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Research on Teaching Reform and Practice of Discrete Mathematics Course in Information Security Major

Yuanyuan Huang[1*], Peilin He[2], Haozhe Tang[3], Jiazhong Lu[1], Zhongzhi Li[1]

[1]Department of Network Engineering, Chengdu University of Information Technology, Chengdu, 610225, P.R. China
[2]Department of Informatics and Networked Systems, University of Pittsburgh, Pittsburgh, PA 15260, USA
[3]Department of Artificial Intelligence, L'École Pour l'Informatique et les Techniques Avancées, Le Kremlin-Bicêtre 94270, île-de-France, France

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***Corresponding author:** Yuanyuan Huang
Department of Network Engineering, Chengdu University of Information Technology, Chengdu, 610225, P.R. China

Abstract **Review Article**

A proposed teaching reform idea is developed by examining the talent training approach of "Discrete Mathematics" within the information security curriculum and the unique features of the course's knowledge system. This new approach aligns with the characteristics of applied information security specialty and emphasizes the cultivation of practical information security talents. The proposed teaching reform idea involves integrating engineering ethics and MOOC teaching reform elements to expand the teaching approach and to develop a new course teaching mode.

Keywords: security curriculum, Discrete Mathematics Course, teaching reform.

1 INTRODUCTION

The discrete mathematics course holds a significant place in the curriculum of information security major. It is not just a fundamental mathematics course but also a professional basic course. Therefore, enhancing and refining the teaching of this course is crucial for improving the quality of personnel training in the field of information security. Since the institution that the authors working with emphases on fostering skilled undergraduate talents in applied information security, it has developed training objectives for discrete mathematics for information security major.

1. Being able to abstractly establish and solve discrete mathematical models for specific information security issues;
2. Being able to use subject knowledge and discrete mathematical model methods to analyze and deduce information security engineering problems;
3. The ability to comprehensively use relevant knowledge and discrete mathematical models to compare and optimize solutions to complex information security problems;
4. Being able to comprehensively apply the principles of discrete mathematics, natural science and engineering science, abstract the actual needs of information security issues, and make formal descriptions;

Our major has recently undergone a teaching reform of its professional curriculum system. As part of this reform, there was a proposal to reduce the number of hours devoted to discrete mathematics in order to allocate more time to other characteristic courses of information security major. However, given that the content of discrete mathematics is extensive and challenging to comprehend, the reduction may impact the quality of undergraduate teaching of information security major. Therefore, in order to ensure and enhance the quality of undergraduate teaching in this field, further exploration into the teaching reform of discrete mathematics courses is crucial.

2. Course Orientation in the curriculum system

"Discrete Mathematics" is a crucial mandatory course for information security major, with linear algebra as a prerequisite. Linear algebra provides the essential theoretical foundation for subsequent courses, such as data structures, databases, digital logic, compilation principles, artificial intelligence, and operating systems. The course's position in the curriculum of information security major should be in line with its position in computer science major. Discrete mathematics is the mathematical foundation of

the entire professional knowledge system and has strong pertinence, practicality, and utility. It provides students with both the basic professional mathematics knowledge of general education and an integral part of the professional course knowledge. This directly affects the construction of professional knowledge and skill systems for information security students. The discrete mathematics course for information security major mainly comprises four aspects: mathematical logic, sets, and binary relations, algebraic structures, and graph theory. These parts are structurally related and relatively independent, closely linked to the theory and application of computer science. For instance, the "Data Structure" course's primary content focuses on the logical structure of data, physical storage structure, and basic operations. To teach professional course knowledge and develop the professional curriculum, it is necessary to apply the knowledge of set theory, relation, graph theory, and tree in discrete mathematics.

3 Teaching reform and practice

The teaching process for the course discrete mathematics should cater to the needs of training applied information security professionals, based on an understanding and analysis of the knowledge system's characteristics and professional orientation. To achieve this goal, several teaching reforms should be undertaken. Firstly, the course's ideological and political teaching should be reformed to emphasize its importance to students and stimulate their interest in learning. Secondly, teaching should be reformed based on the characteristics of the author's teaching unit. This could involve introducing MOOCs, case studies, exercises, and other elements to expand the course content. These teaching reforms aim to provide the necessary theoretical foundation for studying follow-up courses in information security and focus on developing students' logical reasoning, abstract thinking, and problem-solving abilities, preparing them for future work in information security-related hardware design and software development. The teaching content and mode should be reformed in the following ways.

