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Research on Multi-Integrated Online and Offline Teaching Model in the Post-Epidemic Era —Taking Numerical Analysis Course as an Example

Duan Mei[1,*]

[1]*Faculty of Mathematics and Computer Science, Guangdong Ocean University, Zhanjiang, Guangdong 524088, China*
[*]*Corresponding author. Email: meid@gdou.edu.cn*

ABSTRACT
In the post-epidemic era, online teaching has reached unprecedented heights, and "Internet + Education" has also become a feature of the current new stage of education informationization. Because of the problems existing in the traditional numerical analysis course teaching, such as fewer class hours, more content, more emphasis on theory than practice, and single teaching methods and means, this paper constructed a multi-integrated online and offline teaching model. It can change the shortcomings of the traditional teaching model to a certain extent, and improve the teaching effect.
Keywords: *post-epidemic era, Internet + Education, numerical analysis, diversified integration, online and offline*

1. INTRODUCTION

Numerical analysis, also known as the computational method, is a significant part of computational mathematics. It is a subject that studies the numerical calculation method and its theory and software implementation of solving various mathematical problems with computers. At the same time, numerical analysis is also the theoretical basis and foundation for computer program design and analysis of numerical results. It not only has the characteristics of high abstraction and rigorous science of pure mathematics but also has the features of the extensive application and highly technical aspects of practical experiments. It is a mathematics course with strong practicality. With the rapid development of computer science and technology and the increasingly mature theory of computational mathematics, the scientific calculation has become the third scientific research method after theoretical analysis and scientific experiments. It plays a vital role in scientific and technological progress and social development. Mastering the basic knowledge of numerical calculation methods and proficiently using computers for scientific calculations have become one of the indispensable tools for people to engage in scientific research and engineering applications. Therefore, most of the science and engineering majors in colleges and universities generally offer this course. The numerical analysis course is the core course of professional education for the majors of Information and Computing Science in Guangdong Ocean University, and it is also the compulsory course for the majors of mechanical engineering and other science and engineering majors in Guangdong Ocean University.

The outbreak of the new crown pneumonia in early 2020 has greatly affected the regular offline teaching of schools at all levels across the country. To block the transmission of the virus, the Ministry of Education has issued a "Suspend classes but keep learning" instructions. Education bureaus, schools, and major websites across the country responded to the call and actively prepared and carried out online teaching. The numerical analysis course of Guangdong Ocean University has also changed from offline education to online teaching. Within a short time, the popularity of online instruction has reached unprecedented heights. This nationwide, large-scale online learning has the characteristics of temporary and suddenness. As it has not been practiced and adjusted for a long time, a series of problems have exposed. After mid-May 2020, the epidemic has eased, College students from all over the country have returned to school one after another, the regular teaching order of the school has gradually recovered, and the utilization rate of online teaching has dropped significantly. How to give full play to the advantages of online education, make online instruction and offline courses organically and seamlessly connect, and maximize the learning effect of students, is the critical issue to solve for the sustainable and healthy development of online education in the post-epidemic period.

2. THE CURRENT DILEMMA OF NUMERICAL ANALYSIS COURSE TEACHING

In the traditional numerical analysis course teaching, there are some problems, such as fewer class hours, more content, more emphasis on theory than practice, and fewer teaching methods and means [1]. As a result, students are less interested in learning and less capable of practical operation. Moreover, they are unable to use numerical analysis as a tool to solve practical problems. Similar problems also exist in the teaching of numerical analysis course in Guangdong Ocean University.

2.1. More teaching content and fewer teaching hours

At present, our school's numerical analysis course has a total of 64 class hours, 4 class hours each week, including 48 theoretical class hours arranged in the first 12 weeks and 16 experimental class hours. Due to a large amount of teaching content, and the derivation of many theories and calculation formulas in the teaching process is too complicated, the teachers are limited in-class hours, and difficult to choose the teaching content. As a result, the teachers are tired of catching up with the schedule, and some students are not easy to accept what they have learned, resulting in an unsatisfactory teaching effect. How to deal with the contradiction between less learning and more teaching is not only a problem in the education of numerical analysis courses but also a problem in many other courses. Numerical analysis is not only to teach students to solve problems but also to cultivate students' ability to find, analyze, and solve problems as well as their ability to innovate.

