Cultivating talent in engineering management through an innovative mode

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ABSTRACT: With the constant development of modern science and technology, the need for comprehensive talent in China has increased. Cultivating high-quality and application-oriented talent specialised in engineering management is important. By considering the characteristics of college students, current teaching programmes and the special needs of engineering management, a novel, multi-level and individualised teaching method known as comprehensive talent cultivation (CTC) is proposed in this article. The teaching results verify that the CTC method can play an important role in improving the learning efficiency and employment rate of students. The CTC teaching mode has achieved good teaching results and applicability in cultivating engineering talent.

INTRODUCTION

The development of science and technology has ushered in the knowledge economy. Society urgently needs talent with extensive knowledge and complex abilities. For a long time, higher educational institutions have aimed to cultivate senior professionals and provide high-level professional education. At present, all high-level scientific and technological achievements are the products of interdisciplinary effort [1]. Thus, cultivating high-quality, innovative talent is an urgent issue that must be addressed in higher education.

Engineering education is designed to transform students into successful engineers with specialised techniques, social consciousness and innovative spirit. However, traditional engineering education in China focuses mainly on subject knowledge. Thus, students generally lack an awareness of, and responsibility to, history, society or the environment. However, engineering management requires technical and application-oriented practitioners, who integrate academic theory with professional skills. Currently, the lack of high-quality engineering management professionals hampers the development of industry. Hence, this research topic is addressed by this work.

PROFESSIONAL ENGINEERING MANAGEMENT TRAINING

Personnel Training Objectives

The engineering management specialty is designed to cultivate application-oriented personnel possessing a good understanding of engineering technology and project management. For each institution teaching engineering management, it should be required that students master engineering technology, management, economics and law. Colleges should combine training in the school with external enterprises, and build training platforms of engineering projects for students, so as to develop their practical and project-management ability. Colleges should encourage students to obtain vocational certificates during their learning, so as to improve their employment competitiveness. Considering the emerging requirements for project management, colleges should adjust personnel training objectives, particularly in two respects. First, teaching content should systematically cover the quality, schedule, cost, contract and other items in project management. The second is work type, with a special emphasis on one specialty having multiple capabilities, because an engineering management project usually contains multiple work types; for example, project management, property management and asset management.

The Curriculum and CTC (Comprehensive Talent Cultivation) Mode

In addition to the normal requirements of colleges and universities, the author proposes to reform the structure of the curriculum system and introduce a novel CTC (comprehensive talent cultivation) mode. The objective of this mode is to

enable students to study independently under the guidance of a teacher, combine the course content with real projects, and enhance their practical and comprehensive abilities.

The reformed curriculum for the Signals and Systems course is shown in Figure 1. Five stages are provided, from primary to advanced. The reformed curriculum places equal emphasis on *classic* content and modern technology, emphasises basic theory, promotes practical methods and focuses on the practical application of engineering.

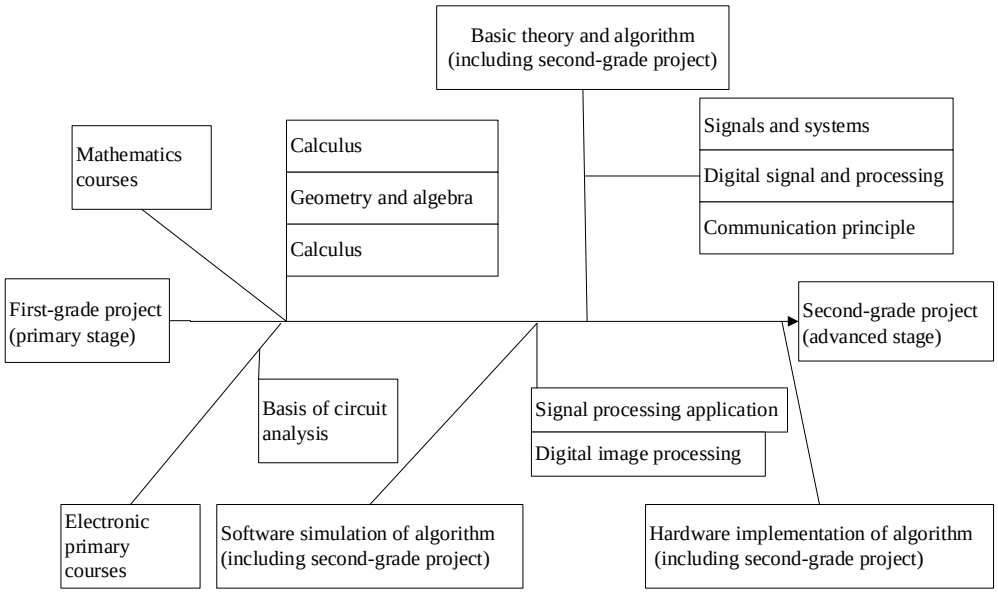

Figure 1: Signals and Systems course syllabus.

