

Application of a multi-course linked project-based teaching approach in a mechanical course

Chunxing Gu^{1,2,a,*}, Han Wang^{1,b}

¹*School of Mechanical Engineering, University of Shanghai for Science and Technology, Shanghai, 200093, China*

²*School of Intelligent Emergency Management, University of Shanghai for Science and Technology, Shanghai, 200093, China*

^a*chunxinggu@hotmail.com*, ^b*wangh9@usst.edu.cn*

^{*}*Corresponding author*

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Abstract: Project-based teaching aims to enhance students' understanding of knowledge through the practice of projects. In recent years, project-based teaching has been more and more widely used in college teaching. Taking students of mechanical majors as an example, students need to learn several professional courses in mechanical design, such as "Mechanical Principles", "Mechanical Innovation Design", "Mechanical Design" and "Course Design of Mechanical Design". There is continuity in the knowledge of these courses. In this work, an approach of implementing a project-based teaching approach that links multiple courses within the field of mechanical engineering was explored. The multi-course linked project-based teaching approach allows students to build on their knowledge progressively, reduce learning pressure, enhance learning curiosity and practical skills, and develop their abilities of teamwork, practical, and critical thinking, as well as their project planning and execution skills. The multi-course linked project-based teaching approach introduced in this paper can provide a useful reference for the reform of mechanical professional courses.

1. Introduction

Project-based teaching is a new type of teaching method that has been gradually developed in recent years, which is different from the traditional teaching method. It is a kind of teacher-guided and student-centered teaching method. Project-based teaching is to infiltrate the knowledge in the project in the teaching process so that students can feel the application of knowledge in the process of participating in the project, and also exercise the practical ability of students[1]. Each project is a complete matter and students should explore, study, and answer questions around the matter. Project-based teaching places significant demands on teachers, both in terms of their teaching and practical skills, as well as their ability to follow the progress of the entire project and provide guidance to students for successful completion of the project and achievement of teaching objectives[2]. Teachers must also be able to effectively monitor the progress of students and the project as a whole and to provide guidance to students for the successful completion of the project

and achievement of teaching objectives. Through the project-based teaching, students can exercise their abilities of teamwork, thinking, and project planning[3, 4].

Compared with traditional teaching method, project-based teaching is more innovative and can attract students' interest. However, extensive research has revealed several issues with the implementation of project-based teaching in mechanical disciplines, including unclear teaching objectives, a lack of diversity in project types, insufficient variation in teaching methods, and an inflexible evaluation system. At the same time, there are many important professional courses for students in mechanical majors. If the project-based teaching methods were used in each course, students would have multiple projects to carry out at the same time, and the workload of the students is huge, which is not conducive to stimulating students' interest. Therefore, there is an urgent need to solve these problems so that project-based teaching can be better applied in mechanical majors.

Mechanical engineering is an important discipline of study in many universities. Students' practical skills should be assessed. The exploration of the multi-course linked project-based teaching approach would produce positive effects in developing students' practical ability, knowledge foundation, initiative, and motivation.

2. The current situation of project-based teaching in mechanical majors

The objective of the project-based teaching method is to integrate academic theory with practical skills, unlocking each student's potential to enhance their professional and innovative capacities. This project-based teaching method fosters comprehensive professionalism among students. The implementation of the project-based teaching approach empowers educators to establish a positive classroom environment, enhance interaction between educators and learners, and ultimately enhance the standard of instruction.

Project-based teaching is a design-focused approach, whereby students are responsible for managing their progress. Completing the corresponding project requires integrating relevant knowledge and personal experience, and collaborating with team members to solve problems and achieve project goals.

Currently, there is a lack of physical models to be demonstrated in mechanical course. Students may find the initial theoretical learning tedious, and later practical operations may be hindered by an incomplete understanding of the theoretical knowledge, resulting in learning difficulties. Consequently, these traditional teaching methods would undermine students' confidence and create undue learning pressure.

Project-based teaching allows students to effectively blend theory and practice, improving their understanding of the meaning of their learning. While project-based teaching has numerous benefits, it is important to recognize that there are a lot of specialized courses that hold great importance for mechanical engineering majors. If the project-based teaching method is implemented in each course, students would be required to undertake a lot of projects for all courses. It could lead to a heavy workload for students, ultimately impacting the effectiveness of project-based teaching. In order to address this issue, our team has proposed the following reform suggestions.

