

Combination of Course Teaching and Practical Teaching in Mathematical Analysis

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Abstract—The mathematical analysis course is a basic course offered by mathematics and applied mathematics in colleges and universities. This paper explores the reform of the traditional teaching model of "Mathematical Analysis". The ideas of mathematical modeling and mathematical experiments are infiltrated into the teaching process, and mathematics software is used to assist teaching. We discuss the reform of mathematics analysis course content, teaching methods, assessment methods and so on. Such a combination of curriculum teaching and practical teaching not only enables students to integrate the knowledge they have learned, but also cultivates the practical, innovative, analytical and problem-solving skills of mathematics.

Keywords: *mathematical analysis, course teaching, practical teaching*

I. INTRODUCTION

Deepening the reform of the education system is an important part of China's science and technology management system reform, and the core content of the education system reform is the curriculum reform [1]. Mathematical analysis is the basic course of mathematics. In teaching, the subject of research is how to correctly deal with the relationship between abstract and abstract, theory and practice. In addition to imparting students' mathematical theory knowledge, the role of mathematics education is to train students to apply the learned mathematics knowledge to solve practical problems, to teach students how to think about problems and how to solve problems.

In 1998, the ministry of education set the majors of mathematics and applied mathematics as undergraduate majors. With the development of the market economy, people often study and solve economic problems in accordance with the laws governing the internal development of the economy. To solve economic problems scientifically, mathematics is the most convincing tool, so some financial and economic institutions have set this major. So far, mathematics and applied mathematics have been well developed in terms of curriculum construction and textbook construction and so on. Some financial and economic colleges have formed their own distinctive professional education concepts. For example, southwestern university of finance and economics has set up a double bachelor's degree in mathematics and economics to train high-quality talent, make a great contribution to the cultivation of high-quality talents in the society.

The purpose of practical teaching is to cultivate students' innovative spirit and practical ability, while mathematics and applied mathematics is a theoretically strong basic specialty. Influenced by some factors, it focuses more on the theoretical teaching based on books and classrooms, ignoring the experimental teaching and practical teaching links of professional courses, so that graduates of mathematics and applied mathematics can not meet the needs of the economy and society in terms of entrepreneurship and practical ability, competitiveness is relatively weak.

Mathematical modeling is an important teaching link in practical teaching. It plays a big role in cultivating students' use of mathematical knowledge to solve practical problems. Mathematical modeling uses the mathematical thinking methods, mathematical language to describe the research object, and computer as an auxiliary tool to solve practical problems. Mathematical experiments and mathematical modeling are closely related. At its core is mathematical modeling and numerical calculations, which use a variety of mathematical software to solve mathematical problems in practice. This requires students to convert the problem to be studied into a mathematical model based on the existing mathematical knowledge, and then use the computer to perform a large number of calculations, and even prove and deduct, to come up with some new conclusions or new findings. This combination of mathematics and computer is inseparable from mathematical experiments [2].

Mathematical analysis is one of the basic courses in mathematics and applied mathematics in colleges and universities. Mathematical analysis course covers four parts in content: limit theory, differential calculus, integral calculus and series theory. It provides the necessary knowledge foundation for the following courses: university physics, differential equation, complex variable function, real variable function and functional analysis. Moreover, the analytical mathematics thought, logical reasoning method and problem-solving skills contained in it are of great significance to the study and research of the whole higher mathematics [3].

Current situation of mathematical analysis course teaching: 1) mathematical analysis is a basic course of mathematics and applied mathematics specialty, with three semesters of study. It involves a wide range of knowledge, abstract and complex content, and has strong theoretical significance. So far, many colleges and universities still use the teaching method of teacher-based teaching in the course of mathematical analysis,

which can not mobilize students' subjective initiative and enthusiasm; 2) mathematical analysis content is difficult and complex, students mechanical memory and use of the concepts and theorems. It is easy to solve the problems that often appear in textbooks or often talked about by teachers. But for new questions or practical problems, we need to think and analyze to solve them, and students can't do it.3) teaching methods are single, mathematics analysis courses teaching, using chalk to teach, copying concept examples and so on will waste time. Because of the large content of the course, the mathematics analysis course in finance and Economics Colleges occupies less time, and teachers teach faster, they do not give students the time to think independently, which affects the teaching effect.

