International Journal of Education and Information Technology
Vol. 3, No. 3, 2018, pp. 46-52
http://www.aiscience.org/journal/ijeit
ISSN: 2381-7410 (Print); ISSN: 2381-7429 (Online)

The Studies on Improving the Ability of Mathematical Modeling for University Students

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Abstract

Mathematical modeling ability is the capability to apply mathematical knowledge to solve practical problems. With the development of economy and culture, the demand for applied talents is expanding, and the mathematical modeling ability of students is particularly important. In this context, how to cultivate the students' ability of mathematical modeling to meet the high standards and high requirements of the society has become an important issue in modern modeling education. Many scholars have studied it and have made quite a lot of achievements. This paper intends to analyze and sort out the research results of predecessors, and make comments for future research.

Keywords

University Students, Mathematics, Modeling, Ability

Received: June 5, 2018 / Accepted: July 6, 2018 / Published online: August 10, 2018

1. Introduction

Improving the ability of mathematical modeling can not only enrich the knowledge structure, but also cultivate the creative thinking and creative ability of the students. It is an important way to improve the comprehensive quality of university students. The contemporary scholars have analyzed the aspects of improving the modeling ability, and put forward practical methods. However, it is not very clear that which aspects have been studied, which aspects have not been involved, which aspects of the study have been more in-depth, which aspects of the study still have problems and so on. For further research in the future, this paper will make a summary of their study.

2. Present Situation of Cultivating the Ability of Mathematical Modeling for University Students

Wu Dongqing and others had analyzed the present situation from many aspects, first of all, most schools paid more attention to the students' test ability, and the students' knowledge level was relatively narrow. At present, most schools adopt the comprehensive evaluation method for students' modeling ability, including students' achievements, past competition performance and teachers' impression. Secondly, in the construction of teaching resources, most universities mainly used theoretical teaching materials. In the construction of network sharing resources, many high-quality courses were mainly displayed with static information, and there were no essential differences between video data and traditional teaching. Thirdly, in terms of teaching methods and teaching practice, mathematical modeling teaching mostly

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centered on classroom, teachers and books [1].

Huang Xianyong and others conducted a questionnaire survey in China's universities. The results showed that only a few students had been trained in modeling, and the competition and mathematical modeling thought were not widely propagate among the students. In addition, students lacked the knowledge of mathematical software and the ability to apply mathematical software. Another point was that most students thought that school leaders were not involved in the process of modeling ability training [2].

3. The way to Improve the Ability of Mathematical Modeling for University Students

3.1. Attaching Importance to the Construction of Mathematical Modeling Culture

Wu Dongqing and others thought that universities should find the orientation of the construction of mathematical modeling culture, determine the basic content, build a variety of communication platforms that student favorite, and integrate the mathematical modeling culture into the teaching [1].

3.2. Attaching Importance to the Penetration of Mathematical Modeling Thought

3.2.1. Integrating Modeling Thought into Classroom Teaching

Zhang Lili and others thought that teachers should connect the examples of mathematical modeling with the current textbooks, and introduce the thought and methods of mathematical modeling in the introduction and application of knowledge points [3-7]. Liu Yulin thought that teachers should infiltrate mathematical modeling thought in concept introduction and explanation, embody the process of mathematical modeling in content explanation, add examples of modeling in the course of teaching, and include the content of mathematical modeling in the assessment [8]. Jia Xiuli thought that teachers should try their best to infiltrate the history of mathematics into the teaching process and explain the partial contents of the book with the thought and methods of modeling [9]. Li Shuchen thought that the problem solving strategy should be implemented in the classroom [10]. Zhao Jianxin thought that teachers needed to strengthen process teaching, attach importance to the teaching and application of important methods, and change the examples and exercises in teaching materials to simple mathematical modeling problems [11]. Ma Shuhong and others thought that teachers must integrate the application consciousness of mathematics into the daily mathematics teaching process [12, 13].

