

Cultivating Middle School Students' Mathematical Modeling Ability under Problem-driven Mode

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Abstract— The new curriculum standard emphasizes on the development of student's core qualities and puts mathematical modeling in an important position, so it puts forward higher requirements for junior middle school mathematics teaching. The problem-driven method mainly takes the problem as the core driving force and guides students to experience the process of raising questions, analyzing problem, establishing models and solving models under the problem-driven mode, so as to cultivate students' mathematical modeling ability, improve their application meaning and innovation ability, and finally achieve the cultivation of mathematical literacy.

Keywords— Problem-driven; mathematical modeling.

I. INTRODUCTION

Previous studies have shown that the inclusion of mathematical modeling in middle school curricula is an urgent application for understanding and promoting the development of mathematical modeling in key national fields, and it plays a significant role in enhancing people's comprehensive abilities [1]. In junior high school learning, mathematical modeling also plays a crucial role in promoting interdisciplinary integration and development. The process and ideas of mathematical modeling can be applied to various disciplines and also require knowledge from multiple disciplines, facilitating cooperation and communication among different disciplines and providing new ideas for their development. To develop various fields, implement educational reforms, and enhance international competitiveness, mathematical modeling should have an important position as a tool for promoting the comprehensive development of the country. From the perspective of the overall mathematics curriculum standards, the status and importance of mathematical modeling in the compulsory education stage have significantly increased, and there is a growing emphasis on the infiltration of mathematical modeling in this stage, which also indicates the importance of mathematical modeling in junior high school mathematics teaching. The 2022 curriculum standards explicitly state: "The concept of a model mainly refers to having a clear understanding of using mathematical models to solve practical problems. The concept of a model is conducive to conducting cross-disciplinary subject learning and perceiving the universality of mathematical applications [2]." "The concept of a model" is one of the ten core competencies proposed in the 2022 curriculum standards and has an important guiding role in achieving the "four abilities" [3].

II. THE CONNOTATION AND CHARACTERISTICS OF MATHEMATICAL MODELING TEACHING IN JUNIOR MIDDLE SCHOOL UNDER PROBLEM-DRIVEN MODEL

2.1 Meaning of problem-driven pattern

Problem-driven teaching is based on the problem situation set up based on the teaching content, and the effective and logical problem chain is used as the driving force for students' learning, guiding students to think and explore [4], allowing students to learn new knowledge in the process of solving problems, and cultivating students' mathematical ability. Problem-driven is a form of constructivist learning, which is problem-centered [5], in which teachers use questions to promote students' thinking, cooperation and communication, so that students can seek problem-solving ideas in the process of self-directed learning and cooperative learning, and as active constructors of knowledge, build models and ultimately promote problem solving, so as to master knowledge and develop the ability of mathematical modeling.

2.2 Characteristics of problem-driven mathematical modeling teaching

2.2.1 Use the question as a "red line"

The problem-driven model takes problems as the starting point and driving force of learning, and first stimulates students' learning enthusiasm by presenting real situations, so that students can find and ask questions from actual situations and learn around the problems that need to be solved. In the process of teaching, teachers should design mathematical problems with targeted goals, and guide students to think in the form of problem chains, and the process of students' problem solving is essentially the process of mathematical modeling. The questions need to be set with clear goals, in line with the characteristics of the students, to stimulate the students' desire to explore, and to consider the students' receptivity. In short,

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"problem" is a "red line", the core content of the classroom, and a bridge to communicate the thinking of teachers and students.

2.2.2 Teacher-led, student-led

In the context of quality education, the classroom is no longer the teacher's world, the teacher is the guide of students' learning, plays a guiding and leading role, the student is the main body of learning, is the constructor of knowledge, not passively accepts knowledge, and the student should be the master of the classroom. Teachers are the proposers and designers of problems, and the process of mathematical modeling teaching is presented in the mode of "raising problems→ analyzing problems→ solving problems", and teachers design a series of questions to gradually increase the difficulty, guide students to take the initiative to ask questions, fully inspire students to explore and solve problems independently, and explore the ideas of mathematical modeling contained in the process of solving mathematical problems.

