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Exploration of Teaching Reform in the Course of Computer Composition Principles Based on Engineering Education Certification

Donghong Shan[1, *], Shufeng Xiong[2], Huili Li[1]

[1]SoftWare School, Pingdingshan University, Pingdingshan, China

[2]School of Information and Science Management, Henan Agricultural University, Zhengzhou, China

Email address:

4335@pdsu.edu.cn (Donghong Shan), 5003273@ qq.com (Shufeng Xiong), 443628416@qq.com (Huili Li)

[*]Corresponding author

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Abstract: The article introduces the exploration and practice of the teaching reform of computer composition principles in local undergraduate colleges and universities across the country under the background of engineering education certification. The research group analyzes students' learning motivation, course content construction, teachers, and teaching methods, and lists the problems faced in the certification process. On the basis of analyzing the root cause of the problem, it is proposed that the reform of engineering education certification needs to be improved from the aspects of course teaching content, teaching design, teaching methods, teacher strength, etc., with a focus on exploring the ideological and political teaching of this course, case studies, and integration points with other series of courses (such as C program design, operating system, data structure, etc.), and introducing the content of industry written exams and exam questions from the Ministry of Human Resources and Social Security, Teaching design emphasizes student-centered thinking, encourages independent thinking, and encourages appropriate communication and discussion. On the one hand, it stimulates students' interest in learning, reduces their resistance to simple theoretical learning, and on the other hand, it can also cultivate students' ability to solve complex engineering problems. Through teaching practice verification, the effectiveness of teaching reform around engineering education certification in improving teaching quality has been verified.

Keywords: Engineering Education Certification, Computer Composition Principle, Teaching Reform

1. Introduction

As a local undergraduate institution, engineering education certification is an indispensable presence in the process of seeking connotation construction and development. Engineering education is an important component of higher education in China, and there is "one in three" in the higher education system [1]. According to statistical data from the China Association of Higher Education (https://www.cahe.edu.cn/), by the end of 2022, the number of engineering majors in China has reached 15733, with 5.51 million students on campus. The number of undergraduate engineering graduates accounts for about 38% of the world's total, ranking first in the total scale. Engineering education professional certification is an internationally recognized system for ensuring the quality of engineering education, and it is also an important foundation for achieving international mutual recognition of engineering education and engineer qualifications. As a local application-oriented undergraduate institution, it has encountered considerable pressure in the process of engineering education certification. In addition to widely drawing on the experience of sister universities, it is also necessary to combine its own characteristics and strengthen course construction in accordance with the engineering education certification goals to assist in engineering certification.

Since 2018, engineering education certification work has gradually begun to be implemented in the college. Around the well-known 12 graduation standards (https://www.ceeaa.org.cn/gcjyzyrzxh/Rzcxjbz/gcjyrzbz/index.html) for engineering education certification, significant reforms have been made in curriculum outline, teaching mode, and assessment methods, emphasizing the use of mathematics, natural sciences, engineering fundamentals, and professional knowledge to solve complex engineering problems, while strengthening students' problem analysis ability The cultivation of teamwork and lifelong learning abilities has achieved certain results in the certification process, which has to some extent improved students' ability to solve complex engineering problems. Engineering education certification is aimed at a major, and all courses in the entire professional system need to be linked in order to jointly meet the 12 graduation standards. Specifically, the course on the principles of computer composition is a compulsory course in three major directions: software engineering, computer science and technology, and data science and big data technology. Its importance is self-evident. Therefore, taking advantage of the trend of engineering education certification, we will study the certification teaching reform of the computer composition principle course, explore the teaching cases of this course and the integration points with other series of courses, and cultivate students' ability to solve complex engineering. This will provide some reference for similar courses and play a role in throwing away a brick in order to get a gem.

2. The Universality of Engineering Education Certification at Present

According to the China Youth Daily, as of the end of 2021, a total of 288 higher education institutions in China have obtained certification for engineering education in 1977 majors. Comparing with the 1600 majors of 257 universities in China that passed engineering education certification at the end of 2020, a total of 377 new certified majors were added in 2021, including light industry and energy and power. The certified majors of 31 new universities have changed from "none" to "have", which has steadily promoted the certification work of engineering education in China.

In China, the engineering education professional certification profession or industry association, association (federation) [2], together with educators in the field and relevant industry and enterprise experts, conducts a qualified evaluation for undergraduate engineering majors in higher education.