Design of the Teaching System

Teaching practice is an essential part of developing application-oriented talent. For a long time, teachers of engineering management have regarded highly the establishment of a practical education that focuses on the innovative and practical ability of students.

The CTC mode classifies projects into three grades, by scale and scope. The first-grade project refers to the project related to core courses and capabilities. The second-grade project is related to more than one core course. The third-grade project refers to the entire syllabus, i.e. the third-grade projects are determined by the requirements of the course syllabus.

The CTC mode requires the introduction of two or more CTC projects, a grade-one project in Introduction to Engineering Design and later, a grade-two project. Additional first-grade projects can be considered, with required modules introduced into the curriculum group. Third-grade projects, related to the course, also can be considered [2].

Abilities required by the CTC syllabus include organisational management, agenda-setting, presentation of minutes, decision-making, method statements, text and image processing, report writing, querying, developing reading materials, oral communication, oral presentation, computer and software operation, and ways to enhance self-confidence. These can be developed by group discussion, under the guidance of a teacher.

Selecting a CTC project is crucial because, on the one hand, a first-grade project that involves engineering technologies is required. On the other hand, a CTC project requires a first-grade project that can be decomposed into second-grade projects, which are progressed in advance.

A reformed curriculum with CTC projects will foster student interest in achieving the objectives of engineering education. This new teaching approach differs significantly from previous approaches:

- The guiding course for CTC is Introduction to Engineering Design. This teaches various methods of engineering design and introduces engineering practice, which helps students appreciate the beauty of engineering technology.

- Comprehensive talent cultivation comprises professional elective courses, emphasises basic knowledge and focuses on the organic links between courses. Specific requirements are proposed for mathematics, physics and English.

- After undertaking the CTC project that runs through all core courses, students will have acquired professional knowledge, undertaken advanced design and applied learned knowledge [3].

Modular Teaching Tailored to Aptitude

Increased college enrolments imply that there will be more variability in abilities, interests and aspirations among students. Colleges should not employ a single standard for students, but rather adopt flexible, multi-level and individualised training programmes, to teach students according to their aptitude and create an educational environment to help every student succeed. The key is to modularise the course, to clarify the required tools and skills. Modular content can be divided into basic and advanced requirements. All students must master basic knowledge, common tools and basic skills [4].

The advanced content can be offered, through seminars, to students with the required capability to achieve individual and personalised development. The teaching must reflect these individual and personal requirements. For example, the requirements for knowledge, tools and skills must be considered in designing a course for an application engineer, designer or system architect, for example.

Knowledge requirements will be met by a basic knowledge module and an advanced knowledge module(s). Modular knowledge is at the core of the curriculum. By studying different modules and mastering various tools and skills, students eventually will be equipped for different roles, thus, effectively achieving the objective of individualised learning.

Textbook Reform

With the diversification of students because of the popularity of higher education and the implementation of CTC education, using the traditional textbooks is no longer appropriate. The textbooks required by CTC include Introduction to Engineering Design and a CTC first-grade project implementation guide book. In addition, there are textbooks for the engineering management specialty. The main method of compilation is to reorganise the teaching contents according to basic and advanced requirements. The basic content will be organised according to principles, implementation methods, application environments, and tools including software and instruments. The advanced content includes expanded knowledge, improved methods, practice assessment and current technological advances.

Student-centred Autonomous Learning

The CTC mode advocates using integrated learning that includes practical engineering problems. Teachers must change teaching methods, to be suitable for the new learning [5]. Teachers should establish a student-oriented teaching mode and enable them to study autonomously. For example, problem-based teaching can be adopted to set questions and guide students in investigation. Hence, they apply knowledge to solve practical problems and develop their critical thinking. This, in turn, develops the ability to learn collaboratively, to acquire knowledge. Comprehensive talent cultivation emphasises the subjectivity and participation of students. Students should take the initiative to learn and strive to improve their problem-solving skills.

Diversified, Flexible Assessment

Student assessment measures the specific learning outcomes. The assessment is an important means of testing the results of teaching reform, and of teachers. As such, it provides important feedback for the quality control system. Comprehensive talent cultivation emphasises individual and interpersonal skills, as well as product, process and system construction skills. These are incorporated into the curriculum. Thus, schools must find an appraisal method by which to evaluate the results [6]. The assessment method must not employ the traditional single mode, and should introduce diversified and flexible assessment. For example, in addition to the traditional written and oral examinations, teachers can evaluate the daily performance of students.

Diverse, Open Teaching Environment

Based on the mantra of *strengthening practice*, many colleges and universities have built provincial experiment teaching centres, ministerial key laboratories, innovation zones, college and enterprise co-operative laboratories, as well as other diversified practice teaching establishments. Under the CTC teaching mode, schools must improve existing laboratories, which comprise the following platforms: basic experiment, professional experiment, engineering training and innovative practice. The teaching similarly occurs at four levels: class experiments, course design, engineering training and innovative practice [7]. Schools should adopt cloud computing to share computer software and hardware resources, and possibly use electronic design automation tools from the cloud, to carry out practice teaching at any time, any place, and using any terminal equipment. Ultimately this achieves a full, open laboratory.

