ISSN 2616-5805 Vol. 4, Issue 3: 20-26, DOI: 10.25236/AJMS.2023.040304

The Application of Geometer's Sketchpad in Mathematics Teaching in Junior Middle School

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Abstract: *With the rapid development of the information age, the emergence of information technology software such as the geometric sketchpad provides a powerful tool for teachers' teaching. Junior high school mathematics teachers can help junior high school students explore mathematical theorems, function concepts, geometric properties and other contents through the geometric sketchpad to assist classroom teaching, and promote the development of junior high school students' mathematical thinking. This paper combines the junior high school teaching cases, integrates the Geometer's Sketchpad into the specific teaching content, and deeply discusses the advantages and effects of Geometer's Sketchpad in junior high school mathematics teaching.*

Keywords: *Geometric Sketchpad; Junior high school mathematics; Classroom teaching*

1. Introduction

Mathematics is a relatively basic subject in middle school teaching, but when learning other subjects, mathematics plays an important role as a foundation and tool, so people attach great importance to learning mathematics in middle school. With the development of information technology and the popularization of the internet, it is inevitable that the reform of mathematics education and teaching will also be impacted. In the process of teaching reform, the updates of teaching methods, teaching methods, and teaching methods will inevitably lead to changes in teaching content, educational concepts, and teaching ideas. Therefore, the updating and upgrading of its software, how to use it in mathematics teaching It is particularly important to leverage its advantages and achieve ideal mathematical teaching results in mathematics classrooms..The Curriculum Standards for Compulsory Education (2022 Edition) points out that "mathematics education should make reasonable use of modern information technology, provide rich learning resources, design vivid teaching activities, and promote the reform of mathematics teaching methods[1]". With the continuous promotion of mathematics curriculum reform, the difficulty of mathematics knowledge in junior high school continues to increase, and the technical means of mathematics classroom teaching in junior high school continue to enrich. The appearance of Geometer's Sketchpad software can effectively solve the problems of teachers' nonstandard drawing, geometric graphics are not intuitive, dynamic graphics are difficult to display, and it is helpful to cultivate junior high school students' thinking of combining numbers and shapes, intuitive imagination, abstract thinking ability and other aspects.

Under the reform of mathematics teaching with great ideas and trends, the Geometer's Sketchpad has entered the research field of many scholars. The geometric sketchpad teaching has changed the traditional teaching method and provided more effective teaching tools for teachers. At the same time, "Geometer's Sketchpad" can create conditions and guide students to actively participate in mathematics learning, so it can effectively stimulate students' interest in learning, make dull and abstract mathematical knowledge intuitive and visualized, let students love mathematics, and help cultivate students' dynamic mathematical view. With the continuous innovation of teaching methods and methods, many front-line teachers have developed new teaching models using the geometric sketchpad and achieved ideal teaching results. This paper discusses the application and value of "Geometer's Sketchpad" in junior high schoiol mathematics education with teaching cases.

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2. Advantages of The Geometer's Sketchpad

2.1. Enrich teaching content and create efficient classrooms

The significant difference between junior high school mathematics and elementary school mathematics lies in the addition of content such as proving geometric figures and learning functional relationships. This is a significant challenge for junior high school students, and to some extent, it puts higher requirements on their abstract and theoretical thinking. Students who have just entered junior high school find it difficult to transition from intuitive thinking to abstract thinking in a short period of time, and are unable to slowly think and accept it within the limited classroom time. Therefore, improving classroom efficiency has become the only way.

The visibility and concreteness of The Geometer's Sketchpad can effectively help students change their thinking, thus improving the efficiency of classroom teaching. In addition, the application of The Geometer's Sketchpad has left a lot of room for teachers to expand their knowledge, so that teachers can supplement the knowledge points on the basis of the original textbooks, help students learn and understand the knowledge points in the textbooks, and thus enrich the classroom teaching content.

2.2. Enhance classroom fun and enhance students' interest in learning

Middle school mathematics has the characteristics of abstraction and rigor. In the traditional teaching mode, teachers excessively focus on classroom teaching, and students' improvement in mathematics mainly relies on the mechanical mode of listening in class and brushing questions after class. This is not conducive to the enhancement of students' interest in learning, and may even lead to serious aversion to learning. The application of The Geometer's Sketchpad in junior high school mathematics, in short, is an innovation in mathematics teaching methods, because mathematics is a subject with high requirements for thinking, imagination and logical ability.