3.2.2. Integrating Modeling Thought into the Reform of Teaching Materials

Zhang Lili thought that some open exercises should be added in the appropriate chapters of the textbook to train students' modeling ability [5]. Xie Hai thought that it was imperative to integrate the teaching materials of higher mathematics at present, and the materials should be conducive to the development of students' thinking, application consciousness and innovation ability [13].

3.3. The Reform of the Construction of Mathematical Modeling Courses

3.3.1. Teaching Contents

Jia Xiuli and others thought that in the process of teaching, it was necessary for teachers to infiltrate the history of mathematics properly to cultivate students' interest in learning and spirit of science [9, 12].

Xu Jiying and others thought that due to the complexity of mathematical modeling, university students needed to have a solid knowledge base of mathematics, so teachers should strengthen the teaching of basic knowledge of mathematics [4]. Li Shuchen and others thought that mathematical modeling was a micro scientific research process. Therefore, teachers should cultivate the students' ability of mathematical modeling, and first of all, they should strengthen the teaching of basic knowledge [9, 12, 14].

Zhao Jianxin thought that teachers should teach specific thinking methods of modeling to cultivate students' ability for solving models [11].

Xu Jiying and others thought that students needed to learn related multidisciplinary knowledge. University students should have certain knowledge and experience in other aspects such as social, economic and literature [4].

Zhu Jianqing thought that students needed to do a lot of practical exercises [15]. Zhang Wei and others thought that in the spare time, some students were selected to study the knowledge of mathematical modeling, then the students were divided into groups, and a small mathematical modeling competition was carried out in a team form [6]. Tan Zhong thought that teachers should organize students to participate in training. Training mainly included two stages: basic knowledge training stage and case analysis training stage [14]. Chen Rongjun and others thought that it not only required students to carry out mathematical and statistical software application training, but also arranged students to get into the Mathematics Laboratory for independent training, and there were professional teachers for individual tutoring [16].

3.3.2. Teaching Methods

Liu Shuangqian and others thought that teachers should use case teaching method and choose cases closely related to students' life [3, 6, 17, 18]. Ma Shuhong and others thought that in teaching, the methods, thought, thinking and consciousness of mathematical modeling should be introduced into the case [12, 15, 18, 19]. Liu Yulin and others thought that teachers should be allowed to add some classic cases of mathematical modeling in the course [8, 18]. Li Shuchen and others thought that teachers should pay attention to the teaching of applied questions [10]. Li Lu and others thought that teachers should add simple modeling cases to the main courses of mathematics [20]. Tan Zhong thought that teachers should select new and interesting cases [14]. Song Liya thought that case teaching instead of lecturing [17].

Xu Jiying and others thought that teachers should pay attention to experimental teaching, and teachers could improve students' software application and programming ability through experimental classes [3, 4]. Li Shuchen and others thought that teachers should attach importance to experimental teaching and let students build mathematical models in the process of hands-on operation [10]. Jia Xiuli and others thought that mathematics experiment courses could help students exercise the ability of computer modeling and applied mathematics [9, 13].

Wu Dongqing and others thought that students were the main body in the classroom. Teachers could create three to five extracurricular learning groups for students to cooperate in completing mathematical models, arrange the presentation courses unregularly, and let students set up mathematical modeling websites for themselves [1]. Zhang Lili thought that teachers could add mathematical modeling contents to classroom teaching in the form of modules, and teachers should give students a certain amount of time and space to solve practical problems [5, 17]. Ma Shuhong thought that in teaching, teachers must take students as the main body, and students had the ability to think independently [12]. Huang Xianyong and others thought that teachers should use various teaching methods flexibly [2]. Xie Hai and others thought that teaching in the form of discussion class [9, 13, 15]. Zhu Jianqing thought that it was necessary to use the heuristic teaching method [15]. Li Shuchen and others thought that teachers should create appropriate problem situations and guide students to actively engage in modeling activities [10]. Wei Chengdong and others thought that case teaching method and interactive teaching method should be combined [21]. Tan Zhong thought that research-based teaching and collaborative learning should be combined. Students were the main body of learning, and teachers only gave guidance in methods [14]. Dai Xiaoqin thought that according to the different professional background and mathematical foundation of students, schools should choose appropriate mathematical modeling courses and teaching teachers for them [18].

