Research on Teaching Reform Strategy of Engineering Mathematics Based on Information Technology

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Abstract. According to the development needs of future education and based on modern information technology, this paper analyzes the new requirements of new talent training for engineering mathematics teaching, puts forward the reform idea of engineering mathematics teaching based on OBE concept, sets scientific teaching and ideological and political goals of engineering mathematics, and builds a three-dimensional integrated engineering mathematics teaching link. The reform of engineering mathematics teaching is carried out from the aspects of broadening the teaching content, strengthening the mathematics experiment, carrying out the mixed teaching and highlighting the inspection of practical ability. The results showed that the average score of the experimental class increased by 10.44 and the pass rate increased by 19.74% compared with the ordinary class. The reform plan greatly strengthened the students' application consciousness, cultivated their modeling ability and improved their innovative application ability of engineering mathematics.

Keywords: information technology; OBE concept; Mathematical experiments; Innovative application component.

1 Introduction

The future war under the conditions of informationization has distinctive features such as knowledge-intensive, diversified specialties, complex systems and cutting-edge fields. New talents mainly refer to junior command officers who meet the needs of informationized war and have a solid theoretical foundation of modern disciplines, flexible and agile innovative thinking consciousness, and strong command and response ability. Ability to react and make decisions quickly in a complex and changing battlefield environment. [1]

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2 New requirements for engineering mathematics teaching in new-type talent training

The main research object of engineering mathematics is the linear relationship of linear space and the quantitative regularity of random phenomena, which is of great significance for laying students' solid foundation of mathematical knowledge, possessing statistical inference ability, cultivating innovative thinking consciousness and improving scientific and cultural literacy. This course is a basic course in the comprehensive quality training of new talents, especially closely related to "big data analysis" and "artificial intelligence technology". It plays an important role in cultivating students' basic ability and comprehensive quality to deal with "random" problems, which can not be replaced by other mathematics courses, and is an important course for cultivating new talents with innovative application ability.[2]

2.1 A complex knowledge reserve

New talents should not only master the knowledge of disciplines related to emerging space and emerging fields and the knowledge of combat training at the same level, but also understand the knowledge of joint operations, the knowledge of services and arms, and master the military strategy, institutional organization, weapons and equipment, operational methods and disciplines, troop deployment and operational characteristics of potential combat objects.[3]

2.2 A creative way of thinking

New talents should not only have subjective initiative, but also make full use of new technologies in actual combat, innovate combat methods, and make command decisions with forward-looking thinking, complex logical reasoning, and fast response speed.

3 Set scientific engineering mathematics teaching and ideological and political goals

Engineering mathematics is a required course of science and culture for students of higher education for military (police) officers. This course, together with advanced mathematics, forms an important mathematical foundation for students and is the basis for other subsequent relevant courses. The main contents of engineering mathematics are linear algebra, probability theory and mathematical statistics, among which linear algebra mainly studies the linear relationship of linear space. Probability theory studies the regularity of random phenomena from the quantitative level, and mathematical statistics studies the collection, processing and analysis of data, as well as the inference, prediction and decision-making of statistical problems. [4] According to the teaching syllabus of military colleges and universities and the requirements of

college personnel training goals, the selection of engineering mathematics content focuses on the combination of analysis and inference, theory and application, thought and method, experiment and modeling.

The main teaching objectives are as follows: first, to enable students to acquire the basic concepts, basic theories and basic methods of linear algebra, probability theory and mathematical statistics, and master the basic ideas and methods of mathematical modeling with uncertainty theory; The second is to cultivate students' ability of abstract thinking, logical reasoning, data analysis and statistical inference; The third is to form rigorous realistic spirit, innovative thinking consciousness and correct value pursuit; Fourth, it is good at quantitative analysis and handling of military problems in combat training and command practice to form a higher military quality. [5]

In particular, the ideological and political goals are set: through the study of this course, the cultivation of Marxist dialectics and scientific spirit is combined to improve students' ability to correctly understand problems, analyze problems and solve problems. [6] Pay attention to the training of scientific thinking methods and the education of scientific ethics, and cultivate students' sense of responsibility and mission in exploring the unknown and pursuing truth.

