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The Use Of Scientific Methods Of Analysis And Synthesis In Teaching Mathematics

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ABSTRACT

This study examines the effectiveness of utilizing scientific methods of analysis and synthesis in teaching mathematics to enhance students' learning outcomes. The research employs a quantitative approach with a quasi-experimental design, involving two groups of 10th-grade students: an experimental group taught using the analysis and synthesis methods and a control group taught using conventional methods. Data were collected through pretests, posttests, questionnaires, and classroom observations. Statistical analysis, including t-tests, was applied to evaluate the differences in learning outcomes, while descriptive analysis was used to interpret students' perceptions and engagement. In this study, the implementation of teaching methods in mathematics within our country is critically assessed, alongside reflections on the effectiveness of using scientific methods to present mathematical concepts to students. The findings reveal that the experimental group achieved significantly higher posttest scores compared to the control group. Additionally, students in the experimental group expressed positive perceptions of the teaching approach, and their engagement in classroom activities improved notably. These results highlight the potential of scientific methods, such as analysis and synthesis, to foster deeper understanding and active participation in mathematics education. This research contributes valuable insights for educators aiming to adopt innovative strategies to enhance teaching practices and improve learning outcomes in mathematics.

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INTRODUCTION

In our country, we are working to reveal the abilities, talents and intellectual potential of the young generation so that they can master modern knowledge and professions that meet world standards, grow up as comprehensively developed generations with high knowledge and thinking, patriots and noble qualities. Great things are being accomplished. President of the Republic of Uzbekistan Sh.M. Mirziyoyev, June 9, 2019, "State support for further development of mathematical education and science, as well as measures for the fundamental improvement of the activities of the V.I. Romanov Academy of Sciences Mathematics Institute of the Republic of Uzbekistan. PQ-4708, May 7, 2020. "On measures to enhance the quality of education in the field of mathematics and the development of scientific research" [2]. Based on this decision, the "Target Program for Improving the Quality of Mathematical Education in the Republic of Uzbekistan for 2020-2023, Improving the Efficiency and Practical Significance of Scientific Research" was developed [3]. Academy of Sciences of the Republic of Uzbekistan V.I. Table of selected staffs of territorial divisions of the Romanovsky Mathematical Institute in the Republic of Karakalpakstan, Namangan, Samarkand and Khorezm regions. In the field of teaching mathematics in our country in recent years, significant work has been carried out. In particular, in the organization of preschool education, work is developing at an accelerated pace to form basic knowledge and skills in mathematics in students, provide schoolchildren with new and improved textbooks, and organize national and world Olympiads for schoolchildren and students. In particular, as a result of the opening of schools in individual subjects,

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the teaching of mathematics was radically reformed. As a result, there was a need for the effective use of various scientific methods in teaching mathematics, for the further development of students' logical thinking skills, that is, increasing the level of students' knowledge not only through open tests, but also determining the level of their mental abilities and theoretical knowledge, which must be determined through closed tests. In this regard, our esteemed President Sh.M. Mirziyoyev and Shavkat Mirziyoyev, holding a meeting with scientists, young researchers, heads of research institutions and representatives of the production sector, expressed the following thoughts: “Mathematics is the basis of all exact sciences. A child who knows this subject well will grow up smart, broad-minded and will work successfully in any field”[4].

As a logical continuation of the Decree of the President of the Republic of Uzbekistan dated February 3, 2022 No. F-22 "On additional measures to reform the public education system" [5], "Public Education" in order to further develop the education system, promote and support new initiatives in the field, address issues that can directly and indirectly affect the quality of education and training requires. In particular, the skill of the teacher is considered important for the effective organization of mathematics lessons. It is known that students have difficulty solving problems on proof. The solution to this problem is that the teacher must know scientific methods and be able to use them during the lesson.

It is known that the science of mathematics deals with ideal objects, but in their content all mathematical objects reflect objects of the material world. Therefore, all mathematical concepts and rules require knowledge of the deepest and most general laws of existence. Mathematics uses special means and scientific methods of research in studying the laws of nature. In the process of learning, students are put in the position of discoverers of mathematical truths, and therefore scientific methods of mathematical research are simultaneously methods of teaching students.

In modern didactics, including in the methodology of teaching mathematics, the tasks of the teaching method are solved in a complex and are characterized by the following two aspects:

a) teaching (teacher's activity);
b) learning (conscious cognitive activity of students).

