Advances in Educational Technology and Psychology (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/aetp.2025.090501
ISSN 2371-9400 Vol. 9 Num. 5

Research on the Innovative Teaching of Discrete Mathematics Courses under the Background of Engineering Certification

Wang Qiming, Chang Xinfeng, Xu Pengfei

Pingdingshan University, Pingdingshan, Henan, China
wqm8157@126.com

Keywords: Engineering Certification, Course Ideological and Political Objectives, Ideological and Political Cases, Teaching Methods, Continuous Improvement

Abstract: According to the requirements of engineering education professional certification, the course objectives need to support the achievement of graduation requirements. Combined with the content and characteristics of this course, ideological and political objectives are added to the course objectives, and ideological and political elements are integrated into the course objectives through the reform of teaching methods, teaching means, and assessment methods. The course is continuously improved based on feedback, and ideological and political education is silently integrated into the course education.

1. Discrete Mathematics Teaching

Discrete mathematics is a core basic course for all computer majors, mainly studying discrete structures and their interrelationships. The course content covers mathematical logic, set theory, graph theory, algebraic structures, etc. It provides students with mathematical tools to process discrete data and cultivate abstract thinking and logical reasoning abilities. Through the study of this course, students can be trained to solve practical problems with abstract, generalized, integrated and logical reasoning methods, lay a solid mathematical foundation for students to improve their professional theoretical level, and prepare for the study of subsequent professional theoretical courses. Taking the Internet of Things Engineering major as an example, discrete mathematics is the theoretical cornerstone for understanding data structures, algorithm design, network topology, information security and other fields, and is of great significance to professional learning and scientific research[1].

2. Ideological and political objectives of discrete mathematics courses

2.1 Course Objectives

According to the requirements of engineering certification, the course objectives support the achievement of graduation requirements and knowledge. Combined with the content and characteristics of this course, the following course objectives are formulated to support the corresponding graduation requirements:

2.1.1 Course Objective 1

It's able to use logic, sets, functions, relations, graphs, trees, counting and other related knowledge and methods to represent and describe the objects and relations involved in engineering problems using discrete structures. To support the graduation requirements, this course requires students to be able to use logic, sets, functions, relations, graphs, trees, counting and other related knowledge and methods to represent and describe the elements and discrete structures of the model according to actual application requirements, and to analyze, describe and reason about complex engineering problems in the Internet of Things[2].

2.1.2 Course Objective 2

It's able to use modeling knowledge such as logic, sets, functions, relations, graphs, trees, and counting to deduce and analyze the completeness of modeling schemes in engineering and the constraints between model elements according to specific application contexts[3]. To support graduation requirements, this course requires students to be able to use modeling knowledge such as logic, sets, functions, relations, graphs, trees, and counting to deduce and analyze the completeness of modeling schemes in engineering and the constraints between model elements according to actual application requirements.

2.1.3 Course Objective 3

It's able to analyze the premise conditions according to the problem description, apply the knowledge and principles of mathematical logic, algebraic systems, set theory, graph theory, etc., construct mathematical model methods, correctly express complex engineering problems in the field of Internet of Things, and thus select reasonable and effective mathematical models and conclusions. To support the graduation requirement indicators, this course requires students to be able to analyze the premise conditions according to the problem description, apply the knowledge and principles of mathematical logic, algebraic systems, set theory, graph theory, etc., construct mathematical model methods, correctly express complex engineering problems in the field of Internet of Things, and thus select reasonable and effective mathematical models and conclusions[4].

2.2 The ideological and political objectives of the course

According to the requirements of the professional education of the course, the project team carried out ideological and political course reform, fully explored the moral education elements in the political beliefs, ideals and beliefs, values, moral sentiments, spiritual pursuits, scientific thinking, and craftsmanship contained in the course, and organically integrated the ideological and political education content with the professional knowledge and skills education content, and formulated the ideological and political goals of this course:

2.2.1 Course Objective 1

We need to have literacy in the humanities and social sciences, civic morality and social responsibility, be able to understand and follow engineering professional ethics and norms in the practice of IoT engineering, and earnestly fulfill their due responsibilities[5].

2.2.2 Course Objective 2

We need to have a craftsman spirit at work. This is reflected in the pursuit of excellence in technical details, strict control of engineering quality, and continuous pursuit of innovation[6]. They

treat each project with a rigorous attitude, focus on the combination of practice and theory, pursue excellence, complete work tasks with a high sense of responsibility and professionalism, and demonstrate the professionalism of IoT engineers and their persistent pursuit of quality.

