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# The Practice and Application of Case Teaching Method in the Teaching Reform of Higher Mathematics Course

**Wei Jiang, Jilin Zhang, Lifeng Guo***

College of Information Engineering, Tarim University, Alar 843300, Xinjiang, China

**Author to whom correspondence should be addressed.*



**Abstract:** This paper explores the practice and application strategies of the case teaching method in the teaching reform of the Advanced Mathematics course. Taking "The limit of sequences to solve the ancient cattle separation problem" as an example, the OLISE teaching design model is adopted for case design. The specific measures for the design of teaching objectives and the organization of teaching activities are introduced. The ideas and plans of the course design can be extended to other university mathematics courses. The blended teaching model of "interaction, participation, and improvement" and case-based teaching can enhance students' interest, strengthen teamwork awareness, enhance two-way communication between teachers and students, and improve students' learning quality and learning effect.

**Keywords:** Case teaching method; Advanced Mathematics; Teaching reform

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## 1. Introduction

Advanced Mathematics is a very important course in the talent cultivation system of application-oriented undergraduate colleges, which can gradually develop students' abstract thinking and logical reasoning abilities, as well as spatial imagination abilities, etc. It is an essential mathematics course for engineering majors. With the rapid development of computer technology, scientific computing, and big data technology, and network science, the theories and ideas of Advanced Mathematics have been applied more deeply and widely in all these fields.

Case teaching is a teaching method that uses typical cases to guide students to think and analyze cases in order to develop and improve their ability to identify and analyze problems. At present, research on the case teaching method mainly focuses on three aspects: case studies that combine teaching content with students' professional background and real life, case studies that combine teaching content with mathematical modeling ideas, and case studies that combine teaching content with mathematical culture [1–3].

## 2. The practice and application of the case teaching method in the teaching reform of the Advanced Mathematics course

The advanced mathematics teaching team, with the goal of "quality education and ability cultivation", integrates the traditional teaching method of "students as the main body and teachers as the leading role" with the blended teaching mode of "interaction, participation and improvement" Educators have carried out research and practice on the reform of the advanced mathematics course in terms of teaching ideology, curriculum design, teaching content, teaching methods, learning guidance and evaluation system. Through persistent exploration and practice over the past few years, some achievements have been made.

### 2.1. Reconfigure the classroom design plan

The case teaching plan mainly consists of five links, including the introduction of teaching cases, process design, interaction design, problem-solving design, and learning summary. The case design is carried out using the OLISE teaching design model. First, three teaching objectives are determined based on the teaching content. Through the introduction of problems, arouse students' desire to solve problems and their curiosity about new knowledge. Introduce new knowledge points, guide students to engage in interactive learning, guide students to connect with real-life examples to deepen their understanding of concepts, use new knowledge to solve the problems introduced in the class, and play the role of summary and improvement. Finally, design questions to evaluate and assess students' mastery of knowledge points and teaching effectiveness [4–6].

### 2.2. The construction of a blended teaching model featuring "interaction, participation, and improvement"

Theoretical teaching is mainly based on course instruction, supplemented by the Chaoxing Learning platform, ensuring that the classroom never goes offline, students can study anytime and anywhere, constantly consolidate what they have learned, and improve their professional skills. Achieve the simultaneous advancement of the three stages of pre-class preview, in-class control, and post-class supervision.

With education on the socialist core value system as the core and moral education as the responsibility, it runs through the entire course teaching process. Entering the classroom, combining current social hot and focal issues, collecting topics of interest to students, imperceptibly integrating ideological and political elements of the course into corresponding knowledge points, helping students establish correct values as college students, develop good professional ethics, and better complete various learning tasks, thereby increasing students' sense of pride and responsibility towards the country and the nation.

With the mathematical modeling laboratory as the base and the mathematical modeling competition as the platform, integrate professional quality education closely with the teaching content of the course. Introduce the idea of mathematical modeling in the teaching process, strengthen the education of students' scientific spirit and craftsmanship spirit, and make the teaching process of higher courses a process of guiding students to learn knowledge, temper their minds, and cultivate their character. At the same time, actively organize and carry out subject competitions such as mathematical modeling, allowing students to exercise their practical skills and scientific spirit in practice [7–9].

## 3. Application of the case teaching method in the teaching of an advanced mathematics lesson example

Taking the section on limits of sequences in Section 2 of Chapter 1 of "Advanced Mathematics" as an example, the OLISE instructional design model is adopted for case design.

### 3.1. Objective

Knowledge objective: To enable students to systematically understand the basic concepts and theories of sequence limits and master the basic methods of advanced mathematics.

Ability objective: To train students' thinking ability in advanced mathematics, to cultivate students' basic awareness and skills of using limits to solve calculus problems, to improve students' professional ability and quality, and to lay a solid ability foundation for subsequent professional courses, other related disciplines, as well as self-study and career development.

Value objective: To enable students to have a deeper theoretical understanding of the relevant content of middle school mathematics, to cultivate students' awareness of lifelong learning and professional development, to guide students to establish a scientific and correct outlook on life, the world and values in combination with the actual content of the course, and to cultivate students' scientific spirit of hard study and the spirit of exploration and innovation [10–12].

### 3.2. Introduction

The issue of cattle division: There was a farmer who raised 19 cattle and wanted to divide them among his three sons before his death. In his will, it was stated: The eldest one gets half, the youngest two quarters, and the youngest three quarters. The cattle cannot be killed or sold for a penny. How should they be divided?

