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THE IMPORTANCE OF INTERACTIVE METHODS IN TEACHING THE TOPIC OF GEOMETRIC PROGRESSION IN SCHOOL MATHEMATICS

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Abstract
This article examines the methodological aspects of using interactive methods in teaching the topic of geometric progression. in school mathematics. The methods of increasing students’ interest and activity in science through organizing a lesson using problem-based learning, cooperative learning, project methods and digital tools, as well as the didactic significance of these methods, are discussed in detail. Also, analysis and practical considerations are given on the adaptation of international pedagogical experience to the educational environment of Uzbekistan and its application in the national context.

Keywords: Mathematics teaching methodology, methods, interactive approaches, interactive methods, modern mathematical education, problem-based learning, geometric progression, cooperative learning, , GeoGebra.

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Introduction

MAKTAB MATEMATIKASIDA GEOMETRIK PROGRESSIYA MAVZUSINI O‘QITISHDA INTERFAOL METODLARNING AHAMIYATI

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Annotatsiya

Ushbu maqolada maktab matematikasida geometrik progressiya mavzusini o‘qitishda interfaol metodlardan foydalanishning metodik jihatlari ko‘rib chiqiladi. Muammoli ta’lim, kooperativ o‘rganish, loyiha metodi va raqamli vositalardan foydalangan holda darsni tashkil etish orqali o‘quvchilarning fanga bo‘lgan qiziqishi va faolligini oshirish yo‘llari hamda bu metodlarning didaktik ahamiyati batafsil yoritiladi. Shuningdek, xalqaro pedagogik tajribaning O‘zbekiston ta’lim muhitiga moslashtirilishi va milliy kontekstda qo‘llanilishi bo‘yicha tahlil hamda amaliy mulohazalar keltiriladi.

Kalit so‘zlar: Matematika o‘qitish netodikasi, metodlar, yondashuv, metodik interfaol yondashuvlar, interfaol metodlar, zamonaviy matematik ta’lim, muammoli ta’lim, geometrik progressiya, kooperativ o‘rganish, GeoGebra.

Аннотация

В данной статье рассматриваются методологические аспекты использования интерактивных методов в преподавании темы геометрической прогрессии в школьной математике. Подробно

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обсуждаются методы повышения интереса и активности учащихся к науке посредством организации урока с использованием проблемно-ориентированного обучения, кооперативного обучения, проектных методов и цифровых инструментов, а также дидактическое значение этих методов. Также дается анализ и практические соображения по адаптации международного педагогического опыта к образовательной среде Узбекистана и его применению в национальном контексте.

Ключевые слова: методика преподавания математики, методологические интерактивные подходы, интерактивные методы, современное математическое образование, проблемно-ориентированное обучение, геометрическая прогрессия, кооперативное обучение, GeoGebra.

The main problem in school mathematics education is that the student memorizes formulas, but does not understand their essence and cannot apply them in real life situations. This situation often arises from the dominance of the traditional explanation-exercise method: the teacher explains, the student listens, copies into a notebook and performs the exercise. As a result, the student becomes a passive listener. The Law of the Republic of Uzbekistan “On Education” (2020) establishes the orientation of the educational process towards the comprehensive development of the student’s personality as a priority task of state policy [1]. The Presidential Decree No. PQ-133 of March 11, 2022 directly instructs the modernization of school education and the widespread use of interactive and innovative methods in the classroom [2]. The education system of Uzbekistan has entered a period of fundamental reforms in recent years, and the introduction of interactive methods has risen to the level of national policy. At the same time, there are a number of opportunities for the application of foreign pedagogical models to national conditions.

As the psychological basis of the methodology of interactive education, L.S. Vygotsky's theory of the "zone of proximal development" occupies a special place. This theory argues that there is a certain distance between the current independent level of knowledge of the student and the level of knowledge that he can achieve in the future - that is, the "zone of proximal development". It is this zone that is the main area of interactive education: real cognitive development occurs when the student performs a task at a level slightly higher than his

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independent capabilities with the help of an experienced partner - a teacher or a more knowledgeable peer [3]. In other words, not giving the student a ready-made answer, but directing him to discover it on his own - this is the theoretical basis of interactive methods.

From the point of view of methodological science, interactive approaches are an integral part of modern mathematics education - they form not only formulas in the student, but also mathematical thinking, problem-solving skills, and independent learning skills

Geometric progression - from a practical point of view, is a topic closely related to many real realities, such as bank interest, population growth, computer memory, biological processes. That is why teaching it through interactive methods forms both knowledge and worldview in the student.

MATHEMATICAL BASIS

To build the methodology correctly, it is first necessary to clearly understand the internal logical structure of the topic. A geometric progression is a numerical sequence in which each subsequent term is obtained by multiplying the previous term by a constant number, that is, by the common ratio (q). If the first term is b_1, then the n-th term is found using the formula $b_n = b_1 \cdot q^{n-1}$. The sum of n terms is expressed in the form $S_n = \frac{b_1(q^n-1)}{q-1}$ $(q \neq 1)$. When the absolute value of the common ratio is less than one, that is, when $|\ q\ | < 1$, the sum of an infinite decreasing geometric progression is equal to $S = \frac{b_1}{1-q}$ [4].

Although these formulas may seem abstract at first glance, they are directly connected with real life. For example, 1 000 000 soums placed in a bank deposit paying 10% annually will become 1 000 000 × $(1{,}1)^5$ = 1 610 510 soums after 5 years. Or, if one bacterium divides into two every 20 minutes, within 10 hours 2^{30} = 1 073 741 824 bacteria will be formed. Through such real examples, the formula naturally acquires meaning, and the student tries not merely to memorize it, but to understand it.

