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Design and implementation of the course of machinery manufacturing technology based on project teaching

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ABSTRACT

Domestic higher vocational schools have been making efforts to advocate the course reform. Spreading theoretical knowledge while increasing students' vocational competence is a common concern of educators. This paper takes the course of machinery manufacturing technology of a higher vocational school as the example where three mechanical products are involved, and redesigns the whole course including its teaching goal, teaching idea, teaching content, teaching method and teaching process. Practice has proved that project teaching incorporated with typical products makes students more active and such teaching method enhances students' vocational competence and quality..

Key words: Vocational competence; Course on machinery manufacturing technology project teaching

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INTRODUCTION

Machinery manufacturing technology is a major course in higher vocational schools of engineering, in particular for machinery majors. The purpose of the course is to equip students with basic theories and knowledge of processing, manufacturing, assembling and testing of machinery products. Students are expected to develop the ability of industrial analysis, fixture design as well as assembling and testing techniques, and be sensitive to the latest technology and development trend. Through this course, students can get practices before they become a qualified engineer. With the advancement of science and technology, the original teaching system, content and method are out of date. This course is theoretical-based, practical-based and comprehensive-oriented, and has a high requirement on knowledge, skill and update speed. Thus, it is necessary to reform the course of machinery manufacturing technology.

Many demonstration vocational schools have implemented project teaching on the course of machinery manufacturing technology at provincial level or national level. With teaching content involving typical parts, teachers can set up specific tasks and students can combine learning and working through processes such as information, decision, planning, implementing, correction and evaluation. Teachers only play a role of teaching, demonstration and guidance[1, 2]. In Jilin Technology College of Electronic Information, there are five typical projects, namely, shaft parts processing technology, plate parts processing technology, box parts processing technology, cylindrical gear parts processing technology and assembling technology. Group evaluation, teacher's evaluation and final exam are adopted to assess students' performance[3].

In Heilongjiang Agricultural Engineering Vocational College, the course of Creation and Reading Process of Products is designed with five typical projects according to products of enterprises. These include rotor processing technology, cover processing technology, drive gear processing technology, chassis processing technology and roots flowmeter assembling process technology. With the innovation driven by tasks, this course focuses on process evaluation and evaluation after each situation. Grades are accumulative to be the final result[4, 5].

In Nanjing Institute of Industry Technology, the course of machinery manufacturing technology contains 7 projects: cylindrical parts processing, parts surface processing, spindle-case processing, reducer assembling, step-shaped shaft parts processing error analysis and fixture design. This course integrates with practical work and designs five learning situations. Each situation is divided into several projects or items for specific training according to cognition rule and growth regularity[6].

In Shunde Polytechnic, the course of machinery manufacturing technology is based on working process. Air condition compressor parts are selected as typical parts. With process planning of machinery manufacturing as the core, metal work practice with machinery manufacturing technology and course design are integrated, providing students with vocational training[7].

In Chengdu Aviation Vocational and Technical College, the course of machinery manufacturing technology includes five projects, namely, shaft parts processing technology, plate parts processing technology, sleeve parts processing technology, shell parts processing technology and special-shaped parts processing technology. These projects are similar to real manufacturing process of enterprises. Students have a better understanding about the key links in manufacturing. As for the evaluation, process evaluation is the primary while result evaluation is the complementary. Learning process and learning method are greatly emphasized[8].

Teaching practices in these higher vocational schools have proved that project teaching is effective in the course of machinery manufacturing technology. Through project teaching, students develop an interest in the knowledge and are free from fear of difficult concepts, get inspired and encouraged, and arise the willingness to explore the field. They are able to use machinery manufacturing technology to solve practical problems and aware of the development trend of machinery manufacturing technology in the mechanical industry.

However, there are still loopholes in project design and implementation. For example, practices may turn into repetitive trainings without clear goals, which is hard for students to keep interest. Task-oriented knowledge lacks theoretical support and inner logics, which is hard for students to form a knowledge system. Parts processing may be difficult to operate. The teaching cost is high for milling spindle processing and linkage processing, which brings difficulties to the teaching.

