

## **Diversified cultivation mode for special talent in an engineering management programme**

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**ABSTRACT:** The aim of this study was to improve the comprehensive quality of students in an engineering management programme, with a special focus on practice and innovation. The engineering management programme should adopt a diversified cultivation mode combining the subject, knowledge, technology and thinking (SKTT), based on a new curriculum system, and taking an innovative approach to training and teaching methods. Through comparing the effects of the SKTT teaching mode and the traditional mode in engineering management specialty at Wenzhou University, China, it has been established that the SKTT mode can promote the practical capability and creativity of students. Thus, the SKTT mode can be a good reference to special talent cultivation in engineering management programmes.

### **INTRODUCTION**

The engineering management speciality aims to cultivate advanced talented graduates with solid professional skills and practical ability, who master the basic knowledge of technology, management, economics and law. However, the teaching results of current training modes are not sufficiently good, due to the lack of pertinence of the training objectives, outdated engineering practice and ineffective evaluation methods. In addition, the internationalisation of engineering projects in various fields is becoming increasingly evident and many projects have high technical standards. The projects cover a wide range of topics, and are supported by modern and sophisticated project management tools. Controlling the future development direction of engineering management education and cultivating competitive professional talent adapted to social needs, are among the crucial problems in engineering management. These need to be urgently resolved [1]. Considering this situation, this article puts forward an innovative approach to diversified talent cultivation focused on the subject, knowledge, technology and thinking (SKTT). The SKTT mode may assist in training more professional talent with a high level of technical expertise able to meet the needs of social development in China.

### **THE NECESSITY OF A DIVERSIFIED CULTIVATION MODE FOR TALENT IN ENGINEERING MANAGEMENT**

Increasingly, projects in China have high technical standards, wide-ranging topics, diversity of project management tools and, therefore, students need to master not only the specifics of relevant engineering technology, but also management, economics, legal and environmental aspects, information management, security, language and other aspects. In the actual work of engineering management, graduates face, and have to address, investment decisions, planning and design, cost analysis, engineering structure, engineering materials, construction organisation, maintenance, risk management and communication, often in foreign languages [2]. So, the specialty of engineering management is a mixed discipline, where the integration of technical, with non-technical knowledge is vital. The authors opine that the diversified talent training mode can make up for the shortcomings of the traditional engineering management training mode, and meet the requirements of social and economic development in regard to project management. The diversified mode would help students become versatile talented graduates with sound knowledge in engineering technology, management, economy, law and language, and able to strengthen existing technology with their innovative and creative ability [3].

### **SKTT TEACHING MODE AND ITS APPLICATION**

In order to realise the diversified cultivation of special talent in engineering management, the article puts forward the teaching mode of SKTT, which is, in the authors' view, one of the more effective teaching methods in engineering management training.

## SKTT Curriculum Construction

At present, a series of problems exist in the engineering management programme, such as lack of student motivation, an unreasonable curriculum structure, assessment limitations, poor quality control, and others. Through analysing the features of engineering management education, it has been established that this speciality requires strong technical, cooperative and time management abilities. Therefore, to cultivate the diversified talent in engineering management, the reform of existing teaching methods and means must be carried out [4]. The SKTT mode considers the needs of the profession, making good use of practice requirements and resources both at school and in society, to fully cultivate students' theoretical and technical skills. Based on that, a new curriculum is proposed for engineering management.

