

Research on Two-way Driven Teaching Mechanism of Higher Mathematics and Discipline Competition for Economics and Management Majors under OBE Philosophy

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Abstract

OBE is the abbreviation of Outcome-based education, highlighting the results-oriented, student-centered teaching philosophy. Advanced mathematics is composed of three courses : calculus (higher mathematics), linear algebra, probability theory and mathematical statistics. It is a compulsory subject for college students majoring in economics and management. Because of the basic nature of mathematical theory, the process of teaching and students ' learning is often boring. As an extension of practical education for college students, many competitions use the construction and solution of mathematical models. Driven by discipline competition, this paper studies the knowledge module of higher mathematics based on OBE concept, reforms and practices the teaching process of higher mathematics according to APOS theory, and finds out the infiltration and correlation between university mathematics knowledge and discipline competition model. Form the teaching case model, and apply it to the actual teaching to nurture the teaching of higher mathematics, forming a two-way drive and mutual promotion cycle teaching mechanism of subject competition and higher mathematics teaching.

Keywords

OBE; Advanced Mathematics; Academic Competition; APOS Theory; Teaching Mechanism.

1. Introduction

The OBE (Outcomes based Education) education concept based on learning output was proposed by Spady et al. in 1981[1]. The American Spady W.D and the Australian education department summarized OBE as: "Student output drives the operation of the Education system, and goals are more important than processes." In 2004, Mollie Butler and Crosby sorted out the philosophical and medical significance of OBE respectively[3]; In 2009, Janet B Apply OBE to language art classes, and point out that the key to successful implementation is teachers. In 2011, Kennedy concluded that policy, theory and practice work together to guide results[2]. The research on OBE in China began in 2003, but it was not really applied until 2012.

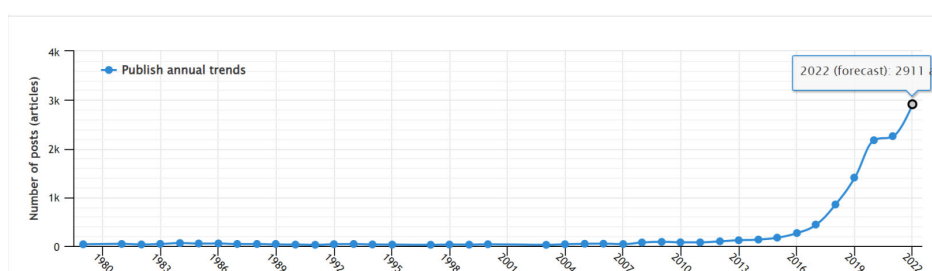


Figure 1. Publication of OBE related papers since 1980

As shown in Figure 1 above, based on the analysis of OBE related literature in recent ten years from the HowNet academic index, it is found that the change in popularity before 2015 was relatively gentle, and academic attention has been greatly improved since 2016. Based on the analysis of the latest 20 OBE related literatures published by CNKI in 2020, it is found that the most cited one is 2014 Gu Peihua's Engineering Education Model Based on "Learning Output" (OBE) - Shantou University's Practice and Exploration [6], which systematically introduces the concept and practice of OBE. The following Figure 2 shows the distribution of disciplines involved in OBE based research practices in China in the past decade.

