The Effect of Teaching a Mathematical Modeling Course based on Student-Centered Approach to cultivate Mathematical Application Ability of Students Majoring in Mathematics in Zhoukou Normal University

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Received: December 13, 2021; Revised: February 9, 2023; Accepted: May 19, 2023

Abstract

The objectives of this research were to: 1) Compare students' Mathematical Application Ability before and after the implementation of mathematical modeling course based on student-centered approach. 2) Assess students' satisfaction about Mathematical modeling course. The sample used in this study was 30 year 2 students in Zhoukou Normal University, Zhoukou City, Henan Province. They were selected by cluster random sampling. The research instruments were: 1) Six lesson plans of mathematical modeling course based on student-centered approach. 2) Mathematical Application Ability test paper. 3) Satisfaction questionnaire. The researcher used the Mathematical Application Ability test paper to conduct pre-test and post-test on the sample. Then the pre-test data and post-test data are analyzed. The content of data analysis includes: score mean, standard deviation, correlation between pre-test data and post test data, t-test of paired dependent sample. The statistics was used for data analysis were the mean, standard deviation, and t-test of a sample.

The results of the study were as follows:

1) The Mathematical Application Ability test paper data analysis about pre-test and post-test showed the mean score of post-test data was 2.87 higher than that of pre-test data. When the confidence level was .05, the correlation between pre-test data and post-test data was 0.75, and the t-test value Sig=0.000<.05 (The mean of pre-test was 11.50, the mean of post-test was 14.37). The above data showed that students' Mathematical Application Ability had been significantly improved.

2) The students' satisfaction was high level. The lowest mean score was 3.83 and the highest was 4.23, higher than 3.51.

Keywords: Mathematical Modeling Course, Student-centered Approach, Mathematical Application Ability, Students' satisfaction

Introduction

On July 29, 2010, the Chinese government released the full text of the Outline of the National Medium and Long-term Plan for Education Reform and Development (2010-2020), which is China's first education plan after entering the 21st century and is a programmatic document guiding the national education reform and development in the coming period. In the program document, the following four points are clearly proposed :(1) China's educational reform and development should be student-centered;(2) China's educational reform and development should reform the teaching quality evaluation, teaching content, methods and means;(3) China's educational reform and development should encourage the innovative spirit of courageous exploration and the practical ability of good at solving problems;(4) China's educational reform and development should focus on improving students' learning ability, practical ability and innovation ability, and educate students to learn knowledge and skills, and learn to use their hands and brains. As an important course for mathematics majors in Chinese universities, the course of mathematical modeling should be student-centered and focus on cultivating students' Mathematical Application Ability in accordance with the requirements of Outline of the National Medium - and Long-term Plan for Education Reform and Development (State Council of PRC, 2010).

In recent decades, with the development of science and technology and the progress of the society, mathematics, the basic science in the field of engineering technology and traditional USES not only play an increasingly important role, and quickly to some of the new field penetration, has formed many cross subject, such as econometrics, population control theory, mathematical biology, geology mathematics, etc. The combination of mathematics and computer technology has produced some important and achievable technologies, which have become an important part of modern high and new technologies, such as big data technology, artificial intelligence, data mining technology, etc. The view that high technology is essentially mathematical technology has been accepted by more and more people. In the process of solving problems encountered in real life with mathematical methods or combining with other disciplines to form a new discipline, the first and key step is to use mathematical language to express the object of study, that is, to establish mathematical models. On this basis, mathematical theory and method can be used to analyze and calculate, and give quantitative results or qualitative quantitative basis for solving practical problems. Computing and modeling are becoming an important way to transform mathematical science and technology. Education, especially higher education, should respond in time and meet the practical needs of social development. For

mathematics education, students should not only master accurate and fast calculation methods and strict logical reasoning, but also cultivate their awareness and ability to analyze and solve practical problems with mathematical tools. Traditional mathematics education system and content focus on cultivating students' computational ability and logical reasoning ability, while mathematical modeling courses focus more on cultivating students' awareness and ability to use mathematical tools to analyze and solve practical problems. Entering the course of mathematical modeling into the university classroom not only conforms to the trend of The Times, but also meets the requirements of China's university education reform. On this basis, it is a beneficial and successful attempt to develop student-centered mathematical modeling course to cultivate college students' Mathematical Application Ability (Jiang Qiyuan, 2010; Xie Jinxing, 2015).

