

College and enterprise education for the joint cultivation of excellent transportation engineers

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ABSTRACT: The joint cultivation of excellent transportation engineers by colleges and enterprises is an advanced mode of Chinese higher engineering education, which will produce strategic advantage in the future. It may make it possible for students, businesses and schools to share resources and to develop together. Additionally, this mode can promote a better combination of theoretical study and practical work.

INTRODUCTION

China has a greater number of higher education engineering undergraduate and graduate students than any other country. Hence there are tens of thousands of engineering and technical personnel, who have made an outstanding contribution to Chinese economic development for more than 30 years since the reforms and opening-up of the country. With the accelerated pace of internationalisation, it is urgent that China cultivates talent that is internationally competitive. It is also important to raise the level of engineering education. Excellent engineering education aims to cultivate excellent engineers, with innovative ability. Such talent can satisfy the needs of social and economic development.

Current foreign research is focused on engineering and entrepreneurship education. For example, Bielenberg thinks there should be an explicit focus on academic literacy, in order to enhance the progress of undergraduate engineers towards the competencies and attributes needed by professional engineers [1]. Fry and Van Treuren studied excellence in undergraduate engineering education and the challenge of research-oriented programmes in engineering and computer science [2]. Sakthivel pointed out a framework presented, which is valuable to the top management of higher education engineering institutions [3]. Doboli et al studied models of entrepreneurship education and their role in increasing creativity [4]; and Shawcross set out to develop a better understanding of the process of skills development [5].

Meanwhile, in China, Shuqing and Qiliang studied the excellent engineer education plan for transportation [6]. Yang et al studied the College and Enterprise Joint Cultivation and Drive Innovation [7]. Wang et al and Xiaohong et al investigated the cultivation of a college and enterprise joint training mode [8][9]; and Xu analysed a case of college and enterprise joint cultivation [10].

The research above was synthesised to determine the education requirements for the joint cultivation by colleges and enterprises of excellent transportation engineers. The study is both systematic and purposeful. The research reported here resolves the following questions definitely: that is, how to build a joint cultivation mode, how to handle all the aspects, and how to ensure students, businesses and schools share resources and develop together.

CULTIVATING EXCELLENT TRANSPORTATION ENGINEERS

Transportation is fundamental to a well-organised society and underpins its economic life. Transportation is the foundation that guarantees the effective circulation of social resources and products. The development of transportation in China has gradually moved into an advanced stage. There is a transformation from large-scale construction to the efficient allocation of transportation resources and the deeper popularisation of transportation technology.

The means of transportation has changed, from a single mode to integrated transportation. Given the development of the industry, it is necessary to cultivate outstanding engineering and technical personnel in college, who can adapt to the development of transportation.

Cultivation Requirements

Improve the Match of Abilities between Engineering Practice and Management

On the one hand, students of a transportation management major learn the technology and science of roads, bridges, automobiles, safety, etc, and so they need to be equipped with the appropriate engineering ability. On the other hand, it is also very important for students to master professional knowledge covering economic, legal and management issues among others.

What is more, the ability to plan engineering projects is badly required. This requires the cultivation of special talent that is proficient in both theory and practice. Therefore, excellent engineering education for transportation subjects is aimed at cultivating specialised personnel with both management and technological knowledge.

Requirements for Cultivating Talent are Led by the Rapid Development of the Industry

The transportation industry is one of the basic industries that supports the national economy and society. After the rapid developments that took place since the reforms opened up the country 30 years ago, there have been great achievements in infrastructure construction. Now, the focus of the work has changed, from building infrastructure to using infrastructure well. At the same time, the demand for transportation management expertise is increasing continually.

During the recent period, with the transformation of the economy and social developments, and the push by super-ministries for the reform of transportation, the transportation field has developed many new problems and requirements. These include adjustment of the functions of the transportation management, the construction of a comprehensive transportation system, the sustainable development of city public transport, the safety of transportation, the co-ordination of road and rail. To cultivate the excellent transportation engineer, the problem of how to meet the requirement of rapid industry development must be considered.

