

# Research on the Reform of Advanced Mathematics Teaching based on Mathematical Modeling Thinking

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**Abstract.** This paper briefly expounds the necessity of integrating mathematical modeling into the teaching of higher mathematics, and gives several mathematical modeling teaching cases that can be integrated into advanced mathematics courses, so that everyone can understand the combination of mathematical modeling ideas and advanced mathematics teaching. Implementation.

**Keywords:** Advanced mathematics; Mathematical modeling; Curriculum reform.

## 1. Introduction

With the advancement of science and technology and production activities, mathematics has penetrated into various fields of the natural sciences and social sciences, making many qualitative problems gradually quantified and refined, making the solution of many practical problems more scientific and reasonable. As an important basic course of colleges and universities, higher mathematics plays an important role in cultivating students' mathematics quality and innovation ability. However, in the current higher mathematics education, it is still widely used to teach students simple mathematics knowledge. From definitions, axioms to theorems and inferences, a series of seemingly seamless systems, rich mathematical knowledge, abstract mathematical concepts, and rigorous Derivation and accurate calculations have left many students tired, and many students have lost confidence in learning. When I wait for the senior class to study professional courses, I encounter relevant mathematics knowledge, but I can't contact them. I can't talk about integration and use relevant mathematics knowledge to solve practical problems. Academician Li Daqian pointed out: "The past mathematics teaching exposed the fundamental flaws, the pursuit of the system is too seamless, the pursuit of the perfection of theory and the rigor of logic, forgetting where mathematics comes from and where to go to this big problem, put mathematics Constructed into a self-enclosed, thus deadly kingdom. As a result, many students are led by a lot of concepts and formulas, knowing it but not knowing why, not only did not get the influence of mathematics culture, but in the maze of mathematics Losing the direction of progress and cultivating innovative ability will inevitably become an empty talk." In order to achieve the goal of mathematics teaching and cultivate students' mathematical quality and innovative ability, we are also constantly trying to introduce the ideas and methods of mathematical modeling into the teaching of higher mathematics.

## 2. The Necessity of Integrating Advanced Mathematics into Mathematical Modeling Thinking

The teaching of higher mathematics gives most students the impression that they are seeking limits, derivation, and integration. In addition to understanding the definition theorem, it is based on mathematical formulas to solve the math problems in books, which is almost useless in real life, thus producing mathematics. The idea of uselessness. Such teaching cannot only achieve the expected teaching effect, but also cannot stimulate students' interest in learning and desire for knowledge. Mathematical modeling courses are quite different from traditional mathematics courses. It makes up for the insufficiency of traditional mathematics courses to transfer knowledge and light training ability, and cultivates students' ability of observation, imagination, logical thinking, divergent thinking, analysis and problem solving. Therefore, changing the traditional higher mathematics teaching mode and integrating mathematics modeling into higher mathematics teaching can greatly promote higher mathematics teaching.

