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Cultivation of Mathematical Intuitive Imagination Literacy in High School Students Based on GeoGebra Software

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Abstract **– With the development of modern information technology, China's Ministry of Education has put forward the "Education Informatization 2.0 Plan, and the integration of information technology and mathematics core literacy is a hot topic nowadays. Among the six core literacies of high school mathematics, intuitive imagination literacy is the foundation of the other five core literacies, and the importance of intuitive imagination is obvious as it is often necessary to get inspiration and ideas before discovering and solving a problem. GeoGeBra is a powerful drawing software, which can be used as a powerful tool to cultivate students' intuitive imagination, therefore, the appropriate application of GeoGeBra in teaching and learning can have twice the effect with half the effort. This paper first analyzes the current situation of GeoGeBra in high school mathematics teaching, and then puts forward the strategy of using GeoGeBra software to cultivate students' intuitive imagination literacy.**

Keywords **– GeoGebra, Intuitive Imagination Literacy, High School Mathematics.**

I. INTRODUCTION

In the era of education informatization, the rapid development of information technology and the development of mathematical software research makes mathematics teaching different from traditional teaching, many teachers began to use a variety of dynamic mathematical teaching software, among which GeoGebra software has the advantages of feature-rich, easy to operate, and free to promote, which can be used in high school mathematics in function, statistical probability, algebra, plane geometry, three-dimensional geometry It can be applied to functions, statistics and probability, algebra, plane geometry, three-dimensional geometry and other aspects of high school mathematics. Intuitive imagination refers to the literacy of understanding and solving mathematical problems with the help of geometric intuition and spatial imagination to perceive the form and change of things, and using spatial forms, especially graphs. GeoGebra can meet the needs of the development of intuitive imagination literacy[1], and its powerful drawing and graphing functions and vivid demonstrations can transform abstract knowledge into intuitive and dynamic graphics, which can be better grasped by students and accomplish the teaching goals. It has powerful plotting and graphing functions and vivid demonstrations, which can transform abstract knowledge into visual and dynamic graphics so that students can better grasp and accomplish the teaching objectives. Therefore, the integration of GeoGeBra software into the development of intuitive imagination literacy can promote students' understanding of abstract mathematical knowledge and make up for the shortcomings of traditional mathematics teaching.

II. CURRENT STATUS OF GEOGEBRA APPLICATION IN TEACHING HIGH SCHOOL MATHEMATICS

GeoGebra's name is a combination of the words "Geometry" and "Algebra", which implies that it combines both geometry and algebra (including calculus) [2]. GeoGebra is a free and multi-platform dynamic math

education software that integrates algebra, geometry, and calculus, and thus can be used in all branches and stages of elementary and middle school mathematics. In 2019, GeoGebra was firstly included in the new general high school Mathematics textbook published by the People's Education Publishing House of China, replacing Geometry Drawing Tablet and Excel, and is recommended for use by teachers and students. It is recommended to be used by teachers and students. However, at present, only some high school mathematics teachers have begun to use the software, and most mathematics teachers have not yet started learning about the use of GeoGebra software because they are not fully aware of its superiority. In fact, with the aid of GeoGebra, the integration of information technology into the high school mathematics classroom can make the mathematics classroom no longer a boring single mode of teaching, and the means and methods of teaching can be rich and varied. GeoGebra software can help to improve the qualities and abilities of both teachers and students, which is in line with the requirements of the change of high school mathematics in the context of China's new curriculum concept. The presentation of teaching content with the help of information technology can also improve students' geometric intuition ability while being able to make mathematics learning intuitive and visual. And information technology can also realize the dynamization of mathematical objects and improve students' spatial imagination ability. Dynamic processes in mathematics are difficult to demonstrate by traditional teaching methods alone, so with GeoGebra software, you can create specific situations, exploratory situations, not only to achieve the visualization, dynamics, but also interesting, to help stimulate the interest of students.

The application of GeoGebra in teaching helps students' mathematical knowledge understanding, problem solving, and improves students' mathematical ability.