The purpose of setting up mathematical modeling course in the sophomore mathematics major is to improve students' Mathematical Application Ability. In the teaching of mathematical modeling course in Zhoukou Normal University, researchers found that the current mathematical modeling course has problems in teaching objective, teaching content, teaching approach, evaluation method, etc. These problems led to the low enthusiasm and initiative of mathematics majors in learning mathematical modeling course, and it was difficult to improve their Mathematical Application Ability. Therefore, the researcher believed that it was necessary to develop a mathematical modeling course based on student-centered approach and implemented it in the teaching process. Through the promotion of Reading information comprehension, Divergent thinking, Logical reasoning, Mathematical translation ability, Model solving ability, Computer application ability, Teamwork ability, students majoring in mathematics could improve their Mathematical Application Ability.

Research objective

This research objective:

1) To compare students’ Mathematical Application Ability before and after the implementation of mathematical modeling course based on student-centered approach.

2) To assess students’ satisfaction on Mathematical modeling course based on student-centered approach

Research hypotheses

The research’s hypotheses of statistical testing are as follows;

1) Mathematical Application Ability after implementing mathematical modeling course based on student-centered approach is higher than before.

2) Students’ satisfaction is a high level after implementing mathematical modeling course based on student-centered approach.

Research Methodology

Population and sample

The population in this study was 300 year 2 students of Mathematics major student in Zhoukou Normal University, Chuanhui District, Zhoukou City, Henan Province, China.

The sample in this study was 30 year 2 students of Mathematics major student in Zhoukou Normal University, Zhoukou City, Henan Province, selected through cluster random sampling method.

Research instruments

Research instruments were the tools for conducting the research to collect data. The research instruments which were used in this study were:

1) Instruments for measuring Mathematical Application Ability

Evaluate mathematical modeling course

The researcher created the evaluation form of lesson plans.

i) Expert group composed of five experts evaluate the evaluation form. Five experts consisted of 2 specialists in curriculum field, 2 specialists in instruction relevant to specific content, and 1 specialist in measurement and evaluation field. The Index of Item Objective Congruence (IOC) of each item of the evaluation form was between 0.60-1.00, higher than 0.5. The result of analyzing the IOC index showed that the evaluation form about lesson plans of mathematical modeling course were appropriate and could be used in the evaluation mathematical modeling course.

ii) Expert group composed of five experts used the evaluation form to evaluate the six lesson plans of the mathematical modeling course. The evaluation form of the lesson plan was established using the 5-point Likert scale method. According to the expert evaluation, the scores of the six lesson plans are all above 3.51. Therefore, the six lesson plans of mathematical modeling course were applicable to the teaching of the year 2 students of mathematics major in Zhoukou Normal University to improve their Mathematical Application Ability.

2) Instruments for collecting data

Instrument for measuring: Test paper of Mathematical Application Ability and satisfaction questionnaire.

(1) Test paper of Mathematical Application Ability

The test paper had a total of 20 items (Single choice), The 20 items tested 7 factors of Mathematical Application Ability, including: Reading information comprehension factor, Divergent thinking factor, Logical reasoning factor, Mathematical translation ability factor, Model solving ability factor, Computer application ability factor, Teamwork ability factor. The Index of Item Objective Congruence (IOC) value of 20 items in the mathematical model course test paper was 0.6 at the lowest and 1 at the highest. The IOC value of each item in the evaluation form of test paper was between

0.60-1.00, the result of analyzing the IOC value showed that all test items were appropriate and could be used in the test. The test paper difficulty (p) was between 0.2-0.8, The test paper discriminability(r) was higher than 0.2 (The discriminability of test paper was 0.71), the reliability of the test paper was computed using the formula of Kuder and Richardson formulas 20 was higher than 0.7 (the reliability of the test was 0.82). This showed that the quality of the test paper was very good.

(2) Satisfaction questionnaire (5-point Likert scale)

Five experts evaluated 20 items of satisfaction questionnaire, and then calculated the formula according to the Index of Item Objective Congruence (IOC). The IOC of each items of the satisfaction questionnaire was between 0.60-1.00. The result of analyzing the IOC index showed that 20 items in satisfaction questionnaire were appropriate and could be used in satisfaction evaluation of mathematical modeling course.

The Cronbach's Alpha method was used to analyze the student satisfaction data, and the Cronbach's Alpha-value was 0.83 (Lee J. Cronbach , 1951) higher than 0.70. This showed that the internal consistency of the student satisfaction questionnaire met the requirements.

Data collection

The procedures of data collection were as follows:

1) The sample was given the pre-test score of the Mathematical Application Ability test paper by using constructed instrument.

2) The sample was taught by using the mathematical modeling course based on student-centered approach.

3) After the sample implemented mathematical modeling course based on student-centered approach, the sample was given the post-test score by using the same instrument which was used in the pre-test.

4) Assess students' satisfaction using satisfaction questionnaire.

Data analysis

In this study, data were analyzed by using the statistical method according to the research objectives.

1) Compare the scores of test paper before and after the teaching of mathematical modeling course based on student-centered approach by using t-test for dependent sample.

