Exploration and Research on Teaching and Learning Model of “Case-based” in Higher Mathematics

Ye Zhao\(^1\), Qian Xu\(^2\), Ying Han\(^3\)*

\(^{1,3}\)Beijing Institute of Petrochemical Technology, Beijing, China
\(^2\)Beijing Union University, Beijing, China
\(^{1,2}\)yze@bipt.edu.cn, \(^{2,3}\)ying@bipt.edu.cn, \(^{3}\)xuqian098@163.com

*Correspondence Author

Abstract: In this paper, taking the Higher Mathematics B course offered by Beijing Institute of Petrochemical Technology for each major of economics and Management as an example, under the background of student-centered theory, combining with the analysis of mathematics situation of the major of economics and Management, the application and implementation of case-based teaching method are discussed, and the organic integration of higher mathematics courses and students majors is promoted.

Keywords: “Case-based” teaching, Higher mathematics, Professional needs.

1. Introduction

Higher Mathematics, taking function as the research object and taking limit as research tool and method, is an important theoretical basis for learning the knowledge of modern subjects and a powerful tool for solving practical problems. This course can lay the necessary knowledge foundation for the follow-up courses, and also plays an important role in cultivating students’ abstract thinking, logical thinking of mathematical literacy and humanistic quality, and so on.

In the continuous reform and innovation of college mathematics teaching method, various teaching methods such as heuristic, inquiry and case-based method are widely used by teachers. In view of the academic condition of the majors of economics and management in our college, the author applies the case-based teaching method to the practical teaching of higher mathematics, and obtains the better teaching effect.

2. Analysis on Mathematical Situation of Economics and Management Major of Our School

Our school administers the courses set up by each major for the purpose of professional training, and the content of which must be closely related to the professional training. The common basic course of mathematics is the basic knowledge necessary for many follow-up courses, and it is also the necessary subject for students to continue to study for graduate students. Thus it has become a compulsory course for most majors. “The purpose and task of higher mathematics education is to make students get basic training from three aspects: theory, method and ability, so as to lay a foundation for further expanding and deepening mathematics knowledge and learning follow-up courses, and also for students to work in management in the future” (Syllabus of Higher Mathematics B, Beijing Institute of Petrochemical Technology). Therefore, the practical value of the higher mathematics affects the strengthening effect of students’ knowledge application ability.

In addition, mathematics courses, especially higher mathematics, are arranged in the first year of university, students are in a relatively blank state of learning mathematics. This is because, on the one hand, the higher mathematics discipline itself is strong in theory, which has always given a kind of abstract, esoteric feeling, such that some students in the learning of higher mathematics produce a certain feeling of fear. In addition, in the mathematics classroom, the teacher basically takes the explanation of the concept, theorem, and calculation in the textbook as the main, which makes the students in the course of learning higher mathematics, lack the understanding of using higher mathematics to solve the practical problem, and makes the students generally think that mathematics is out of practice, or is far away from themselves, so that many students lose their interest in learning. On the other hand, at present, the students majoring in economics and management in our college generally say that many of them lack interest in mathematics study from the middle school stage, so the foundation is relatively weak, the role of mathematics study is lack of understanding, and the purpose of learning is not clear, which has brought some trouble to learning mathematics.

Therefore, the course “Higher Mathematics B” offered by our school urgently needs teachers to carry out teaching reform and improve teaching methods so as to achieve better teaching results. Case-based teaching provides an effective way to solve this problem. In fact, case-based teaching is a teaching method based on “student-centered teaching concept”. The teacher guides the student to think through the unceasing heuristic problem. And through the peer study method, which can make the student obtain the inspiration, the student’s study interest and the motive can be continuously aroused. In particular, in view of the professional characteristics and problems faced by the students in economics and management, we introduce cases which are closely combined with their majors, so that students can fully realize that the knowledge of mathematics is not a “flare-in-a-vacuum”, but a “learning for use”, and let students achieve the goal of “learning for use”.

3. Theoretical Basis—Case-based Teaching Method
Case-based teaching method originated in the 1920s and advocated by Harvard Business School. The cases used in teaching are from the real situation or event of business management. By this way, case-based teaching method helps to train and develop students to participate actively in classroom discussion. And it is after the 1990s that the domestic education community began to explore the case-based teaching method (refer to Baidu Encyclopedia). Thus, case-based teaching is a problem-driven heuristic and interactive teaching method, which combines theory with practice. According to the cases selected by teachers, teachers can organize students’ pre-class research, classroom discussion and analysis and after-class expansion. By making students experience problems, analyze and solve problems in the set situation, thus students’ interest in active learning can be stimulated. Furthermore, students can gain in knowledge and ability, and improve their ability to use the knowledge to solve practical problems.