According to the "China Engineering Education Quality Report" (http://www.moe.gov.cn/jyb_xwfb/s7600/201411/t20141114178247.html), the number of engineering major admissions, current students, and graduates in China's ordinary universities remains the world's highest, with a number three to five times higher than that of closely followed countries such as Russia and the United States. At present, there is a structural surplus and shortage of engineering graduates in China, and the supply of engineering graduates at certain levels cannot fully meet the needs of enterprises and industries. The integration of talent cultivation chain with national innovation chain and industrial chain needs to be further strengthened. Since 2018, the certification of engineering education has gradually been implemented in our college, focusing on the well-known 12 graduation requirements for engineering education certify-cation standard (https://www.ceeaa.org.cn/gcjyzyrzxh/rzcxjbz/gcjyrzbz/index.html) has undergone significant reforms in curriculum outline, teaching mode, and assessment methods, emphasizing the use of mathematics, natural sciences, engineering fundamentals, and professional knowledge to solve complex engineering problems. At the same time, it has strengthened the cultivation of students' problem-analysis ability, teamwork ability, and lifelong learning ability, achieving certain results in the certification process, to some extent, it has improved students' ability to solve complex engineering problems.

At the same time, many peers have also conducted a lot of beneficial explorations on engineering education certification: Qu Zhenyuan et al. [3] pointed out that it is necessary to improve the standards for talent cultivation in higher engineering education, attach importance to the reform of teaching content and curriculum system, deepen the innovation of teaching methods, pay attention to the construction of the teaching team, cultivate students' sound personality, engineering ethics, professional literacy, and humanistic and artistic cultivation, and promote higher engineering education to a higher level. Geng Junhao et al. [4] proposed that although the certification standards for engineering education majors clearly reflect the industry's demand for practical abilities of engineering talents, the effective exercise of students' abilities depends on the careful design of intermediate links in engineering education. Huang Lan et al. [5] proposed a curriculum reverse design based on curriculum output orientation, elaborated on the key points of reconstructing the teaching outline to link the curriculum objectives with graduation requirements, and analyzed the methods of curriculum assessment and evaluation, as well as the continuous improvement of the curriculum. Zhao Shu et al. [6] analyzed the successful experience and shortcomings in the current construction process of the curriculum system, and explored the construction ideas of the curriculum system for engineering education from the aspects of teaching team, teaching content, teaching methods, and talent cultivation. Xu Sankui, Jia Dianru, and Zheng Youjin et al. [7-9] unanimously believe that professional course assessment is an important part of the teaching process, and the methods, methods, and content of course assessment play a very important role in the quality of talent cultivation. They also demonstrate the focus of practical course assessment from different perspectives. Wang Cheng et al. [10] proposed improving the recruitment system, training system, and professional title evaluation mechanism for engineering teachers to improve their engineering quality; Wang Xin et al.

[11-12] proposed to explore the ideas and methods of teaching reform in the C language course from three aspects: students, output, and improvement; Zhao Shu, Liu Xiaoman et al. [8]; Huang Tingpei et al. [13] proposed a teaching content based on split training in the context of new engineering, which aims to develop the teaching content of this course for three majors: computer science and technology, software engineering, and Internet of Things engineering; Qian Zhenjiang, He Yanfeng et al. [14-15] proposed how to achieve seamless integration between talent cultivation and employment, and introduced the experience of engineering education innovation and engineering talent cultivation models based on benign school enterprise cooperation. The above scholars have put forward insightful opinions and suggestions from different perspectives on the top-level design and specific implementation of engineering education certification, which have a good guiding effect on the certification work of engineering education. However, when it comes to the specific discipline of computer composition principles, in addition to universal principles and methods, it is also necessary to combine talent cultivation plans, subject characteristics, and academic situation analysis to construct content that is suitable for oneself.

3. Analysis of the Problems Faced in the Course of Principles of Computer Composition

Engineering education certification is aimed at a major, and all courses in the entire professional system need to be linked in order to jointly meet the requirements of the 12 graduation standards [10]. Specifically, the course on the principles of computer composition is a compulsory course in three major directions: software engineering, computer science and technology, and data science and big data technology. Its importance is self-evident.

In application-oriented local undergraduate colleges, courses on the principles of computer composition are offered. Due to the characteristics of the course and its position in the training system, the following unavoidable problems exist in cultivating students to solve complex engineering problems.

