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Improving the Methodology for Forming Geometric Concepts in Students Based on Problem- Based Learning

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A B S T R A C T
This article examines methods for improving the process of developing geometric concepts in primary school students based on problem-based learning. It discusses the theoretical foundations of problem-based learning, the characteristics of young learners' perception of geometric concepts, and ways to enhance their cognitive activity. Special attention is given to creating problem situations, research-oriented tasks, didactic games, and group work methods, all of which contribute to the development of logical and spatial thinking. Examples of practical tasks aimed at making geometry education more effective are provided.

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Introduction

The formation of geometric concepts in primary school students is a crucial element of mathematics education, helping to develop logical and spatial thinking. Traditional teaching methods are often not engaging enough and do not fully enable students to grasp geometric concepts, which can later lead to difficulties in learning mathematics. From this perspective, problem-based learning is considered an effective tool, allowing students to independently find solutions, analyze geometric situations, and develop stable understandings of shapes and their properties. Developing and implementing problem-based learning methodologies helps increase students' motivation and makes geometry education more meaningful and practically relevant.

Geometric material holds a significant place in the mathematics curriculum of primary school. This is due to the importance of geometry in understanding the surrounding world, shaping a child's personality with a clear purpose, and contributing to intellectual development. The formation of geometric thinking plays a key role in a child's intellectual growth, as its low level can become an almost insurmountable obstacle in mastering several school subjects, particularly mathematics.

Despite the diversity of modern educational systems, meaningful geometric material is rarely found in the mathematics curriculum of primary schools. Teaching geometry elements in primary school is usually limited to recognizing the simplest plane shapes and measuring geometric quantities.

Methodology

Theoretical Foundations of Problem-Based Learning:

1. Lev Semyonovich Vygotsky – Cultural-Historical Development Theory

- Vygotsky examines problem-based learning in relation to the zone of proximal development. According to him, the learning process should be organized between the student's existing knowledge and the knowledge they can potentially acquire. Problem-based learning can be most effective within this zone of development.

2. John Dewey – Experiential Learning Theory

- Dewey views education as a process based on activity and experience. He argues that students should work on real problems and develop their knowledge by solving them.

3. Jerome Bruner – Constructivist Theory

- Bruner believes that instead of providing students with ready-made knowledge, it is essential to encourage them to conduct independent research. This constructivist approach is one of the fundamental principles of problem-based learning.

4. M.I. Makhmutov – Methodology of Problem-Based Learning

- Russian scholar M.I. Makhmutov is one of the theorists who laid the foundation for problem-based learning. According to him, problem-based learning involves creating problem situations in the teaching process to activate students' thinking.

5. A.M. Matyushkin – Theory of Problem Situations

- Matyushkin developed principles for organizing problem-based learning through problem situations. He suggests that students develop creative and critical thinking skills by independently solving problems while acquiring new knowledge.

Key Principles of Problem-Based Learning

- Creating a Problem Situation – Presenting students with a problem that encourages them to think.
- Organizing Research Activities – Students should analyze the problem independently or in groups and attempt to find a solution.
- Reflection and Analysis – Students evaluate their thoughts and draw conclusions.

Problem-based learning plays an essential role in developing mathematical thinking in primary school students. Applying this approach in teaching geometric elements enhances students' independent research skills and helps them develop spatial and logical thinking by solving real-world problems.

Examples of Developing Geometric Concepts in Primary School Students through Problem-Based Learning

1. "The Missing Shape" Problem

- Problem: The teacher shows students a picture with several geometric shapes (triangle, rectangle, circle), then removes one of them and asks: "Which shape is missing and why should it be in that shape?"
- Benefit: This task develops spatial thinking and comparison skills.

2. "The Largest and Smallest Shape"

- Problem: Students are given a picture containing squares, triangles, and circles of different sizes. They are asked: "Which shape is the largest, and which one is the smallest? How can you prove it?"
- Benefit: Students develop measurement, comparison, and reasoning skills based on evidence.

3. "What Shape Can You Make?"

- Problem: The teacher gives students different geometric figures and asks them to create new shapes.

For example, “What new shape can be formed by combining two triangles?”

- Benefit: Students develop analytical thinking skills by understanding the properties of shapes and linking them together.

4. “Which House Is Built Correctly?”

- Problem: Students are given pictures of houses made from different shapes. They are asked: “Which house is built correctly and why?”
- Benefit: Students learn about symmetry, shape stability, and the analysis of real-world geometric objects.

5. “Find the Way” Maze

- Problem: Students are given a maze created with squares, triangles, and other geometric shapes. They are asked: “Which is the shortest way for the child to return home?”
- Benefit: Students develop spatial reasoning and analytical thinking about directions.

These types of problems are based on the principles of problem-based learning, encouraging students to find answers on their own, analyze, and draw independent conclusions.

