Construction and Practice of Competency-Oriented Programming Practice Course Group

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Abstract: In order to cultivate and improve students' ability to solve complex engineering problems, this paper constructs a competency-oriented practical curriculum group. The course group explores and practices the following three aspects: program design practice course group framework system and its curriculum connection plan, the construction of practice platform, and the engineering literacy of teachers. Practice has proved that these measures can effectively improve students' practical and innovative abilities.

1. Introduction

The Outline of the National Medium-and-Long Term Education Reform and Development Plan (2010-2020) clearly emphasizes the importance of persisting in ability, strengthening ability training, and focusing on improving students' practical and innovative abilities [1].It can be seen that practical education plays an extremely important role in the process of personnel training.

The practical education of computer specialty in universities has formed a relatively complete teaching structure after many years of construction. However, the development of students' practical and innovative abilities is restricted by the traditional education concept, which leads to a long process of "transformation" and re-cultivation of graduates after employment. The gap between the practical ability of graduates and the actual needs of social development puts forward higher requirements for the quality of practical teaching of computer specialty at present. Relevant researchers and scholars at home and abroad have put forward their own views on it. Zhang Hui of Beijing Institute of Technology pointed out that many problems in current education have led to slow adaptation of engineering students, poor hands-on ability, lack of independent learning, insufficient innovation capacity, lack of teamwork awareness, little understanding of modern enterprise workflow and culture, and difficulty in coping with social needs[2].In response to the problem of graduates' ability development, Professor Jiang Zongli, deputy director of the Computer-based Professional Teaching Steering Committee of the Ministry of Education, proposed that the basic concept of education in the context of new engineering should shift from curriculum-oriented education to output-oriented education. Output-oriented education develops students' ability to solve complex engineering problems [3] [4]. Practice teaching is the key to cultivating students' ability to solve complex engineering problems. Building a competency-oriented practical course group is a new attempt to practice teaching reform under the new engineering background.

2. Develop a Curriculum Group Framework and Curriculum Convergence Plan

Under the traditional education mode, the development of students' practical ability of program design is restricted. This paper improves the programming practice ability of computer majors by building a competency-oriented program design practice group [5]. Exploring the practical teaching path for cultivating new talents in computer science that adapt to "Made in China 2025" and "Internet +".

The courses related to programming practice in the computer specialty include C programming,

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data structure, algorithm and programming practice, WEB programming, JAVA EE, etc. As a member of the curriculum system of computer specialty, the practical teaching of these courses has contributed to the ultimate goal of training .However, because these courses are devoted to training students' practical ability of programming, when we consider them as a whole, there are problems such as overlapping teaching contents, outdated knowledge points and lack of emphasis on ability training. Therefore, how to screen and determine the curricula in the framework system, and how to combine them organically and maximize the teaching synergy among these curricula is the key problem to be solved.

The overall construction of the course group developed in this paper is shown in Figure 1. Set up a curriculum group framework system and build a practical teaching platform. Students' practical ability in programming is cultivated from three levels: computational thinking ability, engineering thinking ability and innovative thinking ability