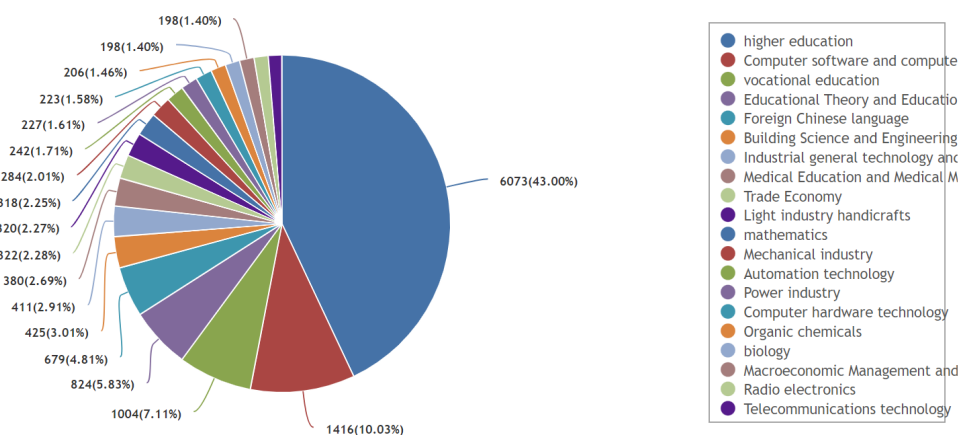


Figure 2. Distribution of related disciplines

In January 2018, the Ministry of Education released the National Standards for the Teaching Quality of Undergraduate Specialty in Ordinary Colleges and Universities, or the "National Standards" for short, which put forward three basic requirements for college talent training, namely, focusing on students, focusing on output orientation, and focusing on continuous improvement. OBE is the abbreviation of outcome based education. It was proposed by Spady and others in 1981 and has become the mainstream concept of education reform in the United States, Britain, Canada and other countries. At present, Chinese universities advocate the consistent use of OBE teaching concept, and attach importance to the teaching reform practice under the OBE concept of "student-centered and results oriented".

2. Research on the Two-way Driving Teaching Mechanism of Higher Mathematics and Subject Competition

Advanced mathematics is a required subject for students majoring in economics and management, which consists of three courses: calculus (advanced mathematics), linear algebra, probability theory and mathematical statistics. It is a required basic course for students majoring in economics and management, finance and engineering, and a required subject for postgraduate entrance examination. Based on the survey and analysis of the teaching situation in many colleges and universities, combined with the comprehensive analysis of the higher mathematics teaching in our school, it is found that college mathematics generally pays attention to theory and calculation, the course content is more abstract, the extension of theory and application is less, and it is boring. In particular, many students of economics, management and liberal arts have weak mathematical foundation, and it is difficult to understand the concept theorem. Many students struggle with "What is the use of mathematics? What is the relationship between college mathematics and production and life?" The problem of. Through the questionnaire, it was found that many students who were afraid of mathematics were full of interest in various subject competitions. According to statistics, the proportion of

participating in mathematical modeling, statistical survey, financial innovation, college students' innovation and entrepreneurship competitions increased year by year. However, most economic and management majors participated in more subject competitions, but the rate of high-level awards was not high, especially those who needed to use mathematical models were at a competitive disadvantage, The students' ability to apply mathematics is poor.

The advanced mathematics in domestic and foreign colleges and universities has been mainly taught by teachers, supplemented by students' listening assignments for many years. Some teachers in some colleges and universities have also tried to reform teaching models such as mixed teaching, flipped classroom, MOOC, etc., which has achieved good results in well-known colleges and universities and science and engineering majors. However, it is difficult to make breakthroughs in the teaching of economics, management, and arts in ordinary two course and three course schools, especially in the liberal arts. In the 1980s, Ed Dubinsky proposed the learning theory of APOS constructivism, which constructs mathematics learning into four stages: action, process, object and scheme. Du's team issued a paper from 1996 to 1997 demonstrating that APOS theory has guiding value in college mathematics teaching[7]. Liana Arnon of Haifa University in Israel, Rina Zazkis of Simonfrancr University in Canada and others conducted practical research on whether APOS theory has applied to postgraduate mathematics education. In the 1990s, Zhang Dienzhou introduced the APOS theory in his Introduction to Mathematics Education; In 2001, Qiao Lianquan of Xiamen University wrote APOS, a Constructivist Teaching Theory, which fully explained its theoretical connotation; In 2009, Bao Jiansheng of China Normal University and others introduced the APOS theory in detail in their papers. In 2013, some scholars demonstrated the effectiveness of APOS in inquiry based mathematics teaching.

