Research on Teaching Model of Engineering Majors Guided by Scientific Research Projects by Taking Computer Science and Technology Major as an Example

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Abstract: The innovative, interdisciplinary, and integrated talents required by the “New Engineering Education” not only require the support of teaching concepts and content, but also need the guidance of scientific research in universities. In this paper, the talent cultivation of the Computer Science and Technology Major was taken as a specific example to analyze the current situation of scientific research and teaching, and summarize the problems of the current “New Engineering Education” talent cultivation plan: unclear cultivation objectives, unduly traditional teaching modes and methods, weak correlation of knowledge systems, and inability of scientific research to effectively back-feeding teaching. Furthermore, based on these issues, we proposed a “Research project-integrated teaching” model in classroom teaching to stimulate students' learning interest, put forward the model of “Guide college students’ scientific and technological innovation through scientific research projects” in innovation training to enhance their innovation and exploration abilities, and came up with the model of graduation project guided by dual tutors from an enterprise and a college to improve the quality of their graduation design and hands-on ability, so as to explore a mutual improvement path that combines teaching and research.

1. Introduction

Wu Aihua first proposed the talent cultivation concept of "New Engineering Education" in his paper "Accelerating the Development and Construction of New Engineering to Actively Adapt and Lead the New Economy". He believed that the construction of new engineering education was relative to traditional engineering education, and its goal was to establish a number of emerging engineering majors in the context of the new economy and new industries, strengthen construction of existing engineering majors, improve their quality, and promote their reform and innovation [1]. It is known as the "New revolution" of engineering education in China. Some scholars have interpreted the new engineering education differently. Zhong Denghua proposed that the connotation of the new engineering subject was to cultivate diversified and innovative outstanding engineering talents in the future by fostering character and civic virtue as the guide, coping with changes and shaping the future as the construction concept, and taking inheritance and innovation, chiastopic fusion, coordination and sharing as the main way [1]. Lin Jian believed that the overall approach to the construction of new engineering majors was to study and predict future national and industrial development needs and directions, coordinate and analyze the resources of the entire university, determine plans for new engineering majors to be built, establish new engineering majors, carry out new engineering major construction and discipline research, set up a platform for enrollment and training of new engineering majors, build a quality assurance system for talent cultivation in new engineering majors, and establish a dynamic adjustment mechanism for majors[2]. From this, it can be seen that the cultivation plan for new engineering talents is not a single chain project, but a complex system engineering. In the cultivation of new engineering talents, innovation and interdisciplinary fusion not only require the support of teaching concepts and content, guidance from university scientific research is also indispensable.

Cui Peng proposed that there was not a clear distinction between scientific research and teaching, but rather "scientific research is source and teaching is flow". Research can provide feedback to teaching, and teaching can also promote research and provide feedback to improve research [3]. Wang Zhenglu pointed out the research on the implementation path of research-based back-feeding teaching in higher education institutions from five aspects: ideological concepts, creating a good atmosphere for research-based back-feeding teaching, accumulating resources for research-based back-feeding teaching, improving teachers' ability to combine teaching with research, and establishing a sound system for integrating research and teaching [4]. Taking the forestry major of Central South University of Forestry and Technology as an example, Liu Linfa deeply analyzed the characteristics of forestry major courses and the problems in practical teaching, as well as the ways of research-based back-feeding teaching of forestry major, and put forward suggestions on establishing relevant guarantees for research-based back-feeding teaching [5]. Shu Hongping took Chengdu University of Information Technology as an example, aiming at the industrial education dilemma of "high threshold, difficult integration and weak connection" in the development of new economy industry, and the problems of "numerous industrial technology systems, scattered teaching allocation resources, lack of industrial teaching platforms, short of online training tools, dislocation of integration of industry and education and different standards for ability achieving" in the universities themselves, proposed the implementation path of promoting teaching through scientific research, so as to promote the transformation of scientific research achievements into textbooks, integrate scientific research projects into teaching cases, and support teaching informationization tools with scientific research technology products. This provides a solution of "science education integration, school enterprise integration, and multi-party collaborative education" to solve industrial education problems, fully proving the importance and feasibility of “scientific research-guided teaching” [6].