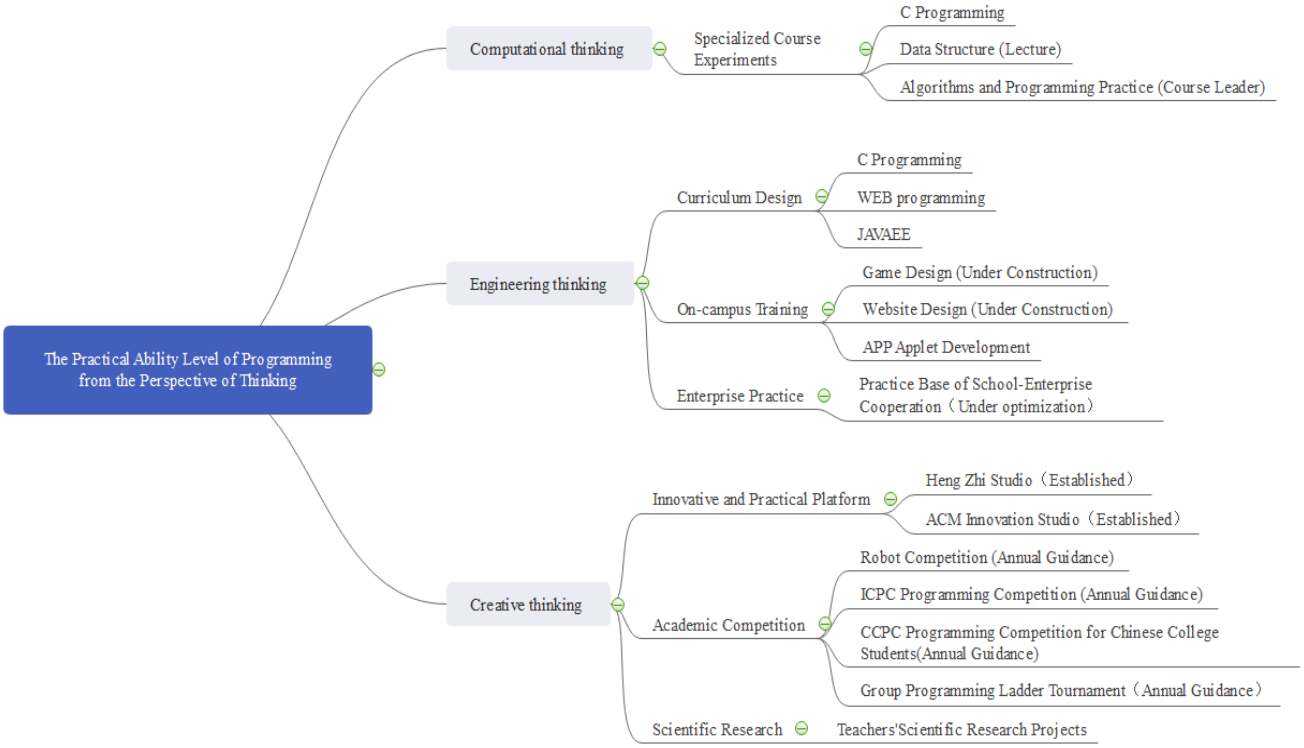

Figure 1 Capacity-Oriented Programming Practice Course Group Construction Plan

The curriculum group should be set up to serve the professional training objectives and meet the ability requirements of new engineering construction for graduates [6]. The author interviewed the university with successful experience, researched the needs of the enterprise, and then hired university experts and enterprise engineers to participate in the development of the curriculum group framework. The course group is expected to optimize the course structure, reduce duplication, refined capacity building matrix, and clarify the support of each course. Further based on the competency matrix, revise the syllabus. Scientifically locate the teaching objectives of each course, delete some old knowledge points in the textbook, and highlight the training of programming practice ability. The concept of modern engineering will be implemented consistently, so that each course will infiltrate and cross each other and work together to achieve the ability indicators of the course group.

Under the overall framework of the course group, set the pre-repair and post-repair sequence of each practical course. We should not only make full use of the advantages of the original curriculum, but also optimize, integrate and expand the original curriculum. What's more ensure that each course can cover the competency matrix in an orderly, hierarchical and progressive way, realize the connection between the courses, ensure the content from shallow to deep, and effectively avoid the repetition of similar content among the courses.

3. Construction of Practice Platform

The existing programming practice platform mainly consists of experimental courses, curriculum design, enterprise practice, graduation design and innovation practice studio. As a supplement to theoretical courses, experimental courses focus on helping students understand theoretical knowledge and cultivate their computational thinking ability. Because of the rapid development of computer technology, they need to keep pace with the times in teaching content, teaching design and teaching implementation.

The course design aims to cultivate students' engineering thinking ability, but due to many reasons such as teachers' own engineering literacy, the content of teaching and the actual application of the enterprise are out of touch. Therefore, corresponding adjustments should be made in the design of the topic and the implementation of the teaching. Enterprise practice and graduation designs are important links to cultivate students' engineering thinking ability. However, at present, only 20% of the internship topics and 15% of the graduation design topics in our computer major come directly from the actual projects of enterprises. It is necessary to continue to expand the new form of internship and substantially increase the proportion of students participating in actual projects. In addition, I founded "ACM Innovation Studio" in 2013 and "Heng Zhi Studio" in 2017, to provide students with innovative practice platform, which plays an important role in improving students' innovative practice ability.

In addition, on the basis of the original practice platform, the school's training links will be added, the innovation practice platform will be improved, students will be encouraged to actively participate in the discipline competition activities, and teachers will be encouraged to participate in scientific research projects. Under the framework system, each course can cultivate students' practical ability and innovative ability of program design in an all-round and progressive way.

4. Improvement of Engineering Literacy of Teachers

Teachers are the key to continuously improve the level of practical teaching. The new engineering course puts forward higher requirements for teachers. As an important participant in teaching, teachers' engineering practice ability will directly affect the cultivation of students' ability to solve complex engineering problems.

4.1 Renewal of Educational Ideas

The main goal of engineering education is to train students to apply engineering principles and engineering knowledge to analyze and solve complex engineering problems. Teachers can renew their educational concepts through reforms in the following three aspects:

In terms of teaching methods. The teaching mode of teacher-oriented and passive learning for students has been changed to student-centered. Making full use of existing micro-classes, mooc resources [7]. Teachers guide students to explore learning in class.