The use of GeoGebra in teaching can effectively improve the ability of combining numbers and shapes, geometric intuition and spatial imagination. In conclusion, GeoGebra is of great significance to the development of intuitive imagination literacy.

III. Strategies for Developing Students' Intuitive Imagery Literacy using GeoGebra Software

Teachers cultivate students' hands-on operation experience in mathematics, turning the knowledge conclusions in the books into an operable exploration process, providing students with the opportunity to "re-create". From intuitive to abstract, from perception to internalization, students can actively construct their own cognition and experience through purposeful operation, observation, comparison, analysis and discussion.

A. *Creating Graphic Scenarios, Enrich Students' Representational Intuition*

Mathematics is the study of quantitative relationships and spatial form of science, to shape to help number or number of shape, through the combination of number and shape of the ideological approach, the establishment of the link between number and shape, which is the most important learners need to cultivate a kind of literacy, some people figuratively referred to as the number and shape of the "two eyes" to see mathematics. Mr. Hua Luogeng has vividly depicted the beauty of the connection between shape and number: "The number lacks shape with less intuition, and the shape is difficult to be subtle when it is small. The combination of numbers and shapes is good in many ways, but isolation is not good at all." Creating an intuitive and interesting mathematical scenario and abstracting things into shapes not only attracts students' attention and stimulates their interest in learning, but also allows students to form an intuitive and clear representation in advance, which

reduces the difficulty of students' understanding of abstract mathematical knowledge [3] . With the use of the GeoGeBra software graphing function and dynamic demonstration function, both dynamic and static situations can be created. Through the creation of graphic scenarios, abstract mathematical knowledge is presented in an intuitive, graphic way, that is, to realize the visualization of mathematical knowledge [4]. GeoGebra can help students to better integrate "number" and "shape" together, so as to cultivate students' mathematical intuitive literacy. GeoGebra can help students better integrate "numbers" and "shapes" to develop their math intuitive literacy.

For example, in the explanation of analytic geometry ellipse, parabola, and hyperbola definition of this lesson, the teacher can use GeoGebra software to draw the trajectory of the moving point, the definition of the parabola, "in the plane, the trajectory of the point which the distance to the fixed point F is equal to the fixed straight line l (the point F is not in the fixed straight line l)", using GeoGebra arbitrary drawing of the fixed point F, and the fixed line l, take any point H on the line l, drawing a straight line m perpendicular to the straight line l, connect FH, as a vertical line of FH intersection of straight line m at the point M, then the trajectory of the M point that is the parabola (as shown in Fig. III-1). GeoGebra can be observed by dragging a point or a line of graphical transformation and showing the trajectory of the dynamic object. This creates a graphic scenario, and can leave a deeper impression on the learning of the definition of the understanding is not to stay on the surface of the text, but to be able to deduce from the knowledge of intuitive understanding of the students to do problems in the future also provides a more solid foundation.