3. Application of a multi-course linked project-based teaching approach

3.1 Designing the Multi-course Linked Project

Project-based teaching should fully utilize the openness and comprehensiveness of the project, and play a key role in the teaching of mechanical students. Given the interdependence of numerous mechanical professional courses, it is imperative to establish a linkage between these courses. For

instance, courses such as "Mechanical Principles", "Mechanical Innovation Design", "Mechanical Design", and "Course Design of Mechanical Design" are all part of the related courses of "Mechanical Design". The knowledge points of these courses are continuous and coherent. Therefore, for these courses with the same knowledge system, the same project can be set up. This project is a multi-course linkage and needs to be improved through the learning process of multiple courses. The tasks that need to be completed for the same project in different courses are different, requiring extensive use of knowledge from the course being studied as well as the knowledge from other courses. The multi-course linked project-based teaching approach not only has the advantages of project-based teaching but also reduces students' learning pressure by giving them enough time to improve the project. Due to the need for the multi-course linked projects to be improved and updated during the different courses, it is easy to form high-quality projects. At the same time, teachers can encourage students to participate in various mechanical innovation and entrepreneurship competitions based on these high-quality projects, fully tapping into their creative talents.

3.2 Enriching project materials for the teaching contents of different courses

In the teaching process of mechanical professional courses, the lecturers of multiple courses under the same knowledge system should concentrate on lesson preparation and set up unified teaching projects. Teaching projects should be able to utilize knowledge from multiple courses within the same knowledge system so that teachers of different courses can use the same teaching project in different courses. Teachers of each course should carefully design the teaching project, which should be more focused on the exercise of the teaching knowledge of the course. When implementing project-based teaching, it is important to find resources that can meet the teaching syllabus and objectives, as well as combine them with practice to enhance students' ability to utilize knowledge. The completion of the project requires students to be able to utilize the knowledge they have learned, or the project requires students to expand their thinking and combine existing knowledge to access relevant materials to complete.

3.3 Establishment of the diversified evaluation system

For the traditional course assessment method, the final exam and the student's daily performance are focused. However, project-based teaching requires a comprehensive evaluation of the student's overall capabilities. The evaluation should not only evaluate the degree of mastery of theoretical knowledge through exams but also evaluate their problem-solving ability. Therefore, the evaluation system should be diversified. Not only can teachers rate students, but students can also evaluate the implementation and completion of their tasks, and group members can conduct mutual evaluations. Only through comprehensive and objective evaluation, students' strengths and weaknesses can be reflected.

4. Effect of the application of the multi-course linked project-based teaching approach

4.1 Beneficial to improve students' learning initiative

In the multi-course linked project-based teaching approach, efficient classroom teaching can be achieved through the arrangement and implementation of project tasks. Due to the relatively simple teaching methods and content in traditional classrooms, mechanical courses lack attractiveness to students, and students lack initiative in learning. Implementation of project tasks can effectively mobilize students' subjective initiative, allowing them to actively explore based on their knowledge.

In this way, students' learning state changes from passive to active, achieving a deepening of learning to mastery.

4.2 Beneficial to cultivate students' teamwork ability

In traditional classrooms, students often learn independently and lack appropriate communication and cooperation. However, the implementation of the multi-course linked project-based teaching approach requires a stable project team, which can effectively cultivate students' teamwork ability. Various types of project tasks in the teaching process require teamwork to complete. During the project task process, students need to complete their specific tasks in the group. They would realize that the completion of their assigned tasks will directly affect the outcome of the entire project task, thus actively engaging in communication and cooperation with other members of the group. It not only improves the cohesion of group members but also cultivates students' teamwork ability.

4.3 Beneficial to the improvement of students' knowledge system

In multi-course linked project-based teaching, students need to solve problems across courses and disciplines. They will actively collect data, obtain information, and explore solutions for projects to solve practical problems, which is conducive to cultivating students' ability to solve practical problems. Therefore, the use of the multi-course linked project-based teaching approach not only reduces students' learning pressure by giving them enough time to improve the project but also helps students connect the entire knowledge system, making it easy for students to master the knowledge system from a global perspective.

5. Conclusion

By analyzing the characteristics of project-based teaching and the current situation of mechanical majors, the author has established the multi-course linked project-based teaching approach to improve the effectiveness of traditional teaching and further enhance students' professional quality and hands-on ability. Practice has proven that setting the same project for multiple courses under the same knowledge system can not only reduce students' learning pressure, and stimulate their interest in learning, but also improve their ability to analyze and solve problems, further cultivating students' spirit of teamwork and exploration. The mechanical major itself is highly practical. If project-based teaching can be well integrated into the teaching of mechanical majors, it will significantly improve students' hands-on abilities. It provides a very good foundation for them to be better qualified for their jobs after graduation.

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