2.2.3 Course Objective 3

We need to have engineering thinking and innovation awareness at work. Demonstrate solid engineering thinking at work, be able to systematically analyze complex engineering problems, and use professional knowledge to solve practical problems throughout the entire process from demand research, solution design to implementation optimization. At the same time, they have a keen sense of innovation, are not limited to traditional methods, are good at combining emerging technologies, and propose optimization solutions, injecting new impetus into the intelligent upgrade of the Internet of Things system and the expansion of application scenarios, and promoting technological progress and industrial upgrading in the industry[7].

2.2.4 Course Objective 4

Students have a scientific spirit and a sense of patriotism. Students have a solid scientific spirit, can analyze complex engineering problems with a rigorous attitude and scientific methods, focus on combining practice with theory, and pursue technological innovation and breakthroughs. At the same time, they have a deep sense of patriotism, pay attention to national strategic needs, closely combine personal development with national interests, actively engage in cutting-edge research and application development of Internet of Things technology, and contribute wisdom and strength to promote independent innovation and high-quality development of China's Internet of Things industry.

3. Integration of ideological and political elements

Although the course team has set ideological and political teaching objectives, in order to integrate ideological and political education into the course education subtly, it is necessary to extract the ideological and political elements and design them carefully.

3.1 Cultivation of humanities and social science literacy, civic ethics and social responsibility

When explaining propositional logic and reasoning rules, introducing classic cases in ethics, such as the "trolley problem", can effectively stimulate students' interest in learning and help them understand the application of logical reasoning in complex situations.

Step 1: Introduce the case context. Take the "trolley problem" as an example. First, introduce the case context to students: an out-of-control trolley is about to kill five people, but you can pull a lever to divert the trolley to another track, thereby saving the five people. However, the diversion will kill one person. The question is: should you pull the lever?

Step 2: Constructing propositional logic. Extract the key propositions from the case:

P: Pull the lever, saving five people but killing one person.

Q: If you don't pull the lever, five people will die, but no one will be killed directly by you.

Step 3: Application of reasoning rules. Guide students to use the reasoning rules of propositional logic to analyze, affirm the antecedent - if P, then Q. If the lever is pulled, one person will be sacrificed to save five people; negate the consequent - if not Q, then not P. If you do not accept the result of sacrificing one person, then do not pull the lever; disjunctive reasoning - $P \vee Q$, that is, you must choose a result, either sacrifice one person to save five people (P), or do not take action and cause the death of five people (Q).

Step 4: Combining ethics with logical reasoning Through logical reasoning, students can see the inevitability of the two choices, but logic cannot determine the "correct" choice because it involves ethical judgments: the utilitarian perspective is from the perspective of maximizing benefits, P (sacrifice one person to save five people) is the better choice; the Kantian ethical perspective is from the perspective of moral law, not actively harming others (not pulling the lever) may be more in line with moral principles.

Step 5: Classroom Discussion and Summary Organize students to discuss and guide them to think. Logical reasoning can help us analyze problems clearly, but ethical decision-making also needs to consider moral principles. In complex situations, logical reasoning and ethical judgment complement each other. Logic provides an analytical framework, and ethics provides value judgments. Through such case introductions, students can not only master propositional logic and reasoning rules, but also understand the limitations of logic in practical problems and cultivate their ability to analyze problems comprehensively.

This method of combining ethics cases can not only enhance the practicality of logical reasoning, but also broaden students' thinking horizons and make the course more attractive and in-depth.

3.2 Cultivation of engineering thinking and innovative consciousness

When teaching propositional logic and predicate logic, we can use the design case of the smart home system to specifically illustrate the importance of logical thinking in system architecture design, and integrate ideological and political elements to cultivate students' rigorous system thinking and sense of responsibility. Taking a specific smart home case as an example, the smart home system design uses sensors, controllers and communication networks to achieve interconnection between devices, improving the convenience, safety and comfort of life. In the design process, logical reasoning is an important tool to ensure that the system functions correctly and works together[8]. Application of propositional logic in smart home Suppose we design a simple smart home lighting control system involving the following propositions:

P: There is someone in the room.

Q: It is night now.

R: The light is on.

The logical expression of the system rules is:

If there is someone in the room (P), turn on the light (R): $P \rightarrow R2$.

If it is night (Q), turn on the light (R): $Q \rightarrow R3$.

If no one is in the room ($\neg P$) and it is not night ($\neg Q$), turn off the light ($\neg R$): $(\neg P \land \neg Q) \rightarrow \neg R$

Application of logical reasoning:

Suppose the sensor detects that there is no one in the room ($\neg P$), but it is night time (Q). Based on Rule 2 ($Q \rightarrow R$), the system infers that the light should be turned on (R). Even though there is no one in the room, the light needs to be turned on at night for safety reasons. Through propositional logic, the system can clearly infer the correct state of the device.