If the educational process consists of teaching and learning, then learning (types of information, methods and means of monitoring and checking the cognitive activity of students), learning (types of educational material, methods and means of its assimilation by students) through the following methods: are carried out. Methods of teaching and learning are inextricably linked and implement the educational process in school. Teaching methods in the school course of mathematics can be classified as follows:

a) Methods of scientific research (observation, experiment, comparison, analysis and synthesis, generalization, abstraction and classification).
b) Teaching methods (heuristic method, programmed learning method, problem-based learning method, lecture and interview methods).
c) Methods of inference (induction, deduction and analogy).

In empirical and theoretical research, such universal methods as analysis and synthesis, deduction and induction, and abstraction are widely used.

METHOD

The research employs a quantitative approach with a quasi-experimental design to measure the effectiveness of using analysis and synthesis methods in teaching mathematics. The population consists of all 10th-grade students at a selected high school during the first semester. The sample

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includes two purposively selected classes: one as the experimental group taught using the analysis and synthesis methods, and the other as the control group taught using conventional methods.

The research instruments include a mathematics achievement test, which evaluates students' understanding of mathematical concepts before and after the intervention; a questionnaire to measure students' perceptions of the applied teaching methods; and observation sheets to assess students' engagement during the learning process.

The research procedure consists of four stages. The preparation stage involves developing teaching materials based on analysis and synthesis methods, creating and validating the research instruments. In the implementation stage, the experimental group is taught using the analysis and synthesis methods, while the control group receives conventional instruction over four weeks, with both groups covering the same mathematical topics. In the data collection stage, a pretest is administered to assess students' initial abilities, followed by a posttest to evaluate learning outcomes. Students in the experimental group complete a questionnaire after the teaching sessions, and classroom observations are conducted throughout the lessons.

Data analysis is carried out using statistical methods, particularly the t-test, to determine significant differences in pretest and posttest results between the two groups. Descriptive analysis is also employed to interpret the questionnaire responses and observation data.

The success criteria for this study are determined by three factors: whether the experimental group's posttest scores are significantly higher than those of the control group, whether students respond positively to the teaching methods, and whether their engagement improves during the lessons. This research aims to provide insights into the effectiveness of scientific methods of analysis and synthesis in enhancing mathematics education at the secondary school level.

RESULTS AND DISCUSSION

Analysis

Analysis is a method of thinking or proving by moving from the unknown to the known, from the sought to the given. Analysis and synthesis (from the Greek analysis - to separate and synthesis - to connect) are closely related research methods that people use in the process of learning about the world. Analysis is thinking or acting to separate things and events into their constituent parts, and synthesis is connecting these parts into a whole in thoughts or actions, studying things as a whole. The objective being that surrounds a person and has various characteristics is complex and at the same time consists of certain things and events. In order to study and know them, it is necessary to separate them into components, that is, to analyze them. But it is impossible to fully know them with this method, so it is necessary to supplement it with synthesis. Synthesis unites something or an event into a single whole based on the results of the analysis. Analysis and synthesis are interconnected, and synthesis without analysis does not provide deep knowledge, and at the same time, incomplete analysis through synthesis is not enough.

The center of activity of analysis and synthesis is the cerebral cortex, but this activity arises and is carried out only in the process of social production and on its basis. In the process of thinking, analysis and synthesis act as techniques of logical thinking, occurring with the help of abstract concepts and firmly connected with abstraction, generalization, etc. Thinking over the method of analysis, the student must answer the following question: "To know that in order to find the unknown that you are looking for" do you need?" [6] Psychologists describe the method of analysis as follows: "the method of finding parts from a whole is called analysis." In school, analysis is used in teaching all subjects, such as arithmetic, geometry, trigonometry and higher mathematics. For example, when solving arithmetic problems using the method of analysis, we begin our reasoning with the unknown, the question of the problem, and arrive at the quantities given in the problem

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and the relationships between them; b) when solving problems related to the formulation of one or more unknown equations, we begin our reasoning from the unknown (one or more unknowns) and find the relationship between the given quantities and the unknowns; d) When solving problems on construction, we begin by considering the desired (unknown) figure that needs to be constructed, and find the connection between this figure and the given elements.

The essence of the analysis method lies in the mental or figurative division of the object of study into its constituent parts and the study of their properties and characteristics separately. For example, when studying the problem of increasing the efficiency of electrical equipment, the issues of its reliability, failure-free operation and maintainability are studied separately and, based on the results obtained, general conclusions (solutions) are made. In this case, the essence of individual elements of the object, their connections and interactions are studied.