In the process of case implementation, the teacher’s task is to create the situation and opportunity of students’ learning, and to encourage students to think about the practical problems by themselves and to put forward the design plan. And students can increase the successful experience, and master the initiative. In this way, students’ learning habits and self-learning patterns are cultivated, and learning efficiency is improved. According to Bandura’s theory of self-efficacy, human behavior is influenced not only by the result of behavior, but also by the ability of self-formation and the expectation of the result of behavior which is formed through human cognition. In other words, the success of the activity can improve the self-efficacy of the individual. So in the higher mathematics curriculum, to create students learning situation and opportunities, increase the success experience of students, consciously put the initiative to college students, can cultivate students’ learning habit and self-learning mode and improve their learning efficiency.

4. The Practice of Case-Based Teaching and Learning

Case-based teaching can improve the matching degree between mathematics knowledge and students’ specialty, and make students better understand and master the theory knowledge, at the same time, practice and use the knowledge to solve the problems in the case. So students’ interest and motivation in mathematics are stimulated. And that provides comprehensive skill support for professional quality promotion.

Case 1. Combined with current issues, in 2020, the U.S. benchmark West Texas Intermediate (WTI) futures trading prices and settlement prices fell historically into the negative region, that is, negative oil prices. Negative oil prices do not mean that crude is of no value per se, but that the cost of transporting or storing crude exceeds the physical value of oil. Draw out inventory function:

\[ q = \frac{Q}{n}, \]  
and the purchase cycle is \( t = \frac{T}{n} \). Assuming that the storage cost per unit time for per item is \( C_1 \), each purchase cost is \( C_2 \), the quantity of each purchase is the same, the purchase interval time is not changed, the consumption of the stored goods is uniform, the average inventory is \( \frac{q}{2} \), so in time \( T \) the total cost \( E \) is:

\[ E = \frac{1}{2} C_1 T q + C_2 \frac{Q}{q}. \]

In the classroom, students can be guided to calculate the average cost of each cycle \( T \), further explore the impact of the size of the cycle \( T \) on the average cost. And then it causes students to think: how much of a cycle \( T \) can minimize the average cost? That sows the seed for the application of derivatives. Finally, students are organized to do after-class research: What are the applications of inventory function? What practical factors should be considered in practical application? And what is the solution?

Case 2. The second important limit is drawn from the problem of maximum compound interest: the merchant borrows money from the owner of the property on the condition that the interest is 1 yuan per loan, i.e. the sum of principal and interest is 2 yuan after one year and the annual interest rate is 100%. Then, 1 yuan loans of the merchant will return 2 yuan to the owner of the property at the end of the year. Half-year interest rate of 50%, if a semi-annual settlement, returns 1.5+1.5×50%=(1.5)^2=2.25 yuan at the end of the year. If a quarterly settlement, returns (1.25)^4=2.44 yuan at the end of the year. More accounts are settled, the more the sum of principal and interest returned at the end of the year. If the accounts are settled \( n \) times a year, the interest rate is \( 1/n \), the deposit is 1 yuan, the sum of principal and interest returned is \((1+1/n)^n\) yuan.

Initiate students thinking: Will the result be infinite? It can be proved that \((1+1/n)^n\) increases with the increase of \( n \), but never exceeds 3. According to the limit existence criterion II, when \( n \) tends to infinity, the limit of \((1+1/n)^n\) exists, and is denoted as:

\[ \lim_{n \to \infty} \left(1+\frac{1}{n}\right)^n = e. \]

The application of professional-related cases in the teaching process, on one hand, can make abstract knowledge easy to understand, on the other hand, can better guide students to participate in it. Organize students to study after class: Is the interest calculation of bank deposits in our country single or compound? How can interest be calculated for the next deposit period if the deposit is renewed at maturity? Through these cases, let students feel mathematics is not so “cold and detached”!

In the case-based teaching mode, the teacher takes the professional demand as the guide, and increases the mathematics knowledge corresponding to the specialty in the classroom. Therefore the cohesion and matching degree of the cultivation of higher mathematics and professional ability can be established. Furthermore, the students can clarify their learning value in the process of higher mathematics learning.
The students’ learning motivation can be stimulated and the students’ sense of participation in the mathematics classroom can be improved. On the other hand, the limitation of classroom time can be transformed into the infinity of extracurricular learning time. In the light of the important mathematics knowledge points, combining with the professional knowledge of every major of economics and management, the teachers can build relevant case sets, and organize the students to discuss in group after class. The students learn to use the abundant network resources, and join the research project group discussion, mathematical modeling group discussion, etc., thus to stimulate students’ interest and motivation in mathematics. The depth and breadth of students’ learning can be improved.

5. Summary

In conclusion, higher mathematics plays an important role in the students’ future development. During the reform of college mathematics teaching, teachers should take the professional demand as the guide, take students as the main body, constantly improve the teaching mode of college mathematics classroom, fit closely the requirements of the training of mathematics skills of different majors, so as to realize the important function of educating people in mathematics teaching.

Acknowledgement

This work is supported by education and teaching reform foundation of Beijing Institute of Petrochemical Technology (NO.: ZDFSGG202107001, NO.: YB202207004).

References


Author Profile

Ying Han She is a professor in Beijing Institute of Petrochemical Technology, China.