

# The Practice of Digitalized Classroom in Junior High School Mathematics Based on the Cultivation of Mathematical Thinking Ability

-- A Case Study of "Similarity" in the People's Education Press (PEP) Ninth Grade Textbook

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**Abstract:** In junior high school mathematics teaching, cultivating students' mathematical thinking can promote their understanding of abstract mathematical knowledge. Cultivating students' thinking requires a supportive environment and needs teachers' guidance in activating students' thinking. This paper primarily studies the cultivation of students' thinking ability in digitalized classrooms in junior high school mathematics, aiming to explore how to better utilize modern digital technologies to promote the innovation of junior high school mathematics teaching. It is believed that digital technology can help frontline teachers find the patterns of students' mathematical thinking development, setting up more classroom activities that promote the development of thinking ability, thereby improving the quality of junior high school mathematics teaching.

**Keywords:** Junior High School Mathematics; Digitalization; Thinking Ability.

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## 1. Introduction

The goal of modern education is not only for students to master corresponding knowledge, but more importantly, to cultivate their thinking ability. Thinking ability is the brain's ability to reflect on objective things indirectly and abstractly. It is the core of wisdom, which involves and controls all intellectual activities. Cultivating thinking ability is an important path for students' growth and success. Junior high school mathematics is an important component of middle school education, and due to its transitional role, greater attention should be given to fostering students' thinking ability in teaching. Thinking is a key assistant in students' classroom learning, and its liveliness and depth directly affect students' learning outcomes in mathematics and their future development. However, cultivating students' thinking ability is not something that happens automatically; it requires external support, such as appropriate teaching methods and a suitable teaching environment. This paper discusses how to use digital technology to assist in cultivating mathematical thinking in junior high school students, creating a suitable teaching environment with the support of digital technology to promote the formation and development of students' mathematical thinking.

## 2. The Role of Digitalized Classrooms in Cultivating Junior High School Mathematics Thinking Ability

First, diverse teaching resources stimulate thinking vitality. In a digitalized classroom, teachers can use digital technology to gather a variety of mathematics learning resources, including traditional text and image formats, animations, videos, and micro-lessons[1]. The combined use of these resources not only effectively captures students' attention but also sparks their interest in learning, laying a solid resource

foundation for cultivating their thinking ability. Second, real-time online interaction promotes the development of thinking ability. The most notable feature of digital technology is its strong interactive capabilities, allowing students to engage in real-time communication with teachers and peers in the digital classroom. This interaction can effectively enhance students' enthusiasm for participating in learning knowledge and provide teachers with immediate feedback, enabling the dynamic adjustments of teaching strategies, and ensuring the efficient attainment of teaching objectives. Lastly, personalized learning empowers thinking ability growth. In a digital classroom, technology allows teachers to record each student's learning process and performance, thus enabling in-depth analysis of learning conditions using multidimensional data. Based on this data, teachers can accurately grasp students' strengths and weaknesses, develop targeted teaching assistance plans, and implement personalized instruction to ensure that each student's mathematical thinking ability is fully cultivated.

## 3. The Practice of Digitalized Classroom for Cultivating Mathematical Thinking Ability in Junior High School — A Case Study of the "Similarity" Unit in the PEP Ninth Grade Textbook

### 3.1. Digital Classroom Introduction to Activate Thinking

In the teaching process of the "Similarity" unit of the PEP Grade Textbook, teachers can use digital technology to create a digital teaching environment and actively introduce new knowledge using digital tools. This approach not only ignites students' interest in learning new concepts but also activates their thinking[2].

Digital scenarios are created to stimulate students' learning desire. With digital technology, teachers can design interesting contextual stories before teaching new knowledge to immerse students in a digital classroom related to "similarity". For example, a digital treasure-hunt adventure story could be created, in which students act as adventurers and need to solve questions related to the unit to obtain clues to the treasure's location. The digital story setting grabs the attention of junior high school students and stimulates their curiosity and competitiveness as they solve problems to find the treasure, thus triggering their logical thinking.