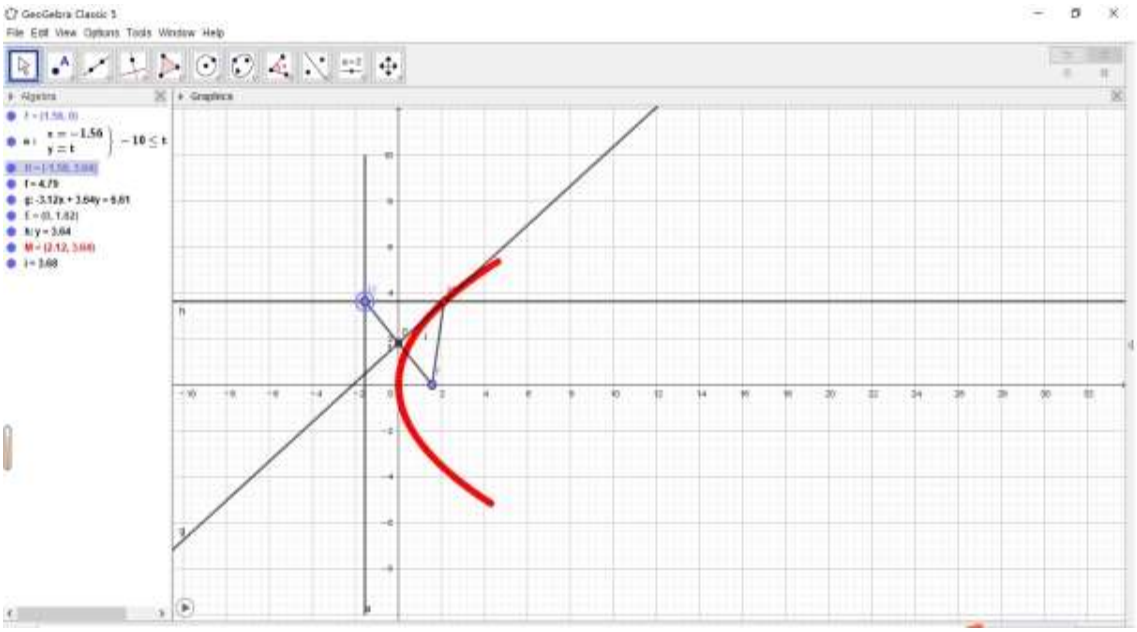

Fig. III-1.

B. *Demonstrate the Thinking Process, Stimulate Students' Interest in Learning*

According to Tolstoy, what is needed for successful teaching is not coercion but the stimulation of students' interest. For GeoGeBra such dynamic multimedia teaching software for geometry algebra, it can well mobilize students' motivation and curiosity in learning mathematics, and can show students the process of mathematical ideas and ways of thinking embedded in all kinds of knowledge, compared to static pictures, the dynamic process can help students to understand the generation and development of knowledge, and students can

experience the process of feeling for themselves; not only the Teachers can teach through the software, students can also be downloaded, online graphing, compared with the traditional teaching of the board, to provide students with a platform for active exploration. Teachers can then teach some simple GeoGeBra software mapping operation, the students' intuitive experience will be more profound, stimulate the students' interest in learning, but also reflect the student's main position in learning.

For example, in teaching the properties of trigonometric graphs, teachers can use GeoGeBra software to visualize the graphs of different trigonometric functions. For the function $y = A\sin(\omega t+\varphi)$,when changing A, the function image is found to move upward or downward; when changing the sliding time t, the function keeps expanding to the right; when changing the initial phase φ, the function image is made to shift left and right; when changing ω, the opening of the function will change (as shown in Fig. III-2). Let the students directly observe the pattern of change in the function image, explore and summarize the graphical properties of trigonometric functions, and finally, the students can also draw images with the help of GeoGeBra software to verify the summarized laws. The traditional trigonometric function image of the nature of the teaching, most of the teachers will choose to give the image directly, with the board is too time-consuming and the board draws the trigonometric function image is not an accurate graph can only be approximate, and the choice of GeoGeBra software will function of the process of change show up, to avoid the teaching of the "heavy conclusions, light process Avoid the phenomenon of "focusing on the conclusion but not the process" in teaching.

