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Building practical talents training mode through college-enterprise co-operation in a mechanical major

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ABSTRACT: With the rapid development of the economy, industry using machinery also has been developing rapidly. The level of mechanisation not only affects the quality of people's lives, but also symbolises the strength of a nation. Countries such as Germany and the United States of America are powerful in mechanisation, and their training of mechanical engineers is so fully developed that they provide a large supply of talent for the country's manufacturing industry. It is a key issue for most developing countries: that they build a training mode of practical talent in mechanical engineering majors based on their own national conditions. Based on years of exploration and practice, the authors here propose a hierarchical personnel training approach, and put forward several important measures to ensure the training runs smoothly.

INTRODUCTION

The aim of mechanical engineering education is to teach basic theory and methods relevant to mechanically based manufacturing and technology. Students are required to possess the ability to operate various machines, maintain and manage them [1], to develop the operating procedures for machines, and to design mechanical and electrical products. Finally, the education should cultivate the talent required by corporations, thus, reflecting market demand. With the rapid development of mechanical disciplines and fierce market competition, besides the solid foundation of theoretical knowledge, professional engineers also should have good practical ability. Moreover, they are expected to understand engineering applications, be innovative, be able to analyse and solve problems, and acquire knowledge through self-study. In order to cultivate such talent, it is important to employ a school mode referred to as college-enterprise co-operation, engineering-learning combination.

Currently, there are three popular international practical training models. The first is the *dual system* mode as operated in Germany. The main task of cultivating talent is shared between businesses and schools [2]. The school organises the professional education and job training of the students in accordance with the requirements of business. Hence, the students are more proficient in the technical abilities required in jobs, and so quickly work well after graduation. The German dual system is famous worldwide for being vocational, which was once regarded as giving a major boost to the German economy. The second mode is the competency-based education (CBE) and it is used in Canada and the United States. The core of the training mode is to determine the competence objectives from the needs of professional positions. The mode uses a curriculum development committee composed of experts from business, who formulate a hierarchical table of competencies, which serves as the goals in setting curricula and organising teaching content. Students are examined against these competencies. The third mode, technical and further education or TAFE, is Australia's leading vocational education and training provider. It operates under a national framework and is supported by industry. The TAFE combines government and industry with schools, and the schools are operated flexibly on the idea of student-centring. This mode provides relatively independent, multi-level training with effective connections between high schools and universities [3].

At present, China is making great efforts to achieve the transition to a strong manufacturing country based on technological innovation. Currently, China's manufacturing industry is weak on technological innovation. Manufacturing industry, underpinned by mechanical engineering, provides technology and equipment for the various sectors of the national economy. Therefore, its development must be advanced, which requires colleges and universities to train and provide senior mechanical and technical graduates in a timely manner. However, there are several problems in mechanical engineering training. The number of university graduates has increased considerably, but they seem less suited to business requirements. For a long time, there has been too much emphasis on instruction, instead of the students' knowledge and abilities [4]. This directly affects innovation and scientific research and, hence, the quality of mechanical equipment in industry. Students' practical ability and sense of innovation is weak. Their lack of motivation for active participation is mainly due to the teaching pattern of *teachers teach and students learn*. Innovation and reform of the contents of specialised courses are not enough to cultivate the students' ability to analyse and solve problems. Also, the students cannot well adapt to the rapid development of modern manufacturing.

ESTABLISH A MECHANICAL MAJOR PRACTICAL TEACHING MODE

In order to implement a new training mode, a module for mechanical professional practice has been developed. It includes theory and practice. Theoretical teaching contains a public basic course, professional basic course, professional required course and an elective course. Practical teaching covers experiments, internship, design, a graduation project and social practice (see Figure 1). The aim of the reform of practical teaching is to strengthen students' integrated skills, innovation and overall quality. The following is proposed to implement the reform.