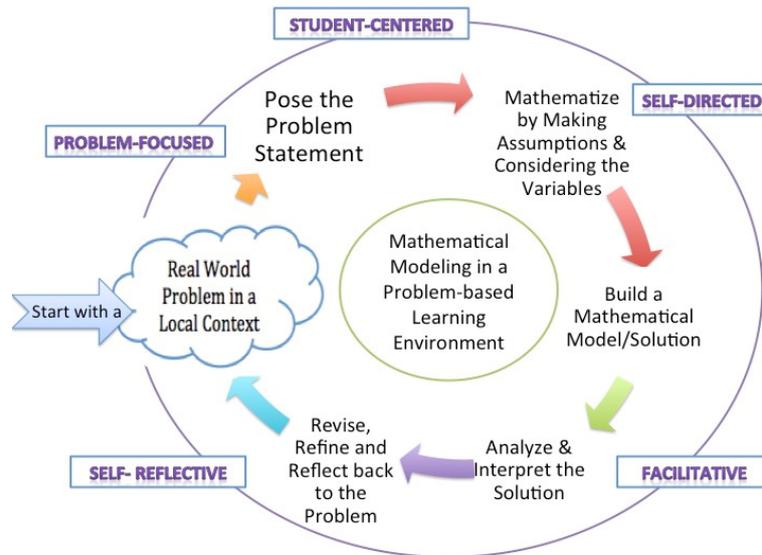


Fig.1 Mathematical modeling thinking

### 3. Research on the Ways of Higher Mathematical Modeling

#### 3.1 Mathematical Modeling Ideas into the Teaching of Mathematical Concepts

In the teaching of advanced mathematics, many concepts have their actual background. Therefore, abstracting mathematical concepts from practical problems in concept teaching is conducive to students' deep understanding of their concepts and enhance students' interest in learning, thus improving the ability to apply mathematical knowledge. For example, before explaining the derivative definition, two examples are given, one is the speed of the shifting linear motion, and the other is the tangent slope of the curve. Through the analysis of the example, the model for the instantaneous velocity of the particle at moment  $t_0$  is  $v(t_0) = \lim_{\Delta t \rightarrow 0} \frac{\Delta s}{\Delta t} = \lim_{\Delta t \rightarrow 0} \frac{s(t_0 + \Delta t) - s(t_0)}{\Delta t}$ , and the

tangent slope at  $x_0$  is  $k = \lim_{\Delta x \rightarrow 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \rightarrow 0} \frac{f(x_0 + \Delta x) - f(x_0)}{\Delta x}$ .

It is easier to solve the simple function model. For complex functions, the calculation limit is difficult to find [1]. So in order to solve this kind of model, we open the actual background and grasp the commonality of the two models, that is, the ratio of the increment of the function increment to the increment of the independent variable takes the limit, and the limit that leads to this form is defined as the derivative. Based on this, the practical problem of the rate of change can be solved, which is the basis for establishing a mathematical model using differential equations. Here, we can also add a story about Fermat's designing the lens curve at one point in 1629. The vivid examples allow students to understand the modeling process of the predecessors in creating new theories, and to stimulate students' interest in learning. In the study of optics, the design of the lens prompted Fermat to explore the tangent of the curve. He found a way to find a tangent in 1629. Newton found inspiration. He said: "I am from Fermat's tangent practice. I got the inspiration from this method, I generalized it, and applied it directly and inversely to the abstract equation." This led to the creation of the calculus method [2].

For another example, in order to introduce the concept of definite integral, the problem of solving the trapezoidal area of the curved edge is thrown. Firstly, guide the students to analyze the problem. If it is a rectangle, the area formula is long and wide, and now one side is a curve. The formula must not be used directly. So consider this: divide the interval into many cells, corresponding to many small curved trapezoids; in each cell, with the direct generation, multiply the length between cells by the function value at any point in the cell is the small curved edge The approximation of the trapezoidal area; approximating the approximate values of the trapezoidal area of all the small curved edges to obtain the approximate value of the trapezoidal area; to obtain the exact value, the

segmentation interval is infinitely refined, so that the inter-cell length tends to zero, and the approximate value is The limit is the area requested. In this way, the model  $A = \lim_{\lambda \rightarrow \infty} \sum_{i=1}^n f(\xi_i) \Delta x_i$  for solving the trapezoidal area of the curved edge is established by four steps of “segmentation, approximation, summation, and taking the limit”. A model  $s = \lim_{\lambda \rightarrow \infty} \sum_{i=1}^n v(\xi_i) \Delta t_i$  of the shifting linear motion displacement can also be established to abstract the concept of the integral. In fact, in all the application problems of definite integral, the analysis of micro-element is the key, and the model of establishing micro-element reflects the idea of definite integral [3].

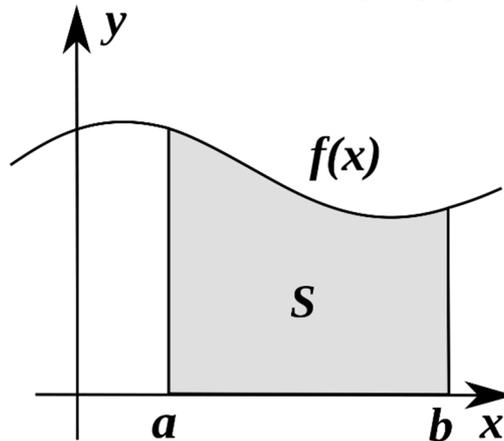


Fig. 2 Solution of the surface trapezoid

When explaining the concept of mathematics, using the actual background to introduce, the essence of it is clear and thorough, which is conducive to students' understanding of the concept, and also teaches students the ability to analyze problems.

