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A Study on the Strategy of Cultivating Senior High School Students' Hands-on Operation Experience in Mathematics

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***Abstract* – Mathematical hands-on operation experience is one of the mathematical fundamental activity experience. Good mathematical hands-on operation experience helps to improve students' application ability and innovation ability, and is conducive to students' re-creation of knowledge. At present, high school mathematics teachers often ignore the cultivation of senior high school students' hands-on operation experience in mathematics. This paper puts forward some strategies to cultivate senior high school students' hands-on operation experience in mathematics from the aspects of making spatial stereo model, adopting mathematical experimental teaching method, using modern information technology to solve problems, and assigning practical homework.**

***Keywords* – Hands-on Operation Experience in Mathematics, Mathematical Fundamental Activity Experience, Application Ability.**

I. INTRODUCTION

After a new round of research on teaching reform, China promulgated the "General High School Mathematics Curriculum Standards (2017 Edition)". In the curriculum objectives, the new standard not only puts forward six core mathematical literacy, but also expands "double basis" to "four basis", and puts forward the goal of "enabling students to acquire 'mathematical fundamental activity experience' ". This is not only beneficial to link up with the curriculum objectives of "Compulsory Education Mathematics Curriculum Standard (2011 Edition)", but also meet the requirements of cultivating students' six core mathematical literacy.

Mathematical activities refer to activities that have a clear mathematical connotation and mathematical purpose and can reflect the essence of mathematics. They are an organic part of mathematics teaching. Teachers' classroom teaching and students' classroom learning are the most important mathematics activities. It includes the exploratory learning activities of students when learning mathematics in class, and the practical activities of students related to mathematics curriculum, including not only the actual mathematical activities in life and production, but also the specially designed activities in mathematics teaching [1].

Mathematical fundamental activity experience is the individual experience gained by the learning subject through personal experience of the mathematical activity process [2]. It includes hands-on operation experience, mathematical exploration experience, mathematical thinking experience, mathematical language application experience, mathematical operation experience, mathematical modeling experience.

"General High School Mathematics Curriculum Standards (2017 Edition)" not only requires students to use their brains, but also requires them to be manual and oral. The purpose of manual operation is to let students feel the characteristics of mathematical materials and the process of mathematical abstraction through hands-on operation. This needs mathematical hands-on operation experience.

Mathematics hands-on operation experience includes students drawing geometric figures and function image-

-s, making geometric models, surveying and collecting data, conducting mathematical experiments, etc. The operation here mainly refers to the operation of behavior, not the operation of thinking. This kind of operation is a direct material for abstraction, generally a direct experience. The direct value orientation of this kind of operation is not problem-solving, but gaining first-hand direct feelings and experience. It is the experience from sensory perception in the actual explicit operation activities [3].

Good hands-on operation experience in mathematics helps students to understand abstract mathematical concepts and facts, and helps students to understand the specific application of mathematical knowledge. It can continuously improve the core literacy of mathematics, and then promote the improvement of students' application ability and innovation ability.

Through the research, it is found that the accumulation of "students' mathematical activity experience" has been paid attention by the majority of mathematics educators, and the research on the accumulation of students' mathematical activity experience strategies is mostly. However, most of these studies are focused on mathematics teaching in junior high school and primary school, and there are few studies on mathematics teaching in senior high school. And most mathematics teachers attach importance to the accumulation of students' exploration experience and mathematics thinking experience, and the cultivation of high school students' mathematical hands-on operation experience has not been paid enough attention. Therefore, inspired by previous studies, this paper focuses on strategies for cultivating senior high school students' hands-on operation experience in mathematics.

II. Current Status of High School Students' Hands-on Operation Experience in Mathematics

At present, the main way for most high school students in China to gain hands-on operation experience is to draw functional images, draw spatial solid geometric images, and collect data through surveys. Among them, the ability of students to draw function images is relatively stronger than the ability to draw spatial geometric images. As senior high school teachers in the explanation of space solid geometry, most of them use PowerPoint to teach, and the courseware automatically plays space stereo images. The teacher demonstrates the spatial solid geometry in front of the students relatively few times, and students have not undergone specific drawing training.

