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Infiltration Strategy of Mathematical Modeling in Mathematics Classroom of Junior Middle School in China

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***Abstract* – Mathematical modeling literacy is one of the essential core qualities for students to learn mathematics at present. Effective infiltration of mathematical modeling ideas is conducive to helping students learn mathematics. The junior middle school students are exposed to a large number of teaching situations, which is a good time to construct mathematical modeling ideas. Starting from the junior middle school mathematics classroom in China, on the basis of understanding the current situation of the junior middle school mathematics modeling thought in China, this paper introduces how to use appropriate teaching methods to infiltrate the mathematical modeling thought, and lists teaching cases to support it, so as to provide teaching reference for junior middle school mathematics teachers.**

***Keywords* – Mathematical Modeling, Chinese Junior High School Mathematics, Infiltration Strategies.**

Mathematical modeling is always regarded as an important way of thinking in learning mathematics because it can help students solve practical problems and improve the efficiency of solving applied problems. Comparing junior high school mathematics teaching with senior high school mathematics teaching, it is easy to create more mathematics situations. Teachers should also use more energy to help students find mathematical problems from mathematical situations, put forward problems to understand problems and establish mathematical models. Therefore, the following will start with the general situation of mathematical modeling, and explore the penetration strategy of mathematical modeling literacy applied in the classroom of junior middle school in China.

I. Overview of Mathematical Modeling

Mathematical modeling is often proposed as an idea. In the 2011 edition of compulsory education mathematics curriculum standard, mathematical modeling is called "model thinking". Later, after the revision of the new high school mathematics curriculum standard in the 2017 edition, the term "model thinking" was defined as "mathematical modeling". At the same time, "Mathematical Modeling" is merged into the "core literacy" that students should have in learning mathematics. This part will introduce the meaning and basic cognition of mathematical modeling, the overview of mathematical modeling in middle school mathematics curriculum standards, and the common difficulties of infiltrating mathematical modeling in junior middle school mathematics teaching.

1. *The Meaning and Basic Cognition of Mathematical Modeling*

Many scholars have summarized mathematical modeling from different perspectives, but with the wave of new curriculum reform, we begin to pay more and more attention to the application of mathematics. In the article "A Survey of Mathematical Modeling thoughts in Senior High School", Dong Hongchao defines mathematical modeling as: "Mathematical modeling thought is a method of dealing with practical problems with mathematical knowledge. Through observation and analysis of practical problems, it abstracts the internal relations of practical problems, and transforms these internal relations into corresponding mathematical relations. It uses mathematical

relations to construct a symbolic system of mathematics that is consistent with practical problems, so that the original problems can be transformed into a mathematical method and thought of mathematical problems [1]. This definition elaborates the concrete process of Applied Mathematical Modeling thought, and emphasizes the application of mathematical modeling.

2. *Summary of Mathematics Modeling in Middle School Mathematics Curriculum Standards*

Up to now, we still use the 2011 edition of compulsory mathematics curriculum standards in junior middle schools in China. In the curriculum standard of junior middle school, it is stipulated that "the establishment of model thinking enables students to understand and understand the ways of linking mathematics with the outside world. " Its process includes abstracting mathematical problems from real life or situations, establishing equations, inequalities, functions and so on with mathematical symbols to express the quantitative relations and changing laws in mathematical problems, finding the results and discussing the significance of the results [2]. Mathematics in junior and senior high schools is in one continuous line. Through the research of many teachers and scholars, the definition of "mathematical modeling" is given in the new high school mathematics curriculum standard of 2017 edition: "Mathematical modeling is the accomplishment of abstracting realistic problems, expressing problems with mathematical language and solving problems with mathematical methods. It is mainly manifested as: discovering and proposing problems, establishing and solving models, checking and perfecting models, analyzing and solving problems [3]. "Compared with the requirements of junior middle school curriculum standard, the definition of "mathematical modeling" in senior high school mathematics curriculum standard attaches more importance to the application of model. Whether in junior high school mathematics teaching or senior high school mathematics teaching, "model thinking" has gradually been replaced by "core literacy of mathematical modeling".

3. *Common Difficulties in Infiltrating Mathematical Modeling thought into Junior Middle School Mathematics Teaching*

In the current junior middle school mathematics teaching, there exists the phenomenon of "pinching the head and removing the tail". That is to say, ignoring the process of knowledge generation and application is contrary to the quantitative relationship and change law of mathematical problems put forward in the curriculum standard, finding out the results and discussing the significance of the results. When infiltrating mathematical modeling literacy, students will be bored because of the lack of knowledge and learning experience in this area, which ultimately leads to the formation of mathematical modeling ideas [4]. Moreover, junior high school gradually opened many school-based courses, and the proportion of sports scores increased in the entrance exam. Mathematics class, like many "main courses", can not escape the fate of reducing class hours [5]. The infiltration of mathematical modeling literacy should be carried out in accordance with the requirements of curriculum standards, which is a long-term front and large investment in the early stage. Therefore, teachers need to find more concise and concise teaching situation for the follow-up development of students. This is also a very difficult test for teachers. The most important thing is that when students hear the word "mathematical modeling", their first reaction is often "application problem". So the primary task of teachers is to correct students ‘thinking and help students understand the process of "analysis problem-building Model-Application model" with more specific examples [6].

