

# The Practice Research of PBL Teaching Mode in the Course of Mechanical Design

Mosi Zheng

Wenzhou Polytechnic, Zhejiang, 325000, China

## Abstract

**This paper describes the research process of applying PBL teaching method in the course of Machine Design. It includes the determination of teaching items, the application of a variety of project implementation measures including flipped classroom, school enterprise joint teaching, competition to promote teaching and so on to practice PBL teaching method. The results of this study have been proved to achieve a good expected effect.**

## Keywords

**PBL teaching model; Mechanical design; Project.**

## 1. Introduction

Project Based Learning (PBL) teaching mode is a widely spread and highly respected teaching mode in the world. It is student-centered and uses dynamic classroom teaching, believing that students gain deeper knowledge by actively exploring real-world challenges and problems. [1] The mechanical design and manufacturing major of our school is a cooperative project with British Columbia University of Technology (BCIT) in Canada, which is a "demonstration Sino-foreign cooperative education project in Zhejiang Province". Project Based Learning (PBL) is a teaching mode that BCIT School of Mechanical Engineering has consistently implemented and achieved fruitful results over the years. [2] We hope to improve students' mastery of professional knowledge and skills through the application of PBL teaching method in the course of Mechanical Design, and at the same time provide reference experience for the application of this method in other courses.

## 2. The Implementation of This Study and the Results Obtained

### 2.1. The Determination of Pbl Teaching Projects

Based on the analysis of BCIT projects used in PBL teaching, we combined the employment orientation of students here and the characteristics of enterprises to develop relevant projects suitable for us. The overall teaching design scheme is as follows: take the mixer design of a certain enterprise as a main project of the whole course. When students take this course for the first time, they are given the design task: they have to complete the design of a mixer at the end of this course. In order to enable students to complete the project and master the relevant knowledge points of the course Mechanical Design, we divided the main content of the whole course into 11 parts, and used the knowledge points of these 11 parts to support the design of blender. At the same time in the individual part to introduce the individual small items to carry on the local knowledge ability exercise. The arrangement of the 11 parts should not only consider the cognitive law of students, but also realize the teaching purpose of letting students master the design content and thinking of mechanical design through the course learning, and finally realize the goal of project teaching. The following Table 1 is part of the schedule of specific projects and teaching parts.

**Table 1.** PBL Teaching Project

No.	Topic	Sub-item content	Main Project Content
1	Machine structure analysis and drawing of mechanism kinematic sketch	1.Determine the type of mechanical equipment 2.Drawing common mechanism kinematic sketch	1.The working principle and composition analysis of the mixer 2.kinematic sketch of mechanism movement of mixer
2	Linkages Design	1.Analysis of connecting rod mechanism in daily life 2.The design of oven opening and closing mechanism	
3	Cams Design	1.Analysis of the working principle of the recorder 2.Composition analysis of automatic seal mechanism	
4	Threaded connection and screw drive design	1.Performance analysis of cylinder thread connection 2.Analysis of fast opening and closing mechanism of compass foot	1.Thread connection design of gear reducer box and accessories of mixer
5	Belt drive	1.Analysis of belt drive in commonly used machinery 2.V belt drive design	1.V belt drive design in mixer
6	Gear drive	1. Dancing sunflower toy gear drive type analysis 2.Design of first stage cylindrical gear transmission	1.Design of gear mechanism in mixer
...	...	1. ...	...

## 2.2. The Implementation of PBL Teaching Projects [3]

### 2.2.1. The Implementation of the Project Will Be Promoted Step by Step and in A Bilingual Manner

During the implementation of a Project, the characteristics of students' ability to accept knowledge learning should be considered. In the process of project promotion, we adopted the way of "easy first, difficult second, step by step". In the first part, we not only give the task of mixer design of the main project, but also introduce a sub-project: the type judgment of mechanical equipment. After class, the group of students will complete and make a bilingual multimedia courseware for class report, and the teacher and other groups of students will evaluate and discuss and determine the score. Through this sub-project, students will have a preliminary exercise, clear the concept of machine body in the first part, analyze the composition of the machine and motion route, which can be an analysis of the composition and working principle of main project, as well as the expression of the professional English vocabulary, to achieve the goal of bilingual teaching in overtime, and improve the ability of students in the professional foreign language application.

