An innovative skills-oriented talent cultivation model for Chinese architectural engineering technology

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ABSTRACT: Cultivating people with professional skills-oriented talent with a holistic ability is a new problem in architectural engineering education. In this study, a skills-based talent training curriculum system, an innovative method to cultivate skills-oriented talented professionals and a teaching appraisal method are developed. An innovative *diversified and comprehensive* talent cultivation model is also proposed. An experiment is performed to verify the effect of the proposed model. Results show that such a talent cultivation model can enhance architectural engineering students' practical skills and increase their employment rate.

INTRODUCTION

Currently, China has few professionals with skills-oriented talent because of its outdated training model. Although the students taught under the traditional educational system possess certain expertise and primarily theoretical knowledge, they have poor practical and operational skills [1].

Given the modern advancements in China's science and technology, the industrial construction sector needs numerous outstanding engineers who both have a solid basic knowledge of engineering science and experiences in modern applied technology [2].

In view of this, programmes in architectural engineering technology need to implement appropriate educational reforms and nurture skills-oriented professionals who can meet social needs and demonstrate a competitive advantage in the human resources market [3].

AN INNOVATIVE SKILLS-ORIENTED TALENT TRAINING MODEL FOR ARCHITECTURAL ENGINEERING TECHNOLOGY

Objective of Professional Talent Cultivation in Architectural Engineering Technology

With the rapid development of modern science and technology, many new technologies are being used in architectural projects. Architectural engineering technology students should, therefore, possess high levels of competence. Skills-oriented talent in professional architectural engineering technology should be able to satisfy the needs of the manufacturing sector, building construction and business management sectors. They should cope with rapid economic development and keep abreast of the latest technologies. To this end, the main objectives of talent cultivation are to improve students' holistic ability, cultivate their interpersonal skills and public relations ability, and enable them to adapt to the overall development in the field of architectural engineering technology.

Establishment of a Skills-based Cultivation Curriculum System

Practical teaching is an effective model to reinforce theoretical knowledge. It is a key method to cultivate students' professional skills and professionalism. Currently, the teaching practice in architectural engineering technology in higher education institutions has numerous problems, such as an inefficient teaching system, poorly trained teaching staff and unclear teaching objectives. Teaching methods should be reformed and innovated to cultivate people with outstanding and innovative engineering talent [4].

Developing a new scientific curriculum system is essential to cultivate skills-based innovative personnel. The characteristics of architectural engineering technology include high technology and team-based work. Teachers should focus on cultivating students' professional skills through the teaching process. In addition, construction projects generally require extensive labour, and use of machinery and equipment to achieve optimised engineering materials, and strong professionalism among practitioners should be emphasised. However, after students graduate, they usually lack practical and operating skills, knowledge of construction methods and actual field operation experience. Accordingly, a new architectural engineering technology curriculum, as shown in Table 1, is proposed to address these problems.

Table 1: Architectural engineering technology curriculum.

Compulsory courses on architectural engineering technology	Architectural Drawing
	Building Materials
	Structural Mechanics
	Construction Technology
Elective courses on architectural engineering technology	Building Surveying
	Construction Supervision
	Introduction to Building Project
	Soil Mechanics and Foundation
	Building Environment and Equipment
	Concrete and Masonry Structure Construction
	Architectural Mechanics and Structural Calculation
	Measurement and Valuation of Architectural Engineering

The established curriculum system should also consider vocational demands, exploit campus and off-campus training resources and establish teaching practice focused on understanding students' needs, including study support and off-campus practice. During the process of learning theories, students should simultaneously master the skills of preparