

Research on Curriculum Reform and Practice of Discrete Mathematics in Computer Science

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Abstract: The importance and necessity of the Discrete Mathematics course in computer science and technology is discussed in this paper. Based on the detailed analysis of the problems existing in the teaching of the Discrete Mathematics course, the reform and practice are carried out through the following four aspects: the teaching objectives, teaching contents, teaching modes, and assessment methods. The teaching effect is improved effectively, and the results of the teaching reform were summarized and analyzed.

1. Introduction

Discrete Mathematics is one of the important fundamental courses in Computer Science and Technology. The Ministry of Education clearly pointed out in “The Implementation Plan of the core course teaching of computer science and Technology in Colleges and Universities” that “Discrete Mathematics is not only an important professional foundation course, but also plays an important role in cultivating students' discipline quality and mastering the correct discipline method; the teaching of Discrete Mathematics plays an important role in student's ability to acquire knowledge and apply knowledge, and in the cultivation of innovative thinking. [1]” As a core foundation course of Computer Science, the status of this course determines that it should be closely integrated with the talent training objectives of the new engineering. Through the study of this course, students can first cultivate mathematical literacy, learn to describe problems with symbols, and construct models for problem-solving; secondly, they can master the tools and methods of discrete problem description and lay the theoretical foundation for the study of subsequent courses. Finally, Discrete Mathematics can improve students' logical reasoning ability and lay the foundation for their future scientific research and high-level software development; on the other hand, it enables students to have computational thinking and innovation ability.

The Discrete Mathematics course takes up 2 credits and 32 teaching hours in the education plan of Computer Science and Technology majors of our college in the class of 2020 and before. The existing traditional Discrete Mathematics teaching is still based on the teacher's explanation, “teaching” and “learning” are separated, and there is too much indoctrination, emphasis on marks, and theoretical knowledge [2-3]. But too little participation, focus on ability, practical knowledge, and problem-solving skills training are considered in Discrete Mathematics teaching. In addition, the course itself is relatively theoretical, with many formulas and abstract content, and involves a large number of mathematical derivations and calculations, which makes students easily intimidated, thus leading to poor overall learning results. We hope all theoretical knowledge that students need to master is clearly explained while inspiring and improving students' comprehensive application of knowledge. Obviously, within the limited class hours, the existing teaching methods cannot accomplish the above two aspects efficiently.

The current assessment method of this course is relatively simple, the final grade of students is determined by the usual homework, attendance, and final exam. Although the examination of the usual homework and attendance is introduced, the student's grade is still almost determined by one test: focusing on the evaluation of results, ignoring the process evaluation. Since the examination

format is closed-book, this also makes the content of the examination somewhat limited, with a large proportion of memorized components in the examination paper and fewer questions that can test and reflect students' comprehensive ability [4].

2. Curriculum Reform

Through the above analysis of the existing Discrete Mathematics course teaching problems, we reformed the teaching from four aspects: teaching objectives, teaching content, teaching mode, and assessment methods.

2.1. Reform of Teaching Objectives

In practical teaching, the Discrete Mathematics course mainly introduces classical concepts and proof methods in several aspects such as mathematical logic, set theory, and graph theory [5]. Discrete Mathematics is characterized by high abstraction, logic, and theory, and can easily be treated as purely theoretical courses, or even purely mathematical courses. Restricted by course hours and theoretical teaching methods, traditional Discrete Mathematics teaching only stays at the level of teaching students reasoning and proof methods and familiarizing them with classical theoretical algorithms, which has great shortcomings in cultivating students' application ability and innovative thinking. In addition, most teachers still position discrete mathematics as a professional theoretical foundation course in the teaching process without experimental teaching. Thus, students only learn the general theory of deduction and the basic theory of abstract models, but cannot deeply understand the core ideas and methods of computational models, making ability training an empty word. Therefore, in order to link Discrete Mathematics with subsequent professional courses, teaching objectives should be adjusted accordingly [6-7].

In the teaching process of Discrete Mathematics, the ability to construct discrete models should be cultivated first. Through theoretical study, this course encourages students to master and understand the basic knowledge of Discrete Mathematics. It can extract concrete problems into abstract mathematical problems, combine the knowledge of Discrete Mathematics, express them mathematically, and then analyze and solve them by using the relevant knowledge.

On the basis of mastering the theory and model construction of Discrete Mathematics, students' ability to connect theory with practice should also be strengthened. Combined with the application of Discrete Mathematics in Computer Science, it enables students to properly understand and master the basic research methods of discrete objects and helps students understand the intrinsic connection between abstract thinking in mathematics and the practice of computer science. Chapters related to theory and practice are selected, practical exercises are assigned, and through group discussions, online experiments, and student presentations, students' comprehensive ability is developed so that they can use the mathematical methods in Discrete Mathematics, to solve practical problems and achieve solutions through computer programming.

2.2. Reform of Teaching Content

In the design of the teaching content of Discrete Mathematics, we should find the balance between basic theory and engineering applications. Starting with the grade of 2021 in our University, the teaching hours of Discrete Mathematics have increased from 32 hours to 64 hours, and the teaching content is formed as static knowledge with dynamic cases. Static knowledge refers to the basic concepts, definitions, theorems, and inferences in the teaching process of Discrete Mathematics, which are taught according to the textbook. Dynamic cases mean that the cases taught in each chapter should follow the frontiers of science and technology and be updated dynamically; draw on the reform experience of Discrete Mathematics teaching in other Universities; not only cultivate students' rational thinking and improve their ability to solve problems with their hands, but also focus on humanistic cultivation and fully mobilize students' enthusiasm and initiative in learning discrete mathematics. Specifically reflected as follows.

2.2.1. Introduce natural and literary content to stimulate students' enthusiasm and enthusiasm for learning

For example, when explaining the concepts of the Principal Conjunctive Normal Form(CNF) and the Principal Disjunctive Normal Form(DNF), guide students that some propositional formulas with different forms can be transformed into the same Principal CNF or Principal DNF, that is, they are equivalent. So some things are different in appearance but are essentially the same. Combined with materialistic dialectics, it is pointed out that phenomenon and essence are a dialectically unified twin, and they explain the external and internal connection of objective things. Selecting appropriate cases is conducive to students' deeper understanding of knowledge. The selection of cases not only helps students to realize the integration and migration of knowledge, and improve their ability to analyze and solve problems but also guides students to think and strengthen their social sentiments.

2.2.2. Expand teaching content and strengthen follow-up course connections

When explaining the concept of the influence process, deductive reasoning is contrasted with logical influence and introduced through the process of human understanding of a new object. The influence is like learning new knowledge, i.e., the process of first having a concept and extracting the corresponding characteristics of that concept and then influencing another object with similar characteristics. Then, the course is expanded to introduce the basic theory and process of machine learning to the students, which is linked to the subsequent courses of Computer Science such as Artificial Intelligence and Machine Learning, so that the students can understand the application background of the Discrete Mathematics course and increase their learning enthusiasm and motivation.

2.2.3. Add programming to cultivate students' computational thinking

Discrete Mathematics courses are abstract in concept and complex in theorem proving. In the process of teaching knowledge, modeling, and programming are integrated to guide students to understand the source of the problem, the premise of the theory, and the idea of solving the problem, analyze each level in depth, present the knowledge in different modes, enlarge the concept, and let students "recreate" and "rediscover" the knowledge in the textbook by tracing back to the source. The students can "recreate" and "rediscover" the knowledge in the textbook by going back to the source. For example, when teaching graph theory, students can extend their knowledge by programming the shortest path and minimum spanning tree through MATLAB.

After the modeling solution of each case, students are arranged to program the implementation after class, which not only improves the students' computational thinking ability and programming abilities but also deepens their understanding of knowledge and helps improve their self-learning ability.

The practical activity is a comprehensive learning activity guided by teachers for students to carry out independently, which can improve the timeliness and participation of the course and give full play to the role of the second classroom. Through these practices, not only can students experience the evaluation of algorithm design on the effectiveness of problem-solving, but also guide students to complete the "problem analyzing -> abstract modeling -> algorithm designing, and programming" process, which cultivates students' ability of computational thinking and the ability to learn new things.

2.3. Reform of Teaching Mode

The reform of the teaching mode can be divided into the following aspects.

