



# Teaching Exploration on Calculation Method Under the Background of Emerging Engineering Education

Shuhui Bi, Liyao Ma, Yuan Xu<sup>(✉)</sup>, and Xuehua Yan

School of Electrical Engineering, University of Jinan, Shandong, China  
{cse\_bish, cse\_maly, cse\_xuy}@ujn.edu.cn

**Abstract.** The Calculation Method is a complicated theoretical and strong practical subject, which is used to study and solve the problem of numerical approximate-calculation and is used to solve mathematical problems on the computer. Under the background of emerging engineering education and under the requirement of current concept and requirements of engineering education professional certification, this paper explores the teaching ideas of Calculation Method course based on the teaching status and the existing problems. The innovative educational reform of the course is discussed from the aspects of the integration and expansion of teaching content, the combination of online and offline teaching mode driven by teaching purpose, the construction of teaching system and so on. So as to improve the knowledge of the course, increase the interaction between teachers and students, release the initiative of students, and achieve the purpose of improving the teaching effect of the course.

**Keywords:** Teaching of calculation method · question-driven · cases-driven · blended teaching

## 1 Introduction

As more and more practical and accurate numerical calculation is needed in scientific research, Calculation Method is also set up as a basic course in engineering majors of many universities [1]. Calculation Method combines the theory of computer science and mathematical theory and introduces the basic methods of scientific calculation, which can effectively train and exercise students' ability in calculation, innovation and solving practical problems. Its role is difficult to be replaced by other courses. Calculation method is highly practical, emphasizing rigorous abstract theoretical analysis and practical practice. Meanwhile, it also provides more intuitive and concise means for the development and research of other subjects and technologies [2].

The core of the construction of new engineering is to cultivate innovative scientists and engineers who adapt to the development of science and technology.

The reform of teaching theory and practice is the key part to achieve this goal [3], which puts forward higher requirements for the teaching of Calculation Method to be precise and quantified. The traditional teaching mode already can no longer be fit for the needs of the teaching, so it is urgent to put forward the relevant reform methods. The reform idea of teaching and research proposed that the main purpose of the course should be cultivate and improve students' innovation ability. Therefore, some teaching reform methods have been put into practice in the teaching process and achieved certain results [4,5]. However, at present, most of the teaching is still focus on the theoretical teaching. Moreover, the main problems can be summarized as follows:

1. The curriculum setup is inconsistent with training objectives.

At present, professional courses are still relatively independent from each other, and there is a fragmentation between courses, which often leads to students' lack of overall concept and difficulty in forming a systematic knowledge structure. The curriculum requires mastery of stages that are very basic, and most of the courses only require students to be able to use the knowledge and methods they learned in class to solve post-course exercises. In addition, students are unable to fully understand the algorithms in the book and apply them in practice. Therefore, the cultivation goal is difficult to achieve completely.

2. There is disconnection between teaching content and application.

Industrial information technology is developing rapidly, but the syllabus related to it is relatively old, and there is a certain disconnect between the current application status and the teaching contents. Moreover, the current teaching method used by most schools is still classroom teaching, with insufficient guidance in application, which makes students lose interest in the course and lacks the ability to solve practical problems.

3. The evaluation method is single and unscientific.

The current examination and evaluation of Calculation Method are limited by the traditional assessment and examination methods in universities. Mostly is written examinations or final submission of large assignments in terms of teaching content, and relatively few examinations are conducted with related to real practice. Which makes the students difficult to truly master the means to solve mathematical problems by computers.

4. Students' initiative is not enough.

Although the current teaching methods have undergone a major transformation, the educational philosophy basically remains at the stage of unilateral indoctrination teaching by teachers and unselective receptive learning by students, which inevitably leads to the lack of students' ability to actively identify problems, further analyze and solve problems.

Therefore, this paper will discuss the mode of teaching reform of Calculation Method from the current problems.

## 2 Teaching Reform Ideas

Engineering education professional accreditation is an internationally accepted quality assurance system for engineering education and an important basis for achieving international mutual recognition of engineering education and engineers' qualifications. The core of engineering education professional accreditation is to confirm that engineering graduates meet the established quality standard requirements recognized by the industry, which is a kind of qualification evaluation oriented to cultivation objectives and graduation export requirements [2]. Therefore, the current teaching should then aim at the actual problems faced by each major, based on the course content, and form a problem-driven, project-driven and active learning-oriented educational concept.

In response to the current teaching problems in Calculation Method, the teaching reform should be conducted in the following ways.