### 2.2.2. Multi-mode Teaching Including Flipped Classroom Promotes Project Implementation

After PBL teaching is applied in classroom teaching, students have more time to participate in discussion and analysis, which sometimes leads to insufficient class hours in classroom teaching. In addition to the application of conventional teaching, we also applied the flipped classroom teaching mode in some parts. For example, in teaching of rolling bearing code, we

introduced the sub-project "Rolling bearing code and characteristic analysis", so that students can understand the types and brands of rolling bearings in advance, and make courseware for reporting. Then let the students in the class to observe and analyze the bearing material, through the textbook and the network to obtain the relevant knowledge points to make judgments and analysis results. Finally, he went on platform to report to the teacher and all the students for the title of "Excellent". The students were very enthusiastic to participate in this teaching mode. After class, some students said that he preferred this teaching mode and gained more knowledge.

### **2.2.3. The Implementation of the Project Is Promoted by the Combination of School and Enterprise Training**

The reason why we choose mixer design as the main project carrier of this course is that the design of mixer includes gear transmission, V-belt transmission, shafting design and other knowledge points mainly taught in the course Mechanical Design. At the same time, the reducer in the mixer is also a common equipment in many mechanical engineering. It is very practical for students studying the course.

In order to enable students to master the above knowledge points smoothly and complete the project, we have added some in-school and out-of-class practical training projects in gear mechanism design and belt transmission design. Such as dancing sunflower gear mechanism analysis, a cylindrical gear transmission design and other projects. Its design difficulty is a little lower, but it is similar to the mixer design in design idea. In order to enable students to master the above knowledge points smoothly and complete the project, we have added some in-school and out-of-class practical training projects in gear mechanism design and belt transmission design. Such as dancing sunflower gear mechanism analysis, a cylindrical gear transmission design and other projects. Its design difficulty is a little lower, but it is similar to the mixer design in design idea. This is also based on the students' learning ability, gradually introducing them to be able to think independently and work together to complete the main project. After the theoretical course, students will complete the main project through the two-week on-campus practical training. During these two weeks, the teacher mainly guided the students to complete the task. The students combined with their professional curriculum knowledge, completed the design task of blender in groups and a public plea of the class, finally got the results. In the summer social practice after the end of this course, the professional teachers led the students to carry out practical training on the production of reducer in enterprises, so that the students had a practical comparison and application of their original design results, realized the transformation from theory to practice, and greatly improved the students' understanding and mastery of professional knowledge. Students' positive learning attitude and exploration spirit have also been recognized by the enterprise.

### **2.2.4. Promote the Implementation of the Project by Competition**

According to the different learning abilities of students, Some excellent students were selected to join the National Robot Competition, National Mechanical Design Competition, Zhejiang Provincial Mechanical Design Competition and other teams to host or participate in the competition. In the spare time, the competition project is regarded as the knowledge application project of mechanical design course, so that students can learn the course knowledge independently and apply professional knowledge creatively. For example, the national robot "track and field horse race" project with the application of planar linkage mechanism won the national first prize, and the project "bicycle automatic lifting double-layer parking frame" with the application of chain drive and multi-bar mechanism won the first prize in the eighth national college students mechanical innovation design competition. The project-based teaching of innovative projects through competition projects expands the content of this teaching method and greatly promotes the improvement of students' learning ability.

### 2.3. The Effect of PBL Teaching Project Implementation

At the end of the course, we asked students to evaluate the effect of PBL mode teaching in the course of Mechanical Design. The comments of 42 students in the class are shown in Table 2 below. It can be seen that PBL teaching mode is effective in the course of "Mechanical Design".

**Table 2.** Student evaluation

Investigation Item	Proportion
PBL teaching style attracts my attention	94%
The application of practical projects in the course helps me to master professional knowledge	100%
After finishing this course, I think my learning effect is excellent	97.5%

### 3. Conclusion

This research has effectively improved students' learning enthusiasm for mechanical design course, professional knowledge mastery and professional English application ability. At the same time, it also provides a reference for other professional teachers to carry out the research work in this field. In the research, we also found that there are some deficiencies, such as The students' learning ability is relatively poor, too few student were able to enter the mechanical design competition, Some students finished the project over time and other problems, which will be gradually improved in the future work.

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### References

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