Teaching design holds key to the whole process. Teaching goal, teaching content, teaching method, teaching process and evaluation should all be considered. Course design should be based on the characteristics of vocational schools. In other word, the design should consider job characteristics and work content and creates a new teaching mode featured by “task-oriented, teaching and learning combined”. The major teaching goal should focus on nurturing technicians with competitive skills. The teaching content should be moderate. The teaching method should be student-oriented. The evaluation should pay attention to theoretical knowledge, skills and professional qualities. Dongguan Polytechnic (referred to as “our college”) conducts an extensive cooperation with machinery manufacturing enterprises. Both sides co-design courses, provide chances to simulate the working process and make specific plans focusing on machinery products processing and assembling. The course design of machinery manufacturing technology is described as below.

TEACHING GOAL DESIGN

Machinery manufacturing technology is the core course of machinery manufacturing and automation relevant majors. It is also the focus of vocational qualification exams such as mechanical lathe worker, mechanical bench worker and assembler. Enterprises that recruit graduates of machinery manufacturing and automation major are machinery manufacturing enterprises. Jobs available include workshop engineer, workshop inspector, workshop scheduler, machine operators (lathe worker, bench worker, miller, grinder, etc). According to job requirements, the course of machinery manufacturing technology sets up three goals: knowledge, skill and quality.

The goal of knowledge includes: master process planning procedure of mechanical manufacturing; master common processing methods; master accuracy testing method of parts processing; know national standards on mechanical manufacturing. The goal of skill includes: create appropriate process planning according to the drawings; have a proper use of common equipment, the ability to design tools and fixtures and to evaluate processing quality. The goal of quality includes: cultivate a spirit of hard-working; enhance students’ awareness on safe production; motivate students to learn by themselves.

TEACHING IDEA DESIGN

Focusing on machinery products processing and assembling with typical mechanical products as examples, knowledge, theories and practices are integrated together. In this course, teaching, learning and working are in a

whole system which emphasizes knowledge application, active participation and practical operation. We put much effort in analyzing job requirements and deconstructing those requirements into small tasks. The course standards and situation constructions are based on these efforts. As a result, students get practices of what they may encounter in their work. This course follows that development nature of student and aims at enhancing their vocational competence. Skill is an important goal in the course design. The course advocates a teaching mode featured by a unification of teaching, learning and working. And the evaluation is open and flexible.