2.3 Teaching mathematical modeling in problem-driven mode

The teaching of mathematical modeling in the problem-driven mode is mainly for students to find and propose meaningful mathematical problems in the actual life situations created by the teacher, and the teacher asks students questions based on the problem chain, and gradually guides the students to solve each problem, and the students learn and master the mathematical knowledge by analyzing and solving these problems. In the process of teachers' problem-driven and students' independent thinking and problem solving, the model and their own knowledge system are gradually constructed, and the students' mathematical modeling ability is cultivated while mastering the knowledge. The core of this teaching model lies in the careful design of "problems", which should not only stimulate students' interest and curiosity, but also point to clear goals, and the connection of each problem should lead to the realization of the mathematical modeling process. Through the problem-driven model, students are guided to raise problems, analyze problems, establish models, solve models, optimize models and other processes, so that students can think, explore, cooperate and communicate in practice, so as to cultivate students' mathematical modeling ability and innovation ability.

III. THE SIGNIFICANCE OF MATHEMATICAL MODELING TEACHING IN JUNIOR HIGH SCHOOL UNDER THE PROBLEM-DRIVEN MODEL

3.1 It helps to improve the overall quality of students

The problem-driven approach to mathematical modeling can help students better understand and apply knowledge. Linking abstract mathematical problems with reality, and then deeply grasping the essential characteristics of mathematical knowledge; The problem-driven model helps to stimulate students' interest and initiative in learning, teachers guide students to solve problems through questions, and students experience the process of independent exploration, analysis and problem solving, which requires students to actively explore. This teaching mode can also improve the development of students' thinking, and students experience the independent construction of mathematical models, which requires the comprehensive application of knowledge and methods, and also requires students to have certain logical thinking, calculation

and analytical skills [6]; In the process of question-answering, students also cultivate their innovative spirit and application awareness, and students solve problems through a variety of ways and models, and then apply the learned models to solve other practical problems. In conclusion, the teaching of mathematical modeling in the problem-driven mode is of great significance in many aspects.

3.2 Implement the basic requirements of quality education

The report of the 20th National Congress of the Communist Party of China pointed out that the overall deployment of education, science and technology, and talents has pointed out the direction for future education. With the continuous progress of curriculum reform, the educational goals also need to conform to the development of the times and society, the current quality education with the goal of improving the quality of the educated in all aspects is being comprehensively promoted, for the cultivation of high-quality talents with innovative spirit and practical ability is the focus of China's education, for the cultivation of innovative compound talents to make the key, to enhance the comprehensive ability of the educated, the implementation of quality education. Therefore, in education and teaching, it is necessary to improve the comprehensive ability, cultivate innovative talents, and strengthen the practical ability of students, so as to promote the all-round development of the educated. However, the teaching of mathematical modeling in the problem-driven mode is conducive to the development of students' abilities in all aspects, promotes the sustainable development of students, and also helps to promote the implementation of quality education.

3.3 Promote the reform and innovation of teaching methods

The teaching of mathematical modeling in the problem-driven mode can transform the traditional teaching mode, so that students can find problems in solving problems and improve their practical ability [7]. To a certain extent, this model makes up for the shortcomings of the traditional teaching mode, and is a teaching method that is more in line with the modern education concept, and promotes the innovation of teaching methods.

IV. PROBLEMS IN THE TEACHING OF MATHEMATICAL MODELING

4.1 Pay attention to theoretical explanation, ignore practical application

The teaching of mathematical modeling emphasizes the application of knowledge, and the knowledge learned can be applied to solve practical problems, mainly so that students can actively construct models, understand models and apply them to practice in learning. However, in the current teaching of mathematical modeling in junior high school, teachers have not departed from the traditional teaching methods, teachers focus on the explanation of knowledge and theory, and explain the knowledge of textbooks in a cramming teaching way, and students only passively accept learning and understanding knowledge in this process. Due to the singularity of teachers' teaching methods, the teaching of mathematical modeling is boring, which obviously cannot enliven the classroom atmosphere and give vitality to the classroom, and students will

naturally lose their enthusiasm for learning [7]. This makes it difficult for students to truly grasp the process and thinking methods of mathematical modeling, and it is also difficult to feel the practical significance and value of mathematical modeling, which reduces the motivation and interest in learning.

