

Research on the Teaching and Practice of Modeling in China and America

Xiaoxue Ji^{1,a}, Zhiqiang Xiao^{1,b,*}

¹Department of Mathematics, Taizhou University, Taizhou, Jiangsu, 225300, China

^a1207630973@qq.com, ^bzhiqiang102@126.com

*Corresponding author

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Abstract: The article first introduces the concept of modeling and briefly discusses about the development, competition form and significance of the mathematical contest in modeling in the United States and China, and then starts with the analysis of the test questions of the mathematical contest in modeling in both countries over the years. It compares and analyzes the similarities and differences between the mathematical contest in modeling in the United States and China from the aspects of the purpose of holding the contest, the form of the contest, the test questions and the contest process. Then it points out the relevant cases of modeling cooperation between the United States and China. Finally, the paper makes a concise summary of the above contents and points out the development direction of mathematical modeling contest.

1. Introduction

When it is necessary to analyze and study a practical problem from a quantitative point of view, people always use mathematical symbols and language to express it as a mathematical formula, that is, a mathematical model, the whole process of establishing a mathematical model is called mathematical modeling. It includes the following aspects: in-depth investigation and research, understanding the information of the object, making simplified assumptions, analyzing the inherent law, establish a model, solve the model and accept the actual test. The teaching of mathematical modeling now has entered the classrooms of universities and middle schools, which has important practical significance and practical value for personnel training, national talent revival and economic revitalization [1].

2. Concepts of Modeling Teaching and Practical Research

Research on the teaching and practice of modeling refers to the teaching process in which scholars and educators use modeling methods and techniques to guide students to learn. Modeling teaching can help students transform some abstract concepts into concrete models, so as to deepen their understanding and application of knowledge. In the process of modeling, students need to collect data, analyze problems, propose hypotheses, build models and verify models. Modeling teaching emphasizes students' role of participation and exploration, and helps them develop their abilities of

problem solving, logical thinking and innovation. Practice research refers to the study and exploration of teaching problems, the collection and analysis of data, and the acquisition of teaching experience and educational knowledge through actual teaching practice.

2.1 The Relationship between Modeling Teaching and Practical Research

In modeling teaching, practical research can help teachers understand the actual situation and learning needs of students, adjust teaching strategies and methods, and improve teaching effectiveness. At the same time, practical research can also promote educational reform and educational policy formulation, and provide theoretical and empirical basis for educational practice. Modeling teaching and practical research can promote and support each other. Through the practice of modeling teaching, we can produce rich teaching data and cases, and provide research objects and materials for practical research. Practical research can feed back and improve the theory and method of modeling teaching, and improve the effect and quality of modeling teaching. At the same time, both modeling teaching and practical research need to focus on teachers' professional development and training, cultivate teachers' modeling ability and practical research ability, and provide support and motivation for educational reform and innovation. Mathematical modeling is regarded as a kind of practical activity, and the process of mathematical modeling is highlighted[2].

2.2 Specific Analysis of Mathematical Modeling in American High Schools

Mathematical modeling in American middle schools is a teaching method to train students to solve practical problems and apply mathematical knowledge and skills. It aims to develop students' ability to think creatively, collaborate, and model mathematically by confronting and solving real-world problems. The United States has achieved fruitful results in the field of mathematical modeling, and its mathematical modeling papers have an important position in the world. Mathematical modeling papers in the United States cover a wide range of fields, including engineering, physics, social sciences, environmental sciences, finance and so on. Mathematical tools and methods are used to establish models to analyze and solve complex practical problems by researchers in the United States. These models can be used to predict and optimize system behavior, make decisions and policies, and conduct risk assessment and planning. The United States has many famous universities and research institutes, with excellent research teams in mathematics and applied mathematics. These teams have conducted in-depth research on the theory and methods of mathematical modeling and applied them to the solution of practical problems. The Journal and Conference on Mathematical Modeling provides a platform for publishing and communicating research on mathematical modeling. Mathematical modeling papers in the United States enjoy a high reputation in the world. Many researchers and teams in the United States have won awards in international mathematical modeling competitions and contests. Some universities and research institutes in the United States also cooperate with international partners to promote the development of this field.

Generally speaking, the research and paper output in the field of mathematical modeling in the United States is rich, diverse and of high level. These studies have played a positive role in solving practical problems and promoting scientific and technological innovation, and have also had an important impact on the development of international mathematical modeling research.