In this paper, taking the current talent cultivation model for the major of Computer Science and Technology (referred to as "Computer Science and Technology") as the background, we analyzed the problems in the engineering talent cultivation model under the new engineering education model, and proposed a “scientific research project guided” composite talent cultivation strategy for the major of Computer Science and Technology, pointing out the direction for the collaborative development of scientific research and teaching under the new engineering education background.

2. Problems in the cultivation mode of engineering talents in universities

However, current talent cultivation in universities still follows the old model, and there are many problems in university course teaching, mainly showing the following characteristics and trends:

2.1. Unclear talent development goals

In the context of implementing popular higher education, the education concept of “wide range” and “universality” is implemented in talent cultivation in universities. The training objectives are single, the overall structure is simple, and personalized, targeted and diversified training objectives lack. The differences in the abilities and qualities of college graduates are not significant. Students only have an understanding of books and classroom teaching content, seriously lacking engineering practical ability and innovative thinking, and this type of teaching fails to meet the requirements of the talent cultivation goals in the “New Engineering Education” program, thus college graduates are unable to quickly adapt to market demand. Taking the computer science and technology major as an example, its training goal is to enable students to grasp the structure and operation of computer software and hardware, the development and programming of computer systems, and the theoretical and practical methods of various information processing engineering; however, in the actual training process, there is no detailed training, classified management, or in-depth guidance for students. As a result, the current graduates of this major are not clear about their professional employment direction, their knowledge structure is messy, and they are difficult to cope with social changes and needs. The phenomenon of graduates spending a lot of money “Persue college education again" during the graduation season is frequent.

2.2. Teaching ways and methods are too traditional

At present, most teaching in universities are still led by teachers, and students have very little participation in the teaching process, with over-reliance on traditional teaching concepts, teaching ways and management methods. It is still an indoctrination-based teaching method with teachers as the main "battlefield"; The teaching mode is also common, with teacher-based teaching and a combination of teacher based teaching and student self-learning. Teachers mostly play the role of "live television", while students basically act as "viewers". Throughout the process, apart from occupying seats, taking notes, there is almost no communication with teachers, and students are unable to effectively participate in the "teaching-learning" process, resulting in significant limitations in their understanding of professional knowledge. In addition, in the management and evaluation of teaching processes, excessive emphasis is laid on process standardization, such as the standardization of lesson plans, blackboard writing, and the quality of classroom discipline. Thus this limits the teacher's pioneering spirit and innovative ability in teaching methods. At present, the talent cultivation methods for the computer science and technology major mainly rely on teacher classroom teaching and basic experimental training, and students' practical and problem-solving abilities have not been greatly improved, which is contrary to the new engineering talent cultivation model. The new engineering education program not only requires students to have a breadth of knowledge, but also imposes requirements for the depth of learning knowledge and the ability to solve practical engineering problems.