Students' ability to draw and recognize pictures in spatial solid geometry is relatively weak, which is not conducive to the improvement of students' spatial imagination ability, nor is it conducive to students to establish the relationship between space solid geometry and real life. In addition, due to the majority of teachers think that students learn mathematics, as long as they can calculate and prove, coupled with the limitation of class hours, some teachers rarely provide students with hands-on operation opportunities, and rarely use experimental method in teaching. For the parts that students need to operate, most of the time, teachers take the place of students to give conclusions. It leads to the students generally believe that mathematics does not need hands-on operation except calculation and proof, which also hinders the development of students' application consciousness.

III. Strategies To Cultivate Senior High School Students' Hands-on Operation Experience In Mathematics

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. *Make Spatial Stereo Model*

The part of space solid geometry has always been a learning difficulty for senior high school students, mainly due to students' weak spatial concept and insufficient spatial imagination. To this end, high school mathematics teachers can guide students to make spatial three-dimensional models through origami or pinch of plasticine to accumulate hands-on operation experience. In order to improve students' geometrical intuitive and spatial imagination ability, at the same time help students intuitively understand the structure and nature of three-dimensional graphics.

For example, the teacher guides the students to make a model of the cone (as shown in figure III-1), and feels that the side expansion of the cone is a fan shape, so that the students can independently derive the formula of the side area of the cone. After introducing the definition of the circular truncated cone, the teacher asks the students to make a model of the circular truncated cone (as shown in figure III-2) according to the relationship between the circular truncated cone and the cone, and independently deduce the formula of the side area of the circular truncated cone. Through hands-on operation, students have a more intuitive understanding of the geometric features of the cone and the circular truncated cone, as well as the relationship between their side areas. The teacher can also let the students observe the real objects in life and make simple assembly models to display in the class. While enhancing students' sense of application, it also enhances students' sense of accomplishment and increases learning fun. For complex geometry, such as the "semi-regular polyhedron" (as shown in figure III-3) in the national college entrance examination, students feel very abstract. Teachers can ask students to make a three-dimensional model and intuitively feel its characteristics.

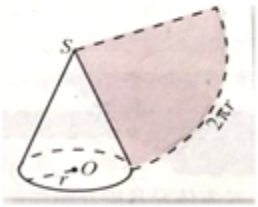

Fig. III-1.

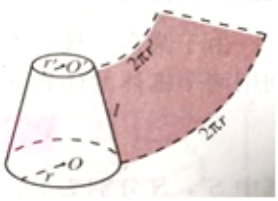

Fig. III-2.

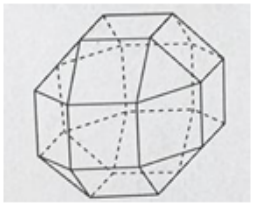

Fig. III-3.

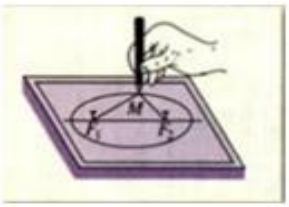

Fig. III-4.

B. *Adopt Mathematical Experimental Teaching Method*

Mathematical experimental teaching method refers to the teacher with the aid of equipment (such as experimental equipment, multimedia equipment, etc.), based on the strict mathematical thought and theory, taking mathematical materials as the experimental object, guiding students to carry out mathematical analysis, hands-on operation, and summarize the problems related to mathematics in real life. Teachers can organize students to conduct mathematical experiments and accumulate hands-on operation experience by creating app--ropriate teaching situations, so that students can discover mathematical problems or conclusions during the pro-

-cess of inquiry.

For example, when teaching how to determine whether a straight line is perpendicular to a plane, the teacher asks the students to do the experiment: insert a bamboo pole on the ground, and let the students go through the measurement to verify whether the bamboo pole is vertical to the ground when it is perpendicular to a straight line on the ground. When the bamboo pole is perpendicular to two intersecting straight lines on the ground, whether the bamboo pole is vertical to the ground. Thus, the judgment theorem that the straight line is perpendicular to the plane is obtained. As another example, the teacher asked the students to make a simple football door model on the table with an ice cream stick. Let students explore how to ensure that the beam of football door is parallel to the table top, so that students can find the judgment theorem that the straight line is parallel to the plane. In this way, students can deepen the impression of these theorems, and also feel the application of mathematics in real life. In the third example, the teacher asks the students to fix the two ends of a piece of string at two different points on the cardboard (as shown in figure III-4), and the distance between these two points is less than the length of the string. Let students use a pencil to tighten the string and move the nib to draw a curve. It enables students to find that the curve drawn is an ellipse, and finds that the characteristic of the points on the ellipse is that the sum of the distances to the two fixed points is a constant, so that the students can independently derive the standard equation of the ellipse. In the course of this experiment, students not only accumulated hands-on operation experience, discovered mathematical conclusions, but also felt the fun of "doing mathematics".