2.2.1 Cases and Applications of Mathematical Modeling in American High Schools

In the United States, mathematical modeling has been widely valued and applied in secondary education. Mathematical modeling in American middle schools usually includes the following aspects:

1) Classroom teaching: Mathematical modeling is used as a teaching method in the middle school mathematics classroom. By introducing practical problems, teachers require students to analyze, model and solve them on the basis of mathematical knowledge. This teaching method can stimulate students' interest and motivation in learning, and cultivate their problem-solving ability and mathematical modeling ability.

2) Mathematical Contest in Modeling: The Mathematical Contest in Modeling for Secondary Schools in the United States is an important part of the field. These competitions are usually sponsored by academic institutions, colleges or professional organizations and are open to secondary school students. Students are required to solve a given mathematical modeling problem within a certain period of time and submit a report. This competition mode provides a platform for students to demonstrate their mathematical modeling ability and teamwork ability, and provides students with the opportunity to apply mathematical knowledge in practice.

3) Academic research: In the United States, academic research involving mathematical modeling in secondary schools is also ongoing. In order to improve the education of mathematical modeling, the researcher discussed about the curriculum design of mathematical modeling, teaching methods, student performance assessment and other issues.

2.2.2 The Objectives and Significance of Mathematical Modeling in American High Schools

The goal of mathematical modeling in American middle schools is to cultivate students' mathematical thinking ability, the ability to apply mathematics to solve practical problems and the ability to cooperate in teams. This educational method can not only improve students' mathematics performance, but also lay a solid foundation for their future academic research and career development.

2.3 Specific Analysis of Mathematical Modeling in Chinese High Schools

Chinese mathematical modeling refers to a teaching method and competition activity promoted in the Chinese education system. China's mathematical modeling papers cover many fields, including engineering, finance, environment, transportation, medicine and so on. Mathematical theory and method are used to analyze and solve practical problems by establishing mathematical models by Chinese researchers in these areas. There are a large number of papers on mathematical modeling in China with high quality. Every year, Chinese universities and research institutes hold various mathematical modeling competitions and contests to increase students' interest and creativity. At the same time, many research institutions and journals are also committed to the research and publication of mathematical modeling. China's mathematical modeling papers have also been widely recognized internationally. Chinese researchers have won numerous awards in international mathematical modeling competitions and contests, many high-level papers have been published in journals. Some universities and research institutes in China have also cooperated with their international counterparts to promote the development of mathematical modeling.

Generally speaking, China's mathematical modeling papers have made remarkable achievements in quantity and quality, and provided valuable theoretical and practical experience for scientific research and practical problem solving in China. In the future, China's mathematical modeling research will continue to grow and make greater contributions to solving practical problems and promoting scientific and technological innovation. The teaching strategies of mathematical modeling teaching in senior high school include: making full use of the previous mathematical modeling contest questions; teaching students to be familiar with the process of mathematical modeling; cultivating students' mathematical modeling ability [3].

2.3.1 The Characteristics and Content of Chinese Mathematical Modeling

In China, mathematical modeling has become an important part of middle school education, and is widely used in middle school mathematics classes and competitions. The following are some characteristics and important contents of Chinese mathematical modeling:

1) Classroom teaching: Mathematical modeling has been widely used in middle school mathematics classroom. By introducing real problems, teachers encourage students to use mathematical knowledge and skills to model, analyze and solve problems. This teaching method can not only stimulate students' interest, but also improve their problem-solving ability and mathematical thinking ability.

2) Academic research and teacher training: Many scholars and educational institutions in China have conducted in-depth research on mathematical modeling and carried out relevant teacher training activities. These studies and training are aimed at improving teachers' understanding and application of mathematical modeling teaching methods, and promoting the development of mathematical modeling education.

3. Similarities and Differences in Modeling between China and the United States

Of course, there are some similarities and differences in the practice and research of mathematical modeling between the United States and China.

3.1 Common ground

1) Practice: Mathematical modeling is widely used in secondary education, both in the United States and in China. Middle school students participate in all kinds of mathematical modeling competitions to cultivate their mathematical thinking and problem-solving ability by solving practical problems.