3.1. Insufficient Learning Motivation Among Students in Classroom Teaching

As an application-oriented local undergraduate institution, the school's positioning is to focus on cultivating high-quality application-oriented talents with a solid professional foundation, strong practical abilities, innovative spirit, and a sense of social responsibility. The principle of computer composition is a compulsory course for various majors in the School of Computer Science (Software Engineering), and its importance is self-evident. However, due to the requirements of the school's development positioning, this course does not have any subsequent courses related to the system structure as a follow-up course. Many students only study it as a compulsory subject for the postgraduate entrance examination, and the learning enthusiasm of most students is not high. To investigate the reasons, Whether from the perspective of learning interest or employment needs, the course of Principles of Computer Composition is not as popular among students as other programming and development courses in this major.

In the curriculum system of computer specialty, the course of Principles of Computer Composition has the characteristics of great difficulty in theoretical teaching and practical teaching. In addition, as a local application-oriented undergraduate college, we are not involved in the follow-up courses such as computer architecture in some colleges and universities. Some students even think that this course is useless except for postgraduate entrance examination, The cognitive biases that students may experience are also issues that teachers need to pay attention to.

3.2. The Construction of Course Content Is Relatively Single

The course on the principles of computer composition is highly theoretical and challenging, unlike other language development courses. It has rapid development, changes, and iterations, and its teaching content has less updates and changes. The changes in textbooks cannot keep up with the times, which is also one of the reasons why this subject is not valued by students. In addition, the learning content is entirely based on classroom teaching, and many students feel useless after learning the course, which also increases their aversion to learning.

3.3. Insufficient Proportion of Dual Teacher Types

For engineering education, emphasis should be placed on both practical training of professional skills and the learning of theoretical knowledge. Many teaching teachers do not have labor practice in enterprises after graduation and directly enter the classroom for teaching, lacking experience in industry practice, which to some extent also restricts students' growth. Although teachers impart relevant theoretical knowledge to students, they lack training in practical skills and are unable to better apply theoretical knowledge to practice.

3.4. Teaching Methods and Means Need to Be Improved

The teaching methods and methods need to be improved. Some teachers, in the process of engineering education certification, do not fully recognize the subjectivity of students in teaching, do not pay attention to mobilizing students' learning enthusiasm, and do not fully align with engineering education concepts. They do not have a good understanding of the current popular teaching models, such as reverse classroom, blended teaching, and BOPPPS, resulting in lifeless classroom teaching and students' slack learning.

4. Teaching Reform Approaches for the Course of Principles of Computer Composition

4.1. Teaching Content Reform

4.1.1. Combining Ideological and Political Education to Stimulate Students' Interest in Learning

Integrating ideological and political education into classroom teaching in various forms can not only stimulate the classroom atmosphere, but also help students better understand the classroom teaching content. Combining current affairs hotspots for ideological and political education, such as Huawei's Kirin chip, which is a self-developed mobile phone processor in China, has achieved zero breakthroughs. Chip technology has always been a bottleneck in China. By introducing current affairs hotspots, students can understand the technological development status in the industry, have a profound understanding and understanding of the application of knowledge in the industry, and further stimulate their enthusiasm for learning. Classic case analysis can also be used for ideological and political education, such as "1996 Ariana rocket launch failure". Subsequent investigations have preliminarily determined that it is likely that the integration of the fourth stage rocket nozzle activation system caused the launch vehicle to lose control, which partially involves the problem of "machine number representation and conversion". Introducing professional knowledge through ideological and political education can achieve twice the result with half the effort.

4.1.2. Searching for Course Integration Points

In the context of engineering education certification, studying the certification teaching reform of the course on computer composition principles, exploring the analysis cases of this course and its integration with other series of courses, can effectively stimulate students' learning interest and cultivate their ability to solve complex engineering problems. This course, as a compulsory subject, is also more or less related to other course contents in the course group. The study of the memory part is greatly beneficial for the learning of operating systems; The learning content of Cache is closely related to the efficiency of traversing two-dimensional arrays in C language; The relationship between the way data is stored in memory and when memory allocation function is called in C language; During the interrupt process, there is a correlation between the breakpoint protection and recovery process and the contents of the stack in the data structure. Compared with other courses, the composition principle course focuses on the hardware logic at the bottom of the computer in terms of content explanation. Learning this course well will lay the foundation for students to learn in-depth development technology later, and also can improve students' ability to solve complex engineering problems.