Application of predicate logic in smart home In more complex scenarios, predicate logic can be used to describe the relationship and properties between devices. For example: Light(x): x is a light, On(x): x is on, PersonInRoom(x): x is in the room, Night(): it is night.

The predicate logic of the system rules is expressed as follows: for all devices x, if x is a light and there is someone in the room, then x should be turned on: $\forall x$ (Light(x) $\land$ PersonInRoom(x)) $\rightarrow$ On(x) ; for all devices x, if x is a light and it is night, then x should be turned on: $\forall x$ (Light(x) $\land$ Night()) $\rightarrow$ On(x) ; for all devices x, if x is a light and there is no one in the room and it is not night, then x should be turned off: $\forall x$ (Light(x) $\land$ $\neg$PersonInRoom(x) $\land$ $\neg$Night()) $\rightarrow \neg$On(x) .

Application of logical reasoning Suppose the system detects that there is no one in the room

(¬PersonInRoom(x)), but it is night (Night()). Based on the rules, the system infers that all lights (Light(x)) should be turned on (On(x)). This reasoning process not only takes into account the properties of the device, but also the environmental conditions, ensuring that the system can make correct decisions in complex scenarios.

In short, in the major of Internet of Things Engineering, propositional logic and predicate logic are not only theoretical knowledge, but also important tools for solving practical problems. Through the design case of smart home system, students can understand the importance of logical thinking in system architecture design, and cultivate systematic thinking, rigor and sense of responsibility, laying a solid foundation for future career development.

4. Teaching methods and means of ideological and political education in courses

4.1 Teaching Methods

With the teaching idea of "student-centered and teacher-led" and the cultivation of discrete modeling thinking as the guide, a problem-centered inquiry-based teaching model is carried out through an "interactive and open" classroom format, as shown in Figure 1. Specifically, classroom teaching is the main method, combined with self-study, homework and student autonomous learning, and a problem-based, discussion-based and exchange-based education method is adopted. Ideological and political elements are integrated into the teaching process, based on actual application problems, to improve students' ability to solve engineering problems and meet the requirements of the course objectives.

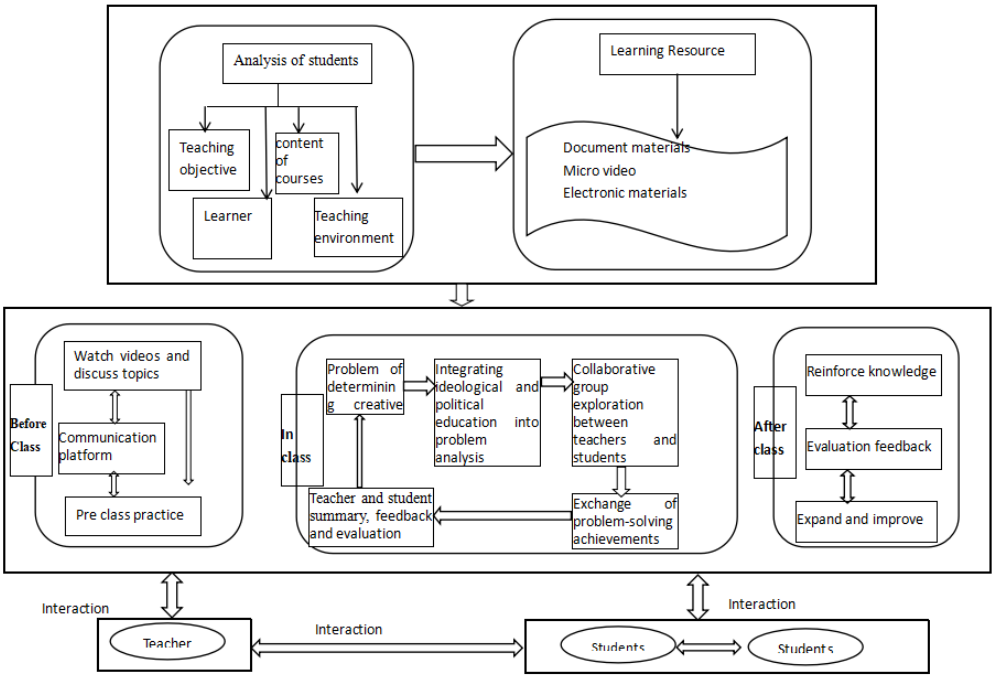

Figure 1 Teaching model design

4.2 Implementation methods

In the revision of the syllabus for discrete mathematics courses, the construction of ideological and political courses is included in the core tasks, the synergistic relationship between ideological and political goals and teaching goals is clarified, and they are deeply integrated with the specific

indicators of graduation requirements to achieve a two-way connection between professional education and ideological and political education.

