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## Problem-Based Teaching Design in Engineering Mathematical Analysis Course

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### Abstract

According to the characteristics of engineering mathematics analysis course, this paper discuss the problem-based teaching design of engineering mathematics analysis from the perspectives of problem raising, problem analysis, problem solving and problem feedback during the whole teaching process.

**Keywords:** Problem-based teaching; Mathematical analysis of engineering; Teaching design.

### 1. Challenges in the teaching of engineering mathematical analysis

Problem-based teaching method refers to a teaching method based on the real world, guided by problems, focus on students, integrating autonomy, cooperation and exploration, and facing problem-based learning 4. The Problem based learning (PBL) was first proposed in the 1950s, and its development is generally attributed to the medical educators of McMaster University in Canada in the 1970s 2. According to the characteristics of Higher Mathematics Curriculum, Liu 4 applied the problem-based teaching in classroom in terms of the teaching content and the students' characteristics to improve teaching effects. It was mentioned in the report of the 19th National Congress of the Communist Party of China "If the young generation has ideals, skills and responsibilities, the country will have a future and the nation will have hope". The course of engineering mathematical analysis is an important course for college science and engineering students in the first and second semesters. The class hours are between 140 and 160 class hours. It is an important basic course so it is very necessary to explore the constructive methods of this course. Zheng 5 and others sorted out the ideological elements of engineering mathematical analysis from the aspects of patriotism, indifference to fame and wealth and teamwork, innovation and struggle spirit, academic integrity and scientific rigor.

For different courses, the practical process, problems, methods and possible effects of implementing problem-based teaching method are different. According to the characteristics of engineering mathematics analysis course, this paper discuss the problem-based teaching design of engineering mathematics analysis from the perspectives of problem raising, problem analysis, problem solving and problem feedback during the whole teaching process.

### 2. Main contents

The problem-based teaching process generally requires teachers to prepare questions according to the course characteristics and students' characteristics before teaching, present problems in the teaching process and guide students to analyse problems. In this process, teachers also need to observe what knowledge students have and what knowledge they lack to collect. When necessary, teachers also need to help students design solutions to problems and discuss the advantages and disadvantages of various solutions with students. After class, teachers should reflect on the teaching design.

#### (1) Adequate pre class preparation

Lesson preparation is all the preparations made by teachers for teaching activities. It is the premise and foundation of classroom teaching **Error! Reference source not found..** In the process of lesson preparation, teachers should not only correctly and accurately master the knowledge to be taught such as basic principles and basic concepts, but also actively think about what are the teaching priorities and difficulties. The teaching priorities and difficulties here do not only refer to the curriculum design in the syllabus, but also the thinking methods and reasoning skills that students must master in the teaching process. Teaching difficulties refer to the places where students may have misunderstandings in the teaching process, or the contents and methods that need time to digest and absorb. Through these thoughts, teachers can reorganize the teaching of teaching content, start with questions and stimulate students' interest in discovery. The raising of this question requires

teachers to understand not only the knowledge structure of the course, but also the students' learning situation or their knowledge reserve.

Let's take the learning of certain integral content as an example. Students all know the circle area formula and can use it very well. "Please explain the derivation of the circle area formula?" Teaching experience tells us that students have been in contact with the circle area formula, so they are very familiar with this formula, but when asked about the source of this formula, few students can say it. We began to help students recall the process of understanding this formula, and then let students realize that they actually used the idea of limit in their cognitive process at that time, but they didn't realize it. All image thinking should finally be improved to abstract thinking.

In order to follow the principle of guided by practical application needs, review old knowledge, introduce new content, abstract new concepts, reasoning new methods, meet application needs, summarize and expand, practice and practice after class, we have to do the learning method analysis. According to the cognitive law, encourage students to observe the relationship between phenomena in daily life and mathematics, and encourage students to use mathematical methods to think and solve problems, so as to generate interest and hobby in mathematics. Inspired by interests and hobbies, combined with appropriate learning methods, let students enjoy the process of learning.