Based on the present teaching situation of mathematical analysis, the mathematics analysis course has important significance in curriculum teaching and practical teaching, which not only improves the quality of teaching, but also cultivates applied talents.

II. STUDYING THE CONTENT, GOALS, PROBLEMS TO BE SOLVED AND MAIN FEATURES OF THE INTEGRATION OF CLASSROOM TEACHING AND PRACTICAL TEACHING IN MATHEMATICAL ANALYSIS

A. Research Content

The research on the training mode of mathematics and applied mathematics professionals is mainly to solve the problem of insufficient application and innovation ability in the training of mathematics professionals, to break through the obstacles between mathematics and finance and economics, and to reflect the mutual integration between mathematics and finance. Mathematical modeling, mathematics competition and college students' innovation and entrepreneurship programs run through the whole process of talent cultivation in this profession [4]. Determining the training plan, reforming the teaching content, and determining the practical teaching links must highlight the teaching philosophy of "mathematics in the discipline of finance and economics, and the discipline of mathematics in the discipline of finance and economics". This topic aims to start from the mathematics and applied mathematics majors, that is, from the "mathematical analysis" course of the compulsory course for financial engineering major in our university. It explores the integration of curriculum teaching and practical teaching, consolidates mathematics knowledge and highlights economic application. Infiltrating the ideas of mathematical modeling and mathematical practice in the teaching process of mathematical analysis, such teaching concepts enable students to understand the purpose of mathematics and how to use mathematical knowledge to solve problems. After a lot of mathematics training, students not only master the mathematics knowledge and methods, but also make the students use the mathematics software skillfully to solve the practical problems.

B. Research Objectives

The traditional mathematical analysis course has a relatively simple teaching method, and the financial and economic colleges have fewer basic mathematics courses,

while the mathematical analysis courses involve more and more complex content. Therefore, in order to complete the teaching tasks, the teaching method of mathematical analysis is teacher-centered. In the classroom teaching, the teacher teaches concepts, theorems, etc., students only need to listen carefully and do the class notes. Throughout the teaching process, students passively accept knowledge, lack initiative and innovation, so it is necessary to reform the traditional "mathematical analysis" teaching mode.

Integrate economic mathematical modeling and mathematical experiments into classroom teaching, integrate knowledge and integrate teaching content. Under the premise of not increasing the total class time, we will use the intensive method to ensure the completion of the teaching content required by the syllabus, and then intersperse a large number of relevant economic mathematical modeling problems, increase a certain amount of experimental teaching links, mobilize the students' enthusiasm for learning, and cultivate student hands-on ability. For the subsequent participation in mathematical modeling, mathematics competition and college students innovation and entrepreneurship plans and other projects lay a solid foundation.

C. Problem to be Solved

1) When the teacher teaches the basic theoretical knowledge of mathematical analysis, they add the content of the corresponding mathematics history. Let students understand the development of this part of the mathematical content. The development of any part of mathematics knowledge is not smooth sailing, it is the result of constant efforts, constant innovation and constant testing by mathematicians. This method can stimulate students' mathematical thinking and improve their mathematical literacy.

2) Add mathematics chapters for practical application in the classroom teaching of mathematical analysis. According to the continuous development of mathematical analysis, this course has practical application value. Therefore, teachers should not only teach theoretical knowledge, but also cultivate students' ability to use mathematical analysis to build mathematical models to solve practical problems, so that the teaching method of combining theory with practice can cultivate mathematical talents in the new era.

3) In the course of mathematical analysis, multimedia courseware is added to the teaching, and some important definitions and theorems in mathematical analysis are demonstrated by using mathematical software. It is helpful for students to understand abstract concepts intuitively and master the theorem in mathematical analysis. In the teaching process, the combination of blackboard and multimedia is used to cultivate students' interest in mathematical analysis.