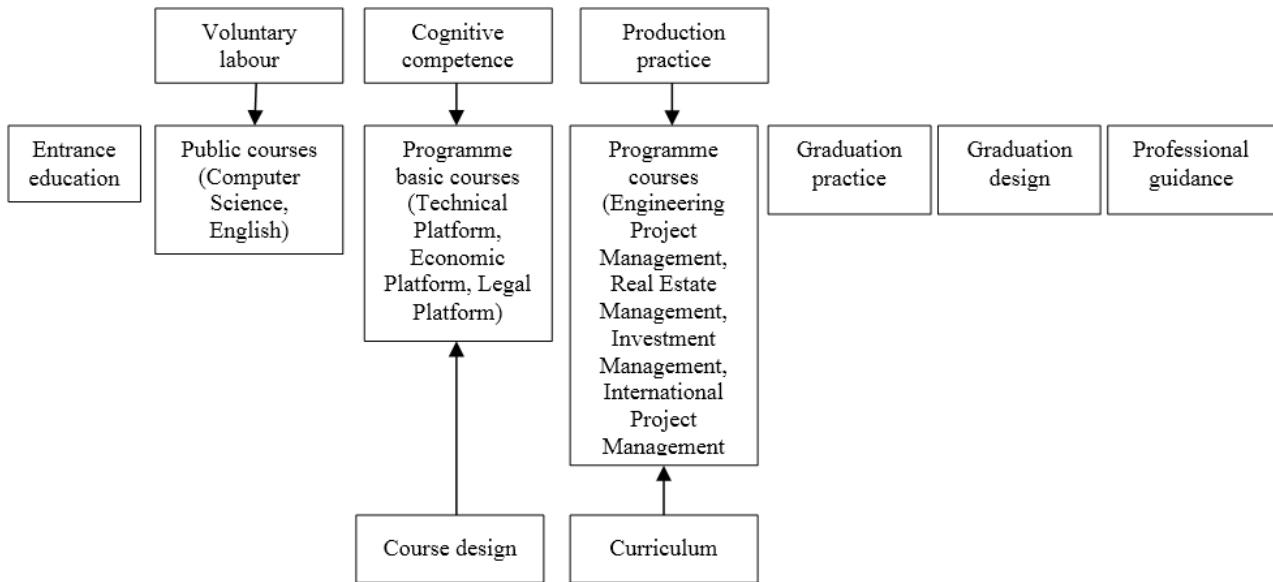


Figure 1: Engineering management curriculum.

Because the basic theories and skills of engineering, management, economy and law are essential in the knowledge structure of engineering management [5], it is necessary to establish a so-called *four-platform* system for the engineering management profession, including also cognitive competence courses.

The first platform is engineering technique. It is concerned mainly with how to go about a project, which is the basis and core of construction project management. To complete the project, students should have a good command of every relevant engineering skill. Engineering technique is also divided into engineering structure, engineering materials and engineering construction, etc.

The second is the management platform. It is mainly concerned with how to achieve a goal, which is about undertaking certain management means and measures to achieve the project's objectives. Students are required to deconstruct the project plan into specific, executable sub-goals and allocate resources and, then, coordinate all participating subjects, thus to control and adjust the process at each stage. The management platform includes project planning, organisation, coordination and control, etc.

The third is the economy platform. It is mainly concerned with how to implement the project reasonably and economically, that is how to choose the technical scheme, which can maximise the benefits of the project. Whether the predetermined goal can be achieved within the budget is the connotation of the economy platform. The economy platform addresses also efficiency and applicability.

The fourth is the law platform. It provides rules for the implementation of the project and the parties involved in the completion of their individual works. Higher social, technical, policy and credit risks exist in engineering construction, which will decide the legal basis for engineering management implementation [6].

## SKTT Teaching Approach Reform

In regard to the development of social economy and engineering technology, the SKTT mode will enable the adaptation of engineering management education to the needs of society. This includes the setting of core course design, practice course, teaching approach and training on active thinking.

*Set core courses:* the core courses of the SKTT cultivation mode include Project Management, Real Estate Management, Investment Management and International Project Management, which should be supported by a number of professional courses. So, the supporting courses of project management include Project Risk Management, IT-based

Project Management and Engineering Information Management. The supporting courses of real estate management include Construction Techniques, Engineering Project Process Management, Staff Welfare and Environmental Management, etc. The supporting courses of investment management include Norms of Specific Estimates, Enterprise Quotas, Project Measurement, Construction Drawing Estimates, Bill of Quantities, Preliminary Estimates, Construction Costs, etc. The supporting courses of international project management include Project Purchasing Management, Structure of the Legal System, Contracts in the Legal System and International Engineering Contract Management. The supporting courses coordinate the logical relationship between the upstream and downstream courses, and solve the problems of scope, content distribution and overlap, so as to avoid confusion and repetition in the course outline.

This approach optimises the course outline, helps dynamically absorb the latest research developments and practice achievements in the relevant field, and brings the teaching content and new approaches from other universities both in China and abroad.