II. Strategies of Infiltrating Mathematical Modeling Teaching Thought into Junior Middle School Mathematics Teaching

1. *Infiltrating Mathematical Modeling Literacy Should Pay Attention to Teaching Organization Form*

In the process of penetrating mathematical modeling literacy, teachers can not completely let go, because teachers play an important role as guides in the whole process. If the teacher lets the students finish their study independently or discuss in groups, the students may treat the situation carefully designed by the teacher as an "application problem" to solve. This is contrary to the original purpose [7]. But this learning method is not totally impossible to implement. Teachers can organize the classroom context by assistant teaching method or tutorial plan. The main line should be controlled by teachers to ensure that students follow the three steps of "analyzing problems - establishing models - applying models".

2. *Infiltrating Mathematical Modeling Literacy should be Controlled Horizontally and Longitudinally*

The core accomplishment of infiltrating mathematical modeling is to divide it into two parts: horizontal and vertical. Horizontal is a course taught by different regions, schools and teachers. Longitudinal is the whole process of learning according to the age of students.

Horizontally speaking, the infiltration of mathematical modeling requires new, new examples and new ways of speaking - creating teaching situations and inspiring thinking. Let students learn to use mathematical language to describe problems, solve problems, and then encounter such problems when there are solutions. In this class, the identity of the teacher's guide remains unchanged, so that students can analyze problems and become the main body of the classroom. Textbooks are authoritative learning materials that students can master. Students often review according to the order of textbooks, so teachers should focus on referring to the content of textbooks when infiltrating. At the same time, don't miss the examples around you, especially the ones that students of this age are interested in, such as games and animation. Or national facts, such as rocket launches, rainfall and so on, can be used as teaching materials in the classroom.

Vertically speaking, teachers should follow the principle from shallow to deep. When students have not fully grasped the idea of modeling, if they encounter a more complex teaching situation, teachers can not penetrate into the more complex, starting from the reading questions, so that students can fully understand the topic and then analyze it. When students are familiar with this way of thinking, they can give simple learning steps, so as to achieve the ultimate goal of penetrating the literacy.

3. *Improving Mathematical Modeling Literacy Should Focus on Cultivating the Conversion Ability of Written Language and Mathematical Language*

Literature and science do not divide. The first step in establishing a mathematical model is to examine the questions. Examination depends on the students 'ability of reading comprehension, that is, the understanding of mathematical situation directly determines whether to establish an appropriate mathematical model. Teachers should consciously train students how to extract the key information of the topic, and then let them translate the written language into the mathematical language, which more effectively links the two courses of mathematics and Chinese [8] [9]. Interdisciplinary cooperation also enhances students' expressive ability of mathematical language.

4. *Improving Mathematical Modeling Literacy Should Pay Attention to Changing Students' Learning Attitude*

To a large extent, learning attitude determines the final learning results of students. The establishment of learning model idea was introduced in the curriculum standard, which helps to improve students' interest in learning mathematics and application consciousness. In the whole process of learning, teachers should pay attention to helping students change their attitudes towards learning mathematics. When students extract key information from a long passage of text and convert it into mathematical language and establish mathematical models to solve problems, they simplify the complexity and greatly enhance their self-confidence. Students are also gradually aware that "mathematics is useful", subtly changing the attitude of learning mathematics.

III. Specific Implementation Process

After understanding the way of penetrating mathematical modeling literacy in daily teaching, we introduce the concrete implementation process of penetrating mathematical modeling literacy according to the examples of Chinese junior middle school textbooks. Different scholars extend mathematical modeling to various dimensions and steps. In the two editions of mathematics curriculum standards of junior and senior middle schools, the general steps of mathematical modeling are also stipulated, but it can not be separated from three processes: analyzing examples, establishing models and applying models. Next, we will start from these three aspects. According to the above, we select the third chapter and the fourth section of the textbook of the first grade of the seventh grade (i.e. the first grade of junior middle school) - the practical problems and the examples of the unitary equation to analyze the problems and build the models, and then apply the practical problems according to the established models. First of all, understand the topic: "Profits and losses in sales

A shop sells two pieces of clothes at a price of 60 Yuan per piece at a certain time. One makes a profit of 25% and the other loses 25%. Is it a profit or a loss to sell these two pieces of clothes, or is it not profit or loss? [10]

1. *Problem Analysis*

The content of this lesson has been deleted many times in the update of the textbook, but this topic has always existed. The content of this topic is simple and easy to understand and close to students ‘life. It takes less time and does not affect the progress of real class. Therefore, such exercises as selling clothes are very suitable for teachers to infiltrate the idea of mathematical modeling as a special case. Moreover, although this topic is simple and easy to understand, it is easy to appear ambiguity in the analysis and establishment of the model, so it is a suitable case for the establishment of the mathematical model. Another example is the problem of incandescent lamp power. With the development of the times, it has been gradually replaced. It is difficult for students to understand the topic. Teachers ‘explanation of the topic delays classroom time and is no longer suitable for classroom explanation.

Teachers first show the question on the blackboard or PPT, give students five minutes to solve the problem by themselves, and test the answers of several students in class. It is not difficult to find that some students confuse the price with the price, or just list a formula to get the wrong answer.

Then the teacher helps the students to analyze the problem.

Teacher: There are two kinds of prices when selling goods. Which two kinds are they?

Student: (After discussion, get the answer) Input price and selling price.

Teacher: Is the known amount of 60 Yuan given in the title the purchase price or the selling price?

After the teacher asks questions, the students who mix the price with the price before will realize their mistakes. At this point, we should take advantage of the victory and pursue, and then guide.

Teacher: Then the price of both clothes is sixty Yuan, but the last one loses one profit. Is the price of the two clothes the same?

Student: Not the same.

Teacher: If the price is different, how many unknowns exist?

At this point, students who list an equation will realize their mistakes and understand that there are two unknowns to solve the problem separately.

After analyzing the problem clearly, the students can list the price expression with unknown number. The teacher can organize the results by tabulating them as follows:

Serial number	purchase price	sale price (excluding unknowns)
1	x	60
2	y	60

So far, the first step of problem analysis is completed, and the teacher guides the students to analyze the problem, and translates the written language into the mathematical language, so as to prepare for the establishment of the mathematical model.

2. *Establishing Mathematical Model*

The most important way to build a model is to solve the problems raised before by mathematical means.

In the analysis of this problem, the teacher has guided the students to find out the price expression of two clothes with unknowns. At this time, the students should deduce the identity relationship between the price expression with unknowns and the known price, which is the most important part of the equation thought. In the whole process of guidance, teachers can emphasize the word "mathematical modeling" so that students really know what mathematical modeling is and what the mathematical model is in the whole process of problem solving.

The following teaching process:

Teacher: What should be the relationship between the purchase price and the selling price of each garment given in the title?

Students think and list the price expressions with unknown numbers.

Student: We can figure out that the price of the first dress is (x + 25% x) and the price of the second dress is (y - 25% y). They are all equal to 60.

Teacher: That's right. Then we get the mathematical model of clothing sales. We build the mathematical model between the known price and the unknown purchase price by using the unknown numbers x and y as the bridge. As follows:

Sequence Number	Purchase Price	Sale Price (Including Unknown Number)	Sale Price (Excluding Unknown Number)
1	x	x+25%x	60
2	y	y-25%y	60

Teacher: We will use the unknown number to express the price, and find out the identical relationship between the known quantity and the unknown quantity. This process uses the idea of mathematical modeling. The unknowns x = 48, y = 80 are solved by the following equations

Students solve the equation and find that the price of two clothes is x + y = 128 Yuan, and the price of two clothes is 60 + 60 = 120 Yuan. The price of two clothes is higher than the price. Therefore, the total loss of two clothes is 8 Yuan.

3. *Application Model*

This problem applies the idea of equation and mathematical modeling. The core idea of the mathematical model is to express the known quantity with the unknown quantity. Therefore, when applying the model, the teacher should find the same way to understand the topic in many application problems of the unitary primary equation. The way to build the model is similar to the economic problem of this topic, but not to the economic problem of this topic. Such topics as engineering problems, travel problems, pursuit problems and clock problems.

For example, the following questions:

The shop sells a kind of coat at the marked price. Each coat can make a profit of 25 Yuan. Ten coats can be sold at a discount of 10 Yuan. How much is the price of the coat?

This problem is not divorced from the application of economic one-dimensional first-order equation. It can be solved by equation. At the same time, the difficulty can be deepened. The price can be set as an unknown, or the price can be set as an unknown, which adds more space for students to think while applying and verifying the model. Of course, teachers can also use local materials, still use the original topic, in the original basic conditions unchanged, let students put forward different questions from the original topic, cultivate students ‘ability to find problems.

IV. CONCLUSION

The infiltration of mathematical modeling literacy is a lasting battle for junior middle school teachers ‘teaching, but it is of great benefit to students' future mathematics learning. Therefore, junior high school mathematics teachers should learn to start from textbooks and students ‘life, find more mathematical situations to exercise the idea of building models, let students learn to use mathematical language, improve students' interest in learning mathematics and application consciousness.

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