### 2.1 Integration and Expansion of Research Content Aimed at Graduation Requirements

Taking the graduation requirements of automation majors as an example, the course Calculation Method corresponds to mastering the mathematical essence of key links in complex engineering problems and being able to describe them reasonably, mastering the basic ideas and methods of scientific and engineering computation using computers, cultivating students' mathematical modeling ability and numerical analysis ability, and being able to use them to solve complex engineering problems in the field of automation. Therefore, when teaching this course to undergraduate students in the context of professional engineering education accreditation, the course contents should be integrated with the professional characteristics, and engineering examples should be introduced to analyze the course, so that students can learn this course and achieve the effect of integration with the professional courses they have studied at the same time.

### 2.2 Focus on the Teaching Content Emphasis and Advancement of Science and Technology

Different courses are related in the cluster system, and the same faculty team should communicate with each other within the course cluster in order to clarify logical relationships, highlight the focus of teaching and standardize the teaching content in terms of the training objectives of students. In view of the direction of research development, more reasonable course objectives should be formulated so that the contents of different disciplines can promote each other and complement each other. The course contents as well as the scope should be revised and improved frequently, and new research results and scientific research directions should be added in the teaching contents. Teaching materials should be discussed and revised, and selected in the light of students' academic level and teaching situation, and teaching teams can be organized to participate in the preparation of teaching materials.

### **2.3 Transformation of Student-Centered, Problem-Driven and “Flipped” Teaching Methods**

Flipped education is to change the teaching form into a discussion by student groups as the main body, to solve problems as the main goal for practical operation, to combine practical application with course thinking, to change the previous one-way knowledge output based teaching mode. The course-group-based online learning platform can be established, which receives the teacher's pre-recorded course lecture contents, and the students can study through the online platform. Then students will ask questions about their independent learning in class, and the questions can be answered by teacher or can be discussed by students internally. This cooperative learning through communication will improve students' ability to learn independently and reduce their dependence on the teachers.

### **2.4 Construction of a Reasonable Teaching System to Improve Students' Practical Ability**

A reasonable teaching system should be created based on the actual situation of students, with a clear system backbone and appropriate hierarchical divisions, from the table to the inside, from easy to difficult, with an overall focus on enhancing students' practical application and innovation. It enhances the sense of comprehensive design and innovation while strengthening the foundation, so that students can actively participate in practice and make the teaching platform with openness, innovation and practicability. It should give full play to the advantages of sharing today's network resources, combine traditional teaching with new teaching, make two-way progress between network learning and practical learning, and sharpen practical skills while familiarizing with software operation. Therefore, the teaching platform should be improved to achieve diversified teaching and open teaching, by the means of integrating the industry construction, curriculum teaching, project research and development, and enhancing the connection between the school and enterprises to cultivate students' practical innovation ability at close range. Moreover, scientific research projects related to the major should also be introduced into the subject, so that students can develop the consciousness of innovation and enhance the ability of solving problems while participating.

For the reform contents, there are two key issues need to be solved. The first one is how to mine and optimize the curriculum resources with the network as the carrier more effectively. The second is how to enter the integration of diversified teaching modes with professional teaching.

## **3 Teaching Reform Program**

In view of the current problems, this paper proposes the following solutions from the aspects of online course resources, teaching methods and dynamic evaluation system.

### 3.1 Optimize the Learning Resources of Online Teaching to Make Up for the Shortage

The learning resources of online courses should be coherent, excluding the overlapping parts, and mutual promotion and supplementation. So that a large number of learning resources can be effectively used by students to get better learning effect, broader vision and more diverse knowledge. Therefore, teachers can make full use of the resources of national high-quality MOOC courses and allocate some easy-to-learn or extended knowledge points as self-study contents, while students can carry out independent learning based on MOOC videos, courseware and online exercises to partially alleviate the problem of limited teaching time in class.

### 3.2 Take Full Advantage of Online-Offline Hybrid Teaching

Give full play to the advantages of online-offline hybrid teaching. Considering the limited classroom time, the derivation of some complex algorithms and mathematical proofs can be distributed to the online teaching platform in advance in the form of documents or videos for students to study, so that students can actively participate in the course learning before class. The teaching network platform can be earmarked for sharing course materials, completing interaction, homework, tests, etc., and tencent conference, QQ group can be adopted for online teaching, group Q&A and seminar teaching. Based on that, the time and space limitations of student-teacher communication can be broken. Then, in the offline classroom teaching, you can communicate with students to understand their difficulties after online learning, so as to conduct targeted lectures and improve students' learning efficiency.

