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The studies on mathematical modeling teaching in Chinese Universities

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Abstract
Mathematical modeling is an important bridge to connect life practice and mathematics, and is widely used in various fields of studies. However, there are still many problems in the mathematical modeling teaching in universities, many Chinese scholars have made studies on this, and many achievements have been made. This paper collated studies results of predecessors, briefly reviewed the significance, current situation and improvement measures of mathematical modeling teaching in colleges and universities, and commented on it, so as to provide references for further studies in the future.

Keywords: mathematical teaching, modeling, university

1. Introduction
Mathematical modeling is playing an increasingly important role in solving practical problems. In the teaching of colleges and universities, it is more related to the overall development and application of mathematics. Therefore, many scholars have attached great importance to the studies of mathematical modeling teaching in colleges and universities. Summarizing the existing studies results, it can be found that contemporary scholars have made many objective and comprehensive analyses and discussions about mathematical modeling teaching in colleges and universities, and all kinds of viewpoints and suggestions are quite comprehensive. The Chinese studies status of mathematical modeling teaching in colleges and universities is reviewed in this paper.

2. The Connotation of Mathematical Modeling
Mathematical modeling is to establish a mathematical model, it is also a mathematical thinking method. It specifically refers to a powerful mathematical method that can be used to depict approximately and solve practical problems by using mathematical principles, methods and languages (Rao, C. J. & Wang, C., 2006) [1]. In short, mathematical modeling is the process of using mathematical ideas and methods to establish mathematical models to solve practical problems (Gu, C. J., 2015) [2]. Mathematical modeling has the characteristics of abstractness, generality and comprehensiveness. In solving practical problems, there are 5 main aspects in the process of mathematical modeling:

1. Modeling preparation. It is necessary to understand the actual background of the problem, clarify the practical significance, master all kinds of information of the object, and describe the problems in mathematical language.
2. Modeling hypothesis. According to the characteristics of the actual object and the purpose of the modeling, the necessary simplification of the problem is made and the scientific hypothesis is put forward in a precise language.
3. Modeling establishment. On the basis of the hypothesis, using the appropriate mathematical tools to depict the relationship between variables, and establish the corresponding mathematical structure.
4. Modeling solution. Using the mathematical method or computer method to calculate or estimate all the parameters of the model.
5. Modeling test. For the model established, using the actual data or other information to test whether the model is in line with the actual situation and whether it can be predicted and evaluated.

It is generally repeated over and over again through these 5 processes, until the established model can solve practical problems well (Rao, C. J. & Wang, C., 2006; Xiao, N., 2015) [1, 3].

3. The Significance and Function of Carrying out the Mathematical Modeling Teaching in Colleges and Universities
3.1 Forming a Scientific and Rigorous Mathematical View
Rao Congjun and Wang Cheng believed that carrying out mathematical modeling teaching could deepen students' understanding and mastery of mathematical knowledge and mathematical methods, adjust students' knowledge structure, cultivate students' conscious learning, deepen their knowledge levels, and form a scientific and rigorous mathematical view (Rao, C. J. & Wang, C., 2006; Zhang, X. P., 2007) [1,4].
Zeng Jingjing thought that the construction process of mathematical modeling from practice to theory to practice could not only help students firmly master mathematical knowledge, but also effectively train students' ability to use mathematical language and mathematical methods, so as to help students establish the correct mathematical view (Zeng, J. J., 2016) [5].

3.2 Forming a Proactive Learning View
Rao Congjun and Wang Cheng thought that the mathematical

modeling teaching could cultivate the students' view of conscious learning and study, and promote the changes of their learning concept. Students could complete the modeling process through observation, collection, comparison, analysis, synthesis, induction, transformation, construction, solution and a series of cognitive activities, so that students could truly become the main body of learning (Rao, C. J. & Wang, C., 2006) [1].

Xie Shumo believed that the mathematical modeling teaching could cultivate and improve the students' ability to learn independently and use literature (Xie, S. M., 2009) [6].

Zeng Jingjing thought that the process of ideological mathematical modeling accorded with the development law of students' cognition process of things, mathematical modeling could effectively improve students' enthusiasm in learning mathematics and applying mathematics (Zeng, J. J., 2016) [5].

3.3 Improving the Application Ability of Analyzing and Solving Practical Problems

Rao Congjun and Wang Cheng believed that carrying out mathematical modeling teaching could enable students to understand and master the links between mathematics and related disciplines and real life, to feel the wide application of mathematics, to cultivate students' awareness of applied mathematics, and to improve their ability of analyzing and solving practical problems (Rao, C. J. & Wang, C., 2006; Zhang, X. P., 2007) [1, 4].

