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Research on the Impact of Mathematical Modeling Training Mode on Teaching Mode Reform in China*

Dan Ni
General Education Center
Xiamen Huaxia University
Xiamen, China

***Abstract*—Mathematical modeling has its unique mode in training. The purpose of this paper is to explore the relationship between the training mode of mathematical modeling and other teaching modes, and to point out the possible reference for the reform of teaching mode in China.**

Keywords—mathematical modeling; flipped classroom; traditional mathematical teaching model; modular teaching

I. INTRODUCTION

Mathematical modeling was introduced into some western universities in the 1960s and 1970s. Several universities in China also introduced mathematical modeling into the classroom in the early 1980s. After more than 20 years of development, most undergraduate colleges and many technological colleges have offered various forms of mathematical modeling courses and lectures, which open up an effective way for students to use mathematical methods to analyze and solve practical problems. The increasing scale and influence of mathematical modeling contest promote more reflections on teaching mode reform by educators. The National Mathematical Modeling Competition for College Students in China was founded in 1992 and now has a history of 27 years. In 2018, the teams covered a wide range of regions: 33 provinces/municipalities/districts (including Hong Kong, Macao and Taiwan) and Singapore and Australia. The number of participating institutions, teams and students: 1449 colleges/campuses, 42128 teams (38573 undergraduate teams, 3555 College teams), nearly 120,000 College students, which all created a new record. In addition, the most influential mathematical modeling contest among American college students in the world has attracted the participation of the modeling team of many Chinese universities in recent years. Mathematical modeling teaching and training mode and the competitions provide useful ideas for the reform and research of teaching mode with their natural advantages.

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II. GOOD DEMONSTRATION OF MATHEMATICAL MODELING IN THE REFORM OF EDUCATION SYSTEM

For a long time, academic research has been the main training objective of undergraduate colleges and universities in China, and theoretical learning has been the main goal of study for college students. However, there is an irreconcilable contradiction between the social demand for graduates' skills and technology application and this situation. In 2015, the State Education Commission, the Joint Development and Reform Commission and the Ministry of Finance issued 'the Guiding Opinions on Guiding Some Local Undergraduate Colleges and Universities to Transform to Application-oriented', which is a signal for China to think about the domestic education system and structure. 'Learning for Practice' refers to the level that needs great attention. Taking the reform and exploration of basic mathematics education in colleges and universities as an example, we can see the demonstration role of mathematical modeling.

Taking mathematics education in colleges and universities as an example, mathematics education in Colleges and universities pays significant attention to the cultivation of students' mathematical literacy along with students' ability of thinking and learning. However, in the whole teaching process, the teaching of theoretical knowledge still occupies an absolutely dominant position. Taking a knowledge point in a class as an example, generally speaking, the introduction of concepts, the analysis of geometric background, the introduction of property theorems and the explanation of calculation methods have occupied most of the class time, leaving little time for the application training of knowledge points. For solving practical problems by applying mathematical knowledge, there was few better training modes before the introduction of mathematical modeling course. Mathematical modeling course has built an important bridge for the theoretical study and practical application of mathematics. For example, we can use the knowledge of differential equation to solve the specific problem of alcohol detection for drivers by traffic policemen; for example, we can use the knowledge of linear programming to solve the nutritional problem of three meals. Both teachers and the Ministry of Education have begun to pay attention to this issue. In 2002, the Department of Higher Education of the Ministry of Education approved the project

of "integrating the ideas and methods of mathematical modeling into the research and experiment of the backbone curriculum of mathematics", which is the reflection of the influence of mathematical modeling on the reform of basic mathematics education in colleges and universities.

III. Mathematical Modeling Training Model and Flipped Classroom Teaching Model

Flipping classroom is a popular but controversial teaching mode after the new millennium. Its characteristics are as follows:

- Multimedia, network and other support, with an online platform to facilitate the interaction between students and teachers.
- Teaching assistant videos is one of the important means. Students can watch videos outside the classroom to prepare for self-study in advance, while teachers can give guidance and helpful information and answer students' questions in the process according to the online platform.
- Video is relatively short (thematic, targeted), in order to suit people's usual time limit for attention, usually a single-digit number of minutes which, which is in tune with the fragmented reading, film-watching habits brought by micro-blog, podcasts, friends circles of social networking in the information age.

Mathematical modeling training model embodies many characteristics of the flipped classroom. The most prominent point is that the training process can change the roles of teachers and students to a great extent. Among them, the most direct practice of turning over is the real modeling practice after the topic training (each group completes the paper after class then defend the paper). The specific process is shown below. The instructor assigns mathematical model exercises to the students, and the students are divided into groups to complete the exercises within a time limit (for example, 2 days). Then the instructor will organize the defense after each group submitting the electronic version of the modelling paper within the prescribed time. On the defense day, the role of 'speaking' on the platform will be assumed by students. Students will show their electronic papers in PPT to the instructor and other students, and explain, elaborate the ideas of the papers, present the results, and so on. At the same time, the instructor has changed to the role of 'listening'. In the process of listening, the instructor will ask questions, while the students will answer questions and explain in details. In addition, in the flipped classroom model, students need to spend more time after class than the ordinary classroom for preview, class preparation, and overcome the difficult content. The unsolvable problems can be discussed and communicated with the instructor. So by comparison we can easily get to the conclusion that modeling practices are similar to flipping classes. Students spend a lot of time discussing in the completion of their papers: analysis of the topic, determination of ideas, model hypothesis, model implementation, programming, model evaluation and so on. Because of the short time limit, some groups even need to work all night to complete their papers.

