Problem-Driven Teaching Reform of Numerical Analysis Course Under the Background of Big Data

Duan Mei[1] Qiang Liu[2,*]

[1]Faculty of Mathematics and Computer Science, Guangdong Ocean University, Zhanjiang, Guangdong 524088, China

[2]School of Mechanical and Power Engineering, Guangdong Ocean University, Zhanjiang, Guangdong 524088, China

[*]Corresponding author. Email: liuqiang@gdou.edu.cn

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ABSTRACT In view of the problems existing in the teaching of numerical analysis, such as less class hours, more content, emphasis on theory rather than practice, single teaching means and unreasonable assessment methods, this paper proposes to introduce the problem-driven teaching method into the teaching of numerical analysis. Driven by problems, the teaching reform of numerical analysis course is carried out from three aspects: teaching objective, teaching mode and assessment mode .Then the reform is applied in the teaching process of Guangdong Ocean University. The results show that the application of problem-driven teaching method in numerical analysis course can improve the teaching effect.

1. INTRODUCTION

The era of big data has arrived. With the increasing maturity of information technology and the rapid development of the Internet, social media, electronic commerce and network finance, global data scale shows explosive growth. The number of big data companies continues to rise, resulting in a shortage of big data talents. For example, big data analysts are mainly engaged in data mining, using algorithms to solve and analyze problems, revealing the truth of data, and promoting the continuous update of data solutions. For another example, a data scientist needs to have data analysis and processing capabilities and be proficient in various algorithms. Big data technology has become an indispensable strategic high technology. In this context, as one of the basic theories supporting big data analysis, the content of numerical analysis courses is of great importance. It mainly studies numerical calculation methods and theories in the process of solving and analyzing problems by computers. It is a very practical branch of mathematics which is closely combined with computers. In fact, the numerical analysis course is the basic core course of the majors of mathematics and applied mathematics, information and computing science in Chinese universities, and it is also an important degree course for engineering graduate students. It not only has the characteristics of high degree of abstraction and rigorous science of pure mathematics, but also has the characteristics of the extensiveness of application and the high technicality of practical experiments. It is a mathematical course with strong practicality and practicality.

However, the traditional numerical analysis course teaching has problems such as less class time and more content, more emphasis on theory than practice, and single teaching methods and means, which lead to students' low learning interest and weak practical ability, and inability to use it as a tool to solve practical problems. In this regard, scholars have launched extensive teaching research. Song [1] studied the teaching method of incorporating mathematical thinking and mathematical experiments into the teaching of numerical analysis. It mainly introduced numerical cases into the mathematical modeling process, and then describes, reproduces and discusses the numerical case design process based on computer simulation software. It can increase the amount of lecture information in a short time and stimulate students' interest in learning. Bao [2] analyzed the current teaching situation of numerical analysis course, pointed out the problems existing in the current

teaching, and proposed the teaching reform methods from strengthening practice, combining with mathematical modeling in teaching, combining with project in practice and so on. Fang [3] introduced advanced teaching methods based on the common problems in numerical analysis teaching, and gave some suggestions in combination with teaching practice and learning experience of famous teachers. Tan [4] integrated teaching content, adopted heuristic teaching, carried out intuitive teaching, strengthened practical teaching, and reformed assessment methods to improve teaching quality and cultivate students' scientific research and innovation capabilities. The measures mentioned in the above literature can all improve the existing problems to a certain extent, but for the class, students are the center of teaching, and we must give full play to students' subjective initiative and innovative spirit. In recent years, China is implementing a series of educational reform measures in order to obtain a more complete and more in line with the development of The Times of education system.

Taking the numerical analysis course of Guangdong Ocean University as an example, in the context of the shortage of high-end technical talents in big data, this article analyzes the current teaching problems of numerical analysis courses' teaching objectives, curriculum content, teaching methods, and assessment methods and proposes coping strategies: Using problem-driven teaching methods, that is, taking the problems of mathematical modeling contests and current hot problem cases as "problems", improving the ability of numerical calculation practice and computer programming, to cultivate top talents that are in short supply in society.