C. *Use Modern Information Technology*

Teachers can guide students to use mode$_r$n information technology to solve problems and accumulate hands-on operation experience. For example, in the process of learning trigonometric function image, the translation of the image has always been a difficulty for students. The teacher guides the students to operate the Geometer's Sketchpad by themselves. By changing the size of the parameters, students can intuitively feel the change process from the image of function $y = \sin x$ to the image of $y = A\sin(\omega x + \phi)$ (as shown in figure III-5). To enable students to intuitively understand the relationship between these two function images and the impact of the three quantities A, ω and ϕ on the function $y = A\sin(\omega x + \phi)$ image. Using the experience generated here, students can continue to explore the relationship between sine and cosine function images independently.

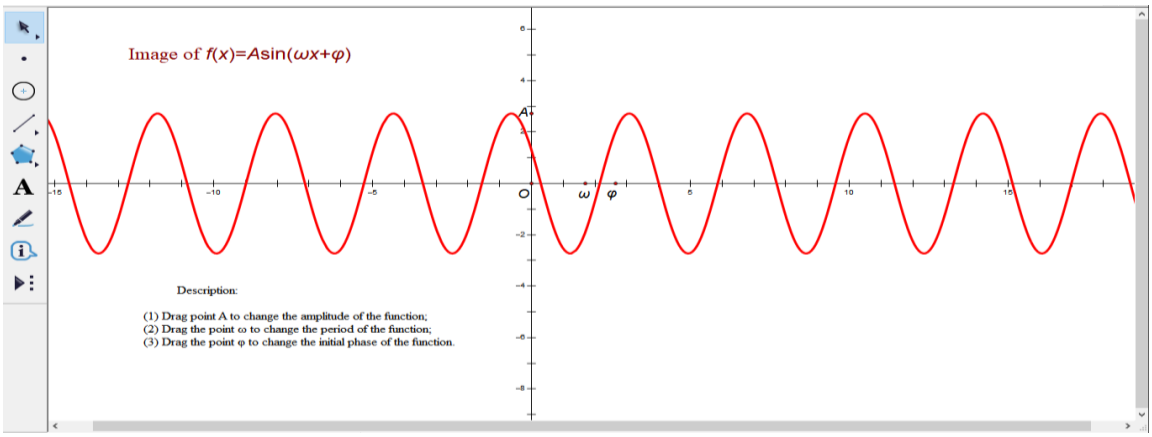

Fig. III-5.

D. *Arrange Practical Homework*

Teachers assign practical work to students, which not only accumulates students' hands-on operation experience, but also allows students to further appreciate the application of the mathematical knowledge they have learned in life. For example, after the teacher has finished teaching the use of samples to estimate the total content of the statistics. Practical homework can be designed to allow students to conduct a data survey on a phenomenon that interests them in life. Let students experience the process of data analysis such as data collection, data processing, information extraction and inference. Through hands-on operation, students have not only consolidated the knowledge they have learned, but also realized the practical application of statistical methods in their lives in the process of accumulating statistical experience. In addition, during holidays, teachers can assign practical exercises to students. Let students observe the discounts in shopping malls during the festival, and design the most economical consumption scheme. Or let students through the survey, design the best travel plan during the festival and so on. Through collecting materials, practicing operation and making plans, students can realize the application value of mathematics in the process of accumulating experience.

IV. Conclusion

The training of senior high school students' hands-on operation experience in mathematics meets the requirements of cultivating students' mathematical core literacy in "General High School Mathematics Curriculum Standards (2017 Edition)". The accumulation of senior high school students' hands-on operation experience in mathematics is conducive to the formation of students' experience in mathematical exploration, mathematical thinking, mathematical operation and mathematical modeling. It is also conducive to the senior high school students to develop the habit of hands-on operation, and constantly enhance the students' awareness of applying mathematics to life, so as to promote the improvement of students' practical ability and application ability. Therefore, senior high school mathematics teachers should improve the understanding of mathematics hands-on experience. Teachers should make full use of teaching resources and further explore the connection between the content of teaching materials and real life. Create a variety of ways and activities to cultivate students' hands-on operation experience to help they accumulate experience, so that students can "learn" in "doing" and constantly experience the fun of "doing mathematics".

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