2.3. Weak correlation of knowledge system

Currently, under the educational concept of "wide range" and "universality", teaching organizations implement broad teaching for students. Although students' knowledge has greatly improved, the lack of directional guidance in course content has led to the disconnection of courses with the practice, unclear learning objectives, and incomplete system of course knowledge; In the teaching process, the correlation between the consecutive content of the course is not clear, and the teacher of teaching the prerequisite course is not clear about which content will affect the future teaching content or even which course teaching. Therefore, in the teaching process, only a large-scale general teaching can be implemented; This inevitably leads to the situation that the focus is not prominent and the specialty characteristics of the courses are not distinct, so that the following problems often occur: in the process of cultivation design for different majors, except for some differences in the names of the courses in the talent training program, teaching materials, syllabus, teaching content and even assessment method are identical. The teachers of teaching the later courses are also unclear about the teaching situation of the prerequisite course. In the design of the later curriculum teaching plan, there are often cases where the later curriculum content is duplicated with the prerequisite course content or the knowledge requirements of the later curriculum are not covered by the prerequisite course. In a survey of the teaching situation of engineering electronic specialized courses, we found that in a certain university, the repetition rate of teaching content in the Electronic Information Engineering major, the Information Engineering major and the Electronic Science and Technology major was as high as 90%, and even some courses were taught by the same teacher; so it is difficult to reflect major differences and to leverage students' major strengths. In the design of experimental courses, the hierarchical nature of the implementation content is not clear, and in addition to the weak correlation between prerequisite and later course experiments, there is often repetition in theoretical courses; The various problems exposed in the entire teaching content of the curriculum knowledge system will lead to very slow improvement of students' abilities. Taking the computer science major as an example, its main core courses include C++ programming, logic design, C# programming/Java programming, discrete mathematics, data structure, principles of computer organization, operating system, computer network, database system principle and application, assembly language and interface technology, compilation principle, software engineering, algorithm design and analysis, etc. In the current talent cultivation program, excessive emphasis is laid on the curriculum structure; The progressive relationship between prerequisite and later courses is not reflected in the correlation between courses, so that students treat each course as an independent unit during the learning process, and therefore they are unable to effectively integrate the course content in a reasonable manner. Students find it very difficult both in terms of learning and in the application of knowledge.

2.4. Scientific research cannot effectively provide feedback to teaching, with separate teaching and research

In view of the cultivation objectives of new engineering talents, many domestic colleges and universities have introduced the tutorial system in the process of undergraduate talent training, and the tutors here are basically university teachers. In addition to completing basic teaching tasks, university teachers also need to strive to carry out scientific research. Through analysis of the projects approved by the National Natural Science Foundation of China in the past three years, it was found that over 90% of scientific research projects were initiated in universities. A large number of scientific research projects obtained by universities not only contribute to the improvement of teachers' abilities and the overall strength of the school, but more importantly, help universities promote talent cultivation. However, in the actual implementation process of scientific research projects, the main implementers are often the project leader or project team. Teachers with graduate enrollment authority occasionally split the project and hand it over to graduate students for implementation, and undergraduate students are hardly found in the research group; undergraduate graduation projects are rarely concerned with research projects from tutors, even a small portion. The main reasons for this include the execution period and strict completion indicators of the project, the insufficient practice experience of students in the early stage, and the lack of a knowledge system that supports the completion of the project, and the serious lack of abilities; furthermore, the tutors may worry about the failure of the project execution. Taking the approval of scientific research projects and the approval of innovation and entrepreneurship projects for college students in a certain university in the past three years as an example, the number of scientific research projects related to computer science and technology is about 23, while the number of innovation and entrepreneurship projects related to the computer science and technology major is only 18; More importantly, out of these 18 projects, only one is related to the previous research project. The participation of university students in research projects is extremely low, and research has not effectively promoted teaching progress.

3. Teaching model of engineering majors guided by scientific research projects

In the teaching work and the research work of universities, teaching and research are usually set opposite. The main reason is that scientific research output requires a lot of time, while the teachers are required to allocate more time within the limited time to prepare teaching content and lectures. This will inevitably cause conflicts in terms of time, leading to conflicts between scientific research and teaching.

In fact, scientific research and teaching are an inseparable whole. In order to cultivate innovative, interdisciplinary and integrated new engineering students, it is far from enough to simply teach the contents of books. Teachers need to always find the dynamics of disciplines, keep their thinking and knowledge structure consistent with the world's advanced scientific research trends, and incorporate them into classroom or practical teaching.