### 3.2 Mathematical Modeling Ideas into Case Teaching

The application of mathematical knowledge is one of the teaching goals of mathematics. Many cases in mathematical modeling exemplify the application of knowledge. Therefore, in the actual classroom teaching process, after the theoretical knowledge of each chapter is completed, the teacher can appropriately use the specific case as the teaching content to carry out modeling and demonstration. Through problem analysis, students abstract, simplify, and assume, establish mathematical models, and solve mathematical models to solve practical problems. This will enable students to understand the method steps of mathematical modeling, and enable students to understand the application of mathematics in practical problems, while training and cultivating students' ability to solve problems, and further deepen the understanding and mastery of knowledge.

After explaining the chapter on the derivative, a simple example of “optimal price” in economics can be introduced, that is, a factory seeks to maximize the profit of the factory under the balance of production and sales [4].

First of all, this problem is analyzed. The so-called production and sales balance mean that the output of the product is equal to the sales volume in the market. Profit is equal to the difference between sales revenue and production expenditure. Secondly, the symbol hypothesis is: the price of each product is  $p$ , the cost is  $q$ , and the sales volume is  $x$  (equal to the output). So, the mathematical model is established: total income  $I = px$ , total expenditure  $C = qx$ . In the market competition, the sales volume depends on the price, that is  $x = f(p)$ , the profit can be expressed as  $U(p) = I(p) - C(p)$ , and the problem is finally converted into the maximum value of  $U(p)$ . This is a one-dimensional function to find the most value problem. From  $\frac{dU}{dp} = 0$ , we can find  $p = p^*$ , that is,

there is  $\left. \frac{dI}{dp} \right|_{p=p^*} = \left. \frac{dC}{dp} \right|_{p=p^*}$ . In quantitative economics,  $\frac{dI}{dp}$  is called marginal income,  $\frac{dC}{dp}$  is called

marginal expenditure, and the upper scale shows that maximum profit is reached when marginal revenue equals marginal expenditure.  $f$  is called the demand function and is the decreasing function of  $p$ . Further,  $p^*$  can be obtained according to its specific form [5].

Another example is the solution of power series. Use a combinatorial math problem to explain an application of power series. This example reflects the analogy modeling thinking and cultivates the problem of problem transformation. There are  $2n$  letters A,  $2n$  letters B and  $2n$  letters C; find the number of different ways to select  $3n$  letters from them.

Use factor  $1+x+x^2+\dots+x^{2n}$  to indicate the choice of a letter: 1 means select 0,  $x$  means select 1,  $x^2$  means select 2, .... Let  $f(x)=(1+x+x^2+\dots+x^{2n})^3$ , obviously the coefficient of  $x^{3n}$  is the number of different combinations of  $3n$  letters (think why?).

Solving the idea Because of  $f(x)=(1+x+x^2+\dots+x^{2n})^3=\left(\frac{1-x^{2n+1}}{1-x}\right)^3\frac{1}{(1-x)^3}$ , we want to expand this function into a power series to find the coefficient of  $x^{3n}$ . This requires expanding  $(1-x^{2n+1})^3$  and expanding  $\frac{1}{(1-x)^3}$  to a power series, which can be multiplied to analyze the coefficients of  $x^{3n}$ . Solve

the calculation after class. In this example, there are two aspects to be aware of. The first is the process of turning a practical problem into a mathematical problem; the second is the application of a power series (the problem of determining the number of combinations).

In the teaching process, according to different teaching contents, select the corresponding mathematical model for case teaching. The selected model is as close as possible to the student's actual life, so that students feel that mathematics comes from life and can withstand the test of practice.

Incorporating mathematical modeling into the process of higher mathematics is not to force the example of mathematical modeling into the content of higher mathematics, to change the original system of higher mathematics, but to further the students through the process of mathematical modeling. Familiar with basic teaching content, cultivate students' innovative spirit and scientific research consciousness, and improve students' ideas and methods of applying mathematics to solve practical problems.