3.3.3. Curriculum System

Wu Dongqing thought that the series of mathematical modeling courses should have compulsory courses and elective courses for students with different mathematical foundations to learn [1]. Huang Xianyong and others thought that universities should set up compulsory courses or elective courses of mathematical modeling combined with the majors' characteristics, and build a characteristic modeling course system [2, 14]. Ma Shuhong thought that mathematical modeling ability was the core of practice teaching system [12].

3.3.4. Methods of Examination

Zhu Jianqing thought that teachers should increase the proportion of discussion, class paper and usual achievement in the examination. There was no standard answer in examination [15].

3.3.5. The Construction of Teachers' Team

Liu Shuangqian and others thought that teachers should accumulate mathematical modeling examples and improve their teaching level, and cultivate the students' modeling ability according to the different types and levels of the students [3, 18]. Xie Hai and others thought that in university mathematics teaching, teachers should build up the students' consciousness of mathematical modeling, and first of all, they must renew their own educational ideas and teaching ideas [3, 12, 13]. Zhang Jianfeng and others thought that universities should strengthen the construction of teachers' team. Young teachers should go out for further study, and universities should invite multi-disciplinary teachers to join the modeling team [22]. Zhang Lili and others thought that teachers must change the teaching concept based on theoretical discussion, update the knowledge structure, strengthen the communication and cooperation with the outside world, and understand the latest developments and research directions of mathematical modeling [5]. Xie Hai thought that teachers should not only be proficient in mathematics, but also had a better understanding of natural science and social science, and they needed to strengthen cooperation with teachers in related disciplines [13].

3.4. Cultivating the Essential Quality of Mathematical Modeling

3.4.1. The Necessary Thinking of Mathematical Modeling

Song Liya thought that teachers should arrange more inspirational and exploratory questions for students to guide students to observe and guess [17]. Zhu Jianqing thought that imagination was more important than knowledge, and it

stimulated the progress of science [15]. Zhao Jianxin thought that teachers could cultivate students' ability to observe and guess through analogy and other methods [11].

Song Liya thought that it was necessary to cultivate the insight of the students [17].

Zhao Jianxin thought that teachers should cultivate students' logical thinking. First of all, teachers should strengthen the training of mathematical language. Secondly, teachers should strengthen the teaching of logical thinking method. Finally, teachers should strengthen the intensity and difficulty of logical thinking training [11].

Song Liya thought that mathematical modeling was the abstraction of complex practical problems and then simplified them into mathematical problems. In teaching, teachers should strengthen the integration of functions, calculus, solid geometry and mathematical modeling knowledge [17].

Liu Hao and others thought that inductive thinking and analogical thinking were the most basic thinking in mathematics. Through induction and analogy, students could compare and summarize the new and old methods of knowledge, which was helpful to the mastery of new knowledge methods and the application of old knowledge methods [23].

Liu Hao and others thought that divergent thinking helped to analyze topics in depth and consider modeling from multiple perspectives. The teaching of multiple solutions to the same problem could train the divergence of thinking [23].

Liu Hao and others thought that reverse thinking was an unconventional way of thinking. It had a very special effect in understanding and solving the problem of modeling. Students could strengthen the training of reverse thinking by using reduction to absurdity and indirect method [23].

3.4.2. The Necessary Ability of Mathematical Modeling

Hou Yangyang and others thought that teachers should cultivate students' reading ability in mathematics by reading textbooks [24].

Liu Yulin and others thought that it was necessary to cultivate students' two-way translation ability in mathematical language and written language. This translation ability required students to learn more about the mathematical language in normal times and do a lot of this practice in the classroom [8, 15, 24]. Jia Xiuli thought that, first of all, teachers should attach importance to the process of mutual translation between ordinary language or chart language and mathematical language. Secondly, teachers should select typical competition questions and lead students to learn how to translate practical problems into mathematical problems [9].