Enforce Enterprise Practice in Teaching

There are many problems in the cultivation of transportation undergraduate talent, given the level of development of transportation enterprises. These include a shortage of teachers (few employees have degrees) and an insufficiency of internship positions. Thus, it is almost impossible to meet the need, in transportation, to cultivate undergraduate talent and, in particular, excellent engineering talent. Meanwhile, students are unable to bring benefit to an enterprise since they lack sufficient practical ability. During training in an enterprise, commercial secrets may be involved, which could affect the enthusiasm of the enterprise in co-operating with the teaching. In general, it is necessary to construct a new mode for the joint cultivation by colleges and enterprises of undergraduate talent.

Existing Problems

Outdated Courses and Lack of Doubly Qualified Teachers

China is still putting too much emphasis on discipline in teaching transportation. The *excellent engineer* subject has three stages, viz. the public basic course, professional basic course and professional advanced course. There are no links between these, and so curriculum development and any reforms are implemented independently. Therefore, barriers between these disciplines are still too high to be breached.

Engineering education in colleges focuses on teachers' qualifications rather than the improvement of young teachers' engineering literacy. As a result, most teachers pay more attention to improving their academic standing through research rather than by teaching. Besides, there is a lack of practical engineering material, making it difficult to cultivate students' engineering awareness.

Inadequate Links to Practice and Insufficient Innovation

Transportation teaching gives priority to theory. It places too much emphasis on theoretical knowledge at the expense of practical engineering skills. Practical teaching involves experiments, production practice and the graduation project. College teachers view theoretical rather than practical achievements as the standard by which to evaluate a student. Hence, students do not pay enough attention to the practical aspects of the discipline. Also, due to the continued expansion of colleges, it is difficult to meet the requirements for teaching laboratories and equipment. This makes it hard to cultivate students' practical engineering ability. Insufficient links to practice are bound to affect the cultivation of students' innovation, which results in an inadequate engineering education.

Lack of Communication and Co-ordination Skills

Excellent transportation engineers will manage other engineers for which communication and co-operative abilities are the primary requirements. Existing transportation education pays little attention to communication and co-operative skills, which are not part of the course. All of this means students may lack good communication and co-operative skills.

JOINT CULTIVATION OF STUDENTS BY COLLEGES AND ENTERPRISES

In order to better meet the needs of the transportation industry, colleges and enterprises should jointly cultivate students with both management and technical skills in transportation. To solve the problem of practical undergraduate teaching of economics and management, the proposed mode includes a comprehensive joint college and enterprise cultivation system. The focus is on a *win-win* situation for colleges and enterprises, created by the integration of production, study and research. The construction of teacher teams is equally important, to ensure the effectiveness of this mode of talent cultivation.

The joint cultivation mode is intended to solve problems, such as the shortage of practical teaching facilities, the relevancy of the course to enterprises, the lack of practical teaching material and the challenges presented by managing students in enterprises. Most importantly, it would solve the problem of interaction between production, study and research.

The joint cultivation of excellent engineers is beneficial for enterprises, colleges and students. Colleges can teach while, at the same time, they grasp market dynamics and explore academic frontiers; thus, significantly improving the quality of teaching and education. Enterprises cultivate an elite group, who are loyal to their enterprise. Students can improve their knowledge, cultivate team spirit, strengthen their competitiveness and improve their potential for development. The components of the joint cultivation by colleges and enterprises of talent are shown in Figure 1.