*Designing an experimental course:* the experimental course system should be based on *student-centred* principles. The system should be able to stimulate students' interests in experiments, promote their self-learning ability to gain professional knowledge and develop the creative and innovative awareness [7]. The traditional *closed* teaching mode treats the experiments and the teaching part as a single entity, which results in often unsatisfactory teaching results, with students' enthusiasm and creativity not fully developed. To alleviate the problem, the opening times of the teaching laboratory can be made more flexible, allowing students to enter the laboratory after the experiments have been demonstrated and select a project compatible with their interests. One could also consider establishing a long-distance on-line laboratory and providing convenient learning conditions.

According to different requirements of experimental projects, students can take individual experiments, group experiments or other differently organised projects. Generally speaking, students must master the important points of project management theoretically. The experimental projects should be more concerned with the individual implementation, such as adjusting tools for the experiment, filling in accounting vouchers, graphics to be used, tools for calculation, reinforced numerical experiments, etc. Besides, the experimental project collaboration should be taken into consideration to develop the students' team spirit. Group experiments can be arranged to that effect [8]. In addition, some experimental projects can also adopt both individual and group experiments in order to achieve different results. In regard to the individual approach, it could be preparation for the tender process and bidding; and in the bidding and bid evaluation stage, a cooperative approach can be taken.

*Project-based teaching approach:* project-based teaching is typically student-centred. Students deal with the whole process of a project under the teacher's guidance, and in the process of learning, they master the learning content from the teaching plan. The *teacher's guidance* means that students independently arrange the learning and solve the problems. It enhances students' interest in the problem and mobilises their enthusiasm for learning. Based on the characteristics of engineering project management, the project-based approach can further combine different professional skills from different programmes, and even allow students from different fields to participate in the one project. In this process, teaching staff from different departments will also coordinate and cooperate and, so enhance their abilities.

The project can be carried out in the following steps. First, clearly define the project tasks. Assume one or several project tasks and, then, ask the students to discuss, and ultimately determine the project's objectives and tasks. Second, make a plan. The students should develop a project working plan, determine the steps and procedures, which will be finally approved by the teachers. Third, implement the plan. The students determine the division of labour in the group and the form of cooperation between the group members and, then, follow the established steps and procedures. Fourth, inspect and assess. This is the final step, the teachers or students can assess by themselves. The project-based teaching approach will not guarantee the final result, but paying more attention to the process is vital for the project's completion. In the process, the students will get to understand, and grasp the knowledge and skills as per curriculum requirements, experience the hardships and fun of innovation, and develop the ability to analyse and solve problems.

*Training in creative thinking:* creative thinking training courses are an essential part of quality education. According to the objectives of the cultivation talent mode, creativity training courses must be offered to students. On the basis of systematically teaching creative thinking for creative engineering, students will develop *flexible* thinking, *special* thinking, *divergent* thinking and *reverse* thinking. Through the training focused on observing and memorising, imagining, creative skills enhancement, creative problem-solving and innovation in designing, students will become sensitive and receptive about new knowledge and developments [9]. The innovation ability of engineering management talent is based on the knowledge system of project management, learning process, training of production practice and simulation engineering management.

*SKTT evaluation system:* change the evaluation mode of written examination to a scientific and fair evaluation system. SKTT puts forward a new evaluation system, which pays attention to the comprehensive quality of engineering practice ability, innovation ability, and so on; it avoids too much emphasis on subject knowledge. In regard to the methods of the evaluation, different types of classes can use different assessment methods. Public courses implement the separation of teaching and examination, and the major courses adopt various evaluation methods according to the characteristics of

the course, such as open examinations, reading reports, practice scores, class performance, etc. The teaching component as far as possible should be in accordance with student practical work. The evaluation of real work can also be considered. The theory-based examination can be taken as an open examination, thesis statement and a dissertation defence. In addition, examination times can be made more flexible and more times can be offered to students. The final score should take all the evaluation scores into consideration. When evaluating the theoretical knowledge, many forms can be used, such as the open examination, thesis defences, etc. In addition, the number of assessments should be increased; the final theoretical assessment results should be based on a comprehensive assessment of the theoretical results.

## IMPACT OF THE SKTT TEACHING MODE ON ENGINEERING MANAGEMENT

The SKTT teaching method is very important for engineering education. Taking the engineering management specialty at Wenzhou University, Zhejiang, China, as an example, the authors selected two classes of 35 persons each from among 2012 grade students, which were divided into an ordinary (control) class and an experimental class. The ordinary class was trained according to the traditional teaching mode, while the experimental class followed the SKTT teaching mode. The results of the above experiment, which lasts a learning cycle, are as follows.