Xu Jiying and others thought that mathematical modeling was closely related to computers. Students should not only be proficient in using software, but also at least master a computer or mathematical programming language [4, 5, 12, 22]. Li Juncheng and others thought that students needed to learn computer software systematically [15, 22, 25].

Liu Yulin and others thought that it was necessary to cultivate the students' ability to consult, collect and organize materials [8, 15, 24].

Xu Jiying and others thought that mathematical modeling projects should be written as a paper in the end. It required that students cultivate their writing skills consciously [4, 8, 24]. Li Juncheng thought that even if students had built a good mathematical model, their writing ability was poor, so the model cannot be accepted by others [25].

Zhang Lili thought that it was necessary to cultivate students' innovative ability. In the process of modeling, the students set up a mathematical model for the actual problems, then carried out numerical simulation, further analyzed the results, and finally used it to solve practical problems, which could effectively improve the students' innovative consciousness and ability [5]. Xu Jiying and others thought that, for a problem, teachers could encourage students to try to think from a variety of different angles, which could cultivate students' creative ability [4, 26]. Liu Yulin thought that in daily teaching, teachers should always encourage students to boldly assume and carefully verify. Through discussion of cases and participation in innovative projects, students' creativity could be consciously cultivated [8]. Li Juncheng and others thought that in order to cultivate innovative ability and innovative thinking, students could analyze, improve and build their own models from existing models [25].

Zhang Lili thought that in the process of modeling, students of different specialties and grades should be gathered together to discuss problems and share information, so it was necessary to develop the students' teamwork ability [5]. Xu Jiying and others thought that the mathematical modeling project should be done by three people together. Therefore, students were required to have a team spirit. In addition, they should be good at communicating and listening [4, 15, 25, 26].

Jia Xiuli thought that in order to improve students' ability to solve mathematical models, teachers should carry out teaching in the form of discussion classes. They could set up mathematical experiment courses and lead students to participate in mathematical modeling competition [9]. Zhao Jianxin thought that teachers could cultivate students' ability to solve mathematical modeling by teaching the specific thinking methods [11].

Zhang Lili thought that in the process of modeling, a lot of

knowledge was needed. Therefore, students should cultivate self-learning ability [4, 5].

Zhao Jianxin thought that teachers should cultivate students' self-evaluation ability in teaching. On the one hand, teachers should pay attention to guidance and cultivate the students' habit of self-evaluation, on the other hand, teachers should strengthen the teaching of mathematical thinking and cognitive strategies [11].

Li Juncheng thought that the mathematical model was not produced in the air. It required students to promote and transform the existing models, so as to build new models. Therefore, students had to master some common models [25].

3.5. Strengthening the Popularity of Mathematical Modeling

3.5.1. Publicity of Mathematical Modeling

Huang Xianyong and others thought that schools should increase publicity efforts, create a relaxed and equal learning atmosphere, organize more modeling activities, and popularize knowledge of mathematical modeling [2]. Zhang Jianfeng and others thought that universities should offer general knowledge courses in mathematical modeling [22]. Lilu and others thought that schools should hold a series of lectures on mathematical modeling and publicize the basic idea of modeling [20].

3.5.2. University Students' Mathematical Modeling Competition

Wu Dongqing and others thought that the university student modeling competition was very beneficial to the cultivation of students' innovative spirit, application ability and cooperation ability. Schools should encourage students to participate in competition in many forms [1, 18, 21]. Zhang Lili thought that the mathematical modeling competition could cultivate the ability of analysis, ratiocination, proof and calculation [5]. Jia Xiuli thought that the mathematical modeling competition could rapidly improve students' ability to solve mathematical models [9]. Zhu Jianqing thought that the national university student mathematical modeling competition could make students face practical problems, use mathematics and computer to analyze and solve them. It cultivated students' creative consciousness and ability to study independently. It also cultivated students' ability to consult literature, write papers and other aspects [15]. Wu Dongqing and others thought that schools should organize mathematical modeling competitions, encourage and guide students to participate actively in various ways [1, 2, 19, 20].