4) In the teaching of Mathematical Analysis, mathematical theory knowledge and mathematical experiments should be integrated. In the teaching process, how can we combine the theory and practice, and reasonably arrange the hours of mathematics modeling and mathematics experiments? The key to solving this problem is to find the right entry point. According to the different teaching contents, select the typical

mathematical modeling and mathematical experiments to carry out case teaching. In this case teaching, the idea of integrating mathematical modeling and mathematical experiments helps students develop practical ability, innovative ability and insight ability. The following Table I gives typical examples of mathematical modeling and mathematical experiments in some teaching practices. These cases can be taught in classroom teaching, and can also be reflected in the teaching links such as after-school homework and practical classes.

TABLE I. MATHEMATICAL MODEL CASES AND CORRESPONDING MATHEMATICAL EXPERIMENTS IN THE TEACHING OF MATHEMATICAL ANALYSIS

Teaching content	Teaching model case	Mathematical experiment
Basic theorem of differential calculus	Population growth projections, infectious diseases, continued harvesting in the fishing industry, predator-predator problems, phytoplankton-zooplankton problem with harvesting item	Use MATLAB, SPSS and other mathematical software to draw the function image, and find the first-order and high-order derivatives of the function, the maximum value, the minimum value, and the approximate solution of the equation.
Definite integral	Forest fire fighting model, inventory model, reasonable weight loss model, tree cutting model	Using the idea of "dividing, approximating, summing, taking limits" to solve the problem of "non-uniform distribution total"
Series	Tracking motion signal sources	Fourier series experiment
Multivariate Function differential	River water pollution and purification problems	Drawing multivariate functions using mathematical software such as MATLAB and SPSS

5) Design research and practice of curriculum teaching to develop students' modeling ability. The selected topic must have a high degree of integration with the course and be closely related to the reality. When students participate, teachers should give appropriate guidance so that students do not lose their research interests because they have no way to start, but also fully exercise students' ability to access materials, use mathematical knowledge to analyze, solve practical problems, and the ability to write scientific papers.

6) Establishing a teaching assessment system that is compatible with the new teaching system. The assessment system should comprehensively evaluate students' mastery of basic theories and the performance of practical teaching links.

The traditional assessment method is the usual grade + final grade, or the usual grade + mid-term grade + final grade. This traditional assessment method focuses on the final exam results, ignoring the assessment of the students' usual learning process. The assessment method of applied talents should

break this assessment method. In addition to the traditional mid-term and final exams, it should also include classroom discussion, questioning, research, etc., and encourage students to have a spirit of exploration in practice and actual combat[5].

The purpose of the teaching evaluation system of the mathematics analysis course is to improve the students' ability to master knowledge and practical application ability. The practice class (mathematical modeling and mathematics experiment course) can cultivate students' interest in learning, motivate students' enthusiasm for learning, improve students' learning quality and effect, and lay a foundation for cultivating applied talents.

D. Main Features

1) *Promote the reform of teaching methods:* The course of "Mathematical Analysis" is characterized by complex abstraction and logical rigor. In the existing mathematical analysis textbooks, the emphasis is on the rigor of the theory, and the application cases are few and few, making students feel that the mathematics analysis class is boring. This leads to loss of interest in learning. The project is based on problem design curriculum teaching, integrating practical teaching, through case teaching method, expanding the students' quality embodying the application of Mathematical Analysis, consolidating the mathematical foundation and highlighting economic application. Integrate mathematical modeling and mathematical experiment ideas into Mathematical Analysis to guide students to explore new knowledge. Such classroom teaching can not only improve students' interest in learning, deepen their understanding of abstract concepts and theorems, but also develop students' ability to use practical mathematics to solve practical problems.

For the students of financial mathematics in our school, we emphasize the application of learning. Therefore, we add some economic and financial related mathematics knowledge to the classroom teaching. For example, we add the teaching content of "Important Limits in Financial Mathematics" in the limit section. Through practical problems, students are able to master the algorithm of important limits while learning the concept of limitation, and understand the application of important limits in financial mathematics. In another example, we add the teaching content of "derivative (partial derivative) in economic analysis" in the differential function of the unary function and the differential function of the multivariate function, so that students can understand the economic concept and meaning of the derivative (partial derivative), and grasp the economics of differential calculation and analysis[6]. Adding application-type questions in the teaching process can not only improve students' understanding of the importance of mathematics analysis courses, but also cultivate students' ability to analyze and solve problems.