2.1. Research route

Follow the requirements of the new National Standard, and take the student centered sustainable theory of output orientation and knowledge learning as the main line; The main research object is the higher mathematics courses and subject competitions of the financial management students of the University, combined with the research on at least 30 schools (divided into private and public) inside and outside the province. At the same time, consult various relevant documents at home and abroad, collect the situation of teachers, students' learning and teaching materials in various colleges and universities, and grasp the characteristics of higher mathematics and subject competitions; Analyze the relationship between the two, find the integration point of higher mathematics theory and subject competition model under the main line of OBE concept, form a teaching plan library, summarize, analyze and sublimate, find problems, summarize laws, and provide a two-way driving teaching mechanism. The main line of thinking is the five core issues of OBE, the secondary line APOS teaching theory reform, and the preparation for evaluation and improvement before, during and after the class.

The teaching mechanism of two-way interaction cycle is formed by taking the interaction of the five core issues of OBE and knowledge points of discipline competitions as the main line and APOS as the secondary line of classroom reform.

- (1). What should students learn and master? (Objective)
- (2) Why do you want to learn these contents? (Demand)
- (3) How to help students achieve learning results? (Process)
- (4) How to effectively know the learning results obtained by students? (Evaluation)
- (5) How to ensure that students can effectively achieve these learning outcomes? (Improvement)

2.2. Assisting Higher Mathematics Teaching Based on APOS Theory

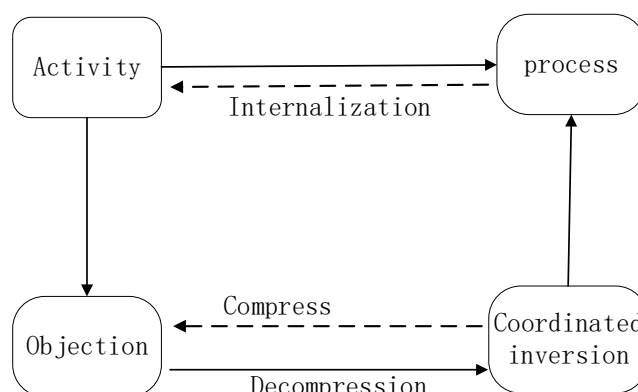


Figure 3. APOS theory learning cycle diagram

(1) Pre class preparation stage of mixed reform: first, the first class of each course will have a group discussion before the first class, plan the main basic content and practical needs of the book, find out the penetration points of knowledge points in the discipline competition, and form a preliminary plan; Secondly, the planning before each chapter defines the goals and needs of "what to learn, what to master, and why to learn". Each chapter at least condenses a theme expansion, links the common methods in discipline competitions, and forms teaching materials; Once again, before each class, we should do a good job of course introduction, and share course introduction materials and thinking questions in advance with the help of learning links, wisdom trees and other teaching platforms;

(2) Reform the traditional teaching design process according to APOS theory, and "how to help students achieve learning results" is clarified.

① Background design of the first stage theory: problem introduction - "action" stage

Five minutes before class, we should summarize and introduce the problems of the teaching platform, teach students to get perceptual experience through experiments like mathematicians, and summarize experience to obtain knowledge. For example, the Derivative Problem can be used as an example for the Olympic sprint champion. When will the maximum speed be reached during the running process? To stimulate students' internal psychological cognitive power, at this stage, teachers can show the relevant contents of derivative to be used for the analysis of optimal profit under multiple influencing factors in mathematical modeling competition and financial innovation competition. In addition, the model guidance is added in the teaching plan to expand students' cognition of knowledge.