2) Analyze the student satisfaction data using Cronbach's Alpha method (Lee J. Cronbach , 1951) and determine the level of student satisfaction.

Research Results

The results were presented according to the research objectives as follows:

1) Result of comparing Mathematical Application Ability of the students before and after receiving mathematical modeling course based on student-centered approach by using t-test for dependent sample.

Table 1 Paired sample test about Mathematical Application Ability

Score	Full score	Mean	N	*SD*	*t*	Sig
Pre-test	20	11.50	30	3.84	5.44	0.000*
Post-test	20	14.37	30	4.29		

* The significance level was .05.

As presented in Table 1, the mean scores of pre-test of students' Mathematical Application Ability was 11.50(*SD*=3.84) and the mean scores of post-test of students' Mathematical Application Ability was 14.37(*SD*=4.29). The result of this Table 1 showed that after implementing the mathematical modeling course based on student-centered approach in the classroom, the post-test scores of students' Mathematical Application Ability was greater than pre-test scores at .05 level of statistical significance(t=5.44,p<.05). The average scores of the study developed increasingly higher than pre-test.

2) Data analysis result of students' satisfaction questionnaire

The researcher used the satisfaction questionnaire to conduct a survey on the year 2 mathematics students of Zhoukou Normal University, and randomly selected 30 students' data for analysis (The same students to pre-test and post-test).

Table 2 Mean score and satisfaction level of student satisfaction about mathematical modeling course Level of student satisfaction:

1) Very high level was between4.51-5.00; 2) High level was between3.51-4.50; 3) Moderate level was between2.51-3.50; 4) Low level was between1.51-2.50; 5) Very low level was between1.51-2.50.

Question number of satisfaction questionnaire		Mean	*SD*	Satisfaction level
Section	Question number			
Part 1: Teaching objectives	1. Satisfaction with whether the teaching objectives of the mathematical modeling course are clear and precise:	3.93	0.81	High level
	2. Satisfaction with the clarity of teaching objectives of mathematical modeling course:	4.13	0.68	High level

Question number of satisfaction questionnaire		Mean	*SD*	Satisfaction level
Section	**Question number**			
	3. Satisfaction of the teaching objectives of mathematical modeling course meet the requirements of improving Mathematical	4.10	0.61	High level
Part 2: Teaching content	4. The satisfaction of whether the teaching content of mathematical model course is easy to understand:	4.00	0.70	High level
	5. Satisfaction with whether the teaching content of mathematical model course is new and can stimulate learning interest:	4.13	0.71	High level
	6. Satisfaction of whether the teaching content of mathematical model course has practical significance:	3.83	0.59	High level
	7. Satisfaction with whether the teaching content of mathematical modeling course can stimulate students' thinking ability:	4.23	0.65	High level
	8. Satisfaction with whether teachers of mathematical modeling course explain the teaching content clearly:	4.03	0.75	High level
Part 3: Instructional strategy	9. Satisfaction with effective communication between teachers and students of mathematical modeling course:	3.97	0.78	High level
	10. Satisfaction with the steps of teaching process design of mathematical modeling course:	4.07	0.71	High level
	11.Satisfaction with the teaching approach(student-centered approach) of mathematical modeling course to improve the classroom atmosphere:	3.93	0.76	High level
	12. Satisfaction with class hour allocation of teaching methods of mathematical modeling course:	4.13	0.66	High level

Question number of satisfaction questionnaire		Mean	*SD*	Satisfaction level
Section	Question number			
	13. Satisfaction with the teaching approach of mathematical model course to improve students' comprehensive Mathematical Application Ability:	4.10	0.76	High level
Part 4: Teaching resources	14.Satisfaction with the combination of teaching resources and media of practical problems:	4.10	0.76	High level
	15. Satisfaction with teaching resources and media to improve Mathematical Application Ability:	4.13	0.78	High level
	16. Every student satisfies with teaching resources and media used in the mathematical modeling course:	4.17	0.74	High level
Part 5: Teaching evaluation	17. Satisfaction with the difficulty of assignment of mathematical modeling course:	4.23	0.66	High level
	18. Satisfaction with the number of assignments for mathematical modeling course:	4.20	0.76	High level
	19. Satisfaction with the effectiveness of the evaluation system(include test paper and course thesis):	4.17	0.73	High level
	20. Evaluation system(include test paper and course thesis) can differentiate student Mathematical Application Ability in learning mathematical modeling course:	4.13	0.76	High level

As presented in Table 2, in the 20 items of satisfaction questionnaire, the lowest mean score was 3.83(*SD*=0.59), and the highest mean score was 4.23(*SD*=0.65). The result of this Table 2 showed that the students' satisfaction of the mathematical modeling course based on student-centered approach was high level.

