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Exploration of Teaching Reform in Programming Courses under the Background of Emerging Engineering Education

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Abstract: In the context of new technologies, in order to accelerate the pace of building a technological powerhouse, the government has proposed to involve everyone in the smart education program and actively promoted the teaching of programming. The government encourages schools at all levels to offer programming courses and introduces artificial intelligence training in education at all levels. In the actual teaching process of programming, many teachers' teaching methods are relatively monotonous and cannot effectively stimulate students' interest and participation in learning. The blended teaching method advocated in this article referred to organizing students to watch online video courses through online learning platforms, and scientifically and reasonably dividing students into different groups in the classroom. By implementing the content of online video courses through offline group collaboration teaching, students could play a leading role in the classroom, thereby improving the teaching quality of programming courses. The final survey analyzed that students' classroom performance in terms of professional norms and their ability to complete assignments individually and in groups improved by 30%.

1. Introduction

With the passage of time, the structure of the computer industry is constantly changing, and the demand for programming products in various industries is increasing. The degree of dependence is also increasing. Large and small mobile internet enterprises, electronic technology enterprises, and online gaming enterprises are all rapidly developing, and the demand for employees in this field, as well as the requirements for talent structure, are undergoing significant adjustments in this trend. This requires more creative and practical talents to complete this adjustment.

Experts have long conducted relevant research on the teaching reform of programming courses. In the context of engineering education certification, Cai M proposed a research on the teaching reform of C language courses based on the OBE (Outcome Based Education) concept, in response to the problems existing in C language courses and following the principle of results orientation. In response to the shortcomings of the C language course in traditional education methods, reform

measures were proposed from three aspects: teaching mode, ideological and political elements, and assessment, and the reform results were elaborated. The aim was to further optimize the teaching of C language courses and improve teaching quality through teaching research on C language courses [1]. Yuan G used Yunnan University as an example to analyze the necessity and importance of improving students' programming skills. Taking Yunnan University as an example, he analyzed the necessity and importance of improving students' programming ability. He explored the exploration and practice of improving students' programming ability from four aspects: the arrangement and reform of programming courses, the construction of online programming practice innovation platforms, programming ability certification, and the organization of programming competitions. These reforms achieved good results in recent years and could provide reference for the practical teaching reform of computer majors in relevant universities [2]. Vinnervik P reported a survey on teachers preparing to implement new policies. Less than four months after the implementation of the new curriculum reform, a group interview was conducted to conduct in-depth research on the preparation process before the new curriculum reform and collect relevant information. The research findings were conceptualized through both internal and external challenge frameworks, revealing several challenges that might affect the acceptance and implementation quality of programming policies, such as uncertainty in subject content, inequality in professional development opportunities, lack of teaching materials, and frequent problems in school information technology infrastructure [3]. The classroom reform of the above literature has had some effect, but it is not thorough enough.

The emerging engineering education has been a topic being explored by various universities in recent years. Emerging engineering education emphasizes the integration of engineering technology with natural sciences, social sciences, humanities and arts, and promotes the cross-border integration of engineering education and scientific research. This article aimed to explore the teaching reform of program design courses in the context of emerging engineering education, explored the strategies for program design course reform, and conducted a survey and research on the achievements of university reform. Faced with the issue of current university teaching content deviating from the reality of society, the research topic of this article was of great research significance.

2. Teaching Reform of Programming Courses in the Context of Emerging Engineering Education

2.1. Characteristics of Programming Courses

Programming courses usually focus on a programming language, which includes a series of online exercises, language grammar introduction, use of programming interfaces and language tools, design and development of different applications and systems, problem-solving, and classroom work [4].

(1) The focus is on cultivating computational thinking and system design skills [5].

Learning a programming language is not about rote memorization of grammar rules, but about learning the characteristics of the language, how to use the language, how to use programming thinking to solve problems in learning and life, and how to deeply use computer tools [6].