2. Problem Analysis and Teaching Reform Program

2.1 Problem analysis

Traditional numerical analysis course teaching has problems such as less class time and more content, more emphasis on theory than practice, and single teaching methods and means, which lead to students' low learning interest and weak practical ability, and inability to use it as a tool to solve practical problems. Similar problems exist in the numerical analysis course teaching of Guangdong Ocean University:

(1) There are many course teaching contents and few teaching hours

At present, the total periods of the numerical analysis course in our school are 64 periods, 4 periods per week, including 48 theoretical periods, which are arranged in the first 12 weeks, and 16 experimental periods, which are arranged in the last 4 weeks. Due to the huge teaching content and the extremely complicated derivation of many theories and calculation formulas in the teaching process, the teaching teachers are limited by the limited class hours and difficult to choose the teaching content. As a result, the teachers are busy trying to catch up with the progress and some students are not easy to accept what they have learned, resulting in unsatisfactory teaching effect. How to deal with the contradiction between less class time and more teaching content is not only a problem in numerical analysis course teaching, but also a problem in many other courses.

(2) Too much emphasis on theory and neglect of practice

Numerical analysis is a theoretical and practical course, while the current teaching of numerical analysis focuses on the rigor and integrity of the theory. If the first 12 weeks only talk about theory, the combination of practicality and experimentation will be diminished. The teacher's classroom teaching emphasizes the explanation of calculation method theory. Most of the teaching time is spent on deriving calculation formulas and teaching theories, ignoring the combination of numerical analysis and computer technology, and ignoring students' practical and experimental teaching. These lead to a serious disconnect between students' theory and application, and insufficient understanding of algorithms.

(3) Lack of "visualization" process in teaching

Numerical analysis is a course combining mathematical theory with computer technology. In the classroom teaching, a lot of tedious formulas and complex algorithms are still explained. However, these theories and formulas are very abstract for students. They don't know how to use these

theories to solve practical problems. Algorithms are just flowcharts for them, and they still don't know how to program or experiment. These lead to the disconnection between the theory and practical application in teaching, which deviate from the teaching goal of numerical analysis course.

(4) Unreasonable assessment methods

The examination method is mainly focused on closed - book examination. Numerical analysis is a problem-oriented course. Closed - book assessment methods are often have limitations and one-sidedness. Only relying on closed-book exams causes students to focus their time and energy on cramming before the final exam. They think they can pass the exam with a quick review as a result, they are not willing to spend more time on in-depth thinking and cannot promote students' accumulation and improvement of knowledge through assessment.

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2.2 Teaching reform scheme

This article discusses the teaching of the course from three aspects: what kind of people the course trains, how to train people, how to evaluate the training effect. It takes the training of data analysis talents in the context of big data as the teaching goal, the problem-driven teaching model as the means, and classroom task as the assessment method to evaluate teaching effects, aiming to create a golden class of numerical analysis. Problems are driven from the three dimensions of course content, practice and teaching method to optimize the teaching model. In the practice, the mathematical modeling contest questions and current hot cases are integrated as "problems", and the students' computer language programming assisted computing ability is cultivated. The specific program route is shown in Figure 1. The blue module is the implementation of the module or the completed implementation module, and the orange module is the ultimate goal of the program.
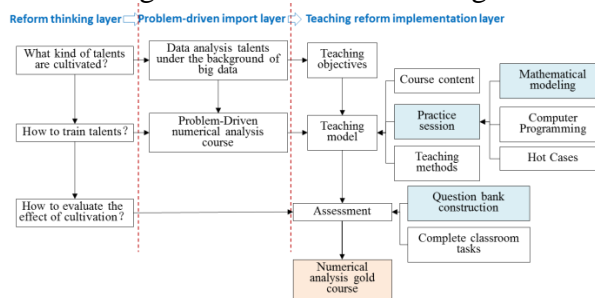

Figure 1. The teaching reform path of problem-driven numerical analysis

3. Case Study

Problem-driven teaching is a teaching method that takes students as the main body, takes some specific problems in the professional field as the starting point of learning, conforms to the logical line of the development of the problem itself, and expands the learning content around the problem reasonably. The role of the teacher in this mode of teaching is that of problem initiator, process designer and outcome evaluator. This paper takes Guangdong Ocean University as an example and carries out reform from the following three aspects.

3.1 Reform of teaching objectives

In the context of the era of big data, as a basic professional course for information and computing science majors, the teaching goal of numerical analysis should be to combine the design and analysis of classical algorithms with big data processing and information extraction, so as to

cultivate application-oriented professionals with certain innovative abilities. Under this teaching objective, the main teaching tasks of numerical analysis are as follows:

(1) To make students master the ideas and solutions of some classical algorithms in numerical analysis;

(2) Enable students to master the methods of big data processing, analysis and acquisition of useful information;

(3) Cultivate students' ability to analyze and solve problems and shape their good sense of innovation.

