Teaching Guided by Project Development Based on Idea of "Learning by Doing"

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Abstract: Massive information explosion and rapid renewal of knowledge have become the distinctive characteristics of today's era. The traditional teaching mode is difficult to meet the needs of students to acquire and use knowledge. In view of this problem, based on the educational thought of "learning by doing", this paper puts forward a teaching mode guided by project development. Through carefully creating practical projects, organizing teaching reproduction projects and project secondary development and innovation, in the process of project development and practice, we can lay a solid foundation of students' scientific knowledge and improve students' comprehensive ability of autonomous learning.

1. Introduction

With the rapid progress of Internet of things, big data, cloud computing, artificial intelligence and other technologies, information explosion and knowledge explosion have become a distinctive feature of today's era[1]. Information owners can transmit information faster, while information recipients can receive information more conveniently and freely. Information technology and other knowledge are updating at an unprecedented speed. Under the traditional teaching mode, the speed of acquiring knowledge and skills is slow. It is likely that when you master a knowledge, the knowledge is outdated, and when you need to use a new knowledge, the knowledge has not been learned. The traditional teaching mode can no longer meet the needs of university education in the new era[2].

The acceleration of information updating requires students to further enhance their ability of autonomous learning and update their knowledge structure and knowledge reserve in time. Project-based teaching is a new teaching method focusing on students, which is conducive to students' learning cognition and consolidate the foundation of autonomous learning in school education. Driven by the project task, students collect information, acquire knowledge and explore solutions through group communication and cooperation, so as to solve practical problems[3]. However, in the actual implementation process, there are the following difficulties and problems:

Firstly, the content selection is difficult. Project selection is usually determined by teachers according to their own scientific research direction, and the knowledge threshold is relatively high, making it difficult for students to get started and promote. On the contrary, if students choose by themselves according to their interests, the content is often divergent and the degree of coincidence with the teacher's specialty is not high, resulting in the lack of effectiveness of teacher guidance.

Secondly, it is difficult to guarantee the conditions. Often self-creative projects involve divergent fields, involve multi-disciplinary knowledge and content, require a variety of experimental conditions and equipment, but the laboratory conditions are generally not enough to support. However, the purchase of equipment for the project often leads to low equipment utilization.

Thirdly, organization and management are difficult. Under the current teaching mode, students' centralized management and free time arrangement are relatively few and scattered, and

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extracurricular practical activities are relatively independent. Therefore, the process of students' activities and teachers' guidance is relatively loose and difficult to manage.

2. Current Situation of Project-Based Teaching Practice

In June 2010, the "Excellent Engineer Education and Training Plan" of the Ministry of Education was officially launched, starting the journey of "return engineering" and "return project" of Engineering Education in China. Since 2017, the Ministry of Education has actively promoted the construction of new engineering. China Software Industry Association has jointly established the "industry university research alliance of new engineering of information technology" with some domestic universities, scientific research institutes and industrial enterprises. Beijing University of Posts and Telecommunications, the director unit of the working committee, has implemented a distinctive training project for freshmen's engineering cognition and innovation quality[4], which has been introduced by many universities. Its main feature is to emphasize the cultivation of freshmen's engineering cognition and innovation quality. Freshmen recognize engineering, discipline and innovation through fun projects, establish an experimental cognition system, promote continuous independent innovation activities through maker community, and carry out engineering education and engineering project practice throughout the four-year university life.

The School of Information and Communication Engineering of Beijing University of Information Technology closely combines the maker concept and entrepreneurship and innovation education into professional education[5], taking the cultivation of students' innovative spirit, engineering quality and practical ability as the basic objectives, penetrating the project practice into the whole process of the university to form a four-year continuous advanced education system. A series of themed activities such as "Freshman Maker Competition", "Maker Carnival" and "Maker Marathon" organized by the school are based on open source hardware and open source projects, and senior students with relevant project experience are introduced as teaching assistants, so that students can quickly complete their own intelligent small system, from simple to complex, from foundation to expansion. The activities gradually introduce students into the world of invention and creation in the form of projects.

In 2000, a team in Massachusetts Institute of Technology led by Professor Ed. Crawley, an academician of the American Academy of Engineering, and three universities including the Royal Swedish Institute of Technology formed a transnational research group. After four years of exploration, they established the CDIO (Coherent, Design, Implementation and Operate) engineering education concept and established the CDIO international cooperation organization[6]. CDIO takes the life cycle of engineering projects from R & D to operation as the carrier, and allows students to learn engineering in the way of active practice and organic connection between courses. As a new talent training mode of project-based teaching, CDIO has only been practiced in the world for more than ten years, but it has shown strong educational power and vitality and it has grown to 81 college members in more than 25 countries.

In 2017, MIT launched a new round of "New Engineering Education Transformation (NEET), which represents the latest development direction of American engineering education[7]. Its core idea is to realize the integration of discipline logic and psychological logic, emphasize that the development of educational activities should follow the law of students' physical and mental development, pay attention to students' practical experience, advocate the project-centered learning method, change the previous discipline-centered learning method. Students can choose a clear "discipline string" of cross department courses and projects, and form a team around common projects. It also focuses on cultivating students' ability to use appropriate thinking to think and solve various unknown and complex problems, involving engineering thinking, scientific thinking and humanistic thinking.