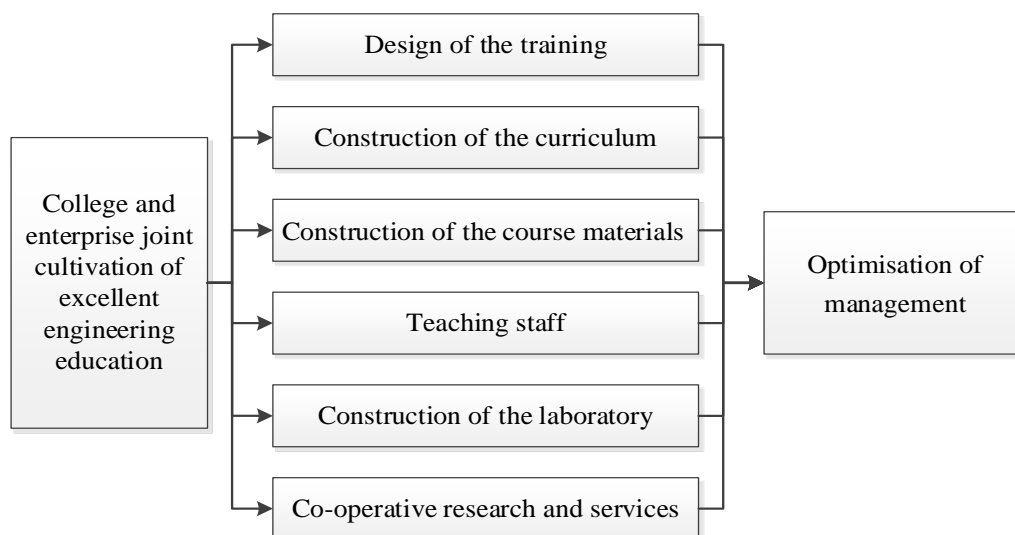


Figure 1: The joint cultivation mode.

Design of the Training

An excellent transportation engineer cannot be produced in less than one year. The training includes taught courses, post-graduation practice, the graduation project and literature studies. Enterprise study involves seminars, case studies and on-the-job learning.

Construction of the Curriculum

This mode is a break from the traditional curriculum. The curriculum has four or five courses and a student can start with school teaching, focusing on theoretical knowledge or enterprise teaching, with an emphasis on cultivating practical engineering ability. There is a cohesion and integration of engineering theory and practice. This mode should increase engineering skills and help students to understand professional engineering.

Construction of the Course Materials

It is necessary to jointly develop and edit the course material. This will include case studies about enterprises' operations and management.

Teaching Staff

There are not enough teachers of transportation studies. As a result, efforts should be made to involve high-level management or technical personnel from enterprises to take on the responsibility of academic tutoring. Given the problem of the shortage of practical teaching, teachers should participate in students' research and university-enterprise co-operation.

Construction of the Laboratory

A laboratory for transportation should be established, using the technology and intellectual resources of the school and the facilities and resources of the enterprise as a joint investment.

Co-operative Research and Services

A road transportation research institute should be set up as a collaboration between schools and enterprises. This will study problems about the industry and provides services for enterprises on decision-making, staff training and specialist subjects.

Optimisation of Management

The college and enterprise should set up a teaching guidance committee about transportation undergraduate teaching and establish a specialised joint talent cultivation office. Therefore, they both can participate in the management of the teaching, of the student and of the teaching staff. In addition, the committee should monitor and modify the system and optimise its organisation and management.

College and Enterprise Joint Cultivation Practice

Two-way Choice between College and Enterprise

There needs to be a joint cultivation, by colleges and enterprises, of excellence in engineers of transportation. When looking for joint cultivation enterprises, the colleges should give priority to the leading enterprises and consider their scale and the number of students that can be accommodated. They should review the specific characteristics of production at the enterprise. If there are overlapping and complementary relationships between the teaching and the enterprise, it will be suitable for the students' development. The existing conditions for the cultivation of knowledge and practice in the enterprise should be considered; judging whether or not the enterprise can carry out joint work with the college. Finally, and as far as possible, the costs of both the combined teaching and the students' accommodation should be taken into account.