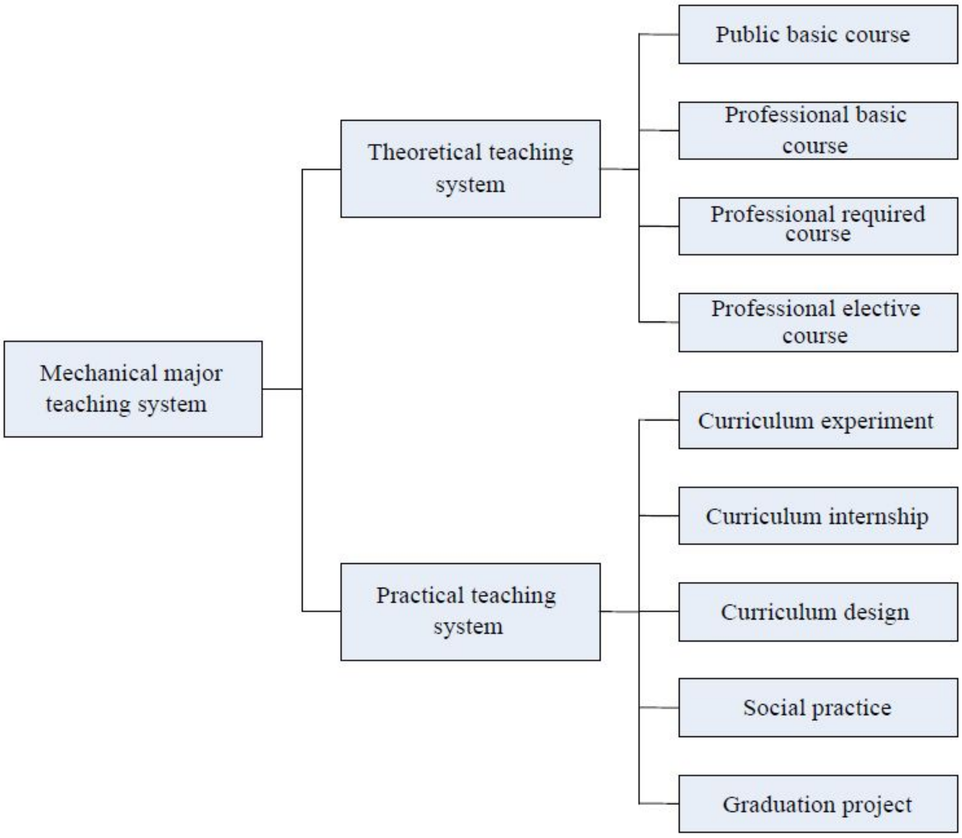

Figure 1: Mechanical major practical teaching mode.

First, reform the experiments component of the teaching. By sharing resources and equipment, the number of participants engaged in specialised basic courses can be increased. Second is to build a high standard of staff able to deliver the engineering training [5]. Skilled staff are needed, who have the capacity to develop high-level mechanical designs and understand manufacturing. Third is to enhance co-operation with companies to establish training bases and specialised laboratories that combine production, study and research. Fourth, the results of research should be used to promote practical teaching. The aim is to help students expand their horizons, enhance their teamwork, train their scientific thinking and boost their practical ability. The mechanical engineering practical teaching mode is divided into four levels, which is shown in Figure 2.

Cognitive Engineering

This level is compulsory for all freshmen. The mode uses lectures, videos and demonstrations. In addition, related areas of knowledge are covered, such as mechanical drawing, mechanical principles, computers and information [6]. Students acquire knowledge of engineering and develop their scientific spirit.

Engineering Training

The training covers the basic knowledge and processes of required courses, such as mechanical materials, and machinery manufacturing, and is taken by all sophomores. The main purpose is to give students a preliminary understanding of mechanical processing and to master the basic skills. The training content and training hours depend upon the specific profession.

Mechanical Professional Skills Training

This level is mainly for the junior. With theory as a basis, special training on modern mechanical systems is carried out to improve the students' practical ability. Meanwhile, the school should gradually strengthen students' technical ability in CNC (computer numerical control) lathes, milling and other projects, in order to achieve the required occupational skill level, and enhance their employability and competitiveness.

Integrated Mechanical Innovation Training

This level is mainly oriented to senior students, who have the ability to innovate. Under the guidance of the instructor, they participate in national, provincial and municipal machinery contests and complete innovative projects [7]. Universities should provide appropriate training platforms for a variety of teaching and learning environments, such as innovative curricular activity groups, teacher education reform base, curriculum design and graduate design.