In the course design, ideological and political elements are integrated into the theoretical and practical aspects. In the theoretical assignments, discussion questions related to professional knowledge are added to guide students to analyze problems from the perspective of ideological and political education, such as the social impact and ethical issues of IoT technology; in the programming practice assignments, by emphasizing indicators such as code quality and complexity, students' craftsmanship is cultivated, such as paying attention to details such as the number of lines of code and readability. Through this design, the deep integration of professional knowledge and ideological and political education is achieved, providing strong support for the all-round development of students.

Improve the final assessment content of the course and integrate the ideological and political elements of the course into the examination. Discrete mathematics examination content can introduce essay questions to discuss the application of a discrete mathematics knowledge point, thereby reflecting the ideological and political elements and guiding students to think about correct values from a result-oriented perspective.

4.3 Teaching Assessment

Explore and practice teaching methods and teaching means suitable for the characteristics of discrete mathematics, and reform the course assessment method. With students as the center, introduce the evaluation of the effect of ideological and political education in courses into the comprehensive evaluation of courses, change the traditional evaluation method of homework and test papers, and make observation evaluations based on exchanges, discussions, and classroom performance; make written evaluations based on experience, summary plans. Add the evaluation of teachers, invite students to evaluate the ideological and political education of courses, and timely improve the content and methods of ideological and political education in courses, so as to achieve the effect of educating people through two-way evaluation.

4.4 Building a diversified and continuously optimized course quality evaluation system

After integrating the elements of ideological and political education into discrete mathematics teaching, it is necessary to build a diversified course quality evaluation system, measure the teaching effect of ideological and political education through questionnaires, student interviews, etc., and analyze its role in promoting the overall teaching effect. Based on evaluation feedback, we need to continuously optimize course design and implementation to ensure continuous improvement of teaching quality. Through the closed-loop mechanism of "evaluation-feedback-improvement", promote the deep integration of ideological and political education and professional knowledge, and provide strong support for the all-round development of students.

5. Conclusion

In the next step of work, the course team will continue to improve, optimize the ideological and political goals of the course , iterate cases, increase the linkage and synergy with other courses, and then deepen the reform of curriculum construction, cultivate students' comprehensive ability and thinking to solve complex engineering problems in the Internet of Things engineering , implement the fundamental task of cultivating morality and cultivating people , further enhance the effectiveness of ideological and political education, and achieve a win-win situation for professional course teaching and ideological and political work.

Acknowledgements

General Ideological and Political Demonstration Courses of Pingdingshan University in 2022

References

[1] He Chuming, Liu Dongning. The integration of computational thinking and ideological and political education in discrete mathematics courses[J]. Computer Education, 2023, (02): 79-82. DOI: 10.16512/j.cnki.jsjjy.2023.02.001.
[2] Cai Lingxia. Reform and practice of ideological and political teaching in discrete mathematics courses: A case study of henan Open University [J]. Journal of henan Open University, 2022, 26(03): 33-36.
[3] Wang Hai, Yuan Zhen, Li Pengwei. Reform of ideological and political teaching in discrete mathematics courses under the background of engineering certification [J]. Western Quality Education, 2023, 9(24): 35-39. DOI: 10.16681/j.cnki.wcqe.202324009.
[4] Zhang Yunyi, Li Jingzhu. Exploration and practice of ideological and political teaching in discrete mathematics courses [J]. Intelligence, 2023, (35): 179-182.
[5] Pang Denghao, Wang Haitao. Research on ideological and political construction of core basic courses in colleges and universities under the background of new engineering: Taking "discrete mathematics" as an example [J]. Journal of Hefei University (Comprehensive Edition), 2023, 40(05): 125-129.
[6] Chen Kehua. Exploration and practice of ideological and political education in the course of "Discrete Mathematics"[J]. Journal of Ningde Normal University (Natural Science Edition), 2022, 34(01): 100-103. DOI: 10.15911/j.cnki.35-1311/n.2022.01.020.
[7] Geng Suyun, Qu Wanling, Zhang Liang. Discrete Mathematics (6th Edition) [M]. Beijing: Tsinghua University Press, 2022
[8] Liu Dongmei, Li Yu. Teaching Reform and Practice of "Intellectual Property Law" Course Based on Ideological and Political Education [J]. Heilongjiang Education (Higher Education Research and Evaluation), 2021(09): 87-89.