## **4. The Concrete Practice of the Integration of Mathematical Modeling Thoughts in Higher Mathematics Teaching**

### **4.1 Increase the Intensity of Mathematical Modeling Teaching**

In order to improve the students' mathematical modeling ability, it is necessary to strengthen the teaching of mathematical modeling. Because the teaching time of advanced mathematics classroom is limited, and the teaching of mathematical modeling needs to invest a long time and more energy, it is possible to arrange the basic theory and method of mathematical modeling in the high number course, and the modeling teaching Training and extension work extends beyond the classroom, and students can choose the appropriate course based on their hobbies and abilities, by setting up a mathematical modeling elective course or a mathematical modeling training class. Special lectures, academic exchange forums, study groups and other forms of extracurricular teaching can also be carried out to give students more opportunities to participate [6]. The specific ones may include:

Firstly, carry out student modeling activity groups and community building. Led by teachers or research groups, students will be organized to organize mathematical modeling activities groups and mathematical modeling communities to arrange regular teacher guidance. Through the daily activities of the student organization, students have more opportunities to access mathematical modeling. To share and communicate, students are encouraged to read more papers and books related to mathematical modeling, expand their knowledge, and gain knowledge and ability in learning from each other.

Secondly, hold a mathematical modeling competition on campus. The school can hold a mathematical modeling competition on a regular basis, and arrange teachers as judges and instructors so that students can freely form teams. In this way, mathematics modeling activities can be popularized, so that more students have the opportunity to experience the atmosphere of the modeling competition, let them have fun and sense of accomplishment during the competition, and cultivate their interest in mathematical modeling. On the other hand, students who develop and select contestants for higher-level mathematical modeling competitions have the opportunity to gain high-level competitions in students who have strong abilities and have a strong interest in mathematical modeling.

#### **4.2 Promote the Integration of Mathematical Modeling Ideas with Advanced Mathematics Teaching**

In the process of higher mathematics classroom teaching, due to time constraints, it is impossible to carry out mathematical modeling teaching in depth, can infiltrate mathematical modeling ideas, and integrate it with higher mathematics education, which can effectively cultivate students' modeling ideas and improve student construction. Modular ability.

Firstly, the combination of mathematical concepts and practical meanings. Mathematics is a tool used to describe the real world. In the teaching process of higher mathematics, we should pay attention to the practical meaning of mathematical concepts and explain the process of abstracting mathematical concepts from practical problems, so that students can have better concepts and theorems. Understanding, at the same time, can improve students' ability to apply mathematical tools to practical problems. For example, in advanced mathematics, derivatives and integrals are two important concepts, and are widely used in other disciplines such as physics and economics. Therefore, the significance of these two mathematical concepts in practical problems can be highlighted in teaching: derivative correspondence The slope, velocity, acceleration, etc. of the tangent line indicate the rate of change of the dependent variable with respect to the independent variable, so that the student can understand that the derivative can be considered when encountering the actual amount of change in the physical problem. The key to the definite integral is to use a straightforward curve in a small range, and take an approximation to represent the effect of the independent variable accumulating within a certain range. At the same time, the concept of the micro-element can be derived, which is very important in the analysis of practical problems. Important tool.

Secondly, emphasize modeling steps and thinking methods. In the limited time in the classroom, all mathematical modeling skills and models cannot be taught to students. Therefore, in advanced mathematics teaching, the focus can be on the steps and thinking methods for modeling practical problems, so that students can Foundation, first establish basic mathematical modeling related concepts, and then choose appropriate extension training according to their own situation to enhance the effect. In the classroom, teachers can explain the modeling steps and methods through the modeling of specific problems, analyze problems through analysis, simplification, abstraction, hypothesis, and model determination, and guide students to actively think and promote problem solving.

### **5. Conclusion**

Mathematical modeling examples cannot only attract students' interest, but also develop students' ability to apply mathematics. As a mathematics basic course for engineering college students, higher mathematics is closely related to mathematical modeling. This paper briefly discusses the feasibility of integrating mathematical modeling into higher mathematics teaching, enriches the teaching methods and teaching methods of higher mathematics, and optimizes the teaching effect.

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