Yang Penghui and Tang Xiaojing believed that mathematical modeling could cultivate students' ability of applying mathematical knowledge. Most of the problems of mathematical modeling came from real life, it needed to analyze them, select useful information, and find effective data, then use reasonable models to solve them, and finally apply the results to reality or test by practice (Yang, P. H. & Tang, X. J., 2014) [7].

Professor Green, the academician of the American Academy of Sciences, once said, "The times need mathematics, mathematics needs to be applied, and applications need to be modeled." Zeng Jingjing believed that students needed to learn to use mathematical models to solve practical problems, he also believed that mathematical modeling translated the dull mathematical theory into a vivid and realistic case, it not only gave students a clear sense of the application of mathematics in daily life, but also could inspire students' mathematical inspiration and improve students' learning efficiency (Zeng, J. J., 2016) [5].

3.4 Cultivate Interest in Mathematics Learning

Rao Congjun and Wang Cheng believed that carrying out mathematical modeling teaching could stimulate students' interest in learning (Rao, C. J. & Wang, C., 2006; Zhang, X. P., 2007) [1, 4].

Yang Penghui and Tang Xiaojing considered mathematics a relatively boring basic subject. Interest was the key to learn mathematics well. The mathematics teachers in college and universities should be good at giving full play to mathematics teachers' specialty, strengths and temperament to attract students, so as to cultivate students' interest in learning. Introducing mathematical models into mathematics teaching not only enriched the contents of mathematics teaching, but also made the connection between mathematics and real life more closely, brought theory into mathematical models, and stimulated students' interest in learning mathematics (Yang, P. H. & Tang, X. J., 2014) [7].

3.5 Cultivating Students' Spirit of Cooperation

Rao Congjun and Wang Cheng believed that the mathematical modeling teaching in Colleges and universities could cultivate the students' spirit of cooperation and common struggle to establish good interpersonal relationships (Rao, C. J. & Wang, C., 2006; Zhang, X. P., 2007) [1, 4].

Xie Shumo believed that mathematical modeling was conducive to the cultivating of students' organization and coordination (Xie, X. M., 2009) [6].

Yang Penghui and Tang Xiaojing believed that mathematical modeling could cultivate the students' team awareness. Nowadays, college students were mostly the only children in the home, and they may be more self - conscious and lack of team consciousness. Mathematical modeling was a complex process that could not be done only by one person, so many people were required to work together. In the case of difficulties, people discussed with each other, gave full play to their advantages and wisdom, and finally worked together (Yang, P. H. & Tang, X. J., 2014) [7].

3.6 Cultivating Students' Creativity

Xie Shumo believed that mathematical modeling could cultivate students' innovative ability. It was an excellent way to cultivate students' creativity and spirit of innovation. It could not be replaced by any other classroom teaching (Xie, S. M., 2009) [6].

Yang Penghui and Tang Xiaojing believed that mathematical modeling helped to cultivate students' creative ability. For the same problem, students could establish different models based on their own conditions and adopt different ways from different angles to help students develop their independent innovation ability (Yang, P. H. & Tang, X. J., 2014) [7].

Zhao Ling believed that for a number of completely different practical problems, the mathematical models of these problems were the same or similar under certain simplified layers. This was the manifestation of the extensive application of mathematics. And students were required to have extensive interest. It also needed to cultivate students diligent thinking, hard-working and pragmatic work style through more learning and practice to achieve the analogy by-pass and mastery of the state (Zhao, L., 2001) [8].

Zeng Jingjing believed that paying attention to the learning of induction in mathematics could cultivate students' ability to be good at discovering and inducing from social reality. The mathematics teachers in colleges and universities should change the concept of education, innovate the educational ideas, introduce mathematical modeling ideas in the mathematics classroom, and also help to improve the students' creative ability (Zeng, J. J., 2016) [5].

4. The Present Situation and Problems of Mathematical Modeling Teaching in Colleges and Universities

4.1 The Limitations of the Curriculum Setting

Wang Xiaoling, Chen Junyan & Zhang Ping thought that the limitations of mathematical modeling correlated curriculum

setting were mainly shown in the curriculum number less, and most of the class teaching in the form of large class elective courses, so it was difficult to excavate outstanding talent of mathematical modeling, it was also difficult to achieve targeted education and focus on the cultivation of excellent students (Wang, X. L. & Chen, J. Y. & Zhang, P., 2015) [9].