The Geometer's Sketchpad is a multimedia form. With its visibility and specificity, it can activate the classroom atmosphere, simplify complex knowledge, stimulate students' interest in learning, and truly help students build confidence in learning mathematics. The Geometer's Sketchpad teaching technology has been integrated into the mathematics classroom, playing its leading role, creating a vivid and vivid life scene, stimulating students' interest in learning, helping us further optimize the cognitive process, highlighting the key points in teaching, breaking through the difficulties, achieving "teaching students in accordance with their aptitude", freeing students from tedious learning, forming a learning atmosphere of cooperation, communication and active exploration, and making the mathematics classroom more exciting.

2.3. Show the beauty of mathematics and understand the essence of mathematics

The beauty of mathematics is an indescribable beauty that is difficult for teachers to describe clearly and for students to fully comprehend. Especially in junior high school, geometric figures and functional curves all demonstrate the beauty and harmony of mathematics. In traditional teaching, mathematics teachers try their best to help students fully understand the meaning of functions and experience geometric relationships by searching for relevant pictures or drawing on the blackboard to help students understand the internal connections between knowledge. However, the teaching effect is not satisfactory.

Applying the The Geometer's Sketchpad to junior high school mathematics teaching, you can draw hexagon, octagon and other arbitrary shapes just by pressing a few times on the Sketchpad according to the prompts, and you can also rotate and change at will to make the figures become vivid. Students do not need to spend a lot of energy imagining, can quickly enter a learning state, understand the content explained by the teacher, and become the leader of the classroom. While guiding students to learn new knowledge, students will also feel the beauty of changes in geometry. Using the The Geometer's Sketchpad to show the translation and rotation of the figure, students can appreciate the beauty of mathematics invisibly, and their attitude towards mathematics will gradually change. Therefore, the use of The Geometer's Sketchpad is an important teaching method for students to understand the aesthetic value of mathematics.

2.4. Easy to understand the combination of numbers and shapes

The Geometer's Sketchpad is a modern scientific and technological software, which can not only

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draw graphs, but also calculate, edit, input text and other operations. These functions make the construction of geometric modeling simple. Through various interactive functions, the The Geometer's Sketchpad organically combines data and graphics to achieve the combination of numbers and shapes, and becomes an efficient and convenient teaching aid tool. It can help students draw difficult figures and produce various animation models. The unique measurement function of The Geometer's Sketchpad makes it easier to observe problems, research experiments, and summarize.

For example, when teaching related knowledge of isosceles triangle and equilateral triangle, teachers can use the The Geometer's Sketchpad to dynamically display these triangles, breaking the order of students' original memory definition. Generally speaking, students first memorize the definition and then continuously apply the features described in the definition in the graphics.

3. The Application of The Geometer's Sketchpad in Junior Mathematics Teaching

3.1. Understand mathematical theorem with the help of geometric sketchpad

Among the subjects in junior high school, mathematics is difficult for students to learn, especially the derivation of mathematical theorems. Therefore, when teaching mathematical theorems, teachers can use the geometric sketchpad to show the required geometric figures, and guide students to further deepen their understanding of mathematical theorems in the dynamic graphic transformation.

Case 1: When teaching the judgment theorem of similar triangles, you can use the rotation function of the geometric sketchpad to show students the "rotation type" similar triangle model. Before the rotation, ΔABC and ΔADE are a pair of similar triangles (as shown in Figure 1). When ΔADE rotates for a certain angle, students will find that a new pair of similar triangles $\Delta ABD'$ and $\Delta ACE'$ (as shown in Figure 2) have been generated, and then guide students to prove that the new similar triangles, the angle of rotation is $\angle BAD' = \angle CAE'$, and the corresponding side proportion is obtained from the original triangle, namely $\frac{AB}{AC}=\frac{AD'}{AE'}$, At last, the judgment theorem of "two sides and one included angle" adopted by the new similar triangle is summarized and proved.

Using the The Geometer's Sketchpad to dynamically demonstrate the formation process of "rotating" similar triangles can, on the one hand, visualize and concretize abstract concepts; on the other hand, students' access to novel knowledge can increase their interest in learning; in addition, the coordination of colors is very helpful for students to observe the relationship between figures.