2) The same goal: both the United States and China hope to cultivate students' innovative thinking, practical ability and cooperative spirit through mathematical modeling education. The problems chosen by both are closely related to real life. They all come from social, economic, life and other practical problems, and can be transformed into mathematical problems to be solved, so that college students understand that mathematics is not an abstract thing, it is around us. Therefore, learning mathematics well is a very practical thing.

3.2 Variance

1) Educational objectives: American Modeling emphasizes the development of students' practical skills, innovative ability and team spirit. It encourages students to actively explore and develop ways to solve practical problems. Chinese modeling focuses on the cultivation of students' test-taking ability and the ability to apply mathematical knowledge, and focuses on the cultivation of students' problem-solving skills in mathematical modeling.

2) Teaching methods: Modeling teaching in the United States uses a heuristic approach to encourage students to learn independently and work in teams. Teachers are more likely to play the role of instructors and assistants, encouraging students to find problems and solve them in practice. Chinese modeling teaching pays attention to teachers' teaching and students' learning, and emphasizes the teaching and mastery of mathematical knowledge and problem-solving skills.

3) Competition format: The American Modeling Competition focuses on teamwork and the ability to solve practical problems. Students are required to conduct practice and research, write solutions, and make evaluations and presentations within a defined time frame. China Modeling Competition

also attaches importance to teamwork, but in the form of competition, it may focus more on the examination of mathematical knowledge.

3.2.1 The Biggest Difference

The biggest difference between the national tournament and the American tournament is that assessment preferences are different: the national competition focuses on results, while the American competition focuses on innovation. The national competition has strict requirements for the application of modeling methods. For specific modeling problems and situational assumptions, there are specific modeling methods to solve problems. The use of inappropriate methods will greatly affect the final results, and the national competition has a reference range of answers. If the answers calculated by the participating teams deviate from the reference range, it will have a bad affect on the final results; The contest mainly examines the idea of modeling, and an innovative idea of solving problems will be greatly favored and beautiful. Competition requires strong logic, and the derivation before and after the model needs detailed demonstration.

3.2.2 The Main Difference

The main difference between the two is the different requirements for the knowledge application of the participating students. Competition topics in China are often targeted by the type of each topic, the description of the problem is detailed and clear, and the conditions and data are sufficient. Usually, these problems can be solved by using specific mathematical algorithms. For example, "optimal fishing strategy" and "water-saving washing machine" in 1996 are all operational research problems, "resource allocation of publishing houses" and "evaluation of AIDS therapy and prediction of its efficacy" in 2006, and "bus scheduling problem" in 2001) One can use statistical knowledge to solve them. Some problems will have more definite results, such as the problem of "displacement identification of oil storage tank and calibration of tank capacity table" in 2010. To a certain extent, this limits the students' divergent thinking and the ability to apply mathematical knowledge. However, the topics of American competitions are often very open, and there are relatively high requirements for the establishment of mathematical models. In the process of participating in the competition, students should first discover the conditions implied in the topic and even the problems to be solved, and then determine the conditions and problems. The mathematical method can have a clear direction in the step-by-step analysis, and get the conclusion that can solve the problem. In this process, we need to have a good understanding of the problem. This is the key aspect for the examination and improvement of students' abilities. For Chinese students, they are accustomed to thinking in Chinese. It is also a great test and exercise to express one's thinking accurately in non-native English.

3.3 The Nature of National and American Tournaments

In terms of the nature of the competition, a problem in the United States can often be considered from many aspects, there is no strict boundary between "right" and "wrong". Therefore, the papers written by different teams on the same topic are always different and have their own merits. To a large extent, this gives the participating students a broad space for thinking and exploring their own potential energy. The participation of the mathematical modeling contest enriches the knowledge structure of Chinese students, broadens their horizons, cultivates their ability to solve practical problems with mathematical knowledge, improves their creativity, writing ability, and the ability to use computers and existing literature. At the same time, the mathematical modeling contest is also a good test for the psychological quality and perseverance of Chinese students.

Although there are some differences in the practice and research of mathematical modeling between the United States and China, both countries realize that mathematical modeling is essential

to the cultivation of students' comprehensive quality and future career development, and both pay attention to incorporating mathematical modeling education into the education system. The two sides can also exchange and cooperate in practice and research, jointly promote the development of mathematical modeling education, and cultivate more students with innovative and practical abilities.