(2) Equal emphasis on theory and practice

In addition to theoretical learning in assistive courses, online practice is even more important. As long as the program is debugged multiple times, it is necessary to avoid paper-based discussions and exploration, continuously improve programming skills, and cultivate patience, diligence, perseverance, and a master's demeanor. Therefore, courses generally divide the theoretical and practical hours equally [7].

(3) The assessment method is different from traditional subjects.

The above two characteristics determine that the exam format of the programming course is not suitable for closed written exams. The exam must allow students to write and debug programs in a programming environment, which is mainly a grammar framework and does not require students to memorize too many details of the API (Application Programming Interface). It is a more realistic test of programming ability [8].

2.2. Strategies for Adopting a Blended Teaching Model in Programming Courses

(1) Adopting a blended teaching model to create problem situations

When learning programming courses, there are significant differences in students' basic level, and different students have different learning expectations when learning this type of course [9].

To change this situation, it is necessary to implement staggered education for students of different levels in the daily teaching process. The main reason for this is that the teaching objectives of teachers are the ultimate goal of teacher education, and the goal of teacher education is the core of teacher education. Therefore, in order to complete teaching tasks with high quality and quantity, teachers must clearly set daily teaching objectives. These teaching objectives must be carefully decomposed. At the beginning of class, based on the actual situation of students in the classroom, problem scenarios must be created to allow students to think about the problems raised by the teacher, and then analyze the learning tasks [10]. At the beginning of the classroom, it is necessary to create problem scenarios based on the actual learning situation of students, encourage students to think about the problems raised by the teacher, analyze the problems, and find effective solutions. Usually, in the introduction process of a course, the teacher creates a problem situation related to the learning objectives, which can quickly attract students' attention and facilitate a questions and answers interaction between the teacher and students, thereby understanding how students absorb new and old knowledge and encouraging students to achieve their creativity based on their initial understanding of the map [11].

(2) Adopting a blended teaching mode and designing teaching content

In this blended learning model, teachers need to scientifically organize and optimize teaching content in order to better achieve teaching objectives, allowing students to acquire both theoretical knowledge and practical skills and experience [12]. Blended learning includes both online and offline forms, and videos of teaching materials should be prepared before class. Therefore, in order to maximize the effectiveness of online and offline blended learning, teachers must have a comprehensive understanding of the concepts and theoretical knowledge contained in textbooks, have a comprehensive understanding of relevant or difficult knowledge in the classroom, and decide and implement an innovative teaching method on how to use online resources without deviating from the purpose of the textbook [13].

(3) Reasonably utilizing multiple teaching modes

Applying blended learning to programming courses requires multiple teaching methods. For example, during the teaching process, teachers can use situational methods, multimedia and other means to help students quickly learn programming. Adopting this blended learning approach requires the organic integration of various learning methods in programming courses to achieve the goal of improving course quality [14]. In the process of designing courses, it is necessary to cultivate students' autonomy. Teachers should combine with the course design, fully utilize micro courses and online activities, so as to fully stimulate students' learning enthusiasm, fully unleash their learning enthusiasm, and form a good learning habit [15-16]. To achieve blended learning, it is necessary to attach importance to emotional communication between teachers and students. Teachers should provide emotional guidance to students in order to effectively reduce their learning

pressure. On this basis, through the flexible application of blended learning, students' confidence and comprehensive quality can be improved [17].

2.3. Current Status of Programming Courses

Programming ability is a necessary quality for software developers. For the discipline system of computer science, programming should be its core discipline [18]. Due to the complex knowledge points involved in programming courses, the corresponding course practice is also complex. Due to the complexity of programming courses, the corresponding exercises are also very complex. This course would take C++programming as an example, focusing on explaining the principles and techniques of object-oriented programming, so that students can have a deeper understanding of the concept reform of object-oriented technology. At the same time, students can have a better understanding of object-oriented programming languages and the rules, programs, and ways of thinking in object-oriented design. At the same time, they can also have a better understanding of the development trends of object-oriented programming technology and make attempts on this basis [19-20]. Based on the experience of the teaching process, this article finds that the main problems faced in teaching are as follows.

(1) There are significant differences among individual students, and homogenized teaching content cannot meet teaching needs.