**Example 1** "Circumcision - Liu Hui"

"If you cut carefully and lose little, and cut again and again so that you can't cut, you will fit with the circumference without losing anything."

**Example2** Zeno's paradox

Zeno's paradox is caused by the lack of calculus, a mathematical tool, which leads to wrong understanding and can not be handled. What is the sum of infinite infinitesimals? When the time considered in each stage becomes smaller and smaller and becomes a convergent infinite series, it is actually proved that Achilles lags behind the tortoise for a limited time and will surpass the tortoise in a limited time.

**Heuristic teaching method in Teaching**

Choosing a suitable teaching mode according to the characteristics of the course and recording conditions greatly reproduces the teaching style of the teacher and ensures the quality of the teaching. From the perspective of teachers, problem-based learning is a teaching method, while from the perspective of students', it is a learning method 1. We divide the teaching process into three parts, at first the teachers will review old knowledge, they will introduce the new content with explanation of difficult points, question discussion, and sometimes a quiz.

Intersperse problem interactions and explanations of important and difficult content will be helpful for the teacher to understand the students' mastery of the knowledge points in time. At the same time, prepare one or two discussion questions with a certain degree of difficulty and comprehensiveness for each class, and determine the "master" of the discussion questions by drawing lots. After class, fully prepare for classroom explanations and exchanges in the next class. After class, students are required to take the unit test of each unit in addition to completing the homework after the traditional textbook, and their test scores are used as the usual results of the course.

**Example3** "Does the derivative of a derivable even function still have parity?"

**(2) The communication after the class**

The communication between the teachers and students should run through the whole process of teaching. After class, students need to analyse problems and collect data, carry out autonomous learning and group discussion, and continue to try to solve problems. As students are the main body of learning, their learning enthusiasm, initiative and sense of responsibility have been mobilized, the ways of autonomous learning and cooperative learning have been well combined, their thinking ability has been trained, and their ability to collect documents and materials has also been exercised and strengthened. These skills are conducive to students' lifelong learning.

After class homework should adopt the combination of teacher guidance and students' independent exploration, take the needs of solving practical problems as the main line, and insert discussion and communication into the whole problem-solving process. For example, after learning the concepts of the concept of uniform convergence of function term series, let students to analyse the reasons of why should we introduce this concept, the teacher should guide students to understand that the essence of the uniform convergence of function sequence is the premise that the algorithms of finite limit, derivation and integration are extended to infinite times.

The teacher should guide students to start from real life experience, experience and observed phenomena, stimulate students' interest in learning mathematics, make students understand the function and value of mathematical knowledge, form an active learning attitude, make students preliminarily realize the significance of learning mathematical knowledge to solve practical problems, and feel the unity of approximation and accuracy, the unity of motion and stillness The transformation from quantitative change to qualitative change is the ideological essence of dialectics, and cultivate students' thinking quality of rational thinking at the same time.

Considering that students will encounter various difficulties in the learning process, teachers should participate in the process of students' exploring new problems and solving problems, and help them determine learning issues. These key points play an important role in problem solving. Students should record these key points and discuss them. During the whole discussion process, students should be encouraged not only to find out what they know, but also to know what else they don't understand. Teachers' participation in such learning and training can make students realize that learning is a continuous and developing process, and there are always new problems for them (even teachers) to explore. Let students personally experience the meaning of "endless learning", change passive learning into active learning, and truly mobilize students' learning initiative.

### 3. Conclusions

Although the curriculum, teaching materials and learners are intrinsically connected, the in-depth integration between them cannot be achieved without the leading role of teachers. Only when teachers realize the importance of integration to improve the quality of teaching, and are willing to devote themselves to the practice of construction, and actively adapt to the new changes brought about by the new era to teaching and curriculum construction and learning needs. The students are willing to share with you the knowledge, accumulated experience and experience gained in the ocean of mathematics without reservation. The joy of working with you to face the difficulties and confusions in the study of advanced mathematics and reap the joy of progress.

Taking the problem traction as the main line, in the process of exploring the theory and method of problem solving, the method of problem solving is given through discussion, so as to complete the process of problem-based teaching task.

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