



## MATHEMATICS AND CREATIVITY: HOW DO GEOMETRIC PROBLEMS DEVELOP CREATIVE THINKING?

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### ABOUT ARTICLE

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**Abstract:** This article analyzes the role of geometry in developing creative thinking. It explores methods for fostering students' analytical and creative abilities through geometric problems. In particular, the importance of using various approaches to solve geometric problems and seeking new and original solutions in cultivating creativity is highlighted. The article elaborates on the use of geometric problems as a tool to stimulate creative thinking, broaden students' cognitive abilities, enhance logical reasoning, and apply these skills in solving real-life problems.

### INTRODUCTION

Geometry, as one of the important branches of mathematics, is not limited to calculations and studying formulas, but also plays a significant role in developing creative thinking. Geometric problems, particularly challenging and complex tasks, test students' analytical and creative abilities. These problems encourage students to find new, unconventional solutions, as well as teach them to approach issues from a different perspective. Through geometric problems, we can see the possibility of developing not only mathematical skills but also creativity. In this article, we will discuss how geometric problems can enhance creative thinking and how they stimulate creative thinking in students. Geometry, due to its complexity and inclusion of various shapes, fosters creative thinking in students. For instance, exploring multiple methods in geometric problems and analyzing them from new perspectives encourages students to discover novel approaches. This, in turn, leads to the development of creativity and innovative thinking. Geometric problems also allow students to independently draw their own conclusions and compare solutions. Consequently, this develops a student's mathematical creativity, as they learn to solve each problem using different methods rather than from a single perspective. In mathematics, creativity is the ability to find and apply new, unique approaches in the process of solving problems, tackling tasks, and creating new knowledge. Creativity requires solving mathematical problems in unconventional ways, which in turn broadens students'

thinking horizons. This, in addition to following basic rules, demands a deeper understanding of mathematics and the ability to express one's thoughts. Creativity helps make mathematics more interesting and effective, as new ways of thinking are necessary to discover novel methods and simplify challenging problems. Creative thinking is crucial in mathematics because it aids in finding distinctive and efficient solutions. This skill allows for examining problems from various perspectives, encourages experimenting with new methods, and helps to think beyond traditional solutions. In mathematics, many problems can have multiple solutions. Through creative thinking, students can experiment with various methods and discover the most effective and straightforward solutions. Creative thinking is beneficial not only in solving mathematical problems but also in grasping complex issues, developing logical reasoning, and making decisions in practical life. The development of creative thinking enhances a person's overall cognition, imagination, and ability to analyze and solve problems. Creative thinking fosters students' intellectual capabilities, enabling them to tackle more challenging and engaging problems. This, in turn, increases their interest in learning and motivates them to achieve success. This increases their interest in learning and motivates them to achieve success.

Creative thinking typically allows for discovering new ideas and solutions, circumventing limitations, and viewing complex situations from different perspectives. This approach is especially crucial in geometric problems, as these often require going beyond simple formulas or classical solutions. Geometric problems are those related to geometric shapes, their dimensions, areas, volumes, and interrelationships. These problems help students delve deeper into mathematical and geometric concepts, develop logical thinking, and apply creative approaches. Various methods, formulas, and concepts are employed in solving geometric problems. For example, creative thinking helps in solving problems related to polygons, circles, and other geometric shapes by applying new methods and identifying connections between geometric objects to find effective solutions. We can categorize geometric problems into several types, such as surface area measurements, perimeter calculations, angles, volume, and symmetry. Calculating the area of geometric shapes is often the simplest and most fundamental task, and finding the perimeter by measuring the edges is also crucial. Furthermore, geometric problems frequently involve angles, and it is essential for students to calculate angles and understand their relationships with one another. In geometric problems, calculating volume, understanding measurements, and applying formulas help students develop mathematical imagination and logical thinking. In geometric problems, symmetry represents a distinct characteristic of a shape or object. Symmetry allows for the repetition of a shape or image through certain fixed points or by reflection. Geometric problems not only aid in learning mathematical knowledge but also contribute to the development of logical thinking and creative approaches. They enable students to understand shapes and their interrelationships, as well as to solve problems using various methods. Studying geometric problems is also beneficial in addressing issues that arise in everyday life. Geometric problems for elementary school students begin with simple shapes and concepts, but as they become more complex, new concepts and solutions are introduced. Consequently, geometric problems progressively increase in difficulty according to age, allowing for the step-by-step development of students. Geometric problems are tasks related to shapes and their properties. Each geometric problem has its own unique characteristics, and various methods and approaches are employed to solve them. In geometric problems, we deal with determining the dimensions of shapes. For example, we find the sides of a triangle, the area of a rectangle, and similar measurements. Each shape has its own unique dimensions and properties. Geometric problems often require logical thinking. When solving a problem, in addition to basic rules and formulas, analytical thinking and searching for structured solutions are