2.2. Pay too much attention to formula derivation and neglect practical ability

Numerical analysis is a course that attaches equal importance to both theory and practice, while the current teaching of numerical analysis focuses on the preciseness and completeness of theory. For example, the first 12 weeks of pure theory teaching has diluted the characteristics of combining practicality and experiment. Teachers' classroom teaching emphasizes on the explanation of calculation methods and theories, and most of the teaching time spent on deducing calculation formulas and teaching theories. The teacher neglected the characteristics of combining numerical analysis courses with computer technology and neglected the practical and experimental teaching of students. These lead to the severe disconnection between students' theory and application, and their understanding of algorithms is not deep enough.

2.3. Students have differences in foundation and learning ability

The fundamental courses of numerical analysis are mathematical analysis, advanced algebra, and numerical analysis, which generally offer in the second semester of sophomore year. Traditional undergraduate teaching mainly adopts the teacher-centered teaching model. In such a teaching model, with the same teaching rhythm, the teacher cannot give guidance to each student and cannot meet the needs of each student. As a result, students with weak foundation find the content too difficult and progress too fast, while top students find the content simple and progress too slow.

2.4. The assessment method is not reasonable

The examination method mainly still focuses on a closed book examination. Most teachers agree that closed-book exams do not necessarily reveal students' actual level and ability. A student with a high level of ability may get average test results, while a student with a lower level and ability may do well on the test. The reason for this is that students spend a lot of time and energy cramming for their final exams. The consequence is that students think that they can pass the exam with a short burst, but are unwilling to spend more time on in-depth thinking, and fail to promote the accumulation and improvement of students' knowledge through the examination.

All of the above seriously deviate from the original intention of the Ministry of Education to set up this course and do not fit in with our talent training objectives. Also, "Internet + Education" has become the feature of the current new stage of education informatization. It can significantly improve the informatization teaching ability of professional teachers, promote the transfer of professional teaching from the on-site classroom to the Internet, promote the improvement of students' autonomous learning ability, and thus effectively improve the teaching quality. Therefore, it is necessary to explore the multi-integration of online and offline teaching model and reform the traditional teaching methods.

3. BUILD A MULTI-INTEGRATED ONLINE AND OFFLINE TEACHING MODEL, AND THE RESULTS ACHIEVED

This course group actively explores the diversified online and offline teaching model [2] of SPOC teaching and simultaneous live broadcast theme discussion, make full use of the Superstar platform, QQ group, test software, such as multivariate

integration, the formation of class autonomous learning layer depth, class interaction and organic integration of teaching a degree evaluation layer, realize the flip classroom, makes teaching from teacher-centered to student-centered. The topological structure of the multi-integration teaching model constructed is shown in Figure 1:

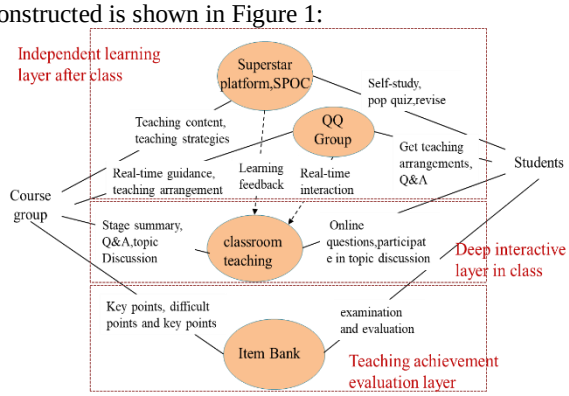

Figure 1 The topological structure of the teaching model of multiple integrations

3.1. Independent learning layer after class -- Construction of Superstar platform SPOC

The implementation of the after-class autonomous learning layer requires teachers to construct SPOC in advance, where the course group is SPOC constructed by the Superstar platform.

3.1.1. Teaching content and teaching strategies

Numerical analysis courses are highly abstract, which poses challenges to SPOC content design and teaching strategies.

In terms of teaching content, we can consider novel cases of "scientific research project and Mathematical Contest in Modeling." Construct advanced, forward-looking, novel, and challenging case teaching content, enhance students' interest in learning numerical calculation methods, and enable students to transform theoretical knowledge into the ability to solve practical problems. These can effectively solve the drawbacks of traditional numerical analysis courses that emphasize theory over practice.