4. The Development and Cooperation between Chinese Modeling and American Modeling

Modeling research in China started late, but after the reform and opening up the government actively supports the research and application of modeling technology. China's modeling research involves many fields, including engineering, environment, transportation, finance and so on. China has also established a number of modeling research institutes and laboratories, and trained a large number of modeling specialists. The United States is one of the leading countries in modeling technology and has been at the forefront of modeling technology for a long time. Modeling research and application in the United States are widely involved in science, engineering, biomedicine, finance and other fields. There are many well-known modeling research centers and laboratories in the United States, which attract a large number of international researchers and students.

4.1 Introduction and Requirements of the Mathematical Contest in Modeling

The United States Collegiate Mathematical Contest in Modeling (MCM) was developed from the Putman Mathematical Contest held by the Mathematical Association of America (MAA) in 1938. The first MCM competition began in 1985, when 90 teams from 70 universities in the United States participated. By 1992, 292 teams from 189 universities around the world had participated. By 2009, the whole nation has 1137 colleges and universities, and more than 45000 college students from various majors participated in the competition. Mathematical modeling contest only require participants to master a basic level of advanced mathematical knowledge. Its topic is very flexible, and it is also a good test for the creativity of the contestants. The competition is a team work of three people, and there are different divisions of labor within the team, which requires the participants to have a better team work ability. The duration of the competition is 3 to 4 days (4 days and 4 nights in the United States and 3 days and 3 nights in China). The latter is to submit a paper to reflect the results, so the participants need to have a clear and novel idea and solution to the problem within the specified time, and have a clear expression of their own ideas. The further development of modeling includes: new practical ideas for seeking new breakthroughs in winning prizes, publishing papers, research on educational reform, declaration of scientific and technological innovation, guidance of graduate design, and cooperation between schools and enterprises[4].

4.2 The Trend of Cooperation between China and the United States in the Field of Modeling

China and the United States have developed a lot of cooperation in the field of modeling. Modeling specialties in China and United States often exchange visits, cooperate in research, and jointly publish academic papers. Some universities and research institutes in China have also established cooperative relations among universities and research centers in the United States to jointly carry out modeling research projects. In addition, scientific research institutions in China and the United States can share data, resources and modeling software through cooperation to improve the efficiency and level of modeling research.

Generally speaking, the development and cooperation between China and the United States have made great contributions to the scientific and technological innovation and economic development of the two countries, and provided valuable experience and achievements for the development of the global modeling field.

4.2.1 Important Modeling Cooperation Cases between China and the United States

In recent years, the number of modeling cooperation cases has been increasing, covering many fields. Here are some of the key examples:

1) Cooperation on climate change modeling: China and the United States have extensive cooperation, including establishing and participating in international climate change model comparison projects, such as cooperation in exploring carbon dioxide emission control strategies and assessing the impact of climate change.

2) Health modeling cooperation: China and the United States are also increasingly cooperating in the field of public health. For example, cooperation in the study of disease transmission models and epidemic prediction will help both sides to respond to infectious diseases and public health events.

4.2.2 Themes of Research Papers on Mathematical Modeling Practice in China and the United States

The following topics can be discussed in the paper on the teaching and practice of mathematical modeling in American middle schools and in China:

1) The impact and role: The paper can further study the impact and role of mathematical modeling education in middle schools on students, such as improving students' problem-solving ability, cultivating innovative thinking and teamwork ability, and analyze them with relevant research and cases.

2) The research and evaluation: The paper can study and evaluate the mathematical contest in modeling in middle schools, including the organization and scale of the contest, the difficulty and type of the contest, the evaluation criteria of the contest results, and put forward suggestions for improvement.

3) Design and implementation: The paper can further study the design and implementation of mathematical modeling curriculum in middle schools, including the selection of teaching materials, teaching content and methods, and explore how to better cultivate students' mathematical modeling ability.

4) The relationship between mathematical modeling and practical application: The paper can further explore the relationship between mathematical modeling and practical application in middle schools, such as the application of mathematical modeling in scientific research, engineering design, social problem and son on, and illustrate it with specific cases.

5. Conclusion

In the paper, we quote the relevant literature and research results, analyze and discuss about modeling from both theoretical and practical aspects, and put forward suggestions for the improvement and development of mathematical modeling education in Chinese and American middle schools.

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