2.3.1. Integrate moral education elements into teaching content

Based on the content of the Discrete Mathematics course, look for elements such as literature and philosophy associated with it, reasonably integrate social hot spots, cutting-edge science, history, and culture into the teaching in a reasonable way, and fully stimulate students' enthusiasm

in class. Help students form a correct worldview and life values, and enhance students' sense of social mission.

2.3.2. Blended teaching, combining theoretical knowledge with practical application through case teaching

In order to prevent the Discrete Mathematics course from becoming a purely mathematical and theoretical course, we adopt a blended teaching mode that combines learning, problem discussion, and case teaching, taking the main content and structure of the course as the guide. In the teaching mode, the teacher first analyzes and summarizes the main content and key and difficult points of each chapter, provides learning resources, releases learning tasks, and students conduct exploratory learning and complete independent learning before the class.

Then, the teacher organizes targeted offline classroom learning according to students' pre-class learning to achieve a second deepening of understanding and consolidation of key knowledge and concepts. By questioning and explanation, the teacher can understand students' pre-class learning situation and guide students to divide the teaching content into several problems through classroom group discussion, resulting in an improvement of their problem-finding, -thinking, and solving abilities.

Finally, the teaching of Discrete Mathematics courses is based on actual engineering cases, integrating the course learning process with solving practical engineering problems, mobilizing students' interest in active learning, and cultivating students' hands-on ability, teamwork spirit, and communication skills. By introducing actual engineering cases, and asking questions, the teacher leads students to build models, and complete algorithm design and implementation. Students are divided into different groups, and the team leader changes each time. The teacher distributes different after-school applied research projects to each group. Students can have an in-depth understanding and discussion of the project by consulting literature, programming practice, writing project reports, etc., and finally, the research materials and research results of each group are displayed in class.

2.3.3. Pay attention to the use of modern information technology

As Figure 1 shows, the "Chengdu Normal College Online Teaching Platform" is used to upload the learning materials and release learning tasks before class. Other teaching aid like micro-video is used to prepare teaching resources. Detailed micro-video recordings are made for the important and difficult points (especially the construction of models, algorithm design, and implementation) in the course to help students better understand, and review the course knowledge.

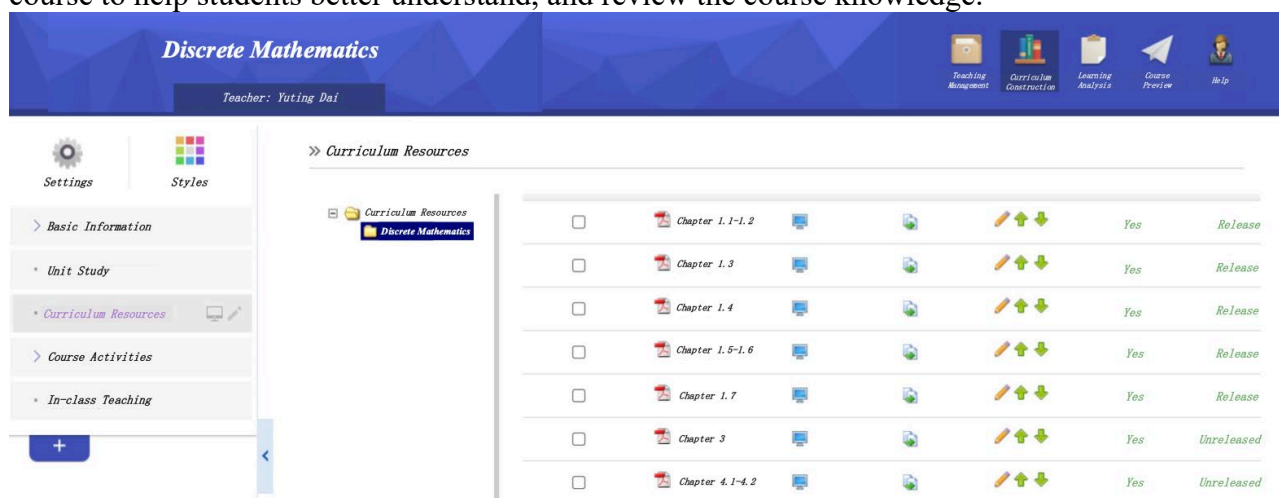


Figure 1 Teaching resources and online test.