2) *Promote the reform of teaching ideas:* Integrating mathematical modeling and mathematical experiment ideas into the teaching of mathematical analysis, the purpose is to let students understand that mathematical analysis not only has boring abstraction, complex theoretical knowledge, but also has application value. For example, in learning limit theory, it

is difficult for students to understand the definition of " $\varepsilon - N$ " of abstract sequence limit and " $\varepsilon - \delta$ " of function limit. Some students do not really understand the practical significance of limit theory until the end of the semester. Therefore, when learning this part of the content, introduce practical cases, let students experience the mathematical language to the actual process of life.

3) *Using mathematics software to assist teaching:* With the development of the information age, computers can transform mathematics teaching based on calculation, reasoning and argumentation into applied mathematics. It is very necessary to strengthen the organic combination of mathematical software and mathematical analysis teaching content. Teachers can combine rich teaching experience, best teaching strategies and mathematical software. Create a "micro-world" for students, and encourage students to practice and explore on their own, which is difficult to achieve in traditional classrooms [7]. For example, in the learning process of the series limit and function limit, many students can't understand the process of infinite approximation. Even if it can mechanically solve the simple limit calculation and proof problem according to the method of textbook, it can't really understand. Therefore, we can use mathematics software to make students observe the process of dynamically indicating the point of a^n on the numerical axis toward the limit a .

In the process of mathematics teaching, the commonly used mathematical software is MATLAB, LINGO and SPSS. These software are the main auxiliary tools for mathematical modeling competition and mathematical experiment. Among the above several kinds of mathematical software, the most widely used is MATLAB software, which not only has powerful data calculation functions and image processing capabilities, but also has simulation capabilities, which combines theory with practice. When using mathematics software for auxiliary teaching, students should avoid the phenomenon of abusing mathematics software. Not all calculations and image problems are processed by mathematical software. For example, in the "mathematical analysis", the integral calculation, derivative operation, etc. should be solved by the theoretical knowledge they have learned, and cannot rely on mathematical software.

4) *Promote the cultivation of applied talents:* The cultivation of applied talents is the product of social development and the development of higher education. Applied talents not only require a certain theoretical knowledge and application knowledge, but also have strong practical and innovative capabilities. The cultivation of applied talents requires schools to break the traditional teaching methods, change the teaching mode of teaching-oriented and teaching conclusive knowledge, and pay attention to the enthusiasm and innovation of teaching.

In the applied talent training mode, the main methods of cultivating applied talents in classroom teaching and practical teaching. The reform of classroom teaching and practical teaching methods is the key to improving the quality of

teaching. The cultivation of innovative spirit and practical ability is the key to cultivating applied talents. The cultivation of mathematics applied talents in local colleges and universities is inseparable from the teaching of basic professional courses in mathematical analysis [8].

Training applied talents in finance, science, agronomy, etc. needs to combine theoretical and practical problems in the teaching process, adding practical experiment links in the teaching process, and cultivating some basic practical skills that students must master to adapt to the rapid development of the contemporary economy and society.

E. Research Ideas

The goal of cultivating talents in mathematics and applied mathematics in finance and economics colleges should be economic management-oriented applied talents with a solid foundation in mathematics. Professional construction should fully absorb, draw on, and utilize the achievements of economic management majors to form their own professional characteristics. [9]. Mathematical analysis is one of the basic courses of mathematics and applied mathematics. The combination of classroom teaching and practical teaching of mathematical analysis can best reflect the characteristics of finance and economics, and can make rational use of the mature practice modes of economics, management and finance, develop students' ability to analyze and solve problems. For example, teachers of mathematics colleges can collaborate with faculty of economics and management to innovate and jointly train talents. This teaching method emphasizes the nature of finance and economics.

Focus on cultivating students' practical ability. Not only pay attention to traditional practice teaching, but also pay attention to professional practice teaching. Train students to adapt to the basic practical ability of social development, let students learn the ability to write graduation thesis, participate in mathematical experiments and mathematical modeling competitions, and improve students' professional practice ability.