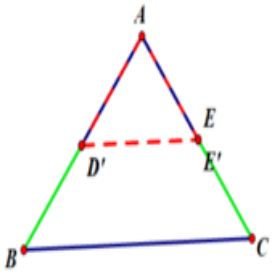

Figure 1: Before rotation

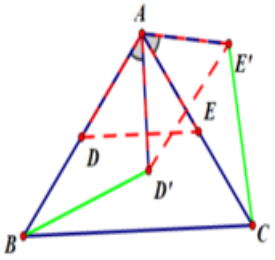

Figure 2: After rotation

After explaining the "rotating" similar triangles, teachers can further use the The Geometer's Sketchpad to demonstrate the "one line three equal angles" similar triangles, guide students to find the basic model of similar triangles from more complex graphics, and pave the way for more complex comprehensive topics. Using the The Geometer's Sketchpad to display three pictures at the same time (as shown in Figure 3) can form a sharp contrast effect, guide students to feel the mathematical idea of "analogy" in the dynamic change of graphics. Through the change of graphics, students will find that, regardless of the angle change, ΔABD and ΔCDE are always similar triangles, and through the translation, symmetry, rotation Various changes such as similarity have cultivated students' rigorous logical thinking and deepened their understanding of concepts and decision theorems during the learning process.

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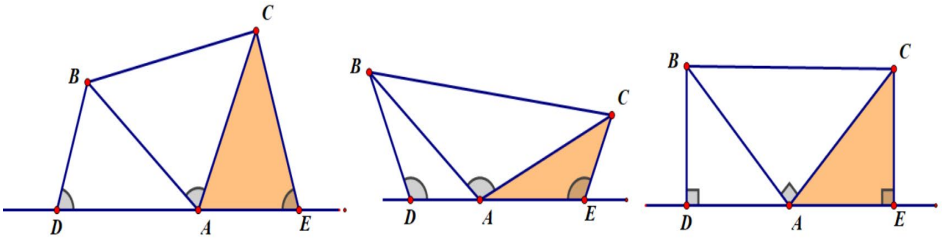

Figure 3: Similar Triangle with "One Line and Three Equal Angles"

3.2. Explore geometric properties with the help of geometric sketchpad

Through the reflection, scaling, translation, rotation and other functions of the Geometer's Sketchpad, the invariant geometric properties can be dynamically reflected. The teacher can guide students to explore the basic properties of geometric figures visually with the help of the geometric sketchpad.

Case 2: Explain the nature of "three lines in one" of isosceles triangle through the "moving" function of the geometric sketchpad[2]. As shown in Figure 4, firstly draw ΔABC with the geometric sketchpad, and draw a point B'on the bottom BC, and $AB = AB'$; Secondly, make a moving pointC'on the bottomBC, and make three line segments such as high AD, middle line$AE$and bisector$AF$of $\angle BAC'$; Finally, demonstrate to the students that as C'moves from$C$to D on the CD, $\Delta ABC'$ gradually changes from an equilateral triangle to an isosceles triangle, and the centerline AE and angular bisectorAFcontinue to "close" to the high $AD$with the movement of C'until they coincide with the high AD (as shown in Figure 5) [2]. This kind of dynamic graphic display is more beneficial for students to master the geometric property of "three lines in one" than the dull explanation of teachers.

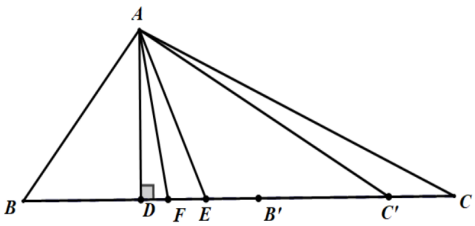

Figure 4: Before moving

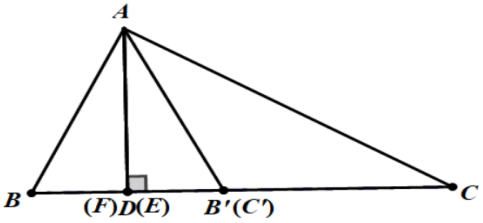

Figure 5: After moving

In addition, the proof of the nature of "three lines in one" can also be intuitively displayed through the "folding" function of the The Geometer's Sketchpad: as shown in Figure 6, in the isosceles triangle ABC, after using the "folding" function of the The Geometer's Sketchpad to rotate ΔABD 180° around the high ADon the bottom BC, it is good to coincide with ΔACD. This process not only intuitively confirms that $BD = CD$, and $\angle BAD = \angle CAD$, but also expands the students' argument ideas, achieving the effect of killing two birds with one stone.