### 3.3 Use Diversified Teaching Methods

*Actual Case-Driven Teaching.* Put the focus of certain teaching knowledge points to the actual case analysis and solution. Through the problem analysis, lead to the engineering origin of the corresponding numerical calculation methods (starting point), the main solution ideas and the basic implementation process. At the same time, in order to increase the intuitiveness of algorithm teaching, flowcharts can also be introduced, or software programming can be used for demonstrating the algorithm, so as to down play the complex and tedious theoretical proofs and formula derivation in the textbook and focus on how to use the algorithm to solve problems in practice. So that students can complete the learning of the algorithm principle while applying it, and avoid the boring and complicated theoretical lectures. This not only increases students' learning motivation, but also helps to improve their ability of analyzing and solving practical problems, and fundamentally answers the question of "what is the use of studying this course".

*Problem-Driven Teaching.* This mode organically integrates teacher's guidance with students' independent inquiry and communication, and focuses on the solution of practical problems [4]. Through the elaborate design of problems, the

teacher makes the knowledge points presented one by one in the driven. Then, students can gradually change from low-order thinking to high-order thinking, so as to understand and master the key points and teaching difficulties from shallow to deep. Which makes students become the real leader of learning. In other words, teachers give clear learning objectives, then the students can explore the basic principles of various algorithms, the connection and difference between algorithms with motivation driven by problems, so as to achieve the purpose of mastering the advantages, disadvantages and applicability conditions of various algorithms, and grasping how to use the learned mathematical knowledge to solve practical application problems. Compared with the traditional teaching mode, the problem-driven teaching method can better stimulate students' learning motivation, cultivate their independent exploration ability, realize the digestion and understanding of knowledge through communication and exchange, exercise students' deep thinking ability, and develop a practical and innovative way of thinking.

*Flipped Teaching.* The teachers act as a guide in the classroom and try to make students participate in the whole teaching process as protagonists. For example, the teacher can teach only one or two classical methods, and the rest of the algorithms are done by students in group debriefings. During the debriefing, the group leader will introduce the principle of the algorithm, the deputy leader will demonstrate the procedure, and the other group members will be asked questions. In this way, students take the initiative to review the literature before class, complete their study and organization of algorithm theory, and prepare the materials needed for the lecture. This process allows students to gain a deeper understanding of the course contents and also to participate in the class better.

### **3.4 Make Full Use of the Advantages of Research Projects, Enterprise Platforms and Other Teaching Resources**

Based on the application of school laboratories, we create conditions and environment for active practice and include students in school or teacher's research projects, forming a teaching mode of "scientific research projects into teaching groups and excellent students in applied research". The teaching resources should be fully utilized so that the participating students can exert their potential. The school-enterprise cooperation optimizes the practical aspects and creates a good platform operation mechanism, so that the platform of practical teaching can be optimized continuously.

### **3.5 Refine and Improve the Assessment Process**

In order to improve the rationality of talent cultivation in higher education institutions and cultivate qualified talents that meet the requirements of professional accreditation of engineering education, the traditional assessment method of final paper examination needs to be reformed. The process assessment links should be increased and refined in the daily teaching process. Meanwhile, the proportion

of practical links should be appropriately increased. For example, class participation, post-class assignments, flipped classroom performance, project reports, final exams, etc. The assessment methods should be more flexible and more applicable to today's teaching system of Calculation Method. The criteria of course assessment such as content, question type, difficulty, scope, and number of questions should be more scientific, with the goal of cultivating students' innovation ability and additional feedback channels for teaching opinions.

To sum up, in order to cultivate more innovative talents, under the requirement of professional accreditation of engineering education, the curriculum teaching reform of Calculation Method should be paid attention to. Teachers should innovate teaching concepts, clarify teaching purposes, improve students' enthusiasm in course learning, enhance students' competitiveness in future work study, and finally achieve the purpose of cultivating high quality composite talents in universities. (1) Increasing the proportion of case teaching and problem-driven teaching, integrating theoretical learning into practical application, making knowledge methods and practice go hand in hand, and integrating industrial practice and scientific research projects into the teaching methods. (2) In order to develop students' scientific way of thinking beyond the learning of classical subjects, the students' interest in classical courses need to be constantly stimulated. (3) The optimization of network course resources and the implementation of diversified teaching methods provide convenience for students' course learning and practical summary, and also facilitate the construction of relevant courses in schools. (4) The construction of relevant industries into course learning can promote the integration of scientific and technological achievements into teaching and research, and establish a more complete teaching system in the context of the integration of industry, education, science and education.

## 4 Conclusion

Calculation Method, as one of the compulsory courses for contemporary engineering students, has both theoretical and practical characteristic. In addition to the teaching of theoretical methods, the teaching should also rely on the background of the integration of industry, education, science and education, and implement new teaching concepts, so that students can be more important participants and the talents cultivation can be more innovative. In the actual teaching, we should keep up with the times, give full play to the advantages of network resources brought by today's technological progress, and combine various ways to establish a diversified teaching platform to cultivate students' innovative and practical abilities.

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