Description

The method of searching from the unknown to the known is called analysis. When thinking about the method of analysis, the student must answer the following question: "What do you need to know to find the unknown?" Psychologists describe the method of analysis as follows: "the method of finding parts from the whole is called analysis." In the analytical method of thinking, each step has its own basis, that is, each step is based on the rules we already know. Research methods of analysis and synthesis are manifested in mathematical education in different forms: the method of solving problems, the method of proving theorems, mathematical concepts are the opposite of analysis, that is, thinking in reverse order is synthesis. Analysis leads to a deeper and more comprehensive assimilation of educational material than synthesis, and opens up opportunities for active and creative development of students' logical thinking. However, it is more difficult for students to master analysis than synthesis, which is carried out based on given values. Analysis and synthesis are often used simultaneously when solving problems. Any analysis has elements of synthesis, and any synthesis has elements of analysis. Analysis and synthesis are inseparable, they complement each other and form a single analytical-synthetic method. For example, with the help of analysis, a problem is broken down into several simple problems, and then with the help of synthesis, the solutions to these simple problems are combined. Initially, analysis was considered as a way of thinking, going from the whole to the parts, and synthesis – as a way of moving from the parts to the whole. Later, analysis was considered as a way of thinking, and it was considered as a way of thinking, which presupposes movement from the result to the cause that caused it. F. Engels describes analysis as a method of scientific research and says: “Thinking consists both in the disintegration of objects of consciousness into their elements, and in the unification of interconnected elements into a unity. Without analysis, there is no synthesis.”

Synthesis is a method of thinking that consists of studying the qualitative properties of an object. In teaching mathematics, analysis and synthesis are used in the meaning of the second level of understanding. These methods are manifested not only as research methods, methods of studying educational material, but also as forms of the thinking process. Analysis and synthesis are also widely used in proving theorems. For example, to prove that the arithmetic mean of two numbers is greater than or equal to their geometric mean, it is necessary to first come from a given inequality to the correct inequality, and then derive this inequality from the correct inequality. In the analytical method, a certain conclusion is derived as a fact from reasoning that proves a theorem by logically justified steps. In the synthetic method, a true opinion is sought from which a given opinion can be derived by logically justified steps. Therefore, this method seems artificially invented. Thus, analysis and synthesis are used together in mathematical research and teaching. The teacher must be able to

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distinguish where to apply analysis and where to apply synthesis, while it is necessary to take into account that analysis is the path to discovery, and synthesis is the path to justification.

Synthesis is a method (method) of reasoning or proof, in which we move from the unknown to the known, from the sought to the given. Synthesis is used in all sections of elementary and higher mathematics. Although analysis, as well as induction, analogy and other methods are used to prove theorems of geometry, many theorems of geometry are proved by synthesis.

Example 1. Prove that $a+1/a\geq 2$ when $a>0$.

Proof. We obtain the true inequality (a-1)2≥0 (*). (*) We write the inequality as a2+1≥2a (**). Dividing both parts (**) by a (a>0), we find the desired inequality a+1/a≥2. The equal sign is valid only when a=1. Although synthesis develops less logical reasoning than analysis, it is much easier for students to understand. When using synthesis, students draw conclusions and think passively; in this case it is difficult to know where to start proving the proposition, but when we think through the analysis, we think clearly and creatively and actively seek a way to prove the proposition. Synthesis is never pure, but always contains elements of analysis, in which the analysis can be fully or partially verbalized. Unlike analysis, synthesis consists of understanding the object of study as a whole in the unity and interdependence of its parts. For example, when studying the duration of the drying process of products, the factors influencing it are temperature, humidity, speed of movement of the coolant, and a conclusion is made about their general influence. After the analysis, a synthesis is carried out and certain hypotheses are created. The methods of analysis and synthesis are related to each other and complement each other in the course of scientific research. They can be used in different forms depending on the nature of the object under study and the purpose of the study. In the modern developing era, conducting mathematics lessons using modern pedagogical technologies and various scientific methods and achieving results is an urgent task for every mathematics teacher.

First of all, this is due to the professionalism and creativity of teachers, and secondly, with various applications in their work. For a deeper insight into the essence of the object under study, it will be possible to use structural-genetic analysis and synthesis. In this form of analysis and synthesis, the most important elements are highlighted that have a significant impact on all aspects of the essence of the object of study.

CONCLUSION

The findings of this study demonstrate that the use of scientific methods of analysis and synthesis is an effective approach to teaching mathematics. Students in the experimental group, who were taught using these methods, showed significantly higher learning outcomes compared to those in the control group taught with conventional methods. Additionally, students responded positively to the use of these scientific methods, expressing a greater understanding of the material and improved engagement during the learning process. These results underscore the importance of integrating innovative teaching strategies to enhance students' comprehension and participation in mathematics. The study also highlights the practical applicability of scientific methods in presenting mathematical concepts effectively, making learning more interactive and meaningful. This research serves as a foundation for further exploration of evidence-based teaching practices to improve mathematics education in various contexts.

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