3.2 Teaching Mode Innovation

3.2.1. Reasonably select textbooks and optimize course content

In terms of textbook selection, we will choose a textbook based on Matlab numerical analysis with many practical cases (also teachers can collect cases), focusing on algorithmic thinking and practical problem solving. This is conducive to the cultivation of students' innovative consciousness and practical ability, which is consistent with the teaching reform purpose of this topic.

Facing the current situation of less class time but more content, we can use problem-driven teaching methods, that is, aiming at cases, asking questions and letting students try to solve the problem after class. In this way, under the premise of not affecting the scientific and systematic nature of the course, based on the main content of the course: numerical approximation, numerical integration and differentiation, numerical algebra, and numerical solutions of ordinary differential equations, select classic highly thoughtful and inspiring parts, optimize the teaching content, and achieve "less and refined ".

3.2.2. Practical education links of mathematical modeling, computer programming, and hot case integration integrate into numerical analysis

In the teaching of the various knowledge modules of the numerical analysis course, through the introduction of mathematical modeling questions over the years (modeling questions in China and the United States) and common real-life problems in real life, students are guided to carry out independent thinking and collaborative discussion and so on. In this way, teachers introduce the numerical methods that need to be taught in the class, and guide students build mathematical models based on what they have learned, use numerical calculation methods to solve the models numerically, and use numerical programming to obtain their numerical solutions. Throughout the learning process, students will experience the perfect combination of theory and practice, and master the practical application of mathematical knowledge and numerical methods. This not only strengthens students' independent thinking ability, but also improves their practical skills. At the same time, computer experiment is also one of the distinguishing features of numerical analysis that distinguish it from other mathematics courses. Its main purpose is to train students to apply the numerical method theory learned in the classroom to practical examples, and to cultivate students' numerical computing practice and computer programming skills. This is also a process of digesting the theoretical knowledge points learned in the class. For the same problem, students can try different methods to solve it and compare the results, so as to test the advantages and disadvantages of various numerical methods. In addition, in the specific calculation process of the experiment, our understanding of theoretical knowledge in class can be deepened by drawing pictures and lists and other intuitive and vivid ways.

3.2.3. Using problem-driven teaching methods to guide students to improve and innovate

The idea of improvement is to improve the method based on the existing method of solving the problem, so as to obtain a more efficient method. In a sense, improvement is scientific research innovation. The teaching content of numerical analysis course is to explain the process of improving numerical method. This idea of "improvement" is reflected in every chapter. For example, when talking about interpolation, the simplest Lagrange interpolation method is mentioned first, and then based on the shortcomings of Lagrange interpolation method that does not have heredity, adding or subtracting a node, and the basic functions are all changed, a Newton interpolation method is proposed. Lagrange interpolation method and Newton interpolation method

are not stable in higher order interpolation, so piecewise low-order interpolation is proposed. Finally, for smooth interpolation, cubic spline interpolation is also proposed. In the teaching process, teachers use problem-driven teaching methods to guide students to learn improved algorithmic ideas. When teaching content, they should pay attention to analyzing the advantages and disadvantages of algorithms. In view of the shortcomings of the algorithm, teachers improve them and guide students to develop new algorithms, which can stimulate students to think and cultivate innovative skills.

3.3 Reform of assessment methods

In problem-driven teaching, teachers guide students to look up information by themselves through conscious guidance, make analysis and judgment through individual or group cooperation, and learn knowledge in the process of actively seeking answers, so as to assess students' daily performance in a variety of ways. Teachers can assess the degree of enthusiasm for students to participate in the discussion of problems, or arrange a practical problem similar to a mathematical modeling problem for students to complete the assessment.

4. Conclusion

By integrating the above measures into the teaching process of numerical analysis of Guangdong Ocean University, it is found that students can not only master the construction principle of various commonly used numerical algorithms, but also improve their ability of algorithm design and theoretical analysis. This lays a good foundation for students in theoretical learning and programming practice. It is helpful to improve students' ability of logical thinking and solving practical problems. In addition, the implementation of problem-driven teaching method in the course of numerical analysis can achieve better teaching results, so the extension to other professional courses can provide a new method and reform ideas for talent training.

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