necessary. This encourages students not only to memorize formulas but also to learn how to apply them. Furthermore, geometric problems demand not just traditional approaches but also creative thinking. Often, problems cannot be solved by simple methods, so students strive to find new and innovative approaches. This teaches them to expand their knowledge and discover solutions through various methods. When solving geometric problems, visualizing shapes is crucial. Students frequently attempt to understand the problem by drawing figures and using diagrams. Visual imagination and sketching help to solve the problem more easily and accurately. Geometric problems help not only to acquire mathematical knowledge but also to develop logical and creative thinking. Through them, students gain skills such as studying shapes, understanding their relationships, and finding solutions. Geometry is an important tool that helps students solve problems not only in mathematics but also in everyday life. Working on geometric problems develops children's creative thinking, allowing them to view problems from different perspectives and find their own new approaches. Here, we may ask the question: how do mathematical problems develop creative thinking? Creative thinking is the process of generating new, original, and useful ideas, thoughts, or solutions. It is primarily a skill necessary for problem-solving, developing new ideas, and adapting to changes. The process of creative thinking encourages a person to adopt new, unconventional approaches and decisions, unlike logical thinking. Below are several stages of creative thinking:

- **Problem identification:** Identify a problem or situation and define questions related to it.
- **Information gathering:** Collect necessary data to better understand the problem or situation.
- **Idea generation:** Create new ideas and consider various thoughts.
- **Idea evaluation:** Analyze the generated ideas and select the best solution.
- **Solution implementation:** Apply the chosen idea or solution into practice.

Now let's examine these steps using an example of geometric problems.

**Problem:** A triangle has two sides measuring 5 cm and 7 cm. If its perimeter is 18 cm, find the third side of the triangle.

**Identifying the problem:** The problem provides two sides of a triangle (5 cm and 7 cm) and we know its perimeter (18 cm). Our task is to find the length of the third side.

**Gathering information:** We know that the perimeter of a triangle is the sum of all three sides:  $P = a + b + c$ . The perimeter is given as 18 cm, two sides are 5 cm and 7 cm, and we know this. We need to find the third side.

**Developing the idea:** Using the perimeter calculation formula, we construct the following equation to find the third side:

$$5 + 7 + c = 18$$

$$12 + c = 18$$

$$c = 18 - 12 = 6$$

**Evaluation of the idea:** Let's check the result. If the sides of a triangle are 5 cm, 7 cm, and 6 cm, their sum is:  $5 + 7 + 6 = 18$

**Implementing the solution:** We found the length of the third side to be 6 cm.

Through this problem, students can be encouraged to formulate equations, gather information, and think creatively. Finding an unknown side using the perimeter of a triangle is a problem that develops creative thinking for elementary school students.

**Problem:** A rectangle is 8 cm long and 4 cm wide. If we divide this rectangle into two, what shapes are formed? Are the resulting shapes symmetrical to each other? Are the shapes symmetrical?

**Identifying the problem:** We are given a rectangle that is 8 cm long and 4 cm wide. The rectangle needs to be divided along its length, width, and diagonal. Will the resulting shapes be symmetrical?

**Information gathering:** There are three ways to divide a rectangle:

1. Dividing by length: In this case, two rectangles are formed.
2. Dividing by width: In this case, two rectangles are formed.
3. Dividing by diagonal: In this case, two triangles are formed.

**Developing the idea:** 1. Dividing by length: If we divide the rectangle lengthwise, we get two rectangles. Both rectangles are 4 cm long and 4 cm wide. These shapes are symmetrical because they have the same dimensions and shapes.

2. Dividing by width: If we divide the rectangle widthwise, we get two squares. Each square has sides of 4 cm. These shapes are also symmetrical because they are equal and of the same shape.