III. RESEARCH PROCESS AND METHOD

A. Change the Course Content

In the course of the course of "Mathematics Analysis", the content should be rectified according to the characteristics of the course, so as to improve the students' practical ability. Consolidate the mathematics foundation, take the actual case as the starting point, derive the basic concepts and theories, give a complete proof, and on this basis, add a certain amount of experimental courses to solve the actual case problems originally proposed.

B. Change the Teaching Method

The content of Mathematical Analysis is more abstract and complex, and students sometimes find it difficult to understand. In response to this phenomenon, we should use mathematical software and modern teaching methods to solve the incomprehensible parts of Mathematical Analysis and

strengthen students' understanding of abstract concepts and complex theorems.

C. *Change the Syllabus*

The development of "Mathematical Analysis" is formed in the development of astronomy, physics, geometry and other research fields [10]. The purpose of the teacher's teaching is to teach students how to apply Mathematical Analysis to practical problems, solve practical problems, and enhance students' self-confidence. In the teaching process of Mathematical Analysis, students are allowed to learn to analyze practical problems, summarize mathematical concepts and theorems related to practical problems, and use the knowledge they have learned to solve problems.

D. *Open a Mathematics Experiment Class*

With the development of social information, solving practical problems is inseparable from computers. The development of mathematical software is conducive to mathematical calculations. The introduction of mathematics experiment classes in mathematics analysis teaching can not only improve the interest in mathematics analysis, but also cultivate students' practical ability. Mathematical experiments are combined with mathematical modeling, using mathematical software to conduct simulation experiments. In the mathematics experiment class, the mathematics analysis content that has been learned is run using mathematical software. In addition, the teacher guides the students to the proficiency of the mathematical modeling process and completes the mathematical modeling competition questions related to the content being studied.

E. *Reasonable Selection of Teaching Materials*

We can refer to the "Mathematical Analysis" books of Shanghai University of Finance and Economics, Central University of Finance and Economics, Southwest University of Finance and Economics and other well-known financial and economic colleges, from which we can choose learning books. In addition, we should also choose the matching review materials with the textbooks, the purpose is to consolidate the content that students have learned and to improve students' ability to apply mathematical analysis to solve problems.

F. *Create Courseware that is Compatible with Mathematical Analysis Materials*

Integrate mathematical analysis into modern computer technology. Applying mathematics software to produce multimedia courseware, and displaying some abstract concepts and theorems in mathematical analysis with PPT, so that students can understand more intuitively and effectively.

- The teaching organization form of large class teaching and small class discussion.

Large class and small class discussion is a combination of traditional large class teaching and small class discussion. Classes in large classes are mainly based on theoretical knowledge, supplemented by mathematical modeling and mathematical experiments; small class discussions are based on discussing practical issues and answering questions for

students. In the actual operation, three to four extracurricular interest group activities are held every semester, which mainly guides some students who have spare energy to carry out research, conduct computer calculations, and write scientific research papers, which is conducive to the cultivation of students' interest in learning.

- The performance of the practice link is reflected in the assessment method.

The practice link is an important teaching link between theory and practice. It can not only train students' ability to analyze and solve problems, but also comprehensively improve students' comprehensive quality, and lay a foundation for students to adapt to social needs and innovation in the future.

In order to successfully complete the practice, it is done in the following steps: grouping 7-8 students into one group. The teacher arranges the content of practical teaching, for example, designing modeling exam questions in the mid-term final exam paper, and arranging several mathematical modeling problems each semester. Students are required to complete three to four assignments in the lab, requiring Matlab or SPSS software to be calculated and finally printed as a small paper. Outside the classroom, students are encouraged to take the initiative to use the library resources to access the materials in the electronic reading room. For each teaching practice, students are required to write their own experiences and conclusions. In the course of practice, if student have any questions, they can ask the teacher for help through email, network and other tools. Arrange students to explain their practical results. According to the student's practice results, the teacher gives reasonable results. Through the above practical teaching, it is possible to effectively cultivate applied talents.

- Invite well-known scholars and professors at home and abroad to hold academic lectures.