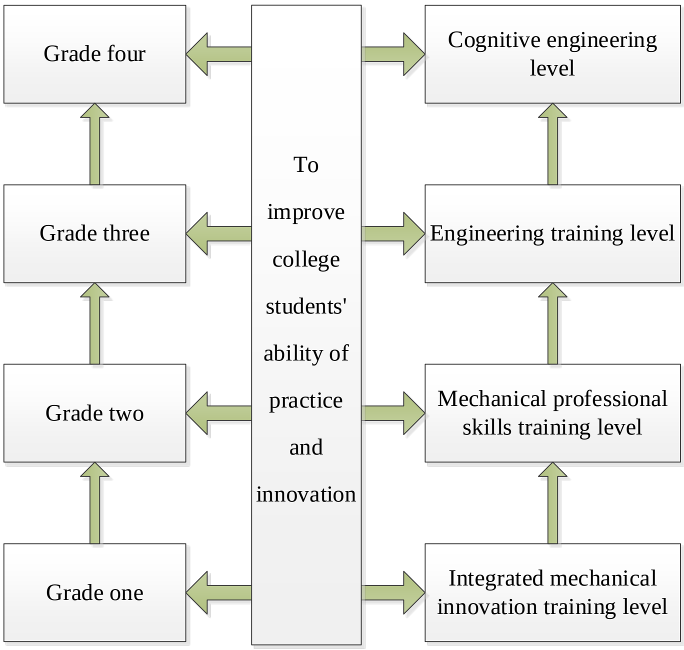

Figure 2: Mechanical major practical teaching.

PRACTICAL MEASURES TO ENSURE SUCCESS

Internships of More than Three Months

The internship is an activity where a student works in a professional organisation, and learns and exercises skills in a real environment. Through internships, students experience real professional work, so that they understand the business needs and requirements for staff competencies. It promotes continued reflection and acquisition of knowledge, a rigorous scientific attitude, and a diligent and pragmatic style of working [8].

By combining theoretical knowledge and practical work, students develop the ability to adapt to the environment and to solve practical problems. They also improve their professional ethics and develop their vocational skills. Professional skills require not only theory but also practice. Through the internship, a student participates in the work process itself, and could experience a variety of different positions requiring a variety of practical skills.

Graduation Design in the Enterprise

The graduation design is a very important part of the practical teaching of mechanical engineering undergraduates. Its aim is to foster a student's ability to use the basic theory to solve practical problems. Senior students should undertake the graduation design by participating in a project in an enterprise. The proportion of participants who do this should gradually increase to ensure the authenticity and practicality of the graduation design topics.

To encourage students to combine professional knowledge and practice, colleges should encourage students to do their graduation design in the employment unit on-site, and should develop *the management approach of students* [...] *to make graduate designs in employment units*. This ensures that a student's graduation design works smoothly in the field and is safe and of good quality. Colleges should sign an agreement with the organisations that provide sites for graduation design to provide accident insurance for students. The school should arrange an on-site mentor to guide students, and invite companies to participate in reviewing and questioning the graduation material.

Promote Practical Teaching through Co-operative Laboratories

Co-operative laboratories can be established by schools and enterprises, although with different respective roles. It is very efficient for universities and enterprises to share laboratories. Such a laboratory provides an effective solution to the shortage of university funding. Mechanical test equipment is expensive, and the corporate investment in equipment would greatly ease the financial pressure [9]. Advanced technology enterprises are the most likely source of a co-operative laboratory. Because of the inseparability of enterprises and social needs, these laboratories bring with them new technologies and new knowledge, thus, ensuring they are advanced technology laboratories. In school-enterprise co-operative laboratories, company engineers would have more advanced technology knowledge and practical experience, while the university teachers have profound theoretical knowledge. So, they enhance each other. Finally, this method enhances practical teaching.

Deepening the Reform by Opening Laboratories to College Students

Practice makes perfect. The laboratory is an important place for students by which to verify conclusions and explore processes. It engenders training, research and knowledge. Through experimental teaching, students enhance their knowledge and cultivate their practical ability. It plays an irreplaceable role in students' quality and development.