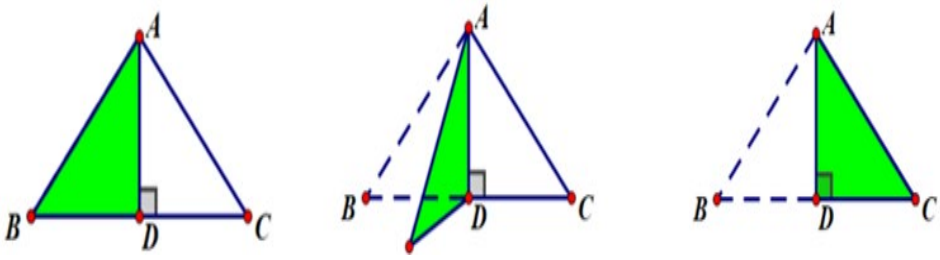

Figure 6: Folding method to prove "three lines in one"

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3.3. Help function learning with the help of geometric sketchpad

In addition to dynamically displaying geometric figures in mathematics teaching, the geometric sketchpad is also very helpful for the teaching of functions. The teacher can use the geometric sketchpad to display the abstract function image in a vivid way to stimulate students' interest in learning function knowledge [3].

Case 3: When exploring the relationship between the quadratic function $y = ax^2$, $y = ax^2 + k$, $y = a(x - h)^2$ and $y = a(x - h)^2 + k$ images, you can use the geometric sketchpad to make corresponding function images (as shown in Figure 7). The points A, H and Kare moving points on the x-axis, and the abscissa of these three points correspond to$a$, h, and k in $y = a(x - h)^2 + k(a \neq 0)$respectively. Drag the three moving points along the x-axis in turn, and the values of the parameters a, h, and k will also change. Students can observe the corresponding changes in the function image. Through the dynamic changes of the function image, students can have a deeper understanding of the relationship between "number" and "shape".

(1) Drag point A, and you will find that the opening size of the image has changed. When $a > 0$, the opening of the function image is upward, and when $a < 0$, the opening of the function image is downward.

(2) Drag point H, you will find that the function image moves left and right with the movement of point H on the x-axis, and then summarize the rule of "left plus right minus", and the straight line $x = h$ is always the symmetry axis of the function image.

(3) Drag point K, and you will find that the function image shifts up and down with the change of K value, and then guide students to summarize the rule of "up plus down minus", and the value of K determines the ordinate of the function image vertex.

So as to guide students to further summarize the relationship between the values of a, h, k and the function image. Through the presentation of the geometric sketchpad, students can directly observe the changes of the function image[4]. Compared with the traditional mathematics class, using the function image drawn by students to explain, using the geometric sketchpad is faster and more intuitive, which not only saves the class time, but also improves the teaching efficiency. At the same time, the moving point demonstration deepens the students' understanding of the function image[5].

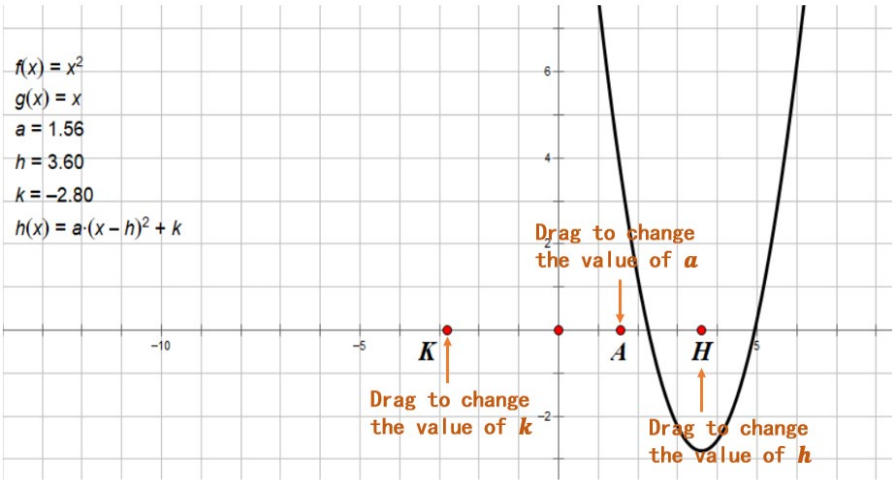

Figure 7: Image of function $y = a(x - h)^2 + k$

Case 4: Function Comprehensive Question Teaching:

As shown in figure 8, it is known that the parabola passes through points $A(-1,0)$, $B(3,0)$, and $C(0,3)$.

(1) Find the analytical formula for a parabola.

