

MATEMATIKA DARSLARIDA RAQAMLI TEXNOLOGIYALAR ASOSIDA O'QUVCHILARNING MANTIQUIY TAFAKKURINI RIVOJLANTIRISH

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Annotatsiya: Ushbu maqolada zamonaviy raqamli transformatsiya sharoitida umumiy o'rta ta'lim maktablari o'quvchilarining mantiqiy tafakkurini shakllantirish muammosiga bag'ishlangan. Maqolada matematika darslarida GeoGebra, Desmos kabi dinamik matematik muhitlar hamda sun'iy intellektga asoslangan platformalarning kognitiv samaradorligi tahlil qilinadi. Tadqiqotning maqsadi – raqamli vositalar yordamida o'quvchilarning analiz, sintez, abstraksiyalash va umumlashtirish kabi mantiqiy operatsiyalarini rivojlantirish metodikasini ishlab chiqishdan iborat. Natijalar shuni ko'rsatadiki, vizual-sxematik modellashtirish o'quvchilarning matematik qonuniyatlarni anglash darajasini 25-30% ga oshiradi.

Kalit so'zlar: Raqamli didaktika, mantiqiy tafakkur, kognitiv rivojlanish, GeoGebra, algoritmlash, matematik modellashtirish, interaktiv ta'lim, evristik yondashuv.

РАЗВИТИЕ ЛОГИЧЕСКОГО МЫШЛЕНИЯ УЧАЩИХСЯ НА УРОКАХ МАТЕМАТИКИ НА ОСНОВЕ ЦИФРОВЫХ ТЕХНОЛОГИЙ

Аннотация: В статье рассматривается проблема формирования логического мышления учащихся общеобразовательных школ в условиях современной цифровой трансформации. Анализируется когнитивная эффективность использования динамических математических сред, таких как GeoGebra и Desmos, а также платформ, основанных на технологиях искусственного интеллекта, в процессе обучения математике. Цель исследования заключается в разработке методики развития логических операций учащихся — анализа, синтеза, абстрагирования и обобщения — с использованием цифровых средств обучения. Результаты исследования показывают, что визуально-схематическое моделирование повышает уровень понимания математических закономерностей у учащихся на 25–30%.

Ключевые слова: цифровая дидактика, логическое мышление, когнитивное развитие, GeoGebra, алгоритмизация, математическое моделирование, интерактивное обучение, эвристический подход.

DEVELOPING STUDENTS' LOGICAL THINKING IN MATHEMATICS LESSONS BASED ON DIGITAL TECHNOLOGIES

Abstract: *This article is devoted to the problem of developing logical thinking in secondary school students under the conditions of modern digital transformation. The study analyzes the cognitive effectiveness of dynamic mathematical environments such as GeoGebra and Desmos, as well as artificial intelligence-based platforms used in mathematics lessons. The purpose of the research is to develop a methodology for enhancing students' logical operations—analysis, synthesis, abstraction, and generalization—through the use of digital tools. The results indicate that visual and schematic modeling increases students' understanding of mathematical patterns by 25–30%.*

Keywords: *digital didactics, logical thinking, cognitive development, GeoGebra, algorithmization, mathematical modeling, interactive learning, heuristic approach.*

INTRODUCTION

Today, the primary goal of the education system is not only the transmission of information but also the development of individual intellectual potential, particularly logical thinking. Mathematics is inherently based on a system of strict logical sequences and abstract concepts. However, for many students, this abstraction is difficult to understand. In the modern education system, one of the priorities is not only developing students' abilities for logical analysis, generalization, and practical application of knowledge. Specifically, mathematics plays a crucial role in developing students' logical thinking, algorithmic reasoning, and problem-solving skills. In the context of digital transformation, the widespread introduction of digital technologies into the educational process requires updating the content and methodology of mathematics education. With the help of digital tools, students have the opportunity to master complex mathematical concepts in a visual and interactive format and gain a deeper understanding of logical relationships. Therefore, the development of logical thinking using digital technologies in mathematics lessons is becoming a pressing scientific and pedagogical issue.

Digital technologies (DT) act as a "bridge" here. They accelerate the learner's logical inference process by visualizing concepts. This article examines digital technologies not simply as technical tools, but as driving forces of cognitive development.