Teachers release the teaching content arrangement in advance through the QQ group, propose the teaching objectives, and emphasize the key points, difficulties, and key points of the course content. In addition, teachers urge students to complete the assigned tasks and give real-time guidance to the questions raised by students in the QQ group, to improve the real-time performance of teaching interaction and cultivate students' ability of independent learning. These can effectively solve the disadvantages of the traditional numerical analysis course, such as fewer class hours and more content. Also, students can learn the course content after class, and the learning video progress can control, which can solve the disadvantages of the difference between students' foundation and learning ability to a certain extent.

3.1.2. Study situation analysis and feedback

Through the Superstar platform to analyze students' learning progress, unit test machine evaluation, and other learning situation analysis functions, timely monitor and master students' off-class independent learning dynamics, and test the degree of achievement of students' independent learning course objectives. These can provide data support for the design of teaching content, such as stage summary in class, topic discussion, key and difficult questions answering, etc., to realize the scientific teaching decision of numerical analysis course.

3.2. Deep interactive layers in class -- In-depth classroom teaching interaction

With the help of the big data feedback from the test results of the Superstar course platform, in the offline classroom teaching, teachers have targeted teaching key points, difficult points, and critical points, and summarized them in stages. Meanwhile, teachers carry out classroom topic discussion and classroom questions, and students work together in groups to solve problems, to improve classroom interaction and immersion. In the epidemic stage, the Tencent conference live broadcast was adopted for offline classroom teaching. The establishment of QQ groups to supplement the lack of real-time interaction of offline classroom teaching. After each offline class, the next teaching arrangement and the content of SPOC will be published.

3.3. Evaluation level of teaching achievement -- test question bank and online examination platform

Teachers can build an online question bank and an examination platform. Students can use the open question bank to self-check the knowledge points of the chapter, and the teachers can also use the examination platform to complete the final test. The Item Bank, online examination platform, and SPOC unit test are combined to form a diversified evaluation system of teaching achievement. These can effectively solve the drawbacks of unreasonable assessment methods in traditional numerical analysis courses.

3.4. Focus on teaching reflection and continuous teaching improvement

Teachers actively participate in SPOC teaching training and regularly exchange online teaching experience and experience. The continuous improvement and spiral rise of teaching quality can be realized through the active exploration of teaching methods and the optimization of teaching design. The constant improvement of teaching quality based on the PDCA [3][4] framework is shown in the following figure:

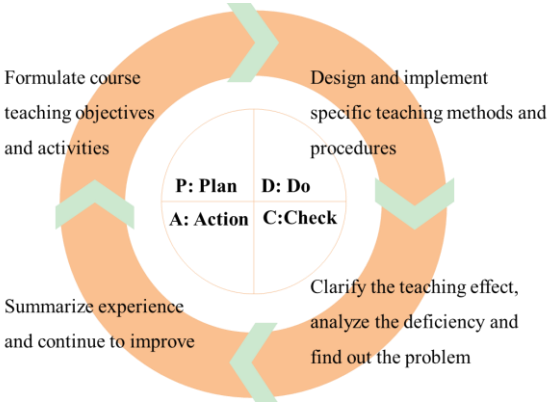

Figure 2 Continuous improvement of teaching quality based on PDCA framework

3.5. Achievements of the teaching model constructed

During the epidemic stage, the flipped classroom model of the self-established Numerical Analysis Course based on SPOC and the Tencent conference live broadcast was used to teach the information and Computing Science major at Guangdong Ocean University. This teaching model was awarded the first prize of excellent cases in the epidemic stage by the Online Open Course Teaching Steering Committee of Guangdong University.s

Students' assessment scores have been significantly improved, from 92.90 points and 93.35 points in the last two academic years to 94.53 points in this academic year. In the year 2020, students of the course cooperated in groups to solve practical engineering problems by using numerical calculation methods and won two undergraduate innovation and entrepreneurship training programs. Besides, more than 20 students participated in the Undergraduate Mathematical Contest in Modeling. Through the construction of multi-integration teaching model, it effectively promotes the students' internalization of the knowledge system of numerical analysis. It cultivates students' comprehensive ability of practice and innovation.

4. CONCLUSION

The multi-integrated online and offline teaching model innovates the traditional education idea and teaching thought, and it can change the disadvantages of the conventional teaching model to some extent, improve the classroom interaction, and enhance the teaching effect. The introduction of multi-integrated online and offline teaching model into the teaching of the numerical analysis course is conducive to the cultivation of students' independent learning ability, solidarity and cooperation ability, and the ability to solve practical problems. This will enable them to better apply their knowledge of numerical analysis to future work.

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