3. Dividing by diagonal: If we divide the rectangle along its diagonal, we get two right triangles. Each triangle has a length of 8 cm, a width of 4 cm, and a hypotenuse. These shapes are symmetrical because the two triangles divided by the diagonal are congruent and identical in shape.

**Evaluating the idea:** The shapes formed in all three methods are symmetrical. Dividing by length results in two equal rectangles. Dividing by width results in two equal squares. Dividing by diagonal results in two equal right triangles.

**Implementation of the solution:** When dividing a rectangle along its length, two symmetrical rectangles are formed. When dividing a rectangle along its width, two symmetrical squares are formed. When dividing a rectangle along its diagonal, two symmetrical right triangles are formed. This problem explains three different ways of dividing a rectangle and the symmetry of the resulting shapes. It is effective in teaching the concept of symmetry to elementary school students.

The connection between mathematics and creativity is remarkably strong, as mathematics serves as an excellent tool for developing creative thinking, especially in the process of problem-solving and exploring various approaches. Mathematics is not merely about numbers and formulas; it teaches individuals to think analytically, logically, and creatively. For instance, solving complex problems requires trying multiple methods and discovering new approaches. This process nurtures students' creative thinking by encouraging them to seek alternatives beyond traditional solutions. Mathematics demands logical and systematic problem-solving. As students break down problems and solve them in small steps, they are compelled to make creative decisions at each stage. This process, in turn, enhances their analytical and creative thinking abilities. Many mathematical problems, especially in geometry, encourage students to visualize concepts through shapes, pictures, and diagrams. This process develops creative thinking, as students learn to enhance their imagination and engage in abstract thinking. For example, identifying and differentiating shapes in geometric problems and comparing them with other shapes fosters students' creative thinking abilities. In mathematics, particularly when solving problems, there arises a need to explore various options and methods, as well as to introduce innovative approaches. This necessity allows learners to experiment and discover new ways of thinking, which in turn supports and nurtures creativity. The development of creative abilities and the formation of creative activity are particularly significant in teaching geometry. The possibilities for developing

creative abilities and various aspects of fostering creative activity in geometry instruction are reflected in the scientific and methodological works of mathematician-educators such as A.Ya. Tsukar, S. Alikhonov, M.V. Egupov, G.D. Gleyzer, V.A. Gusev, S.V. Maslova, I.S. Bekesheva, D.M. Mahmudova, A.K. Nasybulina, and others [2.184]. In the process of teaching mathematics, solving problems serves a dual purpose: it not only achieves one of the main goals of mathematical education - forming mathematical knowledge, skills, and abilities as outlined in the mathematics curriculum and reflected in textbooks - but also naturally fosters creative activity in school students [4.444]. The following methods can be employed to develop students' creative thinking abilities through geometric problems:

**Creating new ideas through problem-solving:** Present students with simple geometric problems and ask them to find solutions using various methods.

Example: Find the area of a rectangle.

Simple method: The area of a rectangle is  $S = \text{length} \times \text{width}$ . If the length is 8 cm and the width is 4 cm, then the area  $S = 8 \times 4 = 32 \text{ cm}^2$ .

Creative approach: Suggest that students divide this rectangle into other shapes (for example, two triangles or a square). Ask them to calculate the area of each shape and then use these to recalculate the total area. This method allows solving the problem in different ways, encouraging creative thinking.

**Generalizing and expanding problems:** Present geometric problems to students at a basic level using simple shapes and ask them to transform these shapes into more complex ones. For example, ask students to divide a shape into two parts and discuss their ideas. Then, you can ask them to divide it into three parts or combine shapes. This develops students' creative thinking.

Example: Find the area of a square.

Simple method: The area of a square is  $S = a^2$ . If the side is 6 cm, the area  $S = 6^2 = 36 \text{ cm}^2$ .

Creative approach: Encourage students to analyze the square in various ways. For instance, dividing the square into two triangles or splitting it into smaller squares. This method helps students understand how area can be represented in different forms.

**Visualizing problems:** Encourage students to connect mathematical shapes with real-life situations. For example, comparing shapes such as circles and rectangles with everyday objects (balls, windows, curtains, etc.) expands their imagination. Место для уравнения. You can also ask them to modify problems as they wish. For instance, asking, "What changes would occur if you transformed this shape into another?" helps develop the student's creative thinking.