4.2 Lack of Close Contact with Actual Problems

Wu Zikai and Zhang Hongjuan thought that traditional mathematics knowledge was too rigid. When students met certain practical problem, students could not apply them well, which resulted in a direct disconnection between curriculum content and solving practical problems. He also believed that mathematics teaching focused on developing students' ability of theoretical deduction and increasing their logical thinking, but rarely involved the combination of practical application and theoretical background, which led students to not extract mathematical problems from practical problems to solve practical problems (Wu, Z. K. & Zhang, H. J., 2015) [10].

Wang Zhifang thought that in the current mathematical modeling teaching, most of the data came from textbooks and courseware. Students lacked the exercise of collecting and analyzing data, so that the established models were difficult to solve practical problems (Wang, Z. F., 2016) [11].

4.3 Students Lack Professional Knowledge of Mathematics

Wu Zikai and Zhang Hongjuan thought that mathematical modeling was a kind of activity that all kinds of knowledge were utilized comprehensively to solve practical problems. It not only needed to learn professional mathematics knowledge, but also had to understand other professional knowledge comprehensively (Wu, Z. K. & Zhang, H. J., 2015) [10].

Wang Zhifang thought that in our country, there was a problem of teaching fault in the mathematics course teaching. The probability theory and linear algebra, the former was less involved in the high school stage, and the latter was hardly involved. Students lacked the consolidation training of a large number of exercises and lacked of proficiency. Teaching methods in universities were quite different from those in senior high schools, so many students had poor basic abilities in mathematical modeling and analysis (Wang, Z. F., 2016) [11].

4.4 Teachers' Own Lack of Experience and Teaching Methods are Backward

Wang Zhifang believed that in the mathematical modeling teaching, the teaching methods of teachers in some colleges and universities were relatively backward. At present, some teachers in colleges and universities were born of mathematics department. In teaching, they still relied on traditional classroom teaching, and used less modern teaching tools. When the students' enthusiasm for learning was difficult to guarantee, the backward teaching methods was difficult to guarantee the teaching effect of this complex course of mathematical modeling (Wang, Z. F., 2016) [11].

Gao Xiaojuan believed that the mathematical modeling teaching was the application of teaching, which was to teach students to use mathematical modeling methods to solve practical problems. Some teachers lacked application knowledge and experience who were responsible for teaching mathematical modeling in colleges and universities. It made the classroom too theoretical in the process of teaching, steps and methods of the restrictions and fetters let students lose interest in learning, and it was difficult to really keep in mind and apply it (Gao, X. J., 2017) [12].

5. Improvement Measures of Mathematics Modeling Teaching in Colleges and Universities

5.1 Reform the teaching method of mathematical modeling and realize multiple connections

Zeng Xianlin, Li Mingzhen thought that the mathematical modeling teaching should emphasize the diversification of mathematical modeling methods, and highlight the general steps of mathematical modeling methods. It was important to pay attention to mathematical modeling methods with extensive universality, such as relationship analysis method, theoretical analysis method, the basic principle of balance method, data analysis and other basic methods. And it also needed to pay attention to the mathematical modeling methods based on the branch of Mathematics such as limit modeling method, differential modeling method, integral modeling method, differential equation modeling method, probability modeling method, statistical modeling method and so on (Zeng, X. L. & Li, M. Z., 2012) [13].

Wu Zikai and Zhang Hongjuan believed that a variety of teaching methods should be adopted in view of the characteristics of the mathematical modeling curriculum (Wu, Z. K. & Zhang, H. J., 2015) [10].

Wei Zhiyuan, Mao Yiping and others believed that the reform of teaching methods should combine the discussion and evaluation, analyze the typical examples to guide students to participate in the modeling, so that students' logical reasoning ability and analysis ability were exercised (Wei, Z. Y. & Mao, Y. P. & Yang, Q. F. & Guan, Y. L., 2003) [14].

Wang Zhifang believed that for mathematical modeling teaching in colleges and universities, some teachers needed to further transform teaching methods, and use mathematical modeling as a mathematical tool to solve practical problems for analysis and teaching (Wang, Z. F., 2016) [11].

Gao Xiaojuan thought that teachers must master the relationship and controlling between different mathematical modeling methods in process of teaching, and teachers should teach students to learn to combine and unite in different methods in a specific problem situation to solve problems well (Gao, X. J., 2017) [12].