3.1 Incorporate modern mathematical thinking

The research on talent cultivation in this major reveal that while students excel in developing their applied technical abilities, they tend to neglect basic skills and struggle with advancing their talents. To produce competent professionals, it is crucial to address these gaps in personnel training. For instance, a lack of proficiency in fundamental mathematical concepts could limit students' growth, especially if they overemphasize narrow specialization at the expense of broader expertise. Integrating modern mathematical thinking into the curriculum could enhance students' problem-solving skills and promote creativity. Specific approaches, such as transformation and induction, graphic modeling, function analysis, and classification discussions, can benefit learners in diverse ways. Furthermore, exposing students to the historical and cultural aspects of discrete mathematics can broaden their knowledge and inspire them to pursue cutting-edge research. By exploring the development of the subject over time, students could appreciate the thinking processes and discoveries of famous scientists. Additionally, incorporating recent research findings in the field can help students connect theory with practice and stay informed about emerging trends. As the renowned scientist Qian Xuesen said, "The ultimate goal of education is to stimulate the thinking process of the human brain".

3.2 Online and offline integrated teaching design

Given the author's team's limited experience in discrete mathematics, integrating high-level MOOC teaching content can compensate for the lack of teaching ability to the greatest extent. Combining online resources with offline teaching can broaden students' horizons and enhance the effectiveness of teaching. These innovative teaching models have resulted in a series of changes in the roles of teachers and students, teaching methods, and management models. By reimagining traditional teaching concepts, reshaping existing theories and knowledge, and transforming teaching methods, flipped classrooms and new teaching methods have been adopted for discrete mathematics courses, enabling educational reforms to meet the demands of engineering and technical talent in the modern engineering era.

This course primarily utilizes MOOC online resources and incorporates innovative teaching methodologies such as mobile learning and the flipped classroom approach, placing the students at the center of the learning process. Figure 1 demonstrates the teaching components involved in this hybrid teaching mode. The implementation of this approach effectively addresses the challenge of reconciling the reduction of class hours with the increased volume of course content, while also promotes independent learning habits among students. This enables students to create personalized study plans and efficiently to manage their time efficiently.