4 The construction of three-dimensional integrated engineering mathematics teaching links

Engineering mathematics is a theoretical course, mainly according to the "intensive teaching - guidance - guidance" three-dimensional integrated teaching model, with teachers as the lead, students as the main body, comprehensive use of heuristic, discussion, case and other teaching methods. Among them, "intensive lecture" refers to the teacher's classroom teaching; "Guided training" refers to the organized practice of students under the guidance of teachers; "Tutoring" is the teacher's answer to students' questions during self-study time. [7]

Integrate the requirements of "cultivating morality and educating people for war" into classroom teaching to help students establish a correct world outlook, outlook on life and values. Through the explanation of theoretical knowledge, it helps students understand the generation and evolution of knowledge, and cultivates the scientific method of discovering knowledge and the spirit of daring to explore. [8] Through the application of engineering mathematics knowledge, students are trained to have a sense of innovation and a scientific practice spirit of applying what they have learned. [9]

The main teaching links are theory teaching, exercise teaching, tutoring learning. According to the new talent training requirements, according to the principle of teaching students according to their aptitude, according to the teaching practice, increase mathematical experiments and mathematical modeling and other practical links to improve students' innovative application ability. [10] Through the introduction of basic concepts, basic theories and basic methods, students are trained to correctly understand problems, analyze problems and solve problems.

5 Implement engineering mathematics teaching strategies based on innovative application

With the development of students as the center, teaching reform innovation focuses on optimizing knowledge structure, strengthening practical teaching, improving methods and means, and enriching evaluation methods, so as to stimulate students' learning interest and potential to the maximum extent, and cultivate students' learning initiative and innovative practice ability.

5.1 Broaden the teaching content and increase military case teaching

According to the content needs, the knowledge points into the relevant historical background, famous problems, social hot spots and other practical issues, guide students to discover the process of concept generation, explore the process of theory proposal, derivation theorem proof process. On the basis of elaborating theoretical knowledge, typical cases with inspiring, malleable, contemporary and military characteristics are developed and designed. In the process of analyzing and solving cases, students are trained to establish stochastic mathematical thinking, deeply understand abstract and obscure theoretical knowledge, and stimulate students' interest and initiative in learning.

In addition to the theoretical knowledge of the textbook, the teaching content is broadened and deepened, the systematic and theoretical nature of the course knowledge structure is highlighted, cases and practice teaching are added, and students are guided to strengthen and apply the course content with an application-oriented approach. Through students' exploration and discovery of military application cases, students' mathematical quality in solving problems is improved.

5.2 Strengthen mathematical experiments and infiltrate modeling ideas

In the teaching process, I designed mathematical experiments, integrated mathematical software such as MATLAB and SPSS into classroom teaching, increased the teaching content of statistical analysis, drawing and experimental simulation with the software, and strengthened statistical application and practical teaching to highlight the training of students' statistical thinking.

Closely combined with the National Mathematical Contest in Modeling for College students and the Military Contest in Modeling for the whole Army and other discipline competitions, the teaching process permeates the idea and method of mathematical modeling, guides the students to learn to simplify and abstract the problem into a mathematical problem, models the problem, solves the problem and evaluates and promotes the results, and focuses on cultivating the students' application ability to solve the problem. The integration of mathematical experiments and mathematical modeling can enable students to better understand the background of relevant knowledge and practical significance of the course, and improve students' innovative thinking and innovative ability through modeling practice training.

5.3 Use modern information technology to promote blended teaching

Supplemented by scientific teaching methods, different teaching methods are adopted according to different teaching contents in the course, and multiple mixed teaching methods such as problem teaching, heuristic teaching, case teaching and flip teaching are adopted. With students as the main body and teachers as the leading, students are guided and cultivated to analyze and solve problems step by step.

Modern teaching platforms such as MOOCs and rain classes in Chinese universities are used to arrange the preview outline in advance, design self-study content and conduct after-class testing, give full play to the role of teachers' teaching activities and students' learning activities, let students actively participate in the discussion of problems, and cultivate students' basic ability to deal with "random" problems. Using modern teaching methods, part of the abstract content involved in course teaching is vividly visualized by using images, animations, videos, numerical simulation experiments, etc., which makes theoretical knowledge visible, practical and interesting, and enables students to deepen their cognition and understanding of abstract knowledge more intuitively and profoundly.