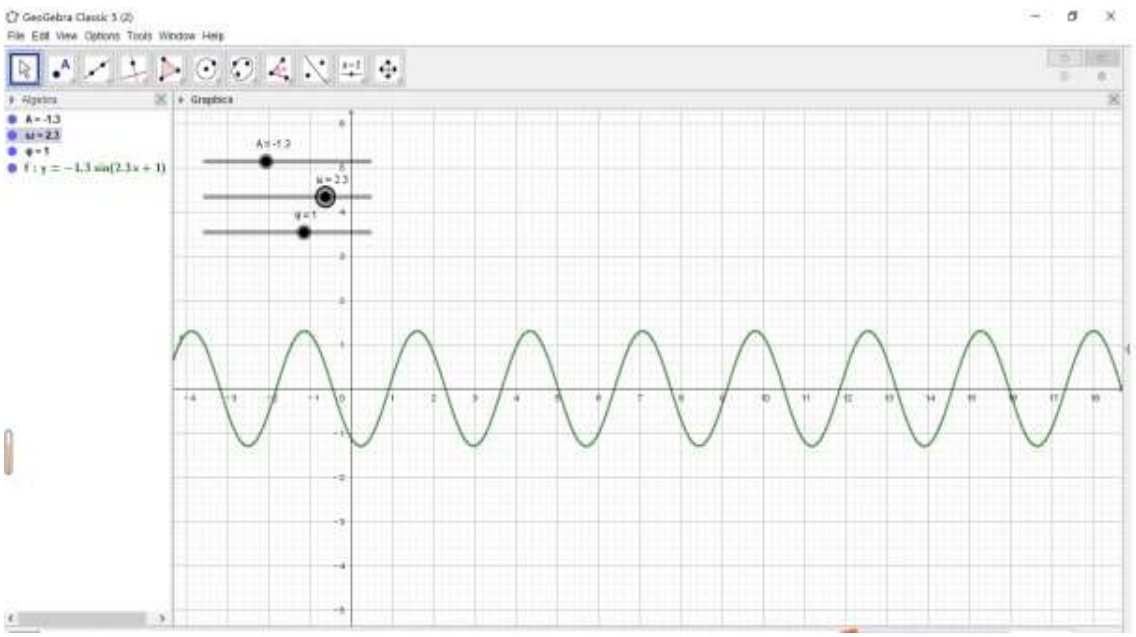

Fig. III-2.

C. *Restore Mathematical Intuition, Build Students' Imaginative Space*

Professor Shi Ningzhong once pointed out that "in most cases, the results of mathematics are 'seen' rather than 'proved'. "Look" is a kind of intuitive judgment, "look" to a certain extent reflects the mathematical intuitive imagination. It is also pointed out in the standard that intuitive imagination literacy is mainly manifested in the establishment of the connection between numbers and shapes, the use of geometric shapes to describe problems, the use of geometric intuition to understand problems, and the use of spatial imagination to recognize things. That is to say, they can use spatial imagination to recognize things. Abstract geometric shapes according to the

characteristics of the object, imagine the described objects according to the geometric shapes, imagine the orientation of the objects and their positional relationship with each other, and describe the movement and change of the shapes. In high school mathematics teaching, very often encounter moving point problems, that is, one or more moving points sliding on a section of a straight line or a plane and then to find the angle, the length of the most value, or the law of motion of the point related problems. For this kind of problem, students should have strong intuitive imagination and according to the idea of combining numbers and shapes, teachers can use GeoGebra software to transform mathematical language into dynamic graphics, and abstract into concrete, to help students visualize the problem.

When teaching geometry, teachers can use GeoGebra software to present geometry content in three dimensions in front of students' eyes, so that students can more clearly see the changes in the points, lines, and surfaces (as shown in Fig. III-3), to deepen the understanding of geometric knowledge, and the teacher can also use GeoGebra software to build graphics, create a good classroom atmosphere, and strengthen the interaction between the students and the teacher. For students, this kind of multi-media software can help students to understand the problem, this multimedia teaching method can deepen their impression of knowledge and enhance their interest in mathematics. In three-dimensional geometry, when solving problems related to the shape of a sphere and various distances, it is difficult for students to imagine the distance between two points on a sphere because there is no existing model for students to observe, which leads to the feeling of nothingness and mirage. At this point, through a specialized 3D graphics drawing area, the sphere model is built, allowing students to visualize the inside of the sphere and helping them to construct a geometric space.