3.1. Teaching mode of integrating scientific research projects

The tutor's research project is split into several undergraduate teaching tasks, and the split knowledge is gradually integrated into each teaching stage during classroom teaching, so as to enable students to have a clear understanding of the application of knowledge while learning basic knowledge. Taking computer vision related projects of the computer science and technology major as an example, it includes project background, current development, problems encountered and technical proposal to complete the project. In the course introduction explanation for the freshmen, the background knowledge of scientific research projects can be designed as course teaching cases.

In case teaching, students are informed of the development direction and technical bottlenecks of their major, and their desire to explore is aroused while learning basic knowledge. In addition, since computer vision related projects are concerned with a large number of mathematical problems, in the process of teaching calculus, linear algebra and other related basic courses, some knowledge can be combined with mathematics teaching, such as combination of matrix operation and image transformation, combination of calculus and Fourier transformation in images, so that students can clearly understand the practical engineering application of basic knowledge while studying basic courses, finally stimulating their interest in learning.

3.2. Model of "Guiding college students' scientific and technological innovation through scientific research projects"

In the context of "Mass Entrepreneurship and Innovation", strengthening the cultivation of innovation ability among college students and guiding the transformation of scientific and technological achievements is an important measure for the cultivation of new engineering talents. This teaching model is mainly aimed at undergraduate students. From the beginning of enrollment, based on students' personal interests and under the guidance of teachers, they follow the teachers to conduct preliminary scientific exploration, thereby enhancing the innovation ability and awareness of scientific and technological achievements transformation of college students. Taking the course design and practical teaching of the computer science and technology major as an example, teachers with relevant project experience divide projects based on the course content and research project requirements, and under the guidance of teachers, students are allowed to complete the content of relevant modules. For example, in the process of teaching Computer Vision, the core course of the computer science and technology major, the teachers split the relevant contents of scientific research projects and integrate them into teaching when teaching calculus, Linear algebra, data structure and algorithm design. Students can apply for the National College Student Innovation and Entrepreneurship Training Program based on their interests while completing the basic design according to the teacher's arrangement. The teacher will refine and evaluate the project based on their research experience, and guide students in completing relevant project design. During the project implementation process, students can continuously enrich their knowledge structure based on the project, while also exploring their interests and enhancing their innovation awareness and hands-on abilities; furthermore, technological transformation of excellent achievements can also be quickly achieved, effectively relieving the employment pressure of students.

3.3. A dual-tutor model is used in "Enterprise + School" graduation project

Guided by the needs of enterprises and combined with the graduation project of undergraduate students, the original 6-8 months of graduation project and enterprise internship will be extended to 12-14 months. The original graduation project evaluation method is upgraded to the "Enterprise + School" dual-tutor evaluation way of graduation project, where the college is responsible for the academic value of the project, while the enterprise is responsible for the industrial value of the project, so this not only can make the undergraduate graduation project meet academic requirements, but also ensure the smooth implementation of the project. Taking the Computer Science and Technology major as an example, as the teaching of this major mainly focuses on engineering practice, the application ability of professional knowledge is a necessary skill for students in this major. Therefore, appropriately extending the duration of undergraduate graduation projects and combining them with the needs of enterprises can greatly improve the quality of undergraduate graduation projects and enhance students' engineering application abilities. On the other hand, it provides useful reference for enterprises to select talents.

4. Conclusions

Guiding teaching reform through scientific research projects is an inevitable trend in the university teaching reform. On the one hand, it can solve the conflict between scientific research and teaching, and on the other hand, it can also enable teachers to keep abreast of the dynamics of subject development at any time, playing a very important role in curriculum teaching and professional development. In this paper, we took the talent cultivation mode of the computer science and technology major as an example in the context of new engineering education, analyzed the problems existing in the existing cultivation plan from four aspects: talent cultivation objectives, teaching methods, the relationship between knowledge systems, and the relationship between scientific research and teaching. Based on these problems, a talent cultivation model guided by scientific research projects was proposed, and implementation strategies were preliminarily explored. This provides useful reference for the cultivation of innovative talents.

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