The teaching content design baesd on typical product

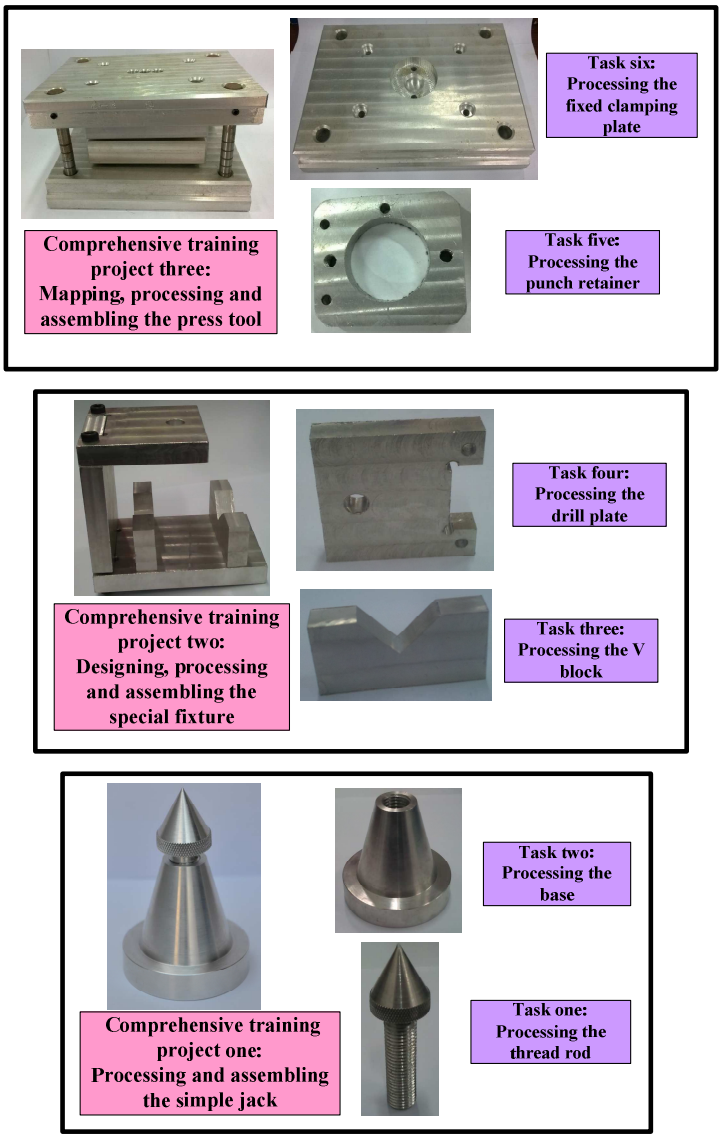

Fig.1 The task design for the course of machinery manufacturing technology

TEACHING CONTENT DESIGN

The deconstruction and construction of teaching content. This course is a departure from the traditional way of teaching in which knowledge is arranged according to relevance. Rather, it deconstructs the original knowledge system but arranges teaching content by inner logic of knowledge. This is a representative of Bloom education target classification model. Each learning situation is equipped with skill training projects. Teaching content is arranged according to the requirement of knowledge, skill and quality of the job. Hence, this course makes it possible to combine working and learning. More importantly, teaching content changes with the development of the industry. New technologies and processes are always added to it in time.

The arrangement of teaching content. We adhere to four principles when arranging teaching content. The first principle is a hierarchical way of ability construction. We stick to cognitive rules and the development of the career. The course is arranged from easy to difficult ones, from one-fold to comprehensive ones, from one task-one skill to

comprehensive skills. Knowledge is taught to students in proper sequence. The second principle is to have case studies. In the course, cases of products are analyzed. The third principle is to be task-oriented. Detailed knowledge is integrated and scheduled to form many learning tasks. The fourth principle is project-based. Teaching content is included in each one of the project, with specific knowledge, skill and quality.

According to these four principles and based on working content of lathe worker, bench worker and assemblers, we divide the course into three learning situations and three comprehensive training projects. The learning situations are: lathe and grinding processing, drilling and milling processing, products measurement and assembling. Each learning situation matches one comprehensive training project. Each comprehensive project can be divided into two single skill training project, shown in Fig.1.

TEACHING METHOD DESIGN

We advocate action-oriented teaching method. This is proper for vocational education. “Action” refers to the working process. In other word, teaching is based on working content. This course adopts the most advanced information technology method, in which students are the main body and teachers play a dominant role. From in-class to out-class, from school to factory, working process is incorporated into multidimensional teaching.

Six steps of teaching. It follows “information, planning, decision, implementation, inspection, evaluation”. Teachers have frequent interaction with students. Students are required to obtain information, then make, implement and evaluate plans all on their own. It is through practice that they acquire professional skills and knowledge and constructs a comprehensive knowledge system with rich experience.

Case study. Teachers illustrate knowledge by showing typical mechanical products such as jack, flat tongs and hardware punching. Schools invite engineers from enterprises to show students how the products are designed, created or processed.

Role playing. Schools often organize students to visit the training center. Students can have a role play and shoulder real tasks. Their ability and skills are enhanced through task playing.

On-the-spot. Some important knowledge is difficult and abstract. Therefore, school proposes to cooperate with outstanding mechanical manufacturing enterprises in Dongguan and provides students chances to learn on the spot. In recent years, three enterprises have established relationship with us. Sometimes, the teaching is carried out in factories nearby.