5.4 Enrich the assessment methods and highlight the ability to investigate practice

In order to test students' learning effect on the course scientifically and reasonably, the paper, report and other practical assessment are added on the basis of the original closed-book written examination, and the detection of students' practical application ability is highlighted. Practical assessment requires students to conduct mathematical modeling for the knowledge of probability theory and mathematical statistics and applications in real life, natural science, military operations and training, analyze and study them through mathematical software, and write research reports or papers to examine students' ability to solve practical problems with the knowledge of probability theory and mathematical statistics.

Practice assessment can more comprehensively examine students' grasp of basic knowledge and basic theories, especially can test students' innovative application ability to analyze and solve problems with knowledge, and diagnose the degree of achievement of course teaching goals.

6 Teaching reform practice and effect analysis

6.1 Experimental objects of teaching reform

In this study, sophomore undergraduates in the fall semester of 2021 were selected as experimental subjects. Among them, Class 1 of the new combat talent teaching class of 2020 is set as an experimental class, and the results-oriented teaching mode reform is implemented. The teaching class 2 is set as the control class and the traditional teaching mode is implemented. The students of the two classes were selected according to the comprehensive evaluation of the grades of the first grade cultural courses

and military sports, and their learning conditions were basically the same, which met the experimental conditions.

6.2 Analysis of achievement objectives and capability index points

In order to integrate the result goal into the teaching process in the form of teaching content more intuitively and guide the teaching implementation, this research divides the course result goal into knowledge goal, ability goal and quality goal according to the talent training goal, teaching syllabus and teaching plan, and subdivides the ability index points. According to the core knowledge points that need to be mastered, the mathematical experiments and application cases are designed, and the learning activities of modeling projects are determined. The teaching content is introduced through cases to help students master the ideas and methods of probability theory and mathematical statistics, and learn to conduct mathematical experiments, modeling and solving of probability and statistics problems.

6.3 Teaching implementation mode

Teaching reform always focuses on students' learning results to carry out teaching activities, and is committed to training students' innovative ability to solve practical problems. Through results orientation, problem guidance, group discussion, evaluation and summary, the teacher provides knowledge support to the students, explains the knowledge and methods involved in the project cases, and guides the students to consider the technical implementation problems in the experiment and modeling. In the process of inquiry, the students conducted independent inquiry by consulting literature and discussing with each other. The introduction of variables, determination of function relation, applicability of model, computational complexity and realization method of each part are discussed. Let the students master the main methods of experiment and modeling, not only effectively cultivate the students' application ability, but also improve the students' comprehensive analysis ability.

6.4 Analysis of learning effect

In the final test, the content of the test focuses on the understanding of basic knowledge, basic concepts and knowledge application ability. The test paper has high reliability, validity and differentiation, and adopts online centralized marking. The usual scores, mid-term scores and final assessment scores accounted for 10%, 20% and 70% of the total scores respectively. The result distribution of experimental class and control class is shown in Table I.

Table 1. Results distribution table of experimental class and control class

Category	Experimental class			Comparison class		
Grade	***Average score***	***Standard deviation***	***Pass rate***	***Average score***	***Standard deviation***	***Pass rate***
Mid-term examination	74.54	10.93	87.5%	65.66	12.01	72.95%
Final examination	81.22	8.37	100%	76.10	10.82	92.69%

As can be seen from Table I, the results of the experimental class are more concentrated, while the results of the control class are more dispersed. The median, 25% quantile and 75% quantile of experimental class were higher than those of control class.

F-test was used to test the final scores of the experimental class and the control class, and the results were shown in Table II.

Table 2. Hypothesis test of final grades of experimental class and control class

Null hypothesis	F Test statistics	Significance level	Significance value	Make a decision
Equality of variance	1.67150	0.05000	0.00073	Significant difference

As can be seen from Table II, there are significant differences in the final scores between the experimental class and the control class.

According to the final grades, the results histogram and normal probability chart of experimental class and control class were respectively made, as shown in FIG. 1,2,3 and 4.