(2) Point$M$ is a point on line segment BC(not coincident with $B$and C), and is there a maximum value for $MN$when creating a $MN \parallel y$ axis intersecting parabola at point Nthrough M? If the abscissa of point M is m, please use the algebraic expression of m to represent the length of MN.

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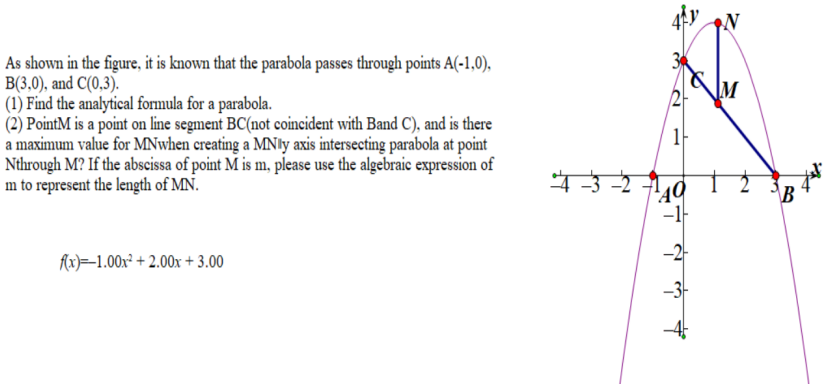

Figure 8: Function Title Display

In this question, the first question is relatively simple. After the students independently complete it, the teacher clicks the "Function Parsing" button to verify the students' answers. The image drawn by the teacher using the The Geometer's Sketchpad is more accurate than the image drawn by the teacher on the blackboard, so the function image can be verified more accurately and pave the way for the second question. In traditional teaching, the function image drawn by the teacher on the blackboard is static, and students can only rely on imagination and the teacher's explanation for the change process of the line segment MN, and cannot intuitively understand the change process of the line segment. By using the The Geometer's Sketchpad to assist teaching, teachers can directly click the "Animation Parallel Line" button to demonstrate the change process of MN. As shown in Figure 9, students can determine that MNchanges from small to large and then to small in the process of moving from left to right through observation, which indicates that there is a maximum value of MN. Then, in combination with the students' solution process, they can explain the solution idea of "using the algebraic expression containing m to express the length of MN", and finally let students summarize the steps of solving the problem of using the algebraic expression of m to express the length of MN. The application of The Geometer's Sketchpad to dynamically demonstrate the change process of line segment MN can help students improve their spatial imagination, and also make students realize that their spatial imagination is reasonable, not unlimited reverie, and increase students' self-confidence, which fully reflects the advantages of The Geometer's Sketchpad in function synthesis.

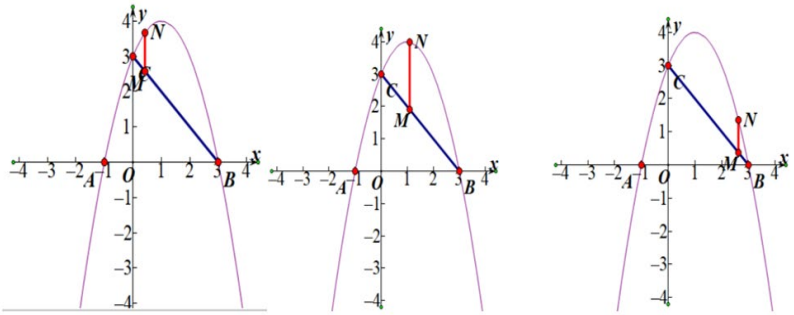

Figure 9: MN Motion Process of Line Segments

4. Summary

Through the analysis of the above cases, it can be found that the use of the geometric sketchpad can flexibly and intuitively display mathematical properties and models, and can also effectively help teachers to accurately draw and intuitively explain. Students in junior high school need to cultivate more interest in learning mathematics. Teachers and students can operate the geometric sketchpad together, gradually explore the essence of mathematics, and cultivate students' dynamic view of mathematics.

The use of Geometer's Sketchpad can effectively improve the efficiency and quality of mathematics teaching in junior high school. By integrating the Geometer's Sketchpad into the junior high school mathematics class, the abstract mathematical knowledge becomes visual and intuitive, which is more in line with the development of students' thinking logic, and is conducive to the formation of students'

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mathematical literacy. Compared with the traditional classroom teaching, the Geometer's Sketchpad teaching has great advantages. Teachers should recognize the advantages of Geometer's Sketchpad teaching, combine the corresponding mathematics curriculum content and reasonably apply Geometer's Sketchpad to teaching, and achieve innovation in mathematics teaching and learning.

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