Example of the Treasure Hunt Story:  
Story Background:

It is said that deep within the Mathematics Kingdom lies an ancient "Temple of Proportions", within which there is a treasure — the "Heart of Proportions", capable of measuring the world and building harmony. The temple is sealed by a magical "similarity" spell cast by an ancient mathematician, and only those who truly master the concept of similarity can pass the tests to uncover its secrets. You are the chosen mathematical adventurers!

Pre-Class Preparation:

Students should review in advance. The teacher will embed digital resources (GeoGebra links, videos, etc.) into "interactive questions" and group the students beforehand.

Adventure Map (corresponding knowledge points)

**Table 1.** Specific Challenge Content.

Level Name	Core Challenge	Activity Content	Digital Implementation and Interactive Design
Level 1: Mirror Canyon	Pass through a canyon with ancient murals and patterns of varying sizes, all of which are identical in shape.	Challenge: Identify similar shapes and calculate their similarity ratio. Task: Each group clicks the link to enter a pre-set GeoGebra file, which contains draggable shapes. Questions: 1. Drag the shapes and find all the shapes similar to the given one. 2. Measure and calculate their similarity ratio.	1. Group Instruction: Each team enters their interactive whiteboard to operate the same GeoGebra file together. 2. Timer: The teacher sets a countdown to create a sense of urgency. 3. Survey: The teacher can enter any group's whiteboard interface at any time to observe progress.

The Use of Digital Technology to Present Knowledge: Teachers can use various digital tools, such as GeoGebra, to visually demonstrate the theorem of "similarity of figures" to students. By proportionally enlarging or shrinking a shape, students can observe the changes and relationships between two shapes. Combined with the definitions given in the textbook, students can easily grasp the theorem related to similar shapes. Additionally, teachers can allow students to personally operate the digital technology and use these tools to explore on their own, thereby discovering other characteristics of similar shapes and promoting a deeper understanding of the theorem.

Example from PEP Ninth Grade Textbook (Section 27.1: "Similarity of Shapes"):

Teacher's Activity:

Using GeoGebra for dynamic demonstration: The teacher proportionally scales a quadrilateral ABCD (a randomly drawn shape) by a ratio (e.g., 1:2 or 2:1), and the scaled shape is labeled as quadrilateral EFGH. Students can visually observe the characteristics of corresponding vertex connections, parallel sides, and equal angles. By combining these observations with the definitions in the textbook, students can intuitively understand the core theorem of similar shapes, which states that "shapes are the same, and the sizes are proportional."

Student's Independent Exploration:

In groups, students use GeoGebra to draw their own shapes, set their own scaling ratios, and measure the ratios of corresponding sides and angles. This allows them to verify that "corresponding angles are equal, and corresponding sides are proportional." This lays the foundation for understanding further properties of similarity, such as the fact that the perimeter ratio equals the similarity ratio, and the area ratio equals the square of the similarity ratio. Students transition from passively receiving information to actively discovering knowledge.

Teacher-Student Interaction: Each group uses GeoGebra to present their exploration results, explaining the characteristics of similar shapes they discovered. Finally, the teacher

provides feedback, guiding students to summarize and deepen their understanding of the properties of similar shapes, while cultivating their geometric intuition and investigative abilities.

Integrating Various Resources to Enrich Teaching. During the classroom introduction, teachers can leverage digital tools to integrate various resources for students, such as image-text resources, videos, or audio resources, thereby allowing students to experience the diversity of mathematical knowledge in a digital classroom. For example, teachers can present historical stories or videos related to the exploration of "similar triangles" to help students understand the research process of the "similar triangles" theorem. Additionally, they can present real-life scenario videos about the theorem to help students gain a better understanding of its practical applications in a relaxed and engaging classroom atmosphere, allowing students to expand their thinking through the ample resources available for viewing and understanding.

Creating Digital Humans to Tell the Historical Story of "Similar Triangles":

In the 3rd century BC, Euclid, in his work Elements, provided a strict definition and criteria for similar triangles, such as triangles with two equal angles being similar, and proved that the corresponding sides of similar triangles are proportional. This laid the foundation for the axiom of the theory of similar triangles[5].