Example: Divide a rectangle into two congruent triangles. The rectangle is 8 cm long and 6 cm wide. Calculate the area of the rectangle and determine the area of each triangle after dividing it into two equal triangles.

Simple method: The area of a rectangle is  $S_{\text{rectangle}} = \text{length} \times \text{width}$ .

$S = 8 \times 6 = 48 \text{ cm}^2$ . If we divide the rectangle into two equal triangles, the area of each triangle will be  $S_{\text{triangle}} = S_{\text{rectangle}} \div 2 = 48 \div 2 = 24 \text{ cm}^2$

Creative approach: Ask students to divide a rectangle into various shapes. For example, you can suggest dividing the rectangle into shapes such as triangles, squares, or parallelograms. Students can determine the dimensions of the rectangle and decide which shapes to divide it into themselves. Through this method, students learn to apply creative approaches in dividing rectangles into different shapes and combining them. This, in turn, helps develop geometric visualization skills.

**Analyzing problems and finding new approaches:** Geometric problems can have multiple solutions, so teach students to solve problems using various methods. For example, calculating the area of a

rectangle using different formulas or determining a circle using different techniques. Encourage students to answer the question "How can you approach this differently?" This approach compels them to think creatively.

Example: How can you calculate the area of a triangle with a base length of 6 cm and a height of 2 cm?  
Simple method: The problem provides the base and height of the triangle, so we apply the formula.

$$S = (\text{base} \times \text{height}) \div 2 = (6 \times 2) \div 2 = 6 \text{ cm}^2$$

Creative approach: Challenge students to transform the triangle into a rectangle. To do this, the triangle can be divided into two equal parts: Draw a line along the middle of the triangle. By converting these two halves into a rectangle, we can calculate its area.

**Visualization and modeling:** Encourage students to think more deeply by modeling geometric problems in real-life situations. For example, demonstrate how these shapes are used in life, such as geometric shapes found in construction, art, or nature. Creating, constructing, or depicting shapes with their own hands stimulates creative thinking.

Example: Calculating the area of a triangle.

Simple method: The area of a triangle is  $S = (\text{base} \times \text{height}) \div 2$ . If the base is 8 cm and the height is 5 cm, then the area  $S = (8 \times 5) \div 2 = 20 \text{ cm}^2$ .

Creative approach: Invite students to make or construct a triangle with their own hands. This helps them understand how shapes can be used in real life. For example, students can learn how the triangle they are studying is applied in construction or art.

**Collaboration and group work:** Encourage students to solve problems in groups. Exchanging ideas on a specific issue and discussing various approaches develops creative thinking. Allowing each student to propose their own method and contribute to reaching a common group solution reinforces students' creative approaches.

Example: Creating a new shape by combining three different shapes.

Simple method: Provide students with rectangle, circle, and triangle shapes and ask them to create a new shape. For instance, combining these shapes to create new geometric figures in various forms.

Creative approach: Divide students into groups and give each group different shapes, asking them to create their own solutions. Then, have each group present their approach and discuss all solutions. This gives students the opportunity to develop creative thinking.

**Learning from trial and error:** Give students the opportunity to find and correct mistakes when solving problems. Finding the answer to the question "Why didn't this method work?" develops their critical thinking skills. Identifying and analyzing various errors in solving geometric problems further enhances creative thinking.

Example: Correcting errors when calculating the area of a rectangle.

Simple method: There can be several errors when calculating the area, such as incorrectly inputting measurements or using the wrong formula.

Creative approach: Ask students to calculate the area of a rectangle, but have each of them use different methods. Then analyze the errors and demonstrate how to arrive at the correct solution. This method develops students' thinking and teaches them how to learn from mistakes during the learning process.

**Integrating topics:** Combine geometry with other subjects, such as art, history, and natural sciences, to offer students new and engaging problems. For example, by integrating geometry and art, you can suggest that students study the works of famous artists and create artworks using geometric shapes.

Example: Integrating geometry and art.

Simple method: Teaching students how to create geometric shapes.

Creative approach: Challenge students to transform geometric shapes into works of art. For instance, they can create mosaics or pictograms using various geometric shapes. This provides them with an opportunity to connect mathematics with art.