(2) Computational thinking is difficult to cultivate and learning motivation is limited.

(3) Theory and practice are disconnected, and students' classroom participation is insufficient.

2.4. Evaluation of Learning Effectiveness

According to the requirements of engineering education certification, the entire learning process of students should be monitored and evaluated to determine whether their learning objectives have been achieved and whether the expected learning outcomes have been achieved. When conducting evaluations, the focus should be on learning outcomes, rather than prioritizing learning content, learning time, and learning methods. In the evaluation process, multiple evaluation criteria and graded evaluation criteria should be used to reduce comparisons between students and focus more on the content of learning outcomes achieved and personal progress. Based on the level of "dissatisfaction" to "excellence", targeted evaluations are conducted based on the level at which each student meets their teaching needs. The programming course uses various evaluation methods, mainly classroom assignments, experiments, assignments, mid-term and final exams, with the aim of improving students' practical work abilities, innovative thinking, teamwork spirit, and related learning needs, and evaluating and analyzing their learning results. The corresponding relationship between learning effectiveness evaluation methods and learning needs is shown in Table 1 on the following page, with specific descriptions as follows:

Firstly, academic achievement (10%): based on academic performance and completion of successful courses, their academic achievement is evaluated.

Secondly, experimental (20%): the exam is divided into three parts: evaluative exam, strategic exam, and comprehensive exam, with appropriate tests tailored to different learning needs. In the evaluation, based on different learning needs, different evaluation methods were adopted and divided into three levels: student self-evaluation (20%), group mutual evaluation (30%), and teacher evaluation (50%). The specific calculation formula is as follows.

$$Score_e = 20\% \times S + 30\% \times G + 50\% \times T \tag{1}$$

Among them, S refers to student self-evaluation; G refers to group mutual evaluation; T refers to

teacher evaluation.

Thirdly, learning from home (10%): appropriate assignments are designed for each student's different needs, and corresponding evaluation criteria are established. The homework results of the students would be used as a reference for exam results.

Fourthly, mid-term exam (20%) and final exam (40%): the mid-term exam methods for each course are different. Some courses mainly focus on practical projects, with small groups as the unit and the same tests as the main content. Others test students' abilities through tests, which would be evaluated based on mid-term and final exams.

Table 1: Correspondence matrix between learning effectiveness evaluation methods and learning needs

Effectiveness evaluation methodology		Classroom Performance	Experiments	Homework	Midterm Exam	Final Exam
learning need	Weighting (%)	10	20	10	20	40
	Engineering knowledge	√		√	√	√
	Problem analysis	√	√	√	√	√
	Designing solutions	√	√	√	√	√
	Engineering and Society		√		√	√
	Individuals and Teams		√		√	√
	Project Management		√		√	√
	Professional Norms	√	√	√	√	√
	Lifelong Learning		√	√		

$$\text{Score} = w_1 C + w_2 E + w_3 A + w_4 T_m + w_5 T_f \tag{2}$$

Among them, C, E, A, T_m, and T_f represent classroom performance, experiments, assignments, mid-term exams, and final exams, respectively. w_1, w_2, w_3, w_4, and w_5 refer to weights.

Teaching effectiveness evaluation refers to the level of students' understanding of the course they are learning, and the results of the evaluation are used to continuously improve teaching. The primary goal of evaluating course learning outcomes is not to supervise teaching quality, but to identify differences in teaching activities and achieved teaching outcomes, degree requirements, and student learning needs, and adjust these differences accordingly to achieve continuous improvement. The continuous improvement includes improving teaching methods, improving teaching evaluation, improving students' learning outcomes, and improving teaching methods and skills. During the evaluation process, teachers should adjust the teaching content and methods in a timely manner based on the evaluation results to correct any deviations that may arise in teaching. In order to achieve the goal of continuous improvement in the curriculum, this article would explore the reasons for this difference in the following steps. For students, this is to recognize the impact of learning on them, so that they can adjust their learning goals, learning methods, and learning skills

in a timely manner.