Quality Assurance System

A teaching quality assurance system is an important method for ensuring the quality of both teaching and learning. It should be a comprehensive, full course system that provides effective methods for monitoring. Colleges and universities should establish a closed loop teaching quality system, with four sub-systems, viz. quality standards, quality

control, quality information and analysis, as well as quality improvements. This will promote standardised, and information-oriented teaching quality management, as well as improve teaching and training quality [8].

The principle of the process is to develop quality standards and, then, establish a quality standard system that considers training outcomes, based on the training programmes as the highest objective. Daily teaching guidelines are essentially rules of conduct that run through the whole of undergraduate teaching. Colleges and universities should establish an all-round and full course teaching quality monitoring system, as well as evaluate and monitor teaching quality from a number of aspects. A quality information and analysis system can evaluate teaching and learning, as well as provide a basis for teaching improvements.

THE EFFECT OF CTC TEACHING

Comprehensive talent cultivation teaching methods can significantly improve the professional knowledge and ability of students and substantially improve their learning motivation.

An experiment was carried out on 885 students enrolled in 2011 and 2009 in the engineering management specialty at the Inner Mongolia University of Finance and Economics. Comprehensive talent cultivation teaching was used for the 2011 students and ordinary teaching was applied to the 2009 students. In Figure 2, Point A is the learning effect and learning motivation of 2009 students, who majored in Engineering Management, and Point B is the learning effect and learning motivation of 2011 students, who also majored in Engineering Management. As can be seen, 2009 students were *poor/weak* on learning and learning motivation, whereas 2011 students were *good/medium*.

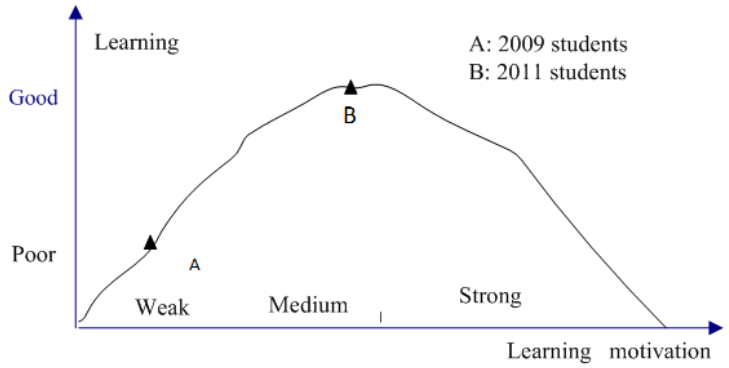

Figure 2: Learning motivation and learning effect for 2011 and 2009 students.

This improvement in learning has translated into improved employability. Figure 3 shows the employment for the 2009 and 2011 students. The employment rate of 2011 students, who majored in Engineering Management is significantly higher than that of 2009 students. The difference is caused by the changes in the engineering management specialty course. Adopting the CTC mode benefited the students and significantly improved the teaching outcomes.

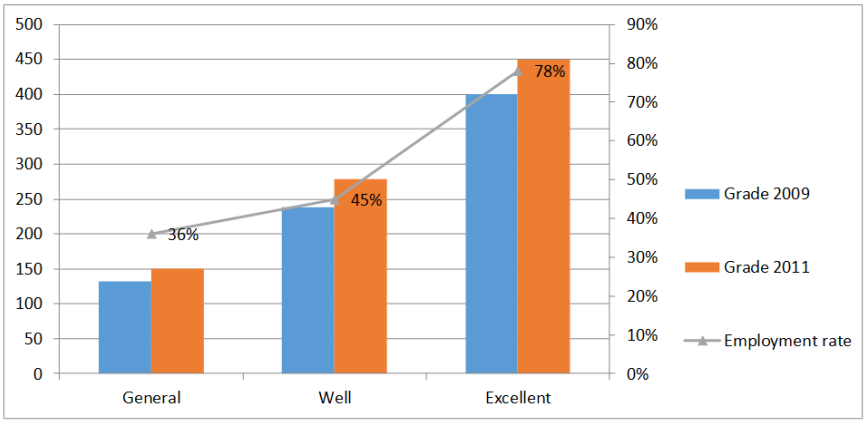

Figure 3: Employment rates for 2011 and 2009 students.

CONCLUSIONS

Considering the urgent need for talent in the current market environment, the author has presented a novel teaching mode, known as CTC teaching, and has investigated the application of this mode to students who majored in Engineering Management at the Inner Mongolia University of Finance and Economics. Comprehensive talent cultivation teaching was found to significantly improve the teaching results and substantially increased the learning

efficiency and employment rate of students. Thus, colleges and universities should employ the CTC teaching mode, instead of the traditional teaching mode, so as to nurture more comprehensive talent for society.

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