Universities should increase the quantity of experiments and improve their quality. Teachers should guide students to think carefully, do serious research and discuss together by using well-designed experiments. These experiments are not simple imitations, but are a type of motivation for the students. Teachers can design more theme-related and modular experiments, so that students realise the importance of program design, data measurement and interrelationships among experiments. In this way, students can share the joy of success, learn lessons from failure and experience the pleasance of exploration. Teachers can question an approach and gradually guide students through the experiment. This reinforces the good habit of hands-on practice that students need.

In the training series of project selection, program design, theoretical analysis, diagram drawing, components purchasing, processing and manufacturing, students will change from focusing on test scores to paying more attention to the learning process. This training method greatly enhances students' learning initiative, significantly develops their aptitude for scientific research and their engineering practical ability. Laboratory experiments and meaningful practice are not only beneficial in accumulating experience to grasp the means to flexibly apply knowledge to practical use, but also increase the student's creativity.

Strengthen Teachers' Teams

Universities should encourage young teachers to train in an enterprise for more than one year to closely integrate with engineering practice and, hence, enhance their practical teaching. The university may invite experts and senior technicians as part-time teachers of mechanical engineering majors. They would form part of an open teaching team composed of lab instructors, technical personnel of the training centre and part-time teachers with extensive practical experience. Introducing enterprise personnel into institutions not only helps students about business and the application of professional knowledge, but also sets an example to teachers on linking theory with practice.

Strengthen Training Bases

The training base is used for teaching and is not a laboratory. It is designed to simulate operational practice, which cannot be completed in a classroom or laboratory. It is used to conduct systematic and normative training of basic skills, which is purposely designed to simulate real positions. The outside training base is used for on-site training, with direct participation in production and practical work. Through visits and internships, it can broaden students' horizons and improve ability and research via practice [10]. It is a necessity if students are to go directly into working. With the application of advanced technology and equipment, the outside training base is becoming an essential part of helping graduates adapt quickly to their jobs.

Importance of Students' Social Practice

Students' social practices are an extension of the classroom teaching. In order to solve practical problems, students must personally take part in activities. Students learn to take the initiative in applying their knowledge to solving practical problems. Social practice is involved with professional learning, social entrepreneurship and employment. It is important for students to understand and master social practice.

To solve specific problems, students use their knowledge by selecting relevant information from memory. They should learn to verify theory knowledge and form an overall judgment on how to solve a problem. This practice not only helps students consolidate knowledge, but also encourages them to learn to change abstract theory into practical knowledge. Finally, it can enrich and expand the existing knowledge structures, promote the transformation of theoretical knowledge into practical capability for use in future work and lays a good foundation for solving new problems.

Local Government Support

Local government should play an important role in enhancing the level of co-operation between universities and businesses. The government must support the co-operative model by policy, funding and other aspects. Examples include providing some tax relief for businesses and developing relevant laws and regulations to promote co-operation.

The government should balance the interest between school-enterprise co-operation and co-ordination to achieve the benefits of co-operation and promote its rapid development. Meanwhile, local governments need to set up co-operative educational assessment agencies responsible for collecting information on local school-enterprise co-operation in education, and the role of a committee of experts. Also, through regular checks on co-operation in education, the direction of co-operation and collaboration should be evaluated to ensure fairness and the development of this co-operation.

CONCLUSIONS

Engineering practical ability and innovation are part of the evaluation indices for higher mechanical engineering and technical personnel training. Through college-enterprise co-operation education, students not only acquire knowledge about theory, but also step into the real engineering environments of enterprise and companies to be involved in technical work. As a result, theoretical knowledge is combined with practical applications, and the student's innovative ability is developed. It can be clearly seen that technical personnel through co-operative education training in mechanical engineering are most needed by companies.

It is the enterprise that cultivates talent and achieves the outcomes that build the nation. It is the enterprise that is an employer, conducts scientific research and exploration, as well as developing technological innovation and new productive systems. To revitalise and develop the mechanical industry and higher mechanical engineering education, colleges and universities must be enterprise-oriented and enterprises must rely on higher engineering colleges. Only through close co-operation with enterprise, can the engineering colleges achieve good practical training.

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