3. Curriculum Reform Achievements and Evaluation

3.1. Achievement of Learning Objectives

Through this course, students can understand and apply basic programming methods such as data types, program control structures, functions, arrays, pointers, etc.; students can understand and apply Object Oriented Programming (OOP) methods such as classes, objects, inheritance, derivation, polymorphism, etc.; students can understand and apply basic methods of generic programming such as vectors, stacks, queues, linked lists, etc.; students can explain the ideas and methods of programming; students can use programming and development tools correctly, and can analyze and model practical problems; students can possess computational thinking in problem-solving and be able to utilize systems.

3.2. Student Evaluation Feedback

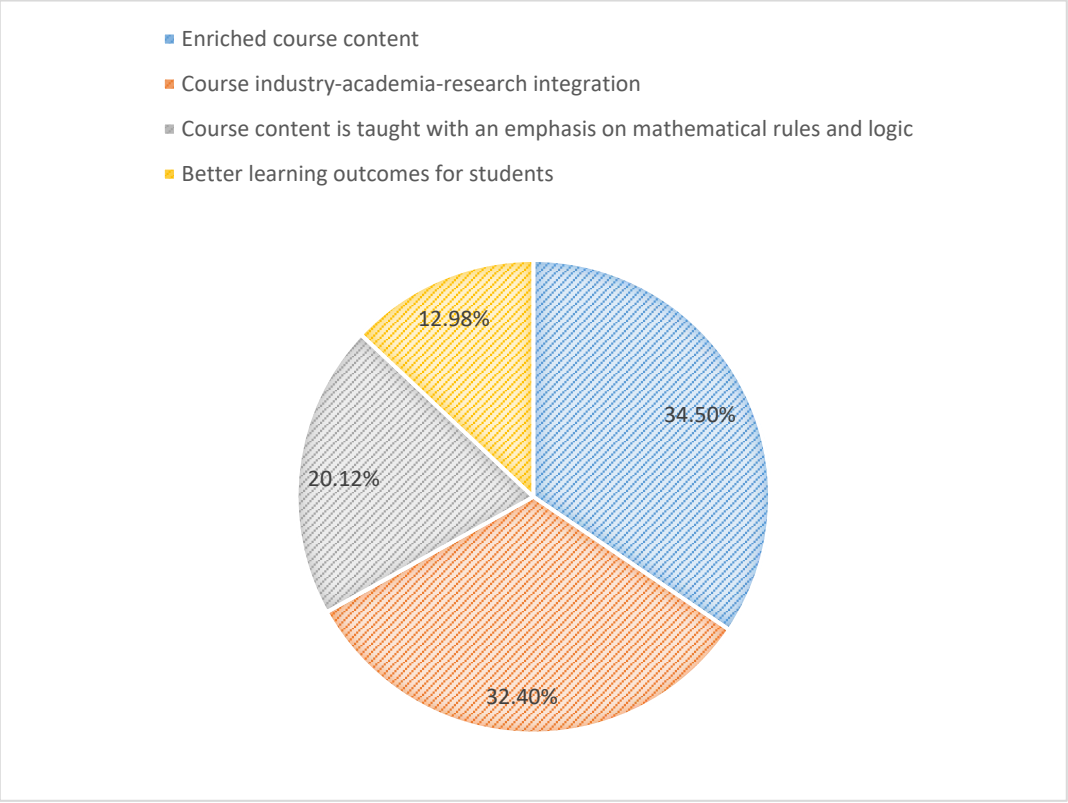

Figure 1: Student evaluation

As shown in Figure 1, students generally believed that the course teaching content was rich and could combine current events, cutting-edge disciplines, and teaching examples. Feedback from students participating in this course: By studying programming principles, students no longer analyzed problems from a single perspective, but focused on the mathematical laws and logical structures within the problem. Students developed good programming habits and analytical thinking, laying a solid foundation for future learning of other computer courses.