② The summary of the content of the second stage: problem exploration - "process" stage

Under the APOS theory, this stage is mainly to internalize the activity stage into a program and abstract the unique properties of the concept. For example, the concept of definite integral is introduced. At this stage, the teacher should guide students to compress the problem solving steps into a program and obtain the operational essence of the concept. At the same time, the students can reverse the specific activity stage, so that when they encounter similar problems again, they can divide the area, approximate substitution, sum, and take the limit. They can also reverse the specific expression, so that the expression corresponds to the activity one by one. This process requires the intellectual participation of students, and teachers should properly inspire and guide students to form a correct understanding. Animation design, case analysis, etc., repeated deduction to deepen students' impression of knowledge

③ Deep analysis of knowledge in the third stage - "object" stage of problem solving

In this stage, the essence abstracted from things is refined into new objects, the content schema of this section is established, and personal experience and knowledge schema are formed. Taking the Concept of Definite Integral as an example, this stage abstracts the definition of the concept, understands the symbols and geometric meanings attached to the definition, connects the limit expressions of the abstract process, makes the knowledge a specific object, and expounds the geometric connotation in combination with the formation process of the definite integral. Through the calculation value, students can understand the symbolic meaning, geometric meaning, physical application and economic meaning of the definite integral. At this stage, teachers can further demonstrate that the establishment of relevant models of irregular three-dimensional volumes in mathematical modeling and statistical design competitions is related to the idea of definite integral, and the financial innovation competition involves the relevant content of limits. The model guidance is added in the teaching plan to illustrate the expandability and applicability of knowledge

④ The fourth stage: the formation of mathematical model -- the "schema" stage of knowledge construction

In this stage, the students can establish contact with the surrounding things and existing knowledge, so that they can gradually apply theory to practice and deepen, and form a clear mathematical conceptual structure. Teachers should guide students to summarize knowledge from symbols, geometric meaning, formation process, etc. For example, from the perspective of symbols, let students understand the meaning of definite integral symbols; From the angle of shape, understand the geometric meaning of definite integral - calculate the area of curved edge figure, and calculate definite integral according to the geometric meaning; In mathematical thought, students know that definite integral contains the idea of substituting straight for curve and limit during the formation of definite integral. Further assimilation conforms to the establishment of a new balance, the formation of a new model, and the construction of students' knowledge system. Teachers should improve the correlation between common knowledge points in subject competitions and the content of this section, and expand to the steps and practices of using knowledge or mathematical software to deal with practical problems.

(3) Evaluation and Improvement Based on Discipline Competition in the Middle and Late Stage of Classroom

① Consolidate the foundation, integrate discipline competition ideas into classroom teaching, and improve students' ability to analyze and solve problems

The subject competitions mainly refer to the National Undergraduate Mathematical Modeling Contest, Zhejiang Statistical Survey Design Contest, Zhejiang Financial Innovation Contest, Investment and Financing Contest, and Undergraduate Innovation and Entrepreneurship Contest. At the same time, it pays attention to the mathematical methods commonly used by the empirical research institute in the graduation thesis of the students of the International Trade and Finance Institute for quality evaluation.

② The project-based teaching method is applied to teaching, and the Internet plus platform is used to enhance students' interest in learning.

Try to change the traditional assessment method by taking the project type question as the key point of the usual assessment; Timely use cloud ink classes to consolidate knowledge such as class roll call and exercises after class, so as to achieve sustainable teaching effect; Integrate hot issues into teaching to improve students' learning interest and learning effect.

③ Establish subject competitions and common knowledge penetration points of higher mathematics to expand the application, and form a database of teaching plan materials.

Through the extraction of knowledge points and the participation of students, the reform effect is improved through empirical research, and the teaching plan material library is built. For example, the principal component analysis method commonly used in data analysis and

modeling can integrate examples and knowledge in the section of "Eigenvalues and Eigenvectors" of Linear Algebra, and the zero point theorem of Calculus can be integrated with the establishment model of "the existence of equilibrium price problem" in economic statistics. In addition to the expansion of the above knowledge points, we preliminarily plan to complete at least $8+7+5=20$ specific case teaching models in higher mathematics according to the main contents used in the chapters and competition modeling. As shown in the following table 1.