TEACHING PROCESS DESIGN

Teaching process is very close to working process. It is open, professional and practical. Teaching process emphasizes on experience, training as well as internship. The openness of teaching process is embodied in two aspects. On one hand the learning environment is open. Besides school, factory and training center are both places for learning. The teaching is carried out through simulating real production conditions and atmospheres. On the other hand, open-mind and innovation are emphasized. We encourage students to brainstorm and innovate. The practical feature of the learning process mainly refers to the careful design of tasks. Based on real production of enterprises, we have arranged single or multiple training projects, hoping to enhance students’ ability through practices. The professional feature of the teaching process is embodied by the fact that teaching process is in line with working process. In other word, students would learn important skills that are useful in the work.

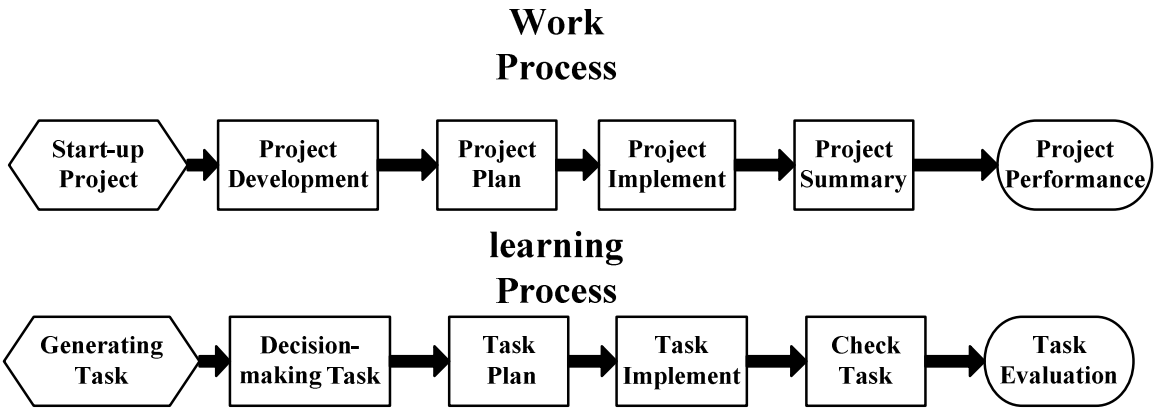

Fig.2 Students are learning important skills that are useful in the work

Construct learning situations. Learning situations are crucial elements of learning as well as a simulation of working. With working tasks and process analyzed and deconstructed, teachers make task-oriented plans. Ability goal and learning content are adjusted to real situation according to teaching and learning theory and methodology. The learning framework consists of small topics. Learning situations for the course of machinery manufacturing technology are shown in Fig.3.

Teaching implement. Teachers would follow the six-step teaching and learning theory. Tasks are naturally given at a certain time or as the teaching proceeds. Usually, teachers proposes a question through showing a part or a CAD chart, set up the goal, analyze the problem, find out breakthroughs and figure out the optimal solution. Then students form groups, write specification and draw operation flow chart for process design, select workblank and tools, process the part and assemble products in the training center, test the processing accuracy and assembling accuracy. Finally, teachers would evaluate the specification, the operation flow chart, and the products. The abovementioned process is in line with the learning and teaching regularity and illustrates the purpose of "learning for working and learning through working".

The course also introduces new ideas of modern higher vocational education. It combines overall design and unit design with vocational competence given a priority. The course updates itself as the development of time. Innovation and cooperation with enterprises are welcomed. This course is in line with job requirements and vocational qualification standards. It involves with typical mechanical products, comprehensive and single skill training projects. Students are the main body of the learning. Knowledge, theory and practices are integrated. Students are able to enhance their vocational competence through the system of learning, teaching and working. Such teaching process has yielded fruitful results.