LITERATURE REVIEW

The development of logical thinking was studied in classical pedagogy by Jean Piaget, Léon Vygotsky, and Jean Bruner. In his theory of cognitive development,

Piaget emphasizes that at the "formal operations stage" (ages 11-15), students become capable of abstract logical thinking.

In the context of modern digital education, R. Mayer (2021) in his theory of "multimedia learning" proved that humans have separate channels for processing visual and auditory information, the synthesis of which plays a decisive role in the creation of a logical model.

Local scholars B. Kadyrov and M. Mirzaakhmedov emphasized the importance of logical analysis in solving mathematical problems, while the issue of optimizing cognitive load using digital platforms (e.g., Khan Academy or local platforms) is reflected in the research of S. Tursunov. However, the mechanisms for developing logical inference through dynamic mathematical modeling systems (dynamic geometric systems) have been understudied.

METHODOLOGY

The following set of scientific and pedagogical methods was used within the framework of the study:

Theoretical foundations for the development of logical thinking

In pedagogy and psychology, logical thinking is considered one of the fundamental intellectual processes in human cognitive activity. Logical thinking manifests itself through such mental operations as analysis, synthesis, comparison, generalization, and conclusion.

In mathematical education, logical thinking is developed in the following areas:

identify connections between mathematical concepts and patterns;

Application of an algorithmic approach to solving problematic tasks;

conduct activities to collect evidence and substantiate;

Develop abstract thinking and modeling skills.

Digital technologies create a favorable didactic environment for the effective organization of these processes.

Pedagogical experiment: The effectiveness of digital and traditional methods was compared in selected control and experimental groups.

Cognitive modeling: The logical steps taken by students in the process of proving geometric theorems in the GeoGebra environment are analyzed.

Mathematical-statistical method: The reliability of the results was determined based on the results of tests conducted among students.

Digital mechanisms for developing logical thinking in mathematics lessons.

Visual-logical analysis

In a traditional textbook, the graph of a function is presented statically. In a digital environment (such as Desmos), the student dynamically observes the graph's evolution as the coefficients change. This creates a logical cause-and-effect chain:

"If $a > 0$, the parabola branches upward; if the value of a increases, the parabola contracts."

Such observations teach the reader to make inductive inferences.

Algorithms and programming elements

Creating algorithms for solving mathematical problems (for example, in Scratch or Python) requires students to adhere to a strict logical sequence. A single error (logical failure) will cause the program to stop running. This develops students' ability to self-monitor and logically correct errors.

Interactive evidence systems: In geometry lessons, "Proof Problems" are considered the most challenging for students. In the GeoGebra program, students see that certain properties (for example, the sum of the angles of a triangle is 180°) remain unchanged even when the shapes are deformed. This develops the concept of logical invariance.

RESULTS AND ANALYSIS

The results of the study showed that in groups where digital tools were used, the level of students' performance in logical operations increased in the following indicators:

- Ability to analyze and synthesize – 22%;
- Formulating a hypothesis and testing it – 18%;
- Checking mathematical conclusions - 15%.

Level of students' logical skills (experimental results)

Table 1.

Skill type	Traditional group (%)	Number group (%)	Difference (%)
Generalization	45	62	+17
Find an analogy	50	74	+24
Chain of evidence	38	55	+17

Digital technologies act as a "cognitive tool" in developing logical thinking. They free students' memory from technical calculations and allow them to focus on logical reasoning. However, there is also a risk of "digital addiction." Therefore, it is advisable to use a "blended learning" model in teaching methods.

CONCLUSION

In conclusion, the effective use of digital technologies in mathematics lessons is an important pedagogical factor in developing students' logical thinking. Digital tools stimulate students' analytical thinking and enable them to master complex mathematical concepts in an easy and understandable manner. The study's results confirmed that mathematics education organized using digital technologies has a positive impact on the development of logical thinking. Widespread implementation of this approach in educational practice will contribute to improving the quality of mathematics education. The use of digital technologies in mathematics lessons is not just a trend, but a cognitive necessity. To develop logical thinking, the following is recommended:

A shift from "dry" formulas to dynamic modeling in mathematics teaching. Empowering students to draw conclusions not based on a finished result, but through a digital experiment (virtual laboratory). Regularly improving teachers' skills in digital didactics. This approach develops students not only mathematical competencies but also a crucial 21st-century skill: critical and logical thinking.

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