5.2 Contact the Actual Problem and Design Case Teaching

Rao Congjun and Wang Cheng believed that teachers took specific cases as the main teaching contents, and introduced the thougtway of modeling through the modeling examples of specific problems (Rao, C. J. & Wang, C., 2006) [1].

Wu Zikai and Zhang Hongjuan believed that in the modeling curriculum teaching, teachers provided relevant practical problems and studied together with the students to discuss, and they provided problems into mathematical modeling. Under the guidance of teachers, students completed the whole process of problem solving and tested the results in practice, finally revised it repeatedly until the result was satisfied (Wu, Z. K. & Zhang, H. J., 2015) [10].

Ouyang Zhangdong and Chen Xiuqiong thought that case

teaching method was closest to mathematical modeling teaching method. Case teaching not only deepened students' understanding of the basic knowledge, but also enhanced the students' mathematics consciousness of applying knowledge to practice and cultivated students' ability of mathematical modeling (Ouyang, Z. D. & Chen, X. Q., 2013) [15].

Zhang Xinping believed that when teachers taught specific modeling cases, they should start from practical problems, expound the background of the problem, requirements for modeling, information that has been mastered and how to establish an optimized mathematical model through reasonable assumptions and simplified analysis (Zhang, X. P., 2007) [4].

Zeng Jingjing believed that mathematics teachers in colleges and universities should introduce teaching examples into the classroom. From the results of teaching, the idea of mathematical modeling allowed students to fully understand that mathematical theory came from reality, but the final goal of learning mathematics was to return the mathematical theory to the practical application (Zeng, J. J., 2016) [5].

5.3 Tamp the Knowledge of Mathematical Modeling and Enrich the Modeling Activities

Gao Peng and Li Yuanyuan believed that colleges and universities should actively carry out corresponding scientific research work, and constantly improve the level of scientific research and teaching level of teachers, so as to successfully implement the mathematical modeling teaching in Colleges and universities (Gao, P. & Li, Y. Y., 2017) [16].

Wu Zikai and Zhang Hongjuan believed that improving the teaching of mathematical modeling in colleges and universities should tamp the teaching of double base, emphasize the students' ability to think in mathematics, and take into account the students' mathematical basis, learning habits and learning ability. They also believed that various scientific research activities and discussions should be carried out, and teachers should encourage students to participate in some small problems in the teachers' part of the subject or College Students' Innovation and Entrepreneurship Project at various levels. In addition to classroom teaching, extracurricular exercises or short curriculum were also important; in addition, participating in a short curriculum or lecture of related knowledge was also a useful attempt (Wu, Z. K. & Zhang, H. J., 2015) [10].

Ouyang Zhangdong and Chen Xiuqiong advocated and encouraged students to set up Mathematical Modeling Association which was responsible for the students themselves, they could hold school mathematical modeling competitions regularly to make more students join the team of mathematical modeling, and actively encourage students to participate in the National College Student Mathematical Modeling Competition through various channels (Ouyang, Z. D. & Chen, X. Q., 2013) [15].

Wang Zhifang believed that improving the basic theory of mathematical modeling teaching was an important means for students' modeling basic skills. In teaching, it needed to strengthen the teaching of basic theories such as probability theory and distribution theory. Outside the classroom, it needed to increase the students' true mathematics level by increasing the students' basic theory (Wang, Z. F., 2016) [11].

5.4 Improve the Level of Mathematics Teachers and Promote the Mathematical Modeling Teaching

Rao Congjun and Wang Cheng believed that teachers who teach mathematical modeling were not only required to have higher professional level, but also have rich practical experience and strong ability to solve practical problems. On the one hand, the colleges and universities could send more teachers to go out for professional training, learning and academic exchanges. On the other hand, many famous expert professors could be invited to do modeling academic reports, so that teachers and students could increase their knowledge (Rao, C. J. & Wang, C., 2006) [1].

Xin Hua, Zeng Zhaoying and others thought it should be taken from the teacher's own quality, not to emphasize the students' ability of accepting. The modeling was different from basic curriculums, teachers were required to find out advantages and disadvantages quickly for students' practice, also were required to have a rich life experience and keen observation (Xin, H. & Zeng, S. Y. & Kong, L. B. & Du, H., 2010) [17].

Wei Zhiyuan, Mao Yiping and others hold that the construction of mathematical modeling curriculum was a widely involved and heavy workload. Building a high-level and high-quality teaching team was a guarantee for the construction of mathematical modeling curriculum (Wei, Z. Y. & Mao, Y. P. & Yang, Q. F. & Guan, Y. L., 2003) [14].