Around the 6th century BC, Thales discovered that when the length of his shadow was equal to his height, the length of the pyramid's shadow was also equal to the height of the pyramid. He measured the distance from the tip of the pyramid's shadow to the center of the pyramid's base, which gave the pyramid's height, utilizing the properties of similar right triangles[6][7]. At the port, Thales used a reed to measure the height and shadow length, and then measured the shadow length of a ship's mast. By using the property of proportional corresponding sides of similar triangles, he was able to calculate the height of the mast, with very small error after multiple measurements[8]. Additionally, the engineer Eupalinos used the principles of similar triangles to ensure precise alignment when designing tunnels[9].

In *The Nine Chapters on the Mathematical Art*, the "method of equal differences" solved problems of measuring great distances or heights that were otherwise inaccessible by using similar triangles, which is a creative application of the theory of similar triangles[10]. During the late Ming and early Qing Dynasties, the "Mei Family of Mathematicians" (such as Mei Wending) further developed the theory of similar triangles and promoted its applications in fields such as astronomy and calendrical systems[11].

The ancient Greek astronomer Eratosthenes used the principles of similar triangles, combined with the differences in the lengths of shadows at two locations, to calculate the Earth's circumference with minimal error, showcasing the value of similar triangles in astronomical measurement[12]. The Arab mathematician Al-Khwarizmi, in *Al-Kitab al-Mukhtasar fi Hisab al-Jabr wal-Muqabala* (The Compendious Book on Calculation by Completion and Balancing), combined the theory of similar triangles with algebraic methods, expanding its range of applications[13].

After the Renaissance, the theory of similar triangles became a foundational tool in fields like perspective drawing, mapmaking, and engineering measurements, advancing the development of science and technology[14].

**Setting Interactive Questions to Stimulate Thinking:** During the introduction, to stimulate students' thinking, teachers can use digital technology to set highly interactive questions for students. This way, students can clarify their own thinking processes while reflecting on "similarity" concepts. These questions can be open-ended for self-discussion, with no standard answers, allowing students to freely express their understanding. Alternatively, questions can be multiple-choice to cultivate students' critical thinking. Through teacher-led questioning and student discussions, the teacher can gradually guide students to a deeper understanding of the "similarity" unit and its theorems and help them master the practical application of the relevant concepts.

#### **Example from PEP Ninth Grade Textbook (Section 27.2.1: "Determining Similar Triangles"):**

First, review the learning path of "Congruent Triangles," then hand the initiative over to the students. In class, directly use "Doubao" to ask questions:

- **Teacher's Question 1:** What is a "similar triangle"?
- **Teacher's Question 2:** Why should we study "similar triangles"?
- **Student's Question 1:** What content about "similar triangles" do we need to learn?
- **Student's Question 2:** How do we determine if two triangles are similar?

While studying the exploration on page 29 of the textbook, use "Doubao" to ask: If the shape changes (by providing multiple deformed shapes with the "Doubao"), are the sides still proportional? How can we verify this?

After completing this exploration, "Doubao" can also be used to ask: Why should we learn this exploration before learning the methods for determining triangle similarity?

Through the above introductory strategy, the teacher can effectively apply digital technology, promoting the creation of a digital classroom for junior high school mathematics. This will activate students' thinking while learning mathematical knowledge, laying a solid foundation for in-depth exploration of new concepts. The use of digital technology in the introductory phase not only stimulates

students' interest in learning but also helps improve their overall literacy. Furthermore, incorporating various digital tools into the classroom's introduction lays a strong foundation for teaching, significantly benefiting the quality and effectiveness of mathematics education.

### **3.2. Digital Classroom Teaching to Optimize Thinking**

In the teaching of the "Similarity" unit in the PEP Ninth Grade Textbook, teachers can use digital technology to allow students to actively explore knowledge in the classroom, showcasing students' central role while also guiding the development of their thinking, thereby optimizing their thinking processes.

#### **1) Using Digital Tools to Develop Spatial Imagination Thinking**

First, 3D modeling software aids in understanding spatial concepts. In digital classroom teaching, 3D modeling software can help students understand spatial concepts. Students are no longer passively receiving knowledge but can actively explore spatial laws through the software, gaining a better understanding of spatial concepts. This helps lay a solid foundation for developing spatial imagination and understanding abstract mathematical knowledge. During the teaching of the "Application of Similar Triangles" section, traditional teaching methods may not fully show students three-dimensional practical cases; instead, students are asked to rely on imagination or flat drawings. This results in students' understanding being somewhat abstract. However, using 3D modeling software allows students to actively participate in observing the shapes. They can operate the software themselves, manipulate the pyramid in Example 4, and simulate the movement of the sun at different times of day. This provides a direct understanding of how ancient Greek mathematicians used the principles of similar triangles to calculate the height of the pyramid.