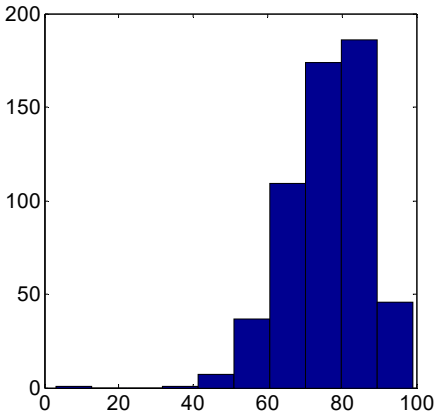

Fig. 1. Normal probability graph of final grade of compare class

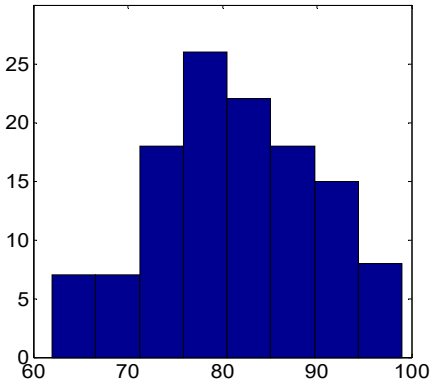

Fig. 2. Histogram of final grades of experimental class

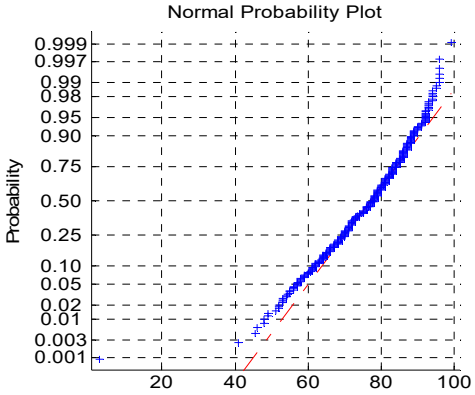

Fig. 3. Normal probability graph of final grade of compare class

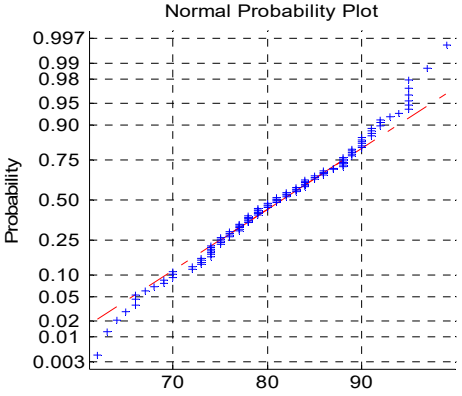

Fig. 4. Normal probability graph of final grade of experimental class

Through the normal hypothesis test, it can be seen from FIG. 1,2,3 and 4 that the results of the experimental class conform to the normal distribution, while the results of the control class are significantly skewed.

From the whole score distribution, the experimental class is obviously higher than the control class, and the individual score difference is small, indicating that the experimental class's innovation consciousness and application ability have been significantly improved, and the teaching reform experiment has achieved good results. The teaching of the experimental class conforms to the law of talent training and achieves the goal of talent training.

7 Conclusion

7.1 Cultivating random thinking consciousness is the basic function of probability and statistics course teaching

The main difference between probability and statistics course and higher mathematics and linear algebra course is that its research object is uncertainty phenomenon, which determines that the main task of the course is to train students to have random thinking consciousness and solve random problems by using random thoughts. In the future post, the new combat talents need to make accurate prediction and decision timely in the face of complex and changeable battlefield environment and combat situation, and must have random thinking consciousness. Therefore, probability statistics course teaching should focus on the training of students' random thinking consciousness.

7.2 Highlighting innovative practical ability is the basic goal of probability and statistics curriculum reform

Result-oriented, we design open situations and experimental cases, guide students to build models in the face of practical problems, use the functional relationship between variables to describe the object relationship of practical problems, design algorithms, and discard the only correct answer. In the process of mathematical modeling of practical problems, the solution of mathematical models can better explain the real world, and the experiment and modeling build a bridge between real problems and mathematical problems. Students improve their application ability to solve practical problems in the process of experimental simulation and model building.

7.3 Improving the quality of teachers is the basic guarantee for the success of probability and statistics course teaching reform

The pilot of new combat talents is an innovation to the traditional personnel training model, and probability statistics is a scientific and cultural course with both foundation and application. From the introduction of teaching concept, teaching planning and design, teaching mode selection, teaching effect evaluation, etc., all rely on a

team of teachers with a solid professional foundation. Only by absorbing modern educational ideas, paying attention to the frontier development of disciplines, and carrying out teaching practice, can teachers effectively support the pilot teaching reform and make due contributions to the training of new combat talents.

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