There is an evaluation by the college before signing a co-operation agreement. First of all, it should take into account the needs of enterprise development. An enterprise can better combine theoretical knowledge with practical work through co-operation with a college and get access to the intellectual resources of the college. At the same time, a lot of work should be done by the enterprise in the joint cultivation, such as the teaching of business, cultivation of double qualified teachers, the co-ordination of enterprise with school work and the management of the relationship between staff and students. Enterprise ought to carry out the joint cultivation work only after full consideration of the quality of the work and the quantity of the students.

The existing enterprise staff should be considered. When carrying out joint training, a certain number of business mentors will be required. Therefore, enterprises will need a number of mentors to guarantee the effectiveness of the teaching. Besides, the enterprise staff will be involved in the management of the students.

Joint work between a school and enterprise needs full enterprise participation rather than just the input of a single department. Therefore, co-ordination between different departments should be taken into consideration before the enterprises carry out joint work. Co-operation between departments and the full support of the staff will provide a harmonious environment for the cultivation of engineering education and encourage a co-operative spirit in the students. College and enterprise joint cultivation needs the careful and active participation and support of all involved.

Joint Cultivation by the College and Enterprise

The partnership between college and enterprise is here advanced as a training mode for the excellent engineer. Excellent technical personnel from the enterprise are expected to participate in the interviews held by the college. Hence, the two sides then determine the quality of the students.

Colleges should not only lay the theoretical foundation in the field of engineering, but also pay attention to deepening the student's professional knowledge. The college and enterprise should mutually agree on the curriculum. The teaching content should be broad, comprehensive and *cutting-edge*.

Meanwhile, senior engineering and technical personnel, with rich practical experience and relevant academic qualifications, should be invited to become business mentors in the enterprise or institution. On this basis, the college and enterprise implement a double tutorial system providing concentrated training and guidance. A college could set up a steering committee for the Master of Engineering Education in the appropriate engineering field. Members of the committee should include the technical directors of related enterprises and campus experts. They may provide practical and reliable advice for the engineering Master's cultivation programme and give full play to the excellent engineer education steering committee on the role of excellent engineer cultivation.

Colleges and Enterprises Benefit from the Learning - Resource Sharing

The college and enterprise joint cultivation improves the sharing of educational teaching materials. First of all, a huge set of teaching resources are at the school (the site, teachers, teaching facilities, teaching funds, etc) and at the enterprise (machinery and equipment, technical personnel, management, production and sales, etc). Reasonable utilisation and sharing can make the best use of these resources. Second, the teachers at a college and the technical personnel at an enterprise are valuable resources, each with their own special talents. One is skilled in theory and the other in practical work. The best way to cultivate qualified excellent engineers is to combine the two. The mode of college and enterprise joint cultivation provides a means to accomplish this.

Finally, it will contribute to cultivating engineering talent by the integration and complementarity of the school's management system and the enterprise's procedures. Therefore, the sharing of resources between enterprises and colleges produces an excellent environment for the cultivation of excellent engineering talent.

The Combination of Practice and Theory

In the mode of college and enterprise joint cultivation, students will be able to apply theoretical knowledge to project management and, hence, combine theory with practice. Meanwhile, practice allows students to examine and improve their knowledge of theory. This effect cannot be achieved through traditional teaching modes. One must consider the example of the organisation of passenger transport. Students can quickly grasp a reasonable way for organising passenger transport by theoretical study and practising vehicle scheduling. What is more, the improvement of theoretical knowledge will vary according to the enterprise. Hence, the mode of college and enterprise joint cultivation can cultivate excellent engineers and mine the students' innovative ability to the utmost degree. Finally, it can make contributions to the enterprise and to society.

CONCLUSIONS

The excellent engineer plan is complex and requires colleges and enterprises to work together. Especially, in the mode of college and enterprise joint cultivation, the co-operation between colleges and enterprises is particularly deep, to actively absorb the successful experience of the enterprise. At the same time, the transportation professional characteristics must match the demands of the transportation industry. Being successful at cultivating excellent engineers is achieved through experimentation in correcting, and continuously adjusting, the system. This will provide practical experience for other engineering courses in participating in the outstanding engineer cultivation plan to cultivate excellent engineers.

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