4.1.3. Extended Course Application Scenarios

Introduce some enterprise interview questions related to the course content (mostly involving concepts such as instruction cycle and instruction flow). In addition, through the industry professional qualification exam (such as the morning exam paper for software designers), students can be aware of other application scenarios of the course, so as to enhance their learning interest and motivation.

4.1.4. Enhancing the Faculty

Based on previous analysis, the current shortage of teaching staff is also an obstacle to the smooth implementation of engineering education certification. When choosing teachers for engineering education, it is important to focus on those with high academic qualifications and corporate backgrounds. Additionally, industry teachers/personnel from relevant enterprises can be hired to teach or train students. This teaching method that combines theory and practice can lead students to integrate into the production and practical environment of enterprises and better achieve the goals of engineering education.

4.2. Improving Instructional Design

Based on the teaching content of the course and the teaching objectives of the chapters, teaching design is carried out to highlight the mastery of students' practical skills and the cultivation of engineering practical abilities. In order to complete the corresponding teaching design, higher requirements have been put forward for the understanding and grasp of course objectives and lesson preparation content of teachers. Teachers need to select and analyze cases from a more professional perspective, guide students to independently analyze and solve problems, and comprehensively cultivate students' ability to solve complex engineering problems. In the teaching of main memory capacity expansion content, students in the early stage master basic knowledge through self-learning and self-testing, and then conduct case analysis and explanation. After learning basic capacity expansion examples, students throw out more complex examples and require analysis. The teacher provides guidance, encourages students to think independently, communicate and discuss appropriately, and comprehensively cultivates students' ability to solve complex engineering problems.

4.3. Adopting Diverse Teaching Methods

Computer Composition Principles offers online courses on the Fanya platform and runs smoothly for multiple semesters, with an audience of over a thousand students. Combined with online teaching platforms, various forms of teaching can be carried out, which helps cultivate students' self-learning ability and lifelong learning habits. Based on the teaching design and content, use effective teaching methods (flipped classrooms, analytical discussions, etc.) to carry out teaching.

4.4. Improve Evaluation Mechanism

Design an evaluation mechanism that can effectively reflect students' learning outcomes based on teaching

objectives for evaluation and feedback. Using the method of achieving course objectives for course evaluation, homework, experiments, and test papers correspond to multiple different teaching objectives. Finally, the final achievement of each objective is calculated based on different course objectives and the proportion of different assessment forms. The achievement values of different assessment forms in each objective also make teaching feedback more intuitive and easy to analyze teaching quality for continuous improvement in the future.

5. Implementation Effect and Analysis

The research group conducted teaching reforms on the principles of computer composition courses for Class 3-4 of Software Engineering 20 and Class 1-2 of Computer Science 20. A comparative analysis was conducted on the degree of achievement of the course objectives compared to the previous class of students. The degree of achievement of the four course objectives was improved by 2.1%, 3%, 0.96%, and 1.5%, respectively, but the increase was not significant. The analysis results of the test paper show that the evaluation values for the achievement of course objectives 3 and 4 are still relatively low compared to other course objectives, indicating that the cultivation of students' ability to identify and judge key modules of hardware engineering problems such as computer storage systems and instruction systems, as well as their ability to conduct technical research and experimental verification on software and hardware related to computer bus structures, control units, arithmetic units, and other issues, still needs to be strengthened. This requires teachers to delve deeply into textbooks, carefully select cases, design teaching processes, fully utilize existing teaching resources and methods, mobilize students' learning enthusiasm, and help students cultivate the ability to solve complex engineering problems. Furthermore, through questionnaire analysis, it was found that some students still lack learning motivation and believe that the curriculum is too theoretical, difficult, and practical. Therefore, the next step for the research group is to rely on departments to accelerate the pace of school enterprise cooperation, expand the scope of school enterprise cooperation, and invite industry teachers into the classroom, so that students can experience the reality of industry development and have a clearer understanding of the purpose of learning;

6. Conclusion

The reform of the computer composition principle course for engineering education certification in this article includes: teaching content, teaching design, teaching methods, and evaluation mechanisms. Through a semester of teaching practice verification, it is demonstrated that the reform measures have a good promoting effect on cultivating students' ability to solve complex engineering problems, but also reflect the necessity of continuous improvement and how to effectively stimulate students' interest in learning the computer composition principle course in the long term, It is also a task that the research group needs further research in the future. Under the guidance of the basic concept of "student-centered, output oriented, and continuous improvement", actively promote the certification of engineering education, and promote the early achievement of the goals of professional construction and talent cultivation.

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