Table 1. Optimization and Improvement of Teaching Cases Based on Interpenetration of Discipline Competition and Knowledge Points

Calculus	Expansion of teaching cases		probability statistics	Expansion of teaching cases	
1	Limit and series		1	Classical probability and geometric probability	
2	Zero point theorem intermediate value theorem		2	The distribution of random variables	
3	Derivative and economic application		3	Covariance and correlation coefficient	
4	The development of definite integral thought		4	parameter estimation	
5	Extreme value of partial derivative condition		5	hypothesis test	
6	The pingdaiqu thought of double integral		6	regression analysis	
7	The prediction model of differential equation		7	variance analysis	
8	Power series and Fourier series				
Linear algebra	1	2	3	4	5
Case development	Matrix and primary transformation	Linear correlation and factor analysis	Linear equations and programming models	Matrix eigendecomposition	Two times application

2.3. Implementation effect

The initial implementation scope is 2 large classes, and the number of beneficiaries is expected to be more than 150 students. Through the teaching comparison with other classes, including the examination results and the award-winning situation of the projects, the resource sharing of higher mathematics and discipline competition cases is realized.

(1). Based on the OBE reform, it is conducive to improving the ability of college students to serve economic and social development.

In February 2019, the general office of the CPC Central Committee and the State Council issued the implementation plan for accelerating the modernization of Education (2,018 - 2,022). The fourth article refers to accelerating the construction of "double first-class", comprehensively implementing the construction of first-class base for training top students in basic disciplines, and further improving the quality of talent training and the ability to serve economic and social development in Colleges and universities; Higher mathematics is a basic discipline, and the subject competition is an application expansion. Based on the OBE education concept, the research on the penetration and optimization of higher mathematics teaching and subject competition in economics and management majors is conducive to improving the ability of college students to serve the economy and society;

(2). The driving force of the subject competition is conducive to improving students' interest in learning and ability to participate.

A large part of the awards in various disciplines competitions depend on the application and analysis of mathematical models, and the application of university mathematics to verify the process and conclusion of analysis. Starting from the relationship between university mathematics and discipline competitions, through the mutual penetration of competition models and mathematical knowledge, enumerate application cases, and strive to correct students' boring and abstract cognition of mathematics, optimize the teaching mode, which is conducive to improving students' interest in learning, enhancing students' enthusiasm and ability to participate in the competition, and improving the award rate of the competition.

(3). The topic selection is based on the theory and practice of the reform of the teaching process, resulting in a case base, which feeds back teaching and competition.

Based on the main line of OBE theory, the teaching mode of university mathematics is studied. Through the application expansion and overall extension of chapters, the teaching methods and teaching methods are optimized in the four stages of operation, process, object and concept, which is conducive to making up for some weaknesses of traditional teaching. It aims to improve the mathematical teaching effect of economic and management students, and enhance the students' ability to flexibly use mathematics to solve practical problems, Achieve the effect of two-way driving of teaching and discipline competition.

3. Research Conclusion

Based on the concept of OBE, this paper makes innovative research on the basis of discipline, the connotation of curriculum, and the direction of talent training, such as the processing of mathematical knowledge points, the convergence of curriculum system, and the condensation of knowledge points in discipline competitions; To achieve the teaching mechanism of the main and secondary line compatibility and two-way drive, that is, the 5 core issues of OBE and the interaction of discipline competition knowledge points as the main line, and APOS as the classroom reform secondary line to form a two-way interactive cycle of teaching mechanism. The practice results show that after the reform, the class students' enthusiasm for learning has been greatly improved, the number of competition awards and papers published has increased by 15%, and the social practice ability has also been improved. The sharing of 20 teaching materials and cases can benefit more teachers and students and improve the teaching effect.

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