First, the interest and enthusiasm of the students in the experimental class were significantly improved. The average attendance rate of the experimental class was 81%, while that of the ordinary class was 64%.

Second, the experiment achievements of simulation engineering management in the experimental class were significantly improved. All of the students in the experimental class participated twice in the simulation engineering management programme, and were divided into seven groups of five students each. The average score of the experimental class was 75%, while the ordinary class achieved only 60% of the quality standard.

In addition, the authors prepared a questionnaire survey and distributed it to 165 students majoring in engineering management at Wenzhou University. As shown in Table 1, 11 students in the experimental class were very satisfied with SKTT talent training mode and hoped that the University would continue the implementation; 19 students expressed satisfaction and only 5 were not satisfied with it. The degree of recognition of the SKTT mode reached 85.7% in the experimental class. In regard to 130 students in the ordinary classes, 58 students were willing to try the SKTT mode, accounting for 44.6%, 49 students approved it as a reasonable method, accounting for 37.7%, while 23 would not accept it, accounting for 17.7%.

When the authors analysed the reasons for non-recognition, it was found that 13 students were used to the existing teaching mode and did not want to try a new teaching mode, while 10 students worried about the long-term implementation of the SKTT mode, which might affect their learning performance; however, they would not refuse to participate, if the mode was implemented. In summary, the number of students who accepted the SKTT mode is much higher than the number of students who would not accept it.

Table 1: Questionnaire survey on the teaching experiment in engineering management.

	Not satisfied	Satisfied	Very satisfied
Experimental Class (35 students)	5	19	11
	Not accept	Accept	Want to try
Other classes in engineering management (130 students)	23	49	58

The investigation of the teaching effect of the SKTT mode in engineering management specialty at Wenzhou University shows that the students' attendance rate and the practical ability were substantially improved. The students' recognition rate of the SKTT mode was on average as high as 83%, which shows that this teaching mode has a positive influence on the teaching and learning of engineering management.

## CONCLUSIONS

Diversified talent training is an inevitable trend in higher education. It is crucial that universities know how to prepare students to become practical, competent and creative professionals [8]. The SKTT diversified talent training mode would help students become versatile talented graduates who master the knowledge of engineering technology, management, economy, law and language, and improve their practical and innovation ability. Thus, courses in engineering management should adopt the SKTT mode so as to supply more diversified talent to society.

## ACKNOWLEDGEMENT

The study was supported by the Classroom Teaching Reform Project of the Educational Department of Zhejiang, China (Grant No. kg2013602), the Educational Technology Research Project of Zhejiang China (Grant No. JB047), the Zhejiang Provincial Natural Science Foundation of China (Grant No. LQ14G030015), and the Ministry of Education Project Humanities and Social Sciences (No. 13YJC790137).

## REFERENCES

1. Zheng, J., Exploration of engineering management talents training. Shanxi Higher School. *J. of Social Science*, **02**, 104-106 (2012).
2. Chen, G., Research on the practice teaching reform of undergraduate engineering education. *J. of Huazhong University of Science and Technol.*, **10**, 81-91 (2012).
3. Kalanidhi, A., Improving the collaboration between academic and industrial organisations in engineering and technology education. *World Trans. on Engng. and Technol. Educ.*, **12**, **4**, 595-598 (2014).
4. Wang, W., Peng, L., Yu, Z. and Xie, Y., Research and practice of diversified cultivation mode of special talents of civil engineering. *Higher Educ. of Construction*, **1**, 144-150 (2015).
5. Chen, J., Li, X., Liu, D. and Zeng, D., The teaching program of core courses in engineering management and its optimization. *Advanced Engng. Educ. Research*, **5**, 135 (2013).
6. Ren, H. and Yan, Y., Innovation of integrated course model and teaching system in engineering management platform. *Higher Engng. Educ.*, **2**, 80-81 (2009).
7. Xu, S., The reform of courses design in specialty of engineering management. *Higher Educ. of Construction*, **4**, 133-136 (2010).
8. Zhang, F., Research on the practical curriculum system of engineering management. *University Educ.*, **7**, 118 (2014).
9. Liu, W., Wang, J. and Wang, D., The curriculum system reform and practice of application oriented personnel training for engineering management specialty. *Higher Educ. of Technol. Research*, **1**, 110-111 (2008).