Construction and Application of Experiment and Training Course System Based on Integrative Teaching

Jingling Wang\textsuperscript{1,a} and Chaohui Xu\textsuperscript{1,b}

\textsuperscript{1}School of Mechanical Engineering, Tianjin University of Technology and Education, Tianjin 300222, China;
\textsuperscript{a}28759400@qq.com, \textsuperscript{b}369568122@qq.com

Keywords: Integrative teaching; three levels; experiment teaching system; Project-based teaching.

Abstract. In order to cultivate the professional practice ability of the integrative vocational teachers, this paper constructs the integrated experiment and practice course system based on the linkage of production, study, research and application. The new curriculum system focuses on students’ vocational skills and enhances the training of engineering practice. Under the guidance of the three levels of experimental teaching system, the development and construction of "integration" and "project type" course are completed, and the actual teaching effect is good.

1. Introduction

Vocational education is an important part of the national education business, which is an important way to promote economic and social development and labor employment. "Made in China" 2025 plan, "Industry 4.0" and the development of intelligent manufacturing request more for vocational education and vocational teachers\textsuperscript{[1]}. The vocational teachers in "machine manufacturing area" should focus on mastering the new generation of information technology and manufacturing techniques. They should be integrative teacher who integrate theory, engineering practice, vocational ability, teaching ability and innovation ability. The so-called integrative teaching is the combination of theoretical teaching, practice teaching, production service and scientific and technological development in teaching activities, learning theory in practice, learning techniques in practice. Its characteristics are taking "teaching, learning, doing" as a whole, learn by doing, do by learning.

The ability of the integrative teacher includes education's teaching ability and professional practice. The cultivation of professional practice is crucial. So, experiment and training are very important for the cultivation of integrative vocational education teachers\textsuperscript{[2,3]}. Combined with the training requirement in knowledge, ability and comprehensive quality of integrative vocational education teachers, this paper constructs the integrative experimental and training system based on the combination of theoretical and practical courses. This system based on the linkage of production, study, research and application, takes the skill training as the starting point, and features "project-based" training. This system taking mould industry as a carrier lay the foundations for developing students' knowledge, skills and ability of engineering practice and innovation

2. Construction of Experiment and Training Course

2.1 Guiding Theory

According to the standards requirements for mechanical "integration" of teacher, to improve the students' professional skills as the main line, combining the demand and cultivation of professional ability, strengthening the ability of engineering practice training and cultivation of innovative consciousness\textsuperscript{[4,5]}, the experiment teaching system are constructed, shown as Fig.1. The experiment teaching system is divided into three levels according to the teaching stage. The system focus on students' learning process in the formation of practical ability and cognitive characteristics and variety of teaching methods.
2.1.1 First level: basic practice

This level mainly aimed at cultivating students' basic skills, which are mainly in the form of various courses and preliminary engineering training. Experimental design combined with professional features, training the knowledge of the mechanical industry system and the basic vocational technical skills. That will give the students a rudimentary understanding of the industry and a basic experience in the structure, design, manufacturing, planning and management of the product, to establish basic engineering consciousness, to master basic technical skills, and to train basic innovation ability.

The basic practice level includes the skills required to complete other levels of work. The base layer emphasizes perception and focuses on operation, which is the basis of forming ability and cultivating quality. The students who were initially enrolled in the experimental class had poor technical ability and a narrow engineering knowledge. For them, teachers need to fully explain the knowledge and skills in the process of teaching process and the formation process, try to increase the demonstration, video, charts and some other visual materials for teaching, to increase the students' perceptual knowledge.

For example, we designed a number of cognitive problems when the students were trained in the field of mould structure in the basic level. Two kinds of teaching methods are used. First, teachers use real mould as the teaching model to carry out the actual demonstration, and let the students do it themselves, to make the students have a perceptual knowledge on mould. The second is using video and multimedia animation to demonstrate the working process of the die, further deepen the students' understanding of the mould structure system.

At the same time, we integrate theory curriculum and practice course, developing a series of integrated courses, practice with theoretical knowledge, and validate theories in practice

2.1.2 Second level: practice improved layer

Based on the comprehensive and innovative experiment, this layer trains the students' system design ability, comprehensive integration ability and basic innovation practice ability. These experiments are mainly in engineering process courses. Through the design and innovation of the process and so on, the students' professional design and innovation ability are enlightened. In addition, through opening laboratory project, students' innovative ability is trained. Fusing each specialized courses in the experiment, students' systematic knowledge structure and comprehensive experimental skills are cultivated.

Practice improved layer emphasis on skills training. Training content according to the project module settings, for example, according to the mould manufacturing process of each module settings, from the shallower to the deeper, from single technical skills to the composite technology, from the professional standard of core skills to high-tech, composite technology skills needed for modern industry. In the experimental module of "die special processing", "die electrode split", "tool electrode detection" and other comprehensive experimental subjects are set up except for the core skill subject of the professional standard. That guides the students in the process of completing the individual
project, expand the knowledge, apply the knowledge and skills, and master the way and method of solving the deeper problem.

2.1.3 Third level: engineering application

This level is based on graduation design, scientific and technological innovation, and actual project production. Teachers choose technical project that have practical application value from scientific research, production line, and instructs the student to complete the project. The student is independent or cooperative; the goal is to train the student's engineering consciousness and the actual production capacity.

The engineering application layer emphasizes autonomy and innovation, encourages and cultivates the training subject of interdisciplinary and professional integration. For example, "Mould manufacturing technology" is the core course of material forming and control engineering (Mould profession direction) major, also is a highly integrated course in theory and practice. We combine the theory and experiment of the course with the practical training of "mould design and manufacturing skills", the teaching of the classroom alternates with the practice of the laboratory, improving teaching effectiveness through knowledge transfer and practical guidance by the integrative teacher.