Based on the results, we could state the following:

It was concluded that, the Mathematical Application Ability of the year 2 students in Zhoukou Normal University who were taught the mathematical modeling course based on student-centered approach was higher than before. The students' satisfaction was high level.

Discussion

The following points based on the research results were discussed:

1) The main teaching objective of mathematical modeling course was to help students improve their ability to solve practical problems. Mathematical modeling course involved a wide range of knowledge and faced a variety of practical problems. The diversity of knowledge content was an advantage of mathematical modeling course, teachers could make full use of its diversity to mobilize students' interest and enthusiasm, and then helped students improve their mathematical modeling ability and innovation ability. (Luo Zhikun, 2020)

2) Mathematical modeling course was a mathematical method was applied to solve practical problems and cross discipline course, it involved mathematics knowledge broad, containing calculus, operations research, probability and statistics and other mathematical disciplines, the solution actual problem of coverage, Such as in economic management, engineering manufacturing, medical biology, economy and finance could be used. In fact, mathematical modeling course permeated every aspect of life. In recent years, with the needs of economic development and technological innovation, more and more economic and management professionals were transforming to compound talents, who needed more solid mathematical skills and were good at solving economic and financial problems by using mathematical modeling course. Therefore, in the teaching process of mathematical modeling course in financial and economic colleges, it was particularly important to deal with the relationship between this course and professional knowledge learning, and to cultivate students' Mathematical Application Ability and innovation consciousness. (Wu Yuan, 2020)

3) Mathematics, as a basic subject, had strong instrumentality and irreplaceable importance for the development of many subjects, especially science and engineering. In today's rapid development of information technology, especially in the case of big data technology on the social radiation more and more profound influence, the role of mathematics was decisive. In order to use mathematics to solve science and technology problems, it was very important to establish a scientific and feasible model, so the mathematical modeling course arose at the historic moment. Mathematical modeling course, first offered in British and American universities, gradually spread to Europe and The United States, and the introduction of mathematical modeling course in China since the 1980s, after decades of development at home and abroad, mathematical modeling course had gradually highlighted the role of students' ability training. Mathematical modeling course was the process of abstracting and simplifying practical problems, determining variables and parameters, establishing mathematical structure between variables and parameters through some rules, and solving practical problems with

mathematical methods. The nature of this course determined that it had high requirements on students' innovation ability, logical thinking, theoretical level and practical ability, which was a challenge and improvement to students' comprehensive quality. (Yang Lei, 2019)

4) With the popularity of intelligent devices, the era of big data had quietly come to everyone's side and penetrated into everyone's daily life. To put it simply, big data was an analysis and processing method that used massive amounts of information to find the undetectable associations among them. The advent of the era of big data, for the education of colleges and universities teaching had brought a lot of opportunities and challenges, accordingly all combined with its own actual situation, colleges and universities by using the characteristics of the era of big data for many subjects of cultivation program, teaching approach, teaching content and so on had made the corresponding modification and adjustment, big data professional had sprung up in various universities. Mathematical Modeling course was the best course that combined computer technology and applied mathematical knowledge to solve practical problems in big data processing in various fields. It played role as a bridge connecting the real world, the data world and the mathematical world. With the development of the times, the importance of mathematical modeling course in various industries was becoming more and more obvious. Therefore, in the era of big data, it was imperative to integrate the thinking of big data into mathematical modeling classroom. (Yu Shuiqing, 2020)

Conclusion

Through data analysis, researcher could draw the following two conclusions:

1) The Mathematical Application Ability test paper data analysis about pre-test and post-test showed the mean score of post-test was 2.87 higher than that of pre-test data. When the confidence level was .05, the correlation between pre-test data and post-test data was 0.75, and the t-test value Sig=0.000<.05(The mean of pre-test was 11.50, the mean of post-test was 14.37). The above data showed that students' Mathematical Application Ability had been significantly improved.

2) The students' satisfaction was high level. The lowest mean score was 3.83 and the highest mean score was 4.23, higher than 3.51.

Recommendations

The following are some recommendations based on the research results:

1) The teacher-centered teaching approach had a profound impact on the mathematical modeling course. Many teachers still used the teacher-centered approach when teaching mathematical modeling course. Therefore, the education management department should strengthen the training of teachers of mathematical modeling course in colleges and universities, so that more mathematical modeling course teachers could use the student-centered approach when teaching mathematical modeling course.

2) With the arrival of the information age, students could more easily obtain knowledge and information through the network. Teachers of mathematical modeling course should guide students to use network means, such as digital library, open paper database (such as spring database, China National Knowledge Infrastructure paper database, etc.), so that students could obtain the latest teaching content.

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