3.5.3. University Students' Scientific and Technological Innovation Activities

Zhu Jianqing thought that through the student union, mathematical modeling Association and other organizations, schools could organize outstanding students with certain modeling ability to participate in university students' scientific and technological innovation activities [15]. Chen Rongjun and others thought that the school should regularly organize students to declare and participate in the practical innovation projects [16].

3.5.4. Modeling Learning Platform

Wu Dongqing and others thought that teachers could organize students to form a mathematical modeling Association as a platform for learning and communication [1, 13, 21]. Song Liya thought that schools could build centralized learning platforms, such as learning groups, societies, laboratories, etc. In addition, schools could update modeling learning resources regularly by establishing a network platform [17]. Huang Xianyong thought that universities could set up various modeling ability training topics. In addition, professional teachers in schools should actively guide students to concentrate on learning and participate in modeling practice [2].

4. Evaluation of the Ability of Mathematical Modeling for University Students

Wu Dongqing and others thought that mathematical modeling ability was an abstract concept which could not be directly observed, but could be indirectly observed through some indicators including the process coverage, the scope of the activity of the modeling, and the level of technology. Wu Dongqing and others refined these three dimensions with a number of indicators, and then designed the questionnaire. The total score of each dimension is 100, and then the mathematical modeling ability is quantified by the product of three [1].

Hou Shouping established the evaluation model of university students' modeling ability by using hierarchical clustering method. First, the evaluation index system of mathematical modeling ability was established, which mainly included innovation ability, cooperation ability, basic knowledge mastering, analysis and solving problem ability and computer application ability. By constructing the comparison matrix, the eigenvalues and eigenvectors of the comparison matrix were calculated and the consistency check was carried out. Then, a certain number of students were selected to do a set of test questions, and the five abilities were scored respectively by percentile system. The evaluation was based on a combination of quantitative and qualitative methods, and the data were processed with SPASS software to get clustering results. Finally, the results were analyzed and summarized [26].

5. Conclusion

In the above literature, the current research on the modeling ability of university students includes three aspects: the status of modeling, the way of training, and the way of evaluation. Among them, the way of training is the focus of most scholars. From literature, the present situation of University Students' mathematical modeling ability is not very optimistic. Although universities have gradually paid attention to it, it is not enough and the overall modeling level of the students is not high. As for the ways of training, scholars and experts also put forward strategies from different angles, which mainly focus on four aspects: the penetration of mathematical modeling thought, the construction of the curriculum, the students' necessary thinking and ability, and the strengthening of the popularity. First, the thought of mathematical modeling should be integrated into the classroom and teaching materials. Secondly, teachers should integrate various teaching methods, update the teaching content, reform the way of examination, and set up a modeling course system to improve the students' mathematical modeling ability. Again, teachers should cultivate the necessary thinking and ability of students' mathematical modeling. In the end, the school should provide students with a learning platform, increase the publicity of modeling, organize students to establish a modeling Association and other communication platforms, and encourage students to participate in the modeling competition. In terms of evaluation methods, different evaluation indexes are given for testing.

Through the collation of the literature, it is not difficult to find that the predecessors' research is relatively comprehensive, but the depth of research is far from enough. First of all, from the research method, most of the literature is analyzed in theory, in addition, there is no empirical research and data to prove its views, the implementation effect is not known, and the overall persuasion of the article is poor. Secondly, in terms of research content, literature is mostly about the way to cultivate modeling ability. There is very little literature on modeling process and evaluation methods. Do these aspects also affect students' modeling ability? There are many strategies for cultivating students' modeling ability in the literature, but are these measures effective? Which measures are most effective? What is the effectiveness of each measure? These problems are not known at the moment. Finally, for different majors, there is no difference in the training strategies, and the implementation is low.

Funding

This study was supported by the Shandong Provincial Education Department under grant number SDYY17127 and the Shandong Normal University under grant number 2016JG29.

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