2.2 Implementation Process

2.2.1 The development of "integrated" courses

We have focused constructing some integration courses, for example, mechanical design and curriculum design, Engineering materials and heat treatment with Metallurgical technology, Mechanical CAD/CAM with 3d drawing training, NC machine tool and programming with skill training integration course. Now taking the integration course of mechanical design and curriculum design as an example, the development process of the course is illustrated.

1) The idea of course development

We improve the curriculum system and construct the integrated course following the principle of cognitive law, downplaying the boundaries of the course, and emphasizing the connection of knowledge, to train students' mechanical engineering literacy and ability, and lay a solid foundation for the study and work of subsequent knowledge. This course centers on the comprehensive development of student ability, and the design process of the project, based on mechanical design, engineering materials and heat treatment, the metalwork internship, and Interchangeability and measurement technology course are integrated. So as to achieve the operation mode of integration course featured on “five in one”: the theoretical study, practice of training, curriculum design, innovation competition and Teacher training.

The course borrows from the CDIO model and reorganizes the teaching content according to the design process of the machine. Students through the mechanical movement scheme design, motion analysis, the structure and parts design, relevant dynamics calculation, assembly drawing and parts drawing, write design specifications, processing production module, completed the systematic knowledge learning, ability training and quality development, which reflects the idea of modern high education.

Redesigning the practice session. New practices include laboratory classes, skill practice and curriculum design. Among them, the practice of skill includes the drawing and analysis of the mechanism, CAM milling machining, Gear processing and displacement and Shaft processing, which has its own characteristics. The content, objectives, evaluation forms and criteria of each practice activity have been clarified.

The experimental part strengthens the characteristics of autonomy, comprehensiveness and design. For example, in addition to the original experiment, a new reducer drive test comprehensive design experiment, not only embodies the comprehensive, design, but also requires students to independent design experiment; determine plans and contents, installation and debugging, testing, and master computer aided test method.

Curriculum design is more comprehensive and practical. The course design selects the mechanical device as the target, emphasizes the design and the actual requirement, and the attention to the point of the CDIO's ability training, and has the height and the difficulty.
At the same time, the seminar is arranged, which reflects the cultivation of students' independent inquiry and independent learning ability.

2) Curriculum implementation

In the course, the engineering example library is set up; system design and technical design are according to the design process of the project. In the design phase of the system, the students are able to design the system based on the typical organization and its design method. In technology design stage, the combination of typical parts, including the selection of engineering materials and heat treatment, design calculation and structure design, selection of compatibility and tolerance matching, etc., student to carry on the detailed engineering design.

The construction of the mechanical design curriculum not only emphasizes the system connection and cohesion of knowledge, but also implements model of the "five body" courses, including the theoretical study, practice of training, curriculum design, innovation competition and Teacher training, which trains the students' mechanical engineering.

According to the model of integrated curriculum, the mechanical design curriculum has built a comprehensive teaching system, the learning and practice skills of theoretical knowledge are integrated through typical design tasks. And extend the design task from theoretical and practical training to curriculum design and innovation competition. Students complete the technical documents of design reports, cost reports, production reports and work reports during the process of design and manufacturing. In the course of theoretical knowledge learning, practice training, curriculum design and innovation competition, the training of teacher skills is carried out, in this way; normal skill training is integrated with theoretical knowledge, practical skills training and curriculum design and innovation competition through typical design tasks.

2.2.2 The development of the "project" training course

1) Guiding theory

We set up the design and manufacture of mould management service platform. The platform is based on the management of mould manufacturing process, and the production characteristics and production process of die manufacturing are designed. In the course of teaching, the concept of "enterprise moving into the classroom" is carried out, and the real production and management process of the enterprise is fully simulated. This paper designs the standard production management practice process and the practice instruction, provides the students with a comprehensive simulation practice environment[6]. Combining actual training and actual production, with the product manufacturing process in real projects as the main line, Integrate the advanced hardware equipment, management idea and production process of actual production into the system, to help students master the production management process in the workshop. Students are more specific and complete about the production of the business through role-playing. Students can better understand the situation of the industry from the perspective of the whole point of view, and cultivate the perspective and professionalism of the industry.

2) Curriculum implementation

On the basis of study in the course, the students finish the training process. Combined with enterprise production examples, Students are divided into groups to arrange their own training, according to their respective products, the production management of the actual enterprises, and the management of the actual enterprises. The contents of the training include die assembly, precision testing and reverse, die special processing, die CNC processing, CAD/CAE/CAM, etc. At the same time, the integrated management service platform is used to coordinate the actual training of each group to ensure the full use of each equipment, to make the students understand the whole process of die production process and the whole process of production management. The students are working together to complete the project of parts analysis, mould design, mould manufacturing and so on.
3. Conclusion

The construction of the experimental course system has played a positive role in the cultivation of the teachers. The course system developed in this paper has been applied in teaching practice. In the course system, the students' enthusiasm for the course is greatly improved and the capacity of engineering practice is strengthened. This has a positive effect on the cultivation of the integrated vocational education. The development of the integrated experimental course will be further improved in the area of teaching site and the construction of teachers' team, so as to realize deeper integration teaching.

4. Acknowledgment

Supported by Teaching reform project of Tianjin University of Technology and Education, No: 201501, and Tianjin higher school undergraduate teaching quality and teaching reform project NO: C03-0802

5. References