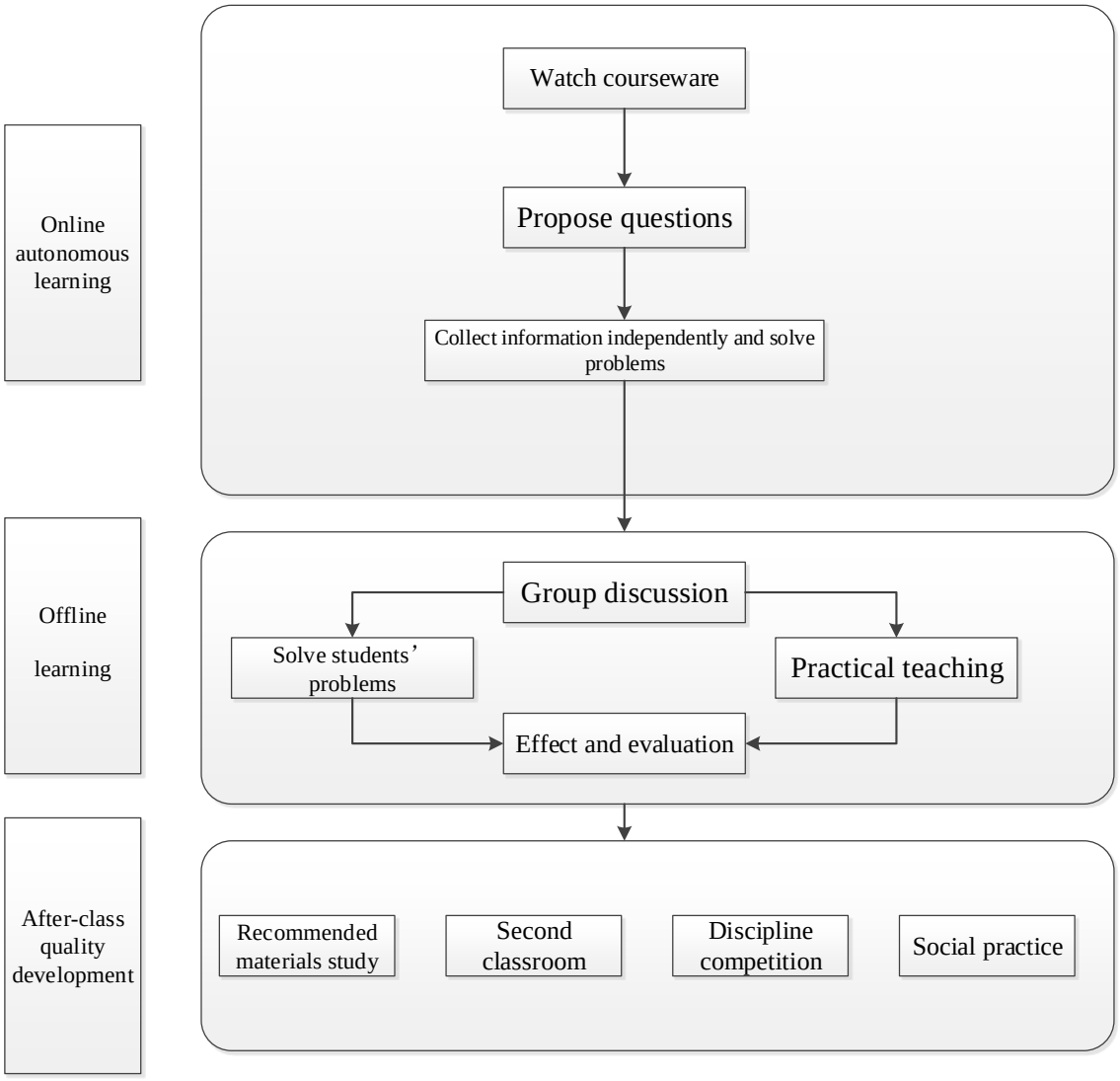

Figure 1: Course teaching design

3.3 Case-based teaching

Case-based teaching has several benefits for students, including the development of their autonomous learning skills and their ability to think academically. This method encourages students to create mathematical models to solve practical problems and to design software based on those models. In the context of teaching discrete mathematics to information security students, the course system can be optimized by breaking down knowledge barriers between different fields and using information security technologies in case designs. This approach helps students understand how discrete mathematics applies to information security and gain a deeper understanding of the basic principles of the field. For instance, linking the group concept to the Caesar cipher can increase students' interest in learning about information security.

3.4 Exercise teaching practice

Discrete mathematics is a fundamental course in the field of information security and is also considered a professional mathematics course, possessing many of the key characteristics of typical math courses. The teaching of exercises plays a crucial role in the overall education of this subject. To ensure effective learning, a staged exercise teaching method is adopted, with process assessment serving as a key monitoring tool. In addition, modern teaching techniques, such as MOOC and flipped classroom models, are incorporated to enable collaborative discussions of exercises in groups and to encourage students to develop multiple solutions to each problem. For instance, when covering proof methods in propositional logic, students are guided to analyze and discuss various approaches, including truth tables, equivalent calculus, and others. Furthermore, since discrete mathematics consists of several relatively independent parts, cross-referencing is essential to achieve a comprehensive understanding. For example, knowledge of algebraic systems provides an essential foundation for understanding calculus of connectives in mathematical logic. Similarly, comparison of De Morgan formulas in mathematical logic and set theory,

and binary relations can provide deeper insight into the application of algebraic systems.

4 SUMMERY

Discrete mathematics is a crucial basic course for information security major, which not only emphasizes the professional characteristics of the discipline but also emphasizes the practical application of mathematical knowledge. To enhance the effectiveness of teaching, it is essential to integrate the teaching content with the professional characteristics of information security and to use a variety of teaching modes. The proper integration of these elements is significant for improving the information security professional curriculum system. In recent years, the author in charge of discrete mathematics teaching has made considerable efforts in teaching reform, which has yielded positive results. In the future, further optimized teaching methods will be explored to continuously enhance the quality of teaching. This project is supported by the Undergraduate Education Teaching Research and Reform Project of Chengdu University of Information Technology (No. JYJG2021061, No. JYJG2021100).

REFERENCE

- Liu, H., Zhang, X., & Zhu, W. (2012). Exploration of Discrete Mathematics Teaching for Information Security [J]. *Computer Education*, 15, 23-25.
- Zhao, M., Mao, J., & Chen, W. (2016). The design of three-dimensional information-based discrete mathematics interactive teaching method for information security majors [J]. *Computer Education*, (3), 32-33.
- Wang, H., & Wang, B. (2012). Exploration on Teaching Reform of Discrete Mathematics Course for Network Security and Law Enforcement [J]. Journal of Chinese People's Public Security University (Natural Science Edition), 18(2), 98-100.
- Chen, H. (2020). Exploration and Practice of Ideology and Politics in Mathematics Courses [J]. *Chinese University Teaching*, 11, 44-49.
- Li, G. (2018). Research on Ideological and Political Education in Colleges and Universities Based on Mathematical Thinking Methods [D]. Guiyang: Guizhou University of Finance and Economics, 2018.
- Liu, W. (2011). Teaching research on the integration of mathematics culture into discrete mathematics [J]. *Computer Education*, 6, 52-55.
- Cao, M. (2021). Ideological and Political Design and Practice of Organic Chemistry Course Based on Brain Science [J]. *University Chemistry*, 36(3), 1-5.
- Ren, X. (2009). Combining Discrete Mathematics and Computer Security to Improve Teaching [J]. *Software Guide*, 8(12), 196-197.