3.3. School Evaluation and Peer Evaluation

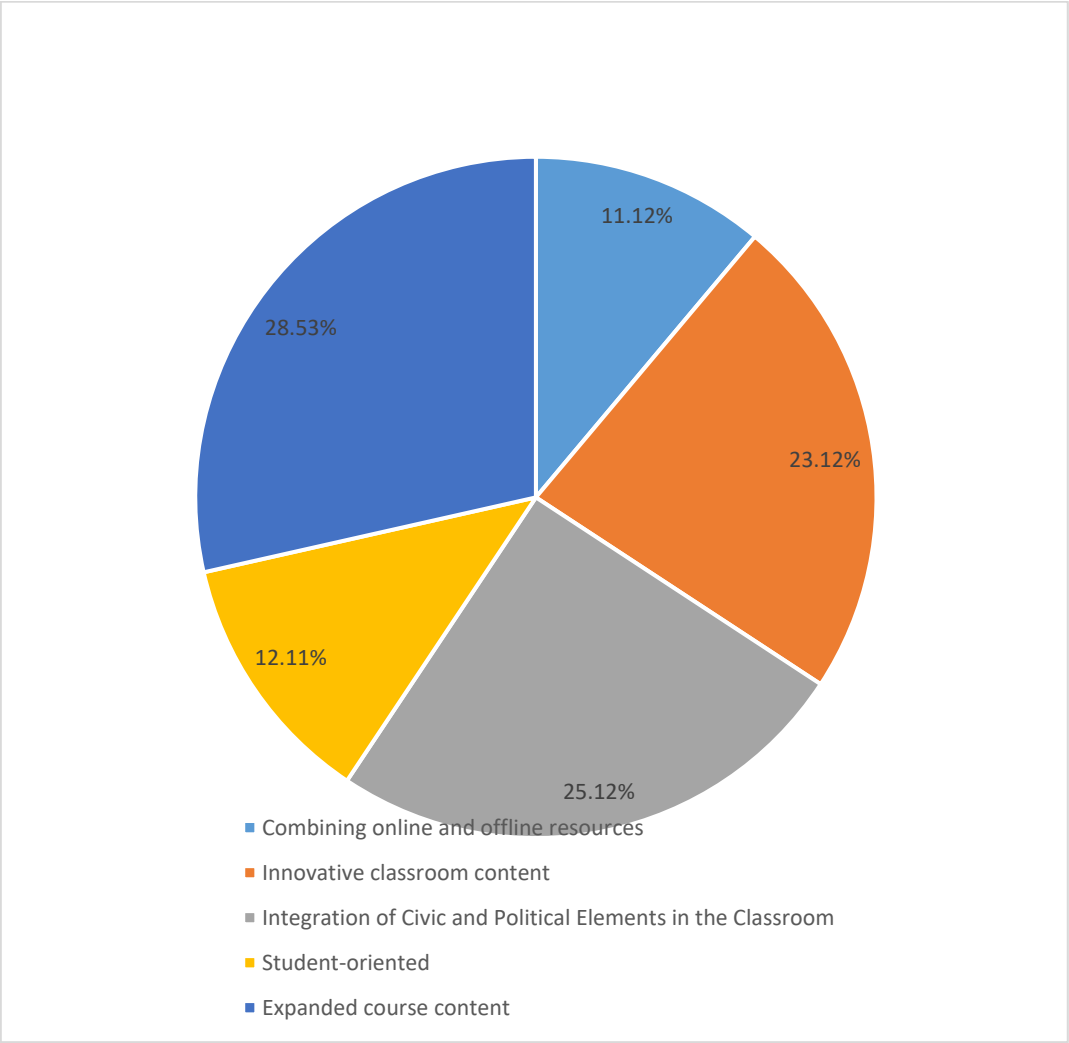

Figure 2: School evaluation and peer evaluation

The leader of the school supervision team stated that they can utilize online and offline resources to carry out high-level blended teaching, stimulate students' learning initiative, and cultivate systematic thinking, so as to improve practical abilities. The teaching content can keep up with the forefront of professional development, ensure the innovation of the course content, and integrate ideological and political elements of the course, thus achieving both teaching and educating, which helps to cultivate students' scientific and craftsman spirit, as shown in Figure 2. The teaching design embodies the concept of "student-centered", which can combine professional characteristics and student foundation to select examples and exercises, ensuring the challenge of practical operations. The teacher who taught the course of data structure stated that students' practical programming skills have generally improved, and the addition of basic algorithms and other expandable content in the course has reduced barriers between courses, laying a solid foundation for subsequent professional course learning.