IV. Advantages of Mathematical Modeling Training Model Comparing with Traditional Mathematical Teaching Model

A. Mathematical Modeling Greatly Improves Students' Ability of Mathematical Application

Traditional mathematics teaching lays particular emphasis on training students' mathematical literacy and logical thinking ability, while its role in application training is weak. Although there are practical problems in mathematics textbooks and ordinary classes, such examples or exercises are usually attached to the knowledge points of specific chapters, which are unable to exercise students' comprehensive application ability. As mentioned earlier, mathematical modeling usually needs to go through topic analysis, determine ideas, model assumptions, model establishment, solution, analysis, model testing, promotion, etc. This requires more knowledge and comprehensive application ability than solving a clear homework problem with simple data.

The application of mathematics often needs the help of computers. The completion of mathematical models requires the use of various mathematical and statistical software. Students can master some very useful software tools such as MATLAB and Lingo in the modeling training, so as to improve their application ability genuinely.

B. Mathematical Modeling Improves Students' Team Cooperation Ability

Team cooperation ability is one of the indispensable abilities of students after they graduate. Therefore, it is necessary to carry out pertinent training in the ability and quality education of colleges and universities. One of the common team cooperation training modes is outdoor quality development activities, which are no different from the activities carried out by some companies and enterprises. These activities reflect physical and intellectual training and require collective cooperation to complete tasks or challenges. However, these activities, which have interesting features, are quite different from the practical problems encountered in the work. Another example is ERP business operation sand table training. During the training process students are usually divided into groups. Teamwork is required to accomplish tasks, but students are limited in their major to accomplish the task in a special direction. Mathematical modeling can overcome the above shortcomings. Firstly, the tasks given by mathematical modeling and the whole process of solving problems by students are very similar to the situation that students encounter after they go to work. Therefore, mathematical modeling is helpful to train students' practical ability in team cooperation and to train students' comprehensive ability to analyze and solve problems. Secondly, the students who participate in mathematical modeling come from different majors such as engineering, computer science, financial management can combine and collocate. They can model in

groups of three. In the process of modeling, the training of knowledge and ability complementarity and cooperation among team members is particularly prominent. Thirdly, mathematical modeling will not be limited to a specific field, and the smaller topic might be the optimal design of machinery parts, such as the 2002's National Mathematical Modeling Competition for College Students A Problem "Optimum Design of Linear Light Source for Car Lights", a larger topic might be related to transportation, energy, medical, education and other fields, such as 2008's National Mathematical Modeling Competition for College Students B Problem 'Exploration of Higher Education Tuition Standards', and then the topic can rise to national economic decision-making, regional planning and construction, such as the 10th Central China University in 2017. The topic C of the Invitational Competition of Mathematical Modeling for Students is 'Research on the Impact of the Establishment of Xiong'an New Area on Beijing.

C. Mathematical Modeling Improves Students' Innovative Ability

In traditional mathematics teaching, the answer is usually fixed and unique, whether it is an example or a homework problem. The methods used in solving problems might not be unique sometimes but they still have great limitations. We know that there is no standard answer to mathematical modeling. When different groups complete a modeling problem, the final data results are usually totally different, and the methods used may be totally different. Without the limitation of methods and answers, students can give full play to their innovative thinking.

V. COMPARISON BETWEEN MATHEMATICAL MODELING TEACHING AND TRAINING MODEL AND MODULAR TEACHING MODEL

Mathematical modeling training can also be carried out from the perspective of basic mathematical knowledge module, computer knowledge module and paper writing skills module. Modular training in basic mathematics knowledge training is a very common form. Some knowledge content which does not have logical sequence can be arranged unorderly in the training schedule, such as differential equation module in the first lesson, linear programming module in the second lesson and time series module in the third lesson. By learning these flexible knowledge modules, students can master common modeling methods and tools. This modular training method is necessary for the training of comprehensive ability of mathematical modeling which also provide a model for the teaching of some comprehensive courses. The so-called modular teaching mode in the world mainly originated from the modular skills training (MES), a teaching mode developed by the International Labor Organization in the early 1970s, which focuses on on-site teaching and skills training. The research and practice of modular teaching in China has been exploring since the 1990s. Many universities have launched modular teaching practice in varying degrees, especially in higher vocational colleges. An example is present below. In the Department of Business the financial management major, financial management and practice major and financial insurance major with overlapping courses can take the approach of course sharing, which is 'a little each time but many times'. According to the training plan, the teaching contents of the related majors can be divided into three modules: general education module, professional skills module and quality education module.

VI. CONCLUSION

From the above analysis we can see that mathematical modeling can provide useful experience for the reform of teaching mode because of its advantages. With the increasing scale and influence of domestic and international mathematical modeling competitions, the advantages of mathematical modeling will be more and more valued and explored.

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