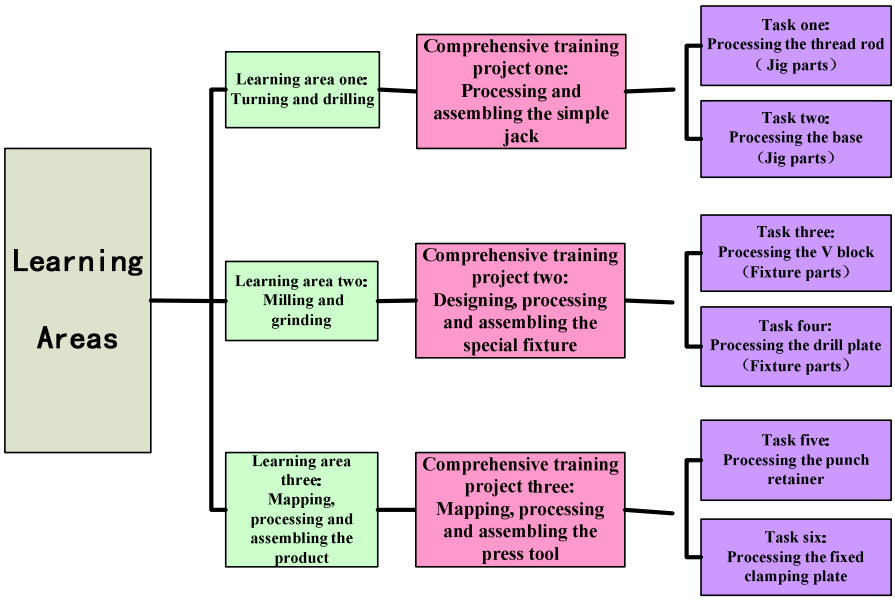

Fig.3 Learning situations for the course of machinery manufacturing technology

PERFORMANCE EVALUATION DESIGN

An evaluation based on working process and vocational competence. In the evaluation of core skills, as the ability to complete a task is of psychological feature, it is hard to conduct quantitative evaluation. Thus, grade evaluation with comment is chosen as the evaluation method. As the project teaching involves knowledge, core skills and professional qualities, these three aspects should be evaluated respectively. Given that knowledge consists of explicit knowledge and implicit knowledge, two evaluation methods are introduced. For explicit knowledge, owing to that theoretical knowledge and non-theoretical knowledge are required to recite and remember, a quantitative evaluation method is adopted. For implicit knowledge, whether at school or in an enterprise, a qualitative evaluation method is necessary as implicit knowledge is hard to be quantified. To be more specific, grade evaluation is combined with comments. The process and the result of task completion are the focus of the qualitative evaluation, which is done by teachers and other members in the group. In the evaluation of vocational qualities, according to job requirements, morality, mental quality and teamwork are core elements when evaluating. These things are hard to be quantified because they are ideal, sentiments or beliefs. Thus, a qualitative evaluation with comments is the best way to evaluate students' performance.

Construct the evaluation system based on AHP. The evaluation content and method are settled according to teaching goal and features of teaching. The evaluation body, form, content and standard form the basic framework. It is

important to make clear and objective evaluation standards. Many theoretical studies have proved that Analytic Hierarchy Process (AHP) is very practical and simple. Thus AHP is introduced to construct the evaluation index system. According to fundamental steps of AHP, the course evaluation index system based on project teaching is established, as is shown in Fig.4.