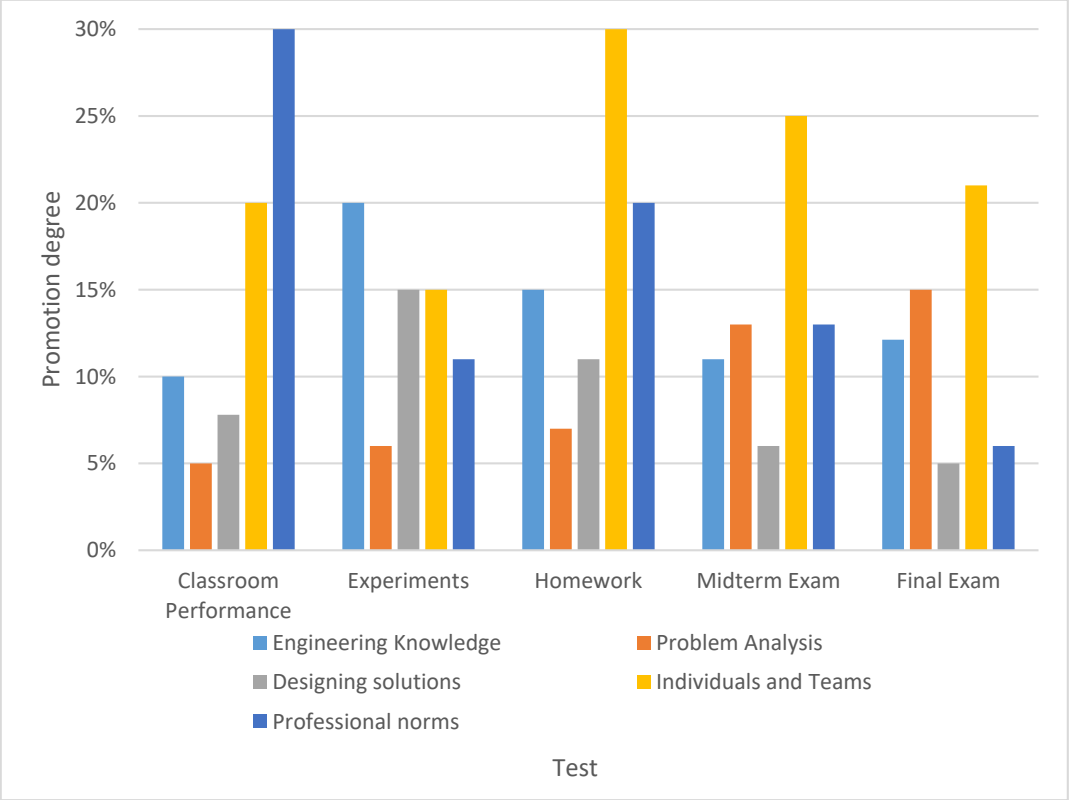

Figure 3: Improvement of students under classroom reform

As shown in Figure 3, under the new teaching mode, students' engineering knowledge, problem analysis, design solutions, individual and team, as well as professional norms all improved to varying degrees. In terms of professional norms, students' classroom performance improved by 30%; in terms of individuals and groups, students' ability to complete assignments increased by 30%.

4. Conclusions

In the context of the emerging engineering education discipline, this article reformed the programming curriculum from the perspectives of curriculum system, teaching mode, and practical teaching, in order to solve the problems of narrow audience, weak pertinence, and insufficient support for innovation and entrepreneurship in curriculum teaching for college students. At present, teaching feedback indicates that the reform of programming courses has improved students' computational thinking ability, practical hands-on ability, and practical engineering problem-solving ability, thus making practical explorations with guiding significance for deepening teaching reform.

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