Second, virtual reality (VR) technology supports spatial perception experience. The use of VR technology can provide much help in the development of spatial perception for junior high school students[1]. In the "Similarity" unit teaching process, VR technology can present almost real three-dimensional scenes to students. With VR, students can feel as though they are in a three-dimensional environment and can observe the relationship between two shapes from different angles and distances. For example, in learning about "similar figures," students can use VR to rotate two similar figures, observing their vertices and sides, and perceive the differences between them from different angles. This immersive learning experience helps students' understanding move beyond flat shapes and spatial imagination, allowing them to observe object characteristics in space. VR also allows for the simulation of real-world situations that are difficult to observe directly, such as measuring the height of a flagpole or understanding the similarities in mathematical activities like artistic lettering. This not only promotes students' spatial perception but also helps spark their interest in spatial geometry exploration. Thus, digital technology tools can facilitate the development of students' spatial imagination thinking abilities, and teachers should continue to explore various digital tools to better apply them in the classroom to enhance students' thinking.

#### **2) Using Digital Tools for Interactive Learning to Cultivate Creative Thinking**

First, online collaboration sparks creative thinking. In

junior high school mathematics digital classrooms, organizing group cooperation activities allows students to ignite creative thinking through the exchange of ideas within the group[2]. By engaging in discussions, students can analyze problems from multiple perspectives and discover the quickest and most effective ways to solve problems, nurtures the development of their creative thinking. For example, in the teaching of "Observation and Conjecture" in "Similar Triangles," the teacher can use digital platforms to divide students into groups, allowing them to explore and analyze the fascinating properties of "fractals." This not only arouses students' desire for challenges but also satisfies their interest in hands-on activities. During group collaboration, students use their knowledge and experiences to manipulate and communicate their ideas. For instance, in the process of cutting a Sierpinski carpet, students will use various cutting methods, such as horizontal cuts, vertical cuts, or folding cuts, and after hands-on practice, they can determine the most efficient cutting method.

Second, online competitions broaden creative horizons. In the digital classroom, teachers can use online competitions as a platform for students to express their new ideas, while also allowing students to absorb ideas from others and expand their own creative horizons. This helps break students' thinking limitations and allows them to fully realize the creative potential in applying mathematical knowledge, further motivating their desire for innovation[3]. Through the "Similarity of Figures" exercises, for example, organizing online competitions where students use digital tools to solve problems in different ways encourages them to integrate their imagination. Through these online competitions, students can learn the problem-solving approaches of other students from different regions or grade levels. By studying other students' solutions, students can discover patterns in solving such problems and broaden their creative thinking while strengthening their mathematical reasoning skills.

The use of advanced digital technology in junior high school mathematics classrooms can optimize students' thinking. The application of such technology attracts students' interest in learning, and the organization of diverse teaching activities helps develop their thinking abilities. In future teaching, teachers can actively explore additional digital technologies and integrate them into mathematics instruction, helping to both develop students' mathematical thinking and enhance their overall mathematical literacy [4].

## 4. Conclusion

In summary, this research, using the "Similarity" unit from the ninth-grade textbook as an example, explores how to use digital technology to create a classroom environment that fosters the development of thinking abilities in junior high school students. The integration of digital technology into mathematics teaching turns the maths classroom into a vital platform for stimulating students' mathematical thinking abilities. Digital technology not only helps enrich the teaching content but also stimulates students' interest in learning mathematics. During the process of exploring knowledge, students not only master the unit's content but also, with the assistance of digital technology, develop their problem-solving abilities, achieving a significant improvement in their

thinking. The application of digital tools allows teachers to obtain timely feedback on students' learning experiences, providing valuable support for targeted teaching strategies. The results of this study offer new perspectives for future junior high school mathematics teaching practices, and they also provide important reference points for improving the quality and effectiveness of mathematics education.

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