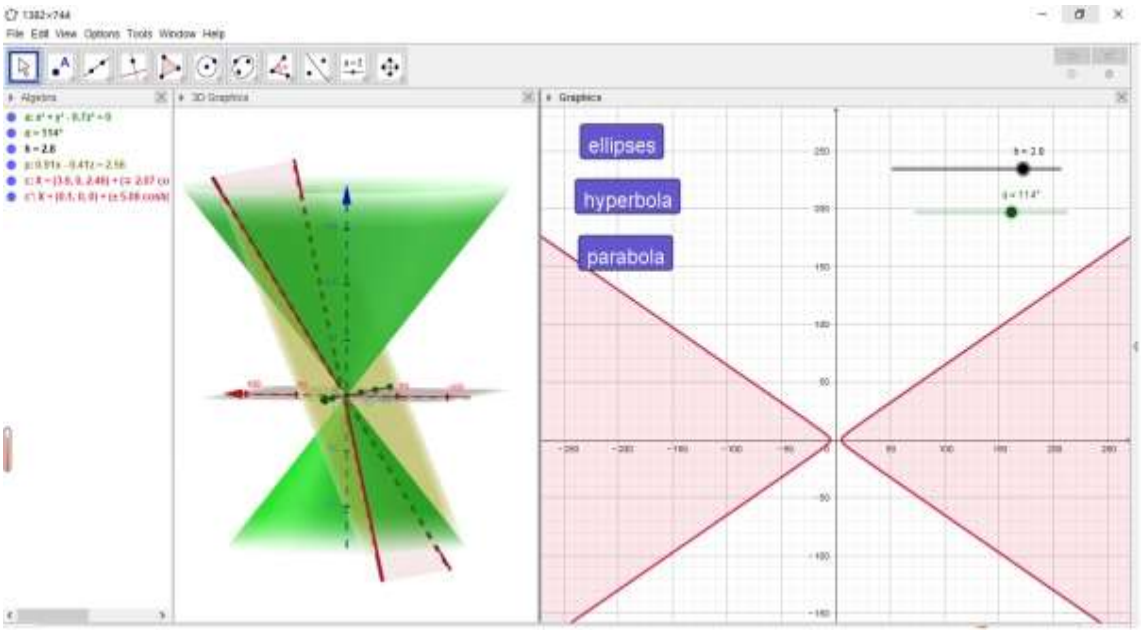

Fig. III-3.

D. *Provide Graphing Practice, Enhance Students' Graphing Skills*

In math and other science courses, we have found that graphing helps to open the mind and simplify problems. A survey found that many students were concerned that their diagrams were confusing, did not accurately represent the meaning of the problem, and that they were not proficient and confident in graphing, which suggests that students need to be optimized in mathematical graphing. Geometry topics in high school

mathematics cannot be separated from the assistance of graphs, which are the basic tools for students to understand and solve math problems. The investigation of students' intuitive imagination core literacy found that when students are answering the questions about graphing, most of them do not standardize the graphing, which is simply drawing and tracing, without realizing the auxiliary role of the image, so this indirectly leads to the delay in the development of students' intuitive imagination core literacy[5]. Therefore, teachers should strengthen the students' graphing training in the teaching process and help students standardize their graphing, and at the same time, teachers should set a good example for their students. GeoGebra software is easy to operate and rich in toolbars; GeoGebra is dynamic, and it is time-consuming and laborious to move the dots, lines, and surfaces on the blackboard, and teachers and students feel that static graphs are not well understood, which causes the students' inaccurate graphing skills. In GeoGebra, students can accurately see the pattern of change of graphics, which is conducive to students' hands-on drawing.

IV. Conclusion

This paper describes the cultivation of high school students' mathematical intuitive imagination literacy based on GeoGebra software, centers on the auxiliary role of GeoGebra in high school mathematics teaching to cultivate students' intuitive imagination literacy and gives a few specific examples, as well as how to better cultivate students' intuitive literacy to put forward the proposal. In conclusion, the extensive auxiliary role of GeoGebra in teaching will enhance students' intuitive imagination, intuitive representation, hands-on graphing and other abilities to a large extent, thereby improving students' intuitive imagination literacy, so that students can gradually reach the three levels of intuitive imagination literacy required by the standards.

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