3. Exploration of Teaching Guided by Project Development

3.1 Theoretical Basis

"Learning by doing" is an educational thought put forward by American educator Dewey, which advocates that students learn from experience and learn by solving problems. Students first face some practical difficult situation, then analyze the problem through reflective thinking, put forward possible solutions, use reason to deliberate on various schemes, and finally test them with action. The thought of "learning by doing" has become an important thought throughout the educational reform in recent 100 years because it conforms to the law of students' physical and mental development. Hundreds of universities around the world have successfully implemented the teaching concept of "learning by doing" and found their own mode in "learning by doing" to adapt to their environment and conditions[8]. On the premise of maintaining a solid scientific foundation, "learning by doing" emphasizes strengthening project practice training, so as to improve students' comprehensive ability.

3.2 Implementation Method

The teaching guided by project development is based on the idea of "learning by doing", emphasizes "project guide, condition support and team cooperation", focuses on building innovative practice teaching projects based on innovative bases from three aspects of project content, experimental conditions and organization and management, and carries out teaching and organization activities according to the projects, so as to effectively improve students' comprehensive ability. The specific implementation methods are:

Firstly, carefully design and build teaching projects. Around the direction of information system, artificial intelligence and unmanned system, design and implement projects covering the main problems and core technologies in all directions, including three teaching projects of "minimum information system based on open-source hardware", "unmanned intelligent vehicle" and "unmanned cluster integrated application", so as to provide students with relevant software and hardware equipment and implementation schemes, and sort out the teaching and training content system according to the core knowledge involved in the scheme.

Secondly, repeat the project of "learning by doing" and organize teaching training. Around the relevant knowledge involved in the project and the implementation method and process of the project, organize special training to enable students to form a general understanding of disciplines, majors, engineering, technology, innovation and other issues, guide students to gradually reproduce the project based on the project implementation scheme, and guide students through teachers' teaching and guidance, technicians' Q&A, personal exploration and learning, old students helping new students, group discussion and communication, so as to realize "learning by doing", generate engineering cognition, establish core concepts and master key knowledge through hands-on.

Thirdly, creatively innovate "secondary development" to improve ability. Based on the project knowledge learned and combined with the practical problems encountered in learning and life, encourage students to innovate, organize students to carry out discipline competitions and project application, gradually deepen and refine their ideas into new projects, and carry out "secondary development" on the basis of the original projects, so as to consolidate knowledge, apply knowledge and effectively improve their innovation ability. Meanwhile, the continuous accumulation and precipitation of new project achievements can also greatly enrich the teaching project library.

Fourthly, strengthen the cohesion of organization and management based on project team cooperation. Continue teaching around the stable "project" to ensure the systematicness and depth of the teaching content. Meanwhile, closely connect the teachers, postgraduates, technicians of relevant enterprises and undergraduate students engaged in the project to improve the pertinence, timeliness and effectiveness of training guidance. The members of the project team can adopt the method of "teaching the new with the old", select the backbone to form an "innovation practice club", organize and carry out daily activities by themselves, strengthen the cohesion of management, and improve the activity and continuity of various activities.

4. Highlights and Characteristics of Teaching Guided by Project Development

4.1 Construction Mode of Knowledge System with Problem as the Traction and Project as the Center

Cloud computing, Internet of things, artificial intelligence and other emerging information technologies are becoming more and more complex, and project practice involves science, engineering and other aspects. According to the previous knowledge system organization mode centered on discipline and specialty, students need to supplement too much learning content and the threshold for innovation practice is too high. Teaching guided by project development modularizes the interdisciplinary knowledge related to typical scenes, and organically combines them into a knowledge system with problems as the traction and project realization as the center, which can enable students to systematically master relevant knowledge around problems, so as to lay a foundation for independent learning and innovative practice.

4.2 "Learning by Doing" Mode Aiming At "Recurrence" Project

In the past, teaching was organized according to the "sequential series" of knowledge system. Students not only had low learning efficiency, but also had difficulty in quickly mastering all the knowledge needed to carry out innovative practice. The teaching guided by project development changes the previous teaching mode according to the knowledge system. Under the guidance of teachers and the help of other students, students are guided to quickly reproduce the project according to the project scheme. With the promotion of the project, they "learn by doing", continue to deeply understand problems, learn relevant knowledge, feel engineering thinking and improve engineering ability. In the process of solving problems, they gradually build a complete knowledge system, so as to achieve quick start.

4.3 Students' Creative Innovation Mode Based on the Process of "Secondary Development"

Students learn knowledge and skills by reproducing the "specified actions" of typical achievements. On this basis, combined with their interests and practical problems encountered in learning and life, they add "optional actions" to carry out creativity and innovation. This not only enables students to have traction and support when planning topics, avoiding the phenomenon that they have no way to start in the past, but also enables all innovative projects to be carried out on a better basis to ensure the quality and level.

5. Conclusion

Autonomous learning and other comprehensive abilities are the inevitable needs of students to deal with massive information explosion and rapid renewal of knowledge. Therefore, the renewal of university teaching mode must adapt to this new demand and change. The teaching guided by project development based on the idea of "learning by doing" can help students build a knowledge system integrating science and engineering, cultivate innovative practical ability and meet the talent training requirements of the new era through the practical processes of project reproduction and project innovation.

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