Methodology for Developing Geometric Concepts in Primary School Students through Problem-Based Learning

Results and discussion

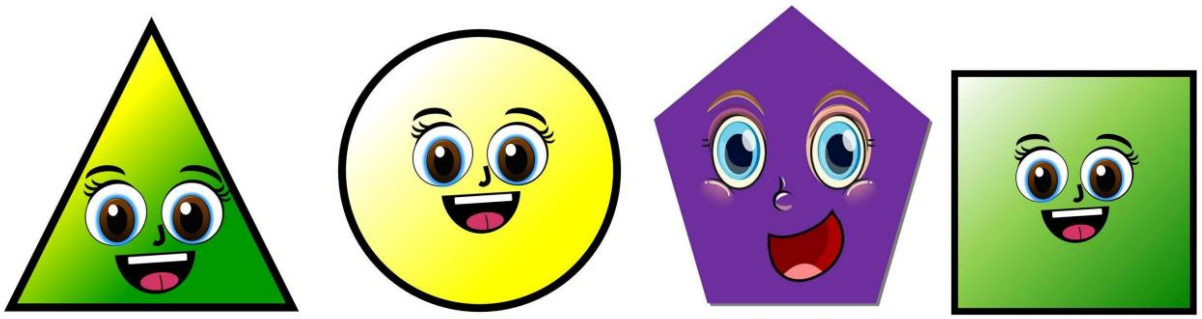
Problem-based learning helps primary school students develop independent thinking, observation, analysis, and problem-solving skills in the process of understanding geometric concepts. This process should be organized through the following stages:

1. Creating a Problematic Situation

Creating a problematic situation is crucial when teaching geometry topics to primary school students. This involves presenting logical questions and giving students the opportunity to think independently.

Example:

- The teacher displays various shapes in the classroom and asks: “In your opinion, which shape is the strongest? Why are triangles used in bridge construction?



- Students think about the problem and try to find an answer.

2. Observing and Discussing Geometric Objects

Children should independently observe geometric shapes in their surroundings and form their own understanding of them.

Activity:

- The teacher shows objects in the classroom and asks: “Which one looks like a circle? Which one looks like a square?”





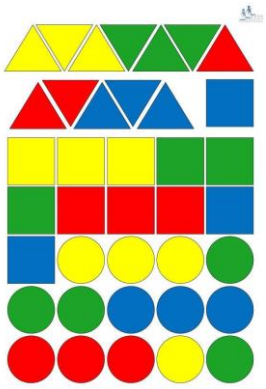
- They express their thoughts and classify the shapes.

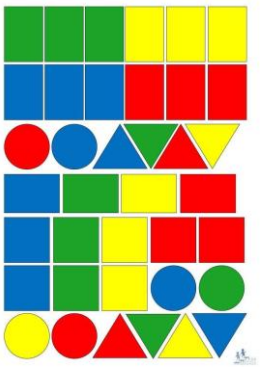
3. Research and Experimentation

In problem-based learning, students should discover new knowledge on their own. To achieve this, research related to geometric shapes is conducted.

Example:

- Students create triangles, squares, and rectangles from paper.





- Then they are given the task: “Which shape do you think is the strongest? Let’s test it!”
- Students examine different shapes and realize that the triangle is the most stable shape.

4. Group Discussion and Collaborative Work

Students are divided into small groups to solve a given problem together.

Example:

- The teacher distributes cards with different geometric shapes to the class.
- Groups analyze the properties of each shape and discuss their differences and similarities.
- Each group presents their conclusions.

5. Solving Problem-Based Tasks Related to Geometry

To develop students’ thinking skills, real-life problem-based tasks are given.

Example:

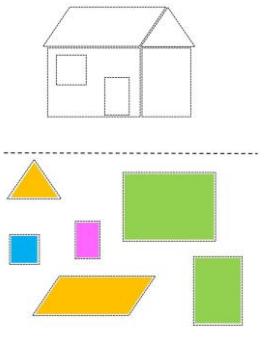
- “A builder is laying bricks in a rectangular shape, but at the corners, he adds triangular bricks. Why did he do this?”
- Students analyze the problem and conclude that triangles provide stability.

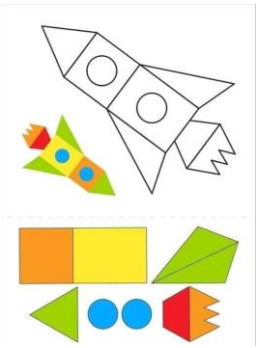
6. Creating Models and Construction Work

Students are given the opportunity to create geometric shapes using paper, cardboard, or clay and apply them in practice.

Activity:

- Students use matchsticks to build triangles and squares and test their stability.
- They combine shapes to create structures resembling real objects (e.g., a house model).





Thus, to develop geometric concepts through problem-based learning, it is important to use the following methods:

1. Creating problem situations,
2. Analyzing geometric objects in the environment,
3. Conducting research and experiments,
4. Organizing group work and collaborative discussions,
5. Solving problem-based tasks,
6. Performing practical construction activities.

This approach increases students' engagement, enhances their independent inquiry, develops logical and spatial thinking, and strengthens their interest in geometry.

CONCLUSION: The research on improving the methodology for developing geometric concepts in students based on problem-based learning demonstrates that this approach is an effective tool for fostering independent thinking and logical analysis skills in young learners. The study confirms that problem-based learning methods encourage student engagement, enhance creativity, and provide opportunities to consolidate theoretical knowledge through practical problem-solving tasks.

To increase students' interest in geometry, it is essential to incorporate interactive and visual materials, offer real-life problem-solving exercises, and use inquiry-based learning strategies. The refinement of this methodology will enhance the effectiveness of the learning process and help primary school students develop a strong understanding of geometric concepts.

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