Introduce the latest developments and trends in mathematics and applied mathematics, and introduce mathematics in economics such as "game theory and development dynamics", "system optimization, equilibrium and equivalence", etc. Let students understand and grasp the dynamics and hotspots of applied mathematics and the close relationship between economy and mathematics.

G. *Strengthen the Construction of Practical Teaching Platforms*

Strengthen the construction of school laboratories, improve the teaching hardware level of mathematics and applied mathematics in finance and economics colleges, and create a good atmosphere for students to use mathematical analysis to solve practical problems, which is conducive to the cultivation of applied talents. Work with the school management, economics, and finance departments to build a comprehensive laboratory and create a good practical teaching environment. With the development of the information age, in practical teaching such as mathematical modeling and mathematical experiments, teachers can use information technology to carry out professional training for students, laying a solid foundation

for students to participate in the mathematical modeling competition.

IV. EXPECTED RESULTS AND SPECIFIC RESULTS

A. *Expected Results*

With the development of informatization, the traditional teaching methods of Mathematical Analysis can no longer meet the needs of students. The teaching process should demonstrate practicality and applicability. This is the reform direction of Mathematical Analysis. Infiltrating mathematical modeling and mathematical experiment ideas into teaching is an effective way to reflect the application and practicality of course teaching. In the course teaching, according to different teaching contents, select appropriate mathematical models, mathematical experiments for case teaching, and use mathematical software to solve problems. It enables students to stimulate their enthusiasm while supplementing their knowledge.

The school will change the single assessment mode to the comprehensive assessment mode. The students' usual classroom performance, after-class group discussion, writing course papers, on-line operation, etc. will be added to the assessment content, so as to improve students' self-learning, thesis writing ability and expand students' innovative ability. After the school's professional training, students take an active part in the mathematical modeling competition, and can obtain excellent results, which is conducive to the training of applied talents. For the case analysis questions related to mathematical analysis, students can carefully analyze the problems, find out the concepts and theorems related to the problems, and use theoretical knowledge to solve the problems.

B. *Specific Results*

1) *Through learning and training, students have achieved certain results in mathematical modeling, mathematics competition and college students' innovation and entrepreneurship programs.*

2) *Form a complete case analysis system.*

3) *Published 1-2 research papers.*

V. SPECIFIC ARRANGEMENTS AND PROGRESS

The Mathematical Analysis course consists of three semesters with a time span of two years. Therefore, the research time of this subject is set at two years, and the entire teaching stage is covered.

1) *Integrate teaching content, highlight basic theories and practical applications, and design knowledge points for experimental teaching.*

2) *Initially establish a case analysis database and a test question database corresponding to "Mathematical Analysis".*

3) *Organize interest groups: Instruct students to conduct research and study, complete research papers, and develop students' innovative ability, practical ability, and ability to write scientific papers.*

VI. SUMMARY

In order to adapt to the fast-growing economic society, graduates of qualified universities in mathematics and applied mathematics are trained for financial and economic institutions. Mathematical analysis teaching reform (integration of curriculum teaching and practical teaching) is inevitable. In the early days of learning mathematics analysis, students will find the course difficult to understand. Teachers should interact with students to help students overcome difficulties. Improve teaching methods and use mathematics software to assist teaching. For example, use simple and intuitive examples to help students understand abstract concepts, theorems, and so on. Mathematical modeling and mathematics experiment classes are offered to improve students' enthusiasm and participation and stimulate students' interest in learning. For practical application problems, let students start from simple mathematics topics and experience the application value of mathematics. It enables students to realize that mathematics comes from life and is applied to life, improving students' ability to apply mathematical ideas and knowledge to analyze and solve problems, and lay a solid foundation for the follow-up course.

The teaching reform itself is more complicated, and it is related to the current educational concepts and systems, the state of social development, and the teaching and learning conditions of teachers and students. Therefore, the teaching reform of mathematical analysis requires joint efforts of all parties. After years of hard work, many colleges and universities have achieved good results in the practical teaching of mathematical analysis. Because the mathematics analysis course is a complex and long-term project, it requires not only the participation of teachers and students, but also the cooperation and support of leaders and relevant functional departments at all levels of the school.

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