment was conducted aimed at teaching a specific target group – secondary school students, while the researcher analysed data from teachers. Comparing the results of these experiments, it can be concluded that innovative teaching methods can indeed significantly improve the effectiveness of mathematics teaching. However, the application of these methods in practice may be limited by various factors such as teacher training, availability of resources and technical capabilities.

In conclusion, the analysis of the results of the conducted study and their comparison with the studies of other authors emphasizing the unique aspects of the developed Innovative Methodology, such as the integrated approach, the emphasis on interactive methods and individual adaptation. At the same time, it is possible to see general trends in educational development, such as the growing role of technology and interactive methods. This analysis allows seeing the Innovative Methodology in the context of modern trends and highlights its significance in the field of teaching algebraic equations and inequalities.

Conclusions

In this research paper, a study was conducted to develop a methodology for teaching secondary school students to solve algebraic equations and inequalities. In the course of the research, complex educational software including interactive methods and educational games was proposed and implemented. This work aimed to identify how effectively such Innovative methodology contributes to teaching students their mathematical skills and abilities.

The analysed results of the study allow drawing the following conclusions. Firstly, the use of interactive methods and educational games does contribute to more effective teaching of students to solve algebraic equations and inequalities. This approach activates students, increases their interest in the subject and promotes a deep understanding of the material. This is because interactive methods stimulate their thinking, promote a deeper understanding of the material and allow them to apply knowledge in practice. Educational games, in turn, create a positive atmosphere in the classroom, improve motivation and increase students' interest in learning mathematics. Second, the results of the study confirmed that comprehensive educational software that includes both theoretical materials and practical tasks using online learning platforms and interactive learning games could effectively help students cope with difficulties in solving algebraic equations and inequalities. This approach encourages their active participation in the learning process, allowing them to master difficult concepts more.

The practical relevance of this Innovative Methodology is that it promotes the development of algebraic thinking, an important skill for understanding more complex mathematical concepts as well as preparing for further learning. The Innovative Methodology can be successfully applied in educational institutions to optimize the algebra learning process. Also, the results of the study allow generalizing on the topic of using interactive methods and educational games in education. This approach is not only effective in teaching algebraic equations and inequalities, but can also be successfully applied in other mathematical topics and disciplines. It promotes a deeper understanding of the material, development of critical thinking and increased interest in the learning process. Taking into account the above conclusions, it is recommended to introduce interactive methods and educational games into the educational process, especially when teaching complex mathematical topics. This will improve the quality of learning, students' motivation and their active participation in the learning process. However, it should be noted that further research in this area could focus on more in-depth analyses of specific methods and their effectiveness

depending on the level of education, student characteristics and other contextual factors. A comparative study with different educational methods and approaches could also be conducted to better identify the benefits of using interactive methods and learning games.

Overall, this study confirms that the use of interactive methods and learning games has significant potential to enhance the effectiveness of mathematics learning, especially in the context of solving algebraic equations and inequalities. The results of the work can serve as a basis for

the development of new teaching methods and programmes, as well as contribute to the further development of educational practices in the field of mathematics.

Acknowledgements

None.

Conflict of Interest

None.

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Методи навчання учнів середньої школи розв'язуванню алгебраїчних рівнянь і нерівностей та їх систем

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Анотація

Актуальність. Актуальність даного дослідження зумовлена невід'ємною роллю алгебраїчних рівнянь і нерівностей у математичній освіті, а також необхідністю пошуку ефективних методів і підходів до їх викладання на рівні середньої школи.

Мета. Метою дослідження є розробка та апробація методики навчання учнів середньої школи розв'язування алгебраїчних рівнянь і нерівностей, зокрема їх систем, з урахуванням сучасних освітніх вимог та педагогічних підходів.

Методологія. У ході дослідження використано такі методи, як експериментальне дослідження, анкетування, статистичний аналіз даних.

Результати. У результаті дослідження було виявлено, що інноваційна методика навчання розв'язування алгебраїчних рівнянь і нерівностей у середній школі позитивно вплинула на засвоєння учнями матеріалу. Учасники продемонстрували глибше розуміння алгебраїчних понять, підвищили самостійність у розв'язуванні задач, розвинули навички критичного мислення. Вони стали більш впевнено аналізувати та інтерпретувати умови задач, визначати взаємозв'язки між змінними та пропонувати адекватні рішення. Новий підхід також покращив мотивацію учнів до вивчення алгебри та їхню успішність, оскільки завдяки інтерактивним методам та практичним завданням зросла зацікавленість та пристрась до предмета.

Висновки. Проведене дослідження підтверджує ефективність інноваційної методики в сучасному освітньому контексті загальноосвітньої школи. Практичне значення дослідження полягає в наданні вчителям основної школи інструментів для успішного навчання учнів алгебраїчним рівнянням і нерівностям, що сприятиме розвитку аналітичного мислення та математичної компетентності.

Ключові слова: інтерактивні уроки; візуалізація математичних понять; індивідуальний прогрес; розвиток навичок.