In terms of teaching content. The teaching mode of focusing on knowledge imparting has been changed to ability training. Teachers teach students to use theoretical knowledge to solve practical problems;

In terms of teaching effect. The teaching mode of focusing on students' examination ability that neglecting the cultivation of ability to solve complex engineering problems has changed to pay attention to Professional Certification of Engineering Education. Guided by the three educational concepts of "Student-centered, output-oriented, and continuous improvement" proposed by the Washington Agreement, the goal is to train students to solve complex engineering problems [8-9].

4.2 Improve teachers' Engineering Literacy

The new engineering course puts forward higher requirements for teachers in terms of knowledge, industry experience, industrial ability, teaching level and comprehensive quality. Specifically, it is to have a broad knowledge. Not only pay attention to our own subject, but also focus on emerging disciplines, interdisciplinary and frontier disciplines, especially new technologies and new industries

related to the profession field; To master the basic operation methods of advanced engineering equipment, have industrial experience in solving various frontier problems, and maintain close cooperation with the industry; Having the industrial ability of research and development and innovation, the ability to solve complex engineering problems using multidisciplinary knowledge, principles and methods, and the ability to deal with challenges and future problems; Must have the concept of engineering education, education and teaching ability, practical teaching ability, and the application of "Internet +" platform and information technology; Must have a good overall quality of dedication, love and noble professional sentiment. The following three methods are used to improve teachers' engineering literacy:

By making full use of the base on the cooperation of industry and school, we can accumulate experience in solving various frontier problems. Meanwhile maintain close cooperation with the industry, and constantly enrich our own industrial background.

Actively formulate a scientific and reasonable training plan for engineering practice, and actively participate in conferences and activities related to new technologies and industries. For example, when purchasing large equipment in the laboratory, sign a training service project with the equipment provider. At the same time, the teacher is assigned and tracked during the installation, commissioning and acceptance of the equipment.

Keep up with the development of discipline competition. Team teachers are encouraged to lead students to take part in algorithmic subject competitions and keep up with the frontiers of the subject. Then, leading students to participate in Enterprise Engineering projects, explore the point of convergence between engineering projects and academic competitions. At last, to cultivate students' problem-oriented thinking mode, improve teachers' and students' practical ability and practical application ability.

5. Teaching Feedback and Effect

In order to obtain feedback on the teaching effect, the course team conducted questionnaires to the students of 2016 and 2017 who had completed the course, and solicited opinions and suggestions on the teaching of the course [10]. A total of 119 questionnaires were distributed, including 3 invalid questionnaires and 116 valid questionnaires. Feedback information was as follows:

- For terms of teaching content, among the students who participated in the questionnaires, 12.07%, 39.66%, 38.79% and 9.48% thought that the curriculum content was difficult, relatively difficult, moderate and easy, respectively;
- 68.1% of the students believe that the online practice and online exams used in the course can improve their programming skills; 62.93% of the students believe that visiting the company can helps to understand the current social development needs; 59.48% of the students believe that participating in the "industry experts face to face" activities can help to understand the current industry development situation and industry needs; 90.52% of the students understand that the engineering practice ability of the students is the most important factor in the recruitment of computer-related jobs.
- As for the support of graduation requirements, 82.76% of the students think that the course is helpful to improve the ability of computational thinking, and 81.9% of the students think that it plays a supporting role in improving the ability of Engineering practice.

From the final evaluation results and the feedback from the students' questionnaires, the course group has basically reached the expectations and achieved the following results:

- Three-dimensional teaching mode is welcomed by students. Students change from passive learning to active learning and are willing to be the dominant learners;
- Combination of competition and education and integration of science and education can effectively help students improve their ability of computing thinking and engineering practice;
- Collaboration between schools and enterprises can effectively help college students understand the current situation and needs of the industry.
- The reform of teaching strategies can effectively help students internalize their knowledge

into the ability to solve complex engineering problems.

6. Conclusion

This article takes the new engineering as the guide and takes the ability as the direction to carry out unified planning and construction of relevant practical courses in the subject. Then build a program design practice course group. Next, the practice curriculum is screened, integrated and optimized. Finally, a practical curriculum will be added to improve the students' practical ability in programming, and the connection plan between the courses will be developed in order to maximize the synergy between the courses. From three levels of computational thinking, engineering thinking and innovative thinking, the programmer's practical ability of computer majors is gradually cultivated.

Practice has proved that these measures effectively improve students' practical and innovative abilities, thus realizing the role of competency-oriented curriculum group of programming practice.

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