The legal-regulatory documents and scientific-theoretical foundations discussed above show that, in teaching the topic of geometric progression, the transition from traditional methods to interactive methods is not only a necessity but also a key condition for improving educational effectiveness. Which of these effective methods can be applied first in a mathematics lesson? Practice shows that among

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these methods, the most widespread and scientifically well-grounded one is the problem-based learning method.

Problem-Based Learning

The problem-based learning method was first used in medical education at McMaster University in Canada in the 1960s and was later successfully applied to the education of all subjects [5]. The essence of the method is that instead of a ready-made concept, the student is presented with an unsolved problem. The student acquires knowledge in the process of self-discovery, and this knowledge is retained in his long-term memory much stronger than in the traditional method. In school mathematics, the problem-based learning method can be applied as follows: - The teacher puts on the screen the question "If 1 penny doubles every day, how much will it be in 30 days?" Most students give a small number as an answer, because their eyes are not good enough to distinguish between linear growth and geometric growth. In order to find the correct answer, the teacher addresses the students with guiding questions without denying their answers. This cognitive conflict awakens the motivation of the student to “want to know”, at which time they are offered to work together. Working in pairs, the students continue the series 1, 2, 4, 8, 16..., find the answer independently and feel the need for the formula themselves. After the groups write and present their formulas on the board, the teacher formalizes the geometric progression formula. At this point, the formula becomes not “ready-made information” for the student, but a “discovery of their own.” In the end, when they count 2^{29} coins, they are surprised that the result is equal to 5.3 million soums, and they truly feel the power of geometric growth.

Along with problem-based learning, another interactive method that is highly effective in teaching the topic of geometric progression is cooperative learning, in particular the Jigsaw method, which involves students in group cooperation.

Cooperative learning - Jigsaw method

A meta-analysis by D. Johnson and R. Johnson, covering more than 600 studies, shows that cooperative learning significantly increases learning compared to individual methods, because students process knowledge more deeply while teaching each other [6]. The Jigsaw method was developed by Elliot Aronson

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(1978), in which each student is personally responsible for the success of the group [7].

The application of this method is carried out in the process of studying geometric progression as follows: - The class is divided into "home groups" of 4–5 people. Each group is given a separate application of geometric progression: bank interest, population growth, computer memory, and COVID-19 spread model. Each group becomes an "expert" by studying its topic in depth: calculations are performed, formulas are applied based on real data, and graphs are drawn up. Then, "experts" who have studied the same topic from different groups come together and compare their experiences and approaches. Finally, representatives of each group return to their "home group" and teach the learned knowledge to the group members. As a result, students fully master all four applications, in which the students themselves, not the teacher, become the transmitters of knowledge. This process simultaneously forms communicative competence, a sense of responsibility, and learning skills through teaching.

While cooperative learning provides for the exchange of knowledge among students, the next method directs them towards a larger goal - solving a real-life problem. As such, the project method is widely used in pedagogical practice and has proven its effectiveness.

The project method allows students to research a real-life problem and create a common product - a report, presentation, or mathematical model - within a week or two [8]. This method provides STEM integration, combining mathematics, computer science, statistics, and social sciences in a single project, and serves to early develop professional skills in students.

The project "Forecasting Population Growth in Uzbekistan" on geometric progression is a vivid example of this. The process is organized as follows: Students collect population statistics for 2000–2023 from the stat.uz and World Bank websites. Then they create a table in Excel, calculate the average annual growth rate, and construct a mathematical answer to the question "When will the population of Uzbekistan reach 40 million?" based on the geometric progression formula. They draw a graph in GeoGebra or Excel comparing the real and forecast lines. During the project defense, each group presents its results to the class and takes questions. In this process, the student not only learns the formula, but also learns to solve a real scientific problem with it.

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Digital tools: GeoGebra and gamification

GeoGebra is a free, open-source mathematical program (geogebra.org) that provides special conveniences for studying geometric progression in a dynamic and visual form [9]. In the lesson, the teacher creates a dynamic model for geometric progression: using a slider, the values of b_1 and q are changed, and students observe how the graph and number series change on the screen in real time. For example, it is visually demonstrated that the series increases rapidly at q>1, and decreases at 0<|q|<1. This visual observation explains the essence of the formula more clearly than words and forms an intuitive mathematical imagination in the reader.

Gamification is a method of introducing game elements into the educational process. On the Kahoot! platform (kahoot.com), a teacher creates a test on geometric progression, and students participate in a competitive environment via their smartphones. For example, the teacher asks the question “If the first term is 2 and the denominator is 3, what is the 5th term?” — four answer options appear on the screen: 54, 162, 81, 486. Students select an answer on their smartphones within 20 seconds, and for each correct answer, points are collected based on speed, and the rating is updated on the screen. According to a study by Hamari et al., properly organized gamification increases student motivation in the lesson by up to 40% [10]. The NCTM (National Council of Teachers of Mathematics) in its standards defines technology as an integral part of modern mathematics education and calls on teachers to use digital tools strategically [11].

In conclusion, teaching the topic of geometric progression using interactive methods is not just a way to make the lesson “interesting”, but a conscious pedagogical strategy aimed at developing the student’s personality. Each of the analyzed methods differs in its specific role, purpose and didactic essence.

The described interactive methods create a cognitive conflict in the student, organize a process of “discovery” of the formula, which firmly stores this knowledge in long-term memory, and forms communicative skills along with mathematical knowledge. Also, the use of these methods creates a free space for creative and critical thinking, and allows you to make the lesson more visual and interactive using digital tools.

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