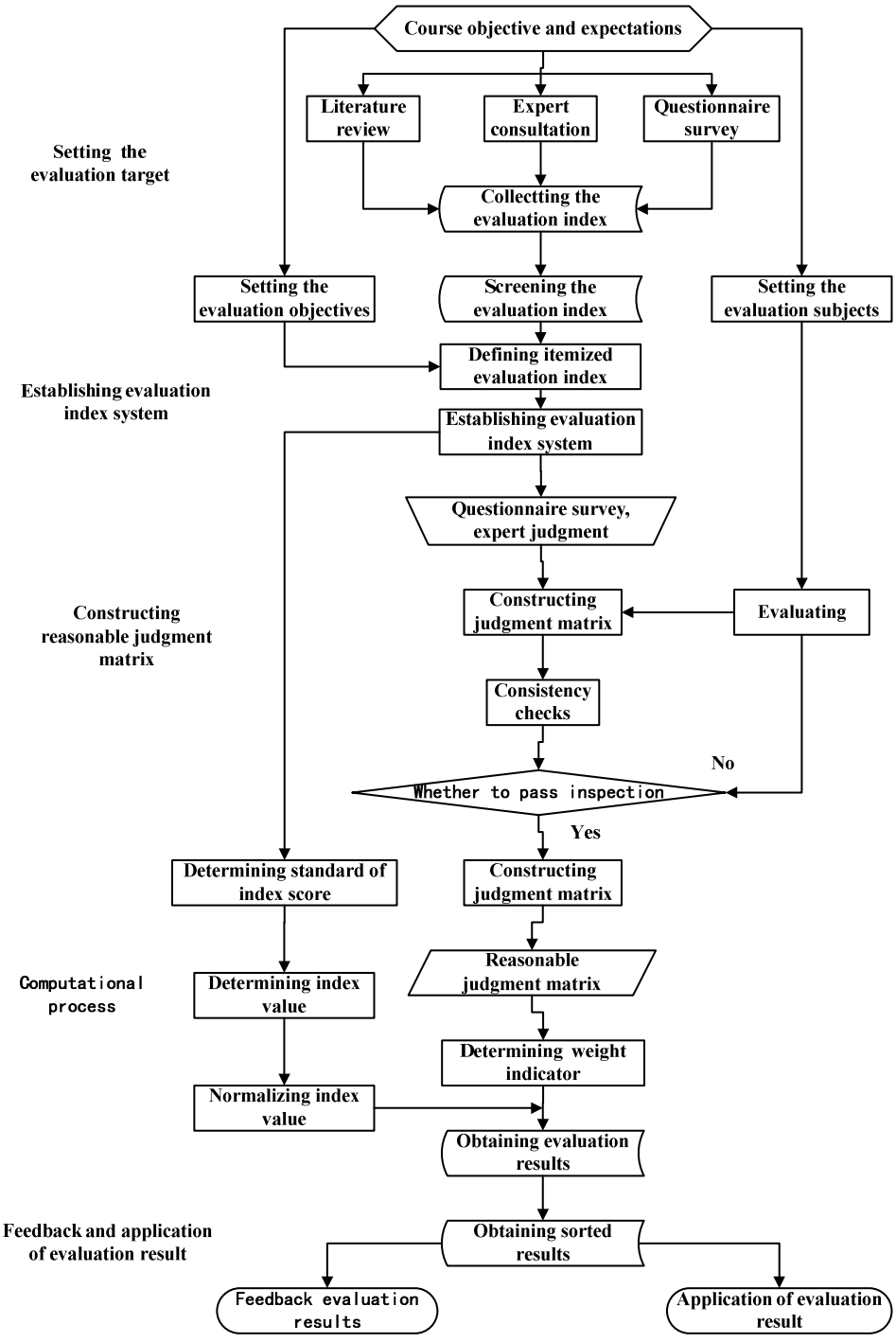

Fig.4 The flow chart of constructing course examination evaluation system based on AHP

The evaluation index system should reflect the real situation where students use skills and develop vocational qualities. It should also consider the operability and convenience when obtaining data. What's more, the selection of index is flexible and should be in line with the purpose of motivating students to learn.

An evaluation hierarchical model for the course of machinery manufacturing technology according to the purpose, the content and the easiness of evaluation, as is shown in Fig.4. From top to bottom are the target layer, the sub-target layer and the factor layer. Elements of the same layer can set up as criteria and have a dominant role over

elements in a lower layer. It is also subject to the higher layer.

CONCLUSION

The course design incorporates knowledge, theories and practices. Being student-oriented, it teaches students to learn through working. The combination of teaching, learning and working gives students practices and enhances their vocational competence. Students can draw and measure parts in person, create parts process route, experience the whole line from processing to assembling products. As a result, they make improvements in operating machine tools, creating process planning, referring to industrial and national standards as well as testing products.

The design and research of project teaching method for the course of machinery manufacturing technology provides research material and data for other machinery manufacturing and automation courses such as numerical control machining technology, nontraditional machining technology and mold processing technology.

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