Guide the students to think about whether they can solve this problem with the knowledge they have learned in high school and junior high school. (Cannot solve it)

The three sons did not know how to divide the cows. A clever neighbor lent them one cow. The three of them were divided into half, a quarter, and a fifth of 20 cows respectively, that is, the eldest had 10 cows, the second had 5 cows, the third had 4 cows, and the remaining one was returned to the neighbor. This solved the problem skillfully. The sequence can be regarded as a rounding function. Advanced mathematics is a course that uses limits as a tool to study functions, and the idea of limits is very important and can solve the problem of dividing the cow well.

### 3.3. Interactive teaching and learning

#### 3.3.1. Examples

The limit describes the changing trend of a variable during a certain change process. It is a mathematical method from approximation to precision.

Example 1: The method by which the ancient Chinese scientist Liu Hui used a regular polygon inscribed inside a circle to calculate the area of a circle — the method of circle division — is an application of the limit idea in geometry.

Example 2. In Zhuangzi, a philosopher of the Warring States period, there is a saying: "A rod of one chi, if cut in half each day, will never be exhausted throughout eternity."

Due to historical constraints, these practical problems were not abstracted into the concept of limits at that time, but the idea was discovered a thousand years earlier than in Europe. Both Zhuangzi and Liu Hui had

an important limit idea of "approximating the unknown with the known and approximating the exact with the approximate" in their minds [13–15].

### 3.3.2. Limits of sequences

Explain the definition of a sequence and the limit of a sequence, and guide the students to observe the trend of the sequence in the example and judge its convergence or divergence.

### 3.3.3. Application of sequence limits

Question 1: Where in life have you ever seen a limit problem? What's the difference between limit problems in daily life and the concept of limit in advanced mathematics?

Let's start with the Dragon TV program "Challenger" to give everyone an intuitive understanding of the difference between the idea of limits and the concept of limits encountered in daily life. The idea of limits in ancient Chinese poetry culture: Li Bai mentioned in "Seeing Meng Haoran off at Guangling from Yellow Crane Tower" that "the solitary sail's shadow fades away in the blue sky, only the Yangtze River flows on the horizon", the contrast between the infinitesimal poetic conception and the infinitesimal friendship of the author.

Question 2: Why did China implement the family planning policy in the 1980s?

Build a mathematical model of population growth and solve it using the important limit formula. If the average annual growth rate of the population in our country is 2.5%, the population will double in 28 years, which theoretically demonstrates the importance and necessity of family planning in the country in the 1980s.

## 3.4. Summary

Back to the problem of dividing cows, can the limit of a sequence be used to solve this problem?

For the first time, 19 cows were given to three sons, each of whom received one cow, leaving one cow; $\frac{19}{2}$、$\frac{19}{4}$ $\frac{19}{5}$ $\frac{19}{20}$The second time, the first ox was given to the three sons, each of whom received the first ox, leaving the first ox; $\frac{19}{20}$ $\frac{19}{20}\cdot\frac{1}{2}$、$\frac{19}{20}\cdot\frac{1}{4}$、$\frac{19}{20}\cdot\frac{1}{5}$ $\frac{19}{20^2}$And so on, since there will always be cattle left each time (one twentieth of what was left from the previous time), the process of dividing the cattle can go on indefinitely (but the number of remaining cattle is a convergent geometric sequence with zero as the limit).

Because at that time, $0<|q|<1$ $\lim_{n\to\infty} a(1+q+q^2+\cdots q^n)=\lim_{n\to\infty}\frac{a(1-q^n)}{1-q}=\frac{a}{1-q}$

So the number of cattle that the three sons were given could be calculated as follows:

$$\lim_{n\to\infty}\frac{19}{2}(1+\frac{1}{20}+\frac{1}{20^2}+\cdots+\frac{1}{20^n})=\frac{19}{2}\frac{1}{1-\frac{1}{20}}=10$$

$$\lim_{n\to\infty}\frac{19}{4}(1+\frac{1}{20}+\frac{1}{20^2}+\cdots+\frac{1}{20^n})=\frac{19}{4}\frac{1}{1-\frac{1}{20}}=5$$

$$\lim_{n\to\infty}\frac{19}{5}(1+\frac{1}{20}+\frac{1}{20^2}+\cdots+\frac{1}{20^n})=\frac{19}{5}\frac{1}{1-\frac{1}{20}}=4$$

That is, the eldest has 10 cattle, the second has 5 cattle, and the third has 4 cattle.

The idea of limits is very important. It is precisely because of the idea of limits that advanced mathematics

can solve many problems that elementary mathematics cannot.

The idea of limits runs through the entire course of advanced mathematics. It can be said that all the important concepts in advanced mathematics are inseparable from limits. Therefore, the theory of functions and the idea of limits are presented first, and then the concept of continuous functions, derivatives, definite integrals, partial derivatives of multivariate functions, double integrals, line integrals, surface integrals, and the convergence and divergence of series are presented by the idea of limits. And then solve problems that elementary mathematics cannot solve, such as the instantaneous velocity of a moving object, the area of a trapezoid with curved sides, and the mass of a cylindrical body with curved tops.

### 3.5. Assessment and evaluation

Guide students to define the limits of a sequence, $\varepsilon$–$N$. Some sequences are given, and students can judge the convergence or divergence of a sequence based on its trend.

## 4. Summary

Compared with traditional teaching methods, the case teaching method can stimulate students' enthusiasm and participation in class to a greater extent, guide students to think independently, enhance two-way communication between teachers and students, deepen students' mastery of knowledge points while focusing on the cultivation of students' learning ability, better meet the teaching requirements of the course, and improve students' learning quality and learning effect.

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