2.3.4. Reform of Assessment Method

Nowadays, the main assessment method for Discrete Mathematics courses is still a closed-book written examination at the end of the course, supplemented by the usual grades, focusing on the

evaluation of results and neglecting the process evaluation. In order to change this situation, according to the characteristics of the course itself, flexible use of examinations, daily assessments, modeling and programming, and writing reports are combined to carry out teaching reforms.

The course adopts a combination of final closed-book examination and regular assessment, focusing on the evaluation of the results, but also paying attention to the process of evaluation. According to the characteristics of the course itself, the teaching reform is carried out by combining examinations, daily assessments, practical skill operations, and writing special reports. The Discrete Mathematics course adopts a mixed assessment to evaluate students' learning results. Students are assessed on their logical reasoning ability, problem modeling ability, practical application ability, and professional knowledge. The specific evaluation mechanism consists of four parts: online learning evaluation, including online testing, learning quality, and peer evaluation; classroom learning evaluation, including learning progress, class participation, and class assignments; extended research evaluation, including research evaluation of the depth and reporting situation; end-of-term comprehensive test, including mid-term test and end-term test. Such multi-angle assessment, can stimulate students' learning initiative, embody the characteristics of being student-centered, and improve students' learning interest and efficiency.

3. Analysis of Teaching Effectiveness

After two rounds of the Discrete Mathematics course, the learning outcomes of the 2019 and 2020 students were compared. The two classes used the same number of hours and materials for the Discrete Mathematics course and were enrolled in similar score bands, which resulted in better learning outcomes after the reform. In terms of the final paper and overall grades, the average score of the grade 2020 was about 5 points higher than the average score of the grade 2019 in the final closed-book exam, with a 6.8% higher merit rate and a 3.2% higher pass rate. This reflects the fact that the changes in teaching and learning have improved the learning outcomes of the learners.

After the teaching reform, the classroom atmosphere is lively and students are more interested in participating in course discussions. This model breaks the independence of traditional Discrete Mathematics courses, integrates humanistic education into professional courses, and links theoretical mathematics courses with subsequent computer professional courses. Students are also very satisfied with the teaching method of discrete mathematics. As Figure 2 shows, the teaching evaluations of the grades 2019 and 2020 students are basically 92.59 and 93.66 respectively. It can be seen that the students have high scores on all aspects of the teachers, indicating that the acceptance rate and satisfaction rate of classroom thinking and administration are generally high.

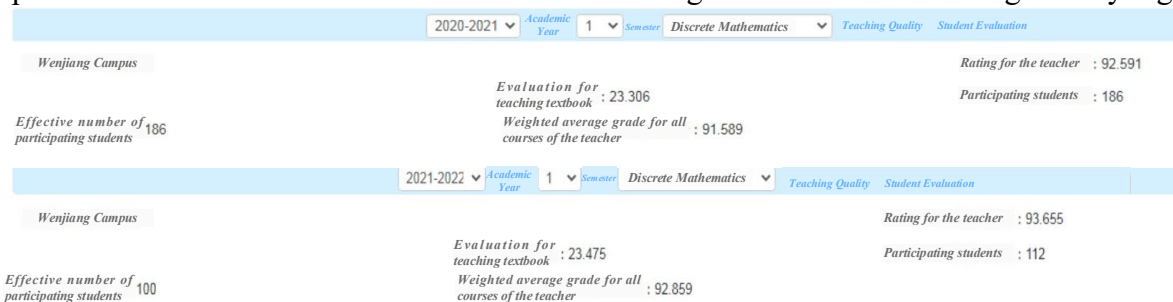


Figure 2 The teaching evaluations of the grades 2019 and 2020 students.

4. Conclusion

By analyzing the problems existing in the current Discrete Mathematics course, combined with the characteristics of Computer Science, the teaching reform and practice of Discrete Mathematics course were carried out from four aspects: teaching objectives, teaching contents, teaching mode, and assessment mode. Since the implementation of the project, initial results have been achieved. After two consecutive teaching cycle reforms, it has been reflected in the three aspects of student assessment results, subjective student feedback information, and potential follow-up professional

course learning impact. The reform measures aimed at the course of Discrete Mathematics are effective and have achieved the expected goal of the reform. In the follow-up teaching, it is also possible to provide timely feedback on the problems existing in the reform by designing questionnaires, and further improving the teaching of the Discrete Mathematics course.

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