Developing students' creative thinking through geometric problems enables them to solve complex problems in interesting and diverse ways. This not only enhances mathematical skills but also expands students' general cognitive abilities. To date, numerous scientific studies have been conducted on the development of creative capabilities. For instance, Dilnora Ziyadullaeva Ergasheva, in her article "Utilizing the PISA Method in Solving Geometric Problems," identifies the development of creative thinking as the primary goal that meets modern educational requirements. This article emphasizes the significance of the PISA methodology in fostering students' creative and critical thinking skills. Solving geometric problems teaches students not only to rely on theoretical knowledge but also to approach problem-solving through various methods. Through the PISA program, creative abilities are developed, and students become prepared to solve real-life problems. For example, students learn how to apply their mathematical knowledge in everyday life. The approaches discussed in the article demonstrate that education is focused on developing creative and logical thinking. Particularly through teaching geometric problems: creative thinking is enhanced, and students are able to apply their knowledge in various situations. Logical thinking is formed, which increases students' mathematical competencies. The effectiveness of the primary education process improves because the PISA methodology focuses not only on theoretical but also on practical development [1.195]. Additionally, in Nargiza Toshboeva's article "Developing Students' Creative Abilities Based on Geometric Problem-Solving," several key conclusions and analyses are presented regarding the development of students' creative abilities. The article highlights the important role of geometric problems in developing students' creative abilities. Geometric tasks help students develop non-standard thinking, which shapes their creative competence. The article also emphasizes the necessity of integrating innovative and traditional teaching methods. It demonstrates that geometric problems in elementary school mathematics lessons can enhance students' intellectual activity, develop spatial imagination, and strengthen logical thinking. The integration of information technology can further boost students' creative abilities in solving geometric problems [2.185]. The role of geometric problems in developing creative thinking has been highlighted in numerous studies. An independent researcher from Termez State University, Aytuvganov Urol, in his article "Fundamentals of Developing Students' Creative Thinking in Teaching Geometry," provides extensive scientific analyses on the development of students' creative abilities, particularly focusing on fostering these skills in geometry. The development of creative and intellectual abilities is considered one of the crucial directions in education. It is noted that geometry lessons serve as an effective tool for developing students' abilities such as intuition, imagination, and visual thinking. The selection and solving of creative tasks foster students' independent thinking, problem analysis, and approaches aimed at finding new solutions. Particularly in elementary school mathematics lessons, developing creative and analytical thinking through geometric problems enables the practical application of future knowledge. Creative abilities are developed through "creative tasks." In these problems, the boundaries of students' thinking expand, they experiment with new methods, and strive to create diverse solutions. Especially when solving a problem using multiple methods is required, new levels of creativity emerge. The development of mental abilities is enhanced through the synthesis of creative tasks. Students gain the opportunity to apply their knowledge to new situations by learning to solve geometric problems

using both algebraic and visual methods simultaneously[3.90.]. These studies are aimed at developing creative thinking and innovative abilities in mathematics and geometry education.

### CONCLUSION

In conclusion, it can be said that geometric problems are important in shaping students' analytical and creative abilities. Geometry is important not only for mathematical calculations, but also for the development of creative and logical thinking. Solving geometric problems in various ways allows for the development of creative abilities. The application of new approaches to solving geometric problems and the application of non-traditional thinking methods is required. This expands students' thinking and encourages them to make independent decisions. The application of geometric problems in mathematics lessons not only increases theoretical knowledge, but also serves to develop practical skills. The article emphasizes the importance of geometry in shaping creative thinking in the education system and proposes the widespread use of methods that develop creative abilities in pedagogical practice. In developing creative abilities in elementary school, students should be given simple but deeply thought-provoking tasks. For example, tasks aimed at finding new geometric representations by combining or partially analyzing shapes make this process effective. The use of geometric problems to develop creative and intellectual abilities is an effective method. By solving problems in various ways, students develop critical thinking, logical analysis, and creative approach skills. Developing students' interest in solving problems it is a very important means of fostering interest in mathematics and its study, as well as an effective means of engaging students in creative learning activities in mathematics. Such work is possible and necessary not only in extracurricular activities, but also during students' direct study of the program material. To do this, in the process of teaching mathematics, it is necessary to consistently include specific problems that are easily designed from the problems placed in mathematics textbooks. The use of tasks that develop students' creative abilities is an important condition for improving the quality of mathematical training for schoolchildren.

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