Yang Penghui and Tang Xiaojing thought that mathematics teachers should have modeling consciousness first and then improve their modeling level. College and universities mathematics teachers needed to learn some new mathematical modeling theories and apply them to classroom teaching reasonably and effectively (Yang, P. H. & Tang, X. J., 2014) [7].

5.5 Enrich the Textbook of Mathematical Modeling and Introduce Software Teaching

Zhang Hua and Liu Subing thought that in the teaching practice of mathematical modeling, Matlab software was usually used. The software was powerful and versatile. Students could learn the use of Matlab mathematical software through the practice of operating computers, and facilitate the processing of massive data of actual problems (Zhang, H. & Liu, S. B., 2013) [18].

According to Xiao Nan, there were many textbooks which could be chosen for mathematical modeling. No matter which textbook was chosen, teachers should take appropriate decisions according to the teaching plan, the actual level of students, and the difficulty of selected textbooks (Xiao, N., 2015) [3].

Yang Penghui and Tang Xiaojing thought that the mathematical models should be combined with the current textbooks (Yang, P. H. & Tang, X. J., 2014) [7].

Wang Zhifang believed that most of the current mathematical models were analyzed by software, such as LINGO, SPSS, SAS and MATLAB. These software had strong professionalism and practicability in the field of focus (Wang, Z. F., 2016) [11].

Zhang Xinping thought that the mathematical software should be taught in a systematic way and students should practice by operating computers. With the development of computer technology, some high performance and applied mathematical

software emerged as the times require. With the mathematical software, complex data calculation and processing in the textbook were no longer a problem. After teaching the specific skills of these mathematical software, the teachers let the students operate computers in person and master the application of the software in the practical mathematical operation (Zhang, X. P., 2007) [4].

5.6 Ensure the Scientificity of the Selection of Mathematical Modeling and Improve the Teaching Effect

Zhao Gang believed that the scientificity of the selected topics of mathematical modeling would directly affect the effect of teaching. Consequently, in the process of topic selection, teachers needed to take full consideration of the teaching plan, the difficulty of the textbooks and the level of the students' practical ability, and strictly follow the principles such as problem centered, selected topics have sufficient research value, as well as feasibility and interest, so as to mobilize students' interest in modeling (Zhao, G., 2017) [19].

6. Comment on Current Studies

Reviewing these studies, it can be seen that the current studies on mathematical modeling teaching in colleges and universities mainly focuses on three aspects: the significance, present situation and improvement measures:

1. The significance of carrying out the mathematical modeling teaching in colleges and universities include: stimulating students' interest in mathematics, mobilizing the enthusiasm and initiative of students to learn mathematics, making students further understand the characteristics of the abstractness and rigorism of mathematics, promoting students' creativity and imagination of the development. The studies of significance are more comprehensive and thorough, so that people can realize the importance of mathematical modeling teaching.
2. For the current problems in mathematical modeling teaching in colleges and universities, such as: the limitation of mathematical modeling curriculum, the teaching process is not closely related to practical problems, students lack mathematical modeling knowledge and teachers lack mathematical modeling experience. It can be said that the current studies on the present situation of mathematical modeling teaching are comprehensive and in-depth.
3. To solve these problems, scholars also put forward many improvement measures, they discuss it from the reform of modeling teaching method, case teaching method, enrich modeling activities, improve the teachers' teaching level, the introduction of software teaching and enrich textbooks and the scientificity of topics selection. These measures can be said to be more detailed.

However, through the analysis of the above studies, it can be seen that although the studies on mathematical modeling teaching in colleges and universities are more comprehensive, there are also some shortcomings, such as:

1. The studies lack case verification. The articles are just a variety of theoretical analysis, there are no real and objective data to prove whether the studies are valid, and the study are lack of persuasion. Consequently, it is a future study direction to analyze the present situation of mathematical modeling teaching in colleges and universities with practical examples.
2. The existing literatures seldom study the improvement effect of mathematical modeling teaching. The good improvement effect is the motive force for carrying out mathematical modeling teaching. Consequently, following the actual teaching of mathematical modeling, it is also a study direction in the future to study the teaching effect after improved.
3. The actual situation in different colleges and universities is different, and the specific conditions for the implementation of various measures are also different. The existing literatures are lumped together. Consequently, it is also a future study direction to make improvement measures in combination with the actual situation of colleges and universities.

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