4.2 *There are cognitive impairments in the understanding of mathematical modeling by teachers and students*

Mathematical modeling is an important idea and method to solve problems, and it is necessary to pay attention to the development of thinking and the improvement of innovation ability while paying attention to students' knowledge mastery. In the teaching of mathematical modeling, teachers consciously infiltrate the concept of modeling, but there are some deficiencies in teachers' understanding of the connotation of mathematical modeling and its teaching value, ignoring students' exploration of the process of mathematical modeling, and the infiltration of model concept is superficial. In the process of learning mathematical modeling, students do not pay attention to the process and ideas of modeling, put knowledge in the basic position, and only pay attention to whether the final problem is solved in the process of solving problems, and lack the sense of inquiry in the formation process of modeling ideas and methods and the application of mathematical models.

V. PEDAGOGICAL INSPIRATION

5.1 *Problems and situations are set up to guide students to analyze*

Problem situations are an important part of students' thinking about problems, and the setting of situations can stimulate students' initiative to solve problems, and well-structured problems are the key to guide students' thinking, to ensure that students can think in the direction of ultimately promoting problem solving, so we should pay attention to the relevance of problems and situations in teaching. The situation should be close to the actual life of students, and the setting of problems should be interlocking, so as to help students analyze the problem, build a correct mathematical model, and promote the solution of the final problem.

5.2 *The process of "building" in mathematical modeling is more important than "using"*

The first step in mathematical modeling is abstraction, abstracting mathematical problems from the context of reality and expressing them in the language of mathematics to symbolize them. In order to go through the process of analysis, students need to guide students to find the relationship between variables, so as to establish a functional model, and pay attention to the process of gradually building the model in the problem-driven process. In teaching, we should also pay attention to the basic steps of mathematical modeling, so that students can go through the process of asking questions, analyzing problems, building models, solving models, using models and optimizing models.

5.3 *Students are guided to mathematical modeling methods in the "Problem Chain"*

The key to understanding and mastering the internalization of knowledge, how to achieve the internalization of knowledge and master the method of thought is the key. The guidance of the "problem chain" plays a key role, and through the problem drive, it can lead students to think from "why" to "how"[8].By splitting a complex problem into each small problem, students can solve it faster and analyze it more thoroughly, so that there are more ways to solve it in the end, and the success rate of solving the problem is also higher. In the process of solving each problem, a complete process of mathematical modeling is formed, and the methods of mathematical modeling are also mastered.

5.4 *Pay attention to the essence of mathematics and cultivate the core literacy of mathematics*

Paying attention to the essence of mathematics and cultivating the core literacy of mathematics is an important task of mathematics education and teaching, and it is necessary to guide students to abstract mathematical problems from specific situations and understand the meaning of mathematical symbols. Guide students to analyze problems and cultivate logical thinking skills; Guide students to apply mathematics to practical problems and cultivate mathematical modeling ability. In teaching, it is necessary to help students construct their own knowledge system, understand the essence of mathematics, develop model concepts, pay attention to cultivating students' abstract ability, innovation consciousness and application ability in the process of mathematical modeling, and cultivate students' ability to raise and solve problems.

Mathematics education is not only about the results of problem solving, but also about the improvement of students' ability and mathematical literacy in the process of problem solving, which should not only pay attention to students' understanding and mastery of knowledge, but also pay attention to the development of students' thinking in the learning process. Problem-driven is the catalyst for inquiry-based learning activities and an important way to cultivate mathematical modeling ability, in the process of solving one problem after another, students not only have a deeper understanding of knowledge, but also deepen their understanding of mathematical modeling and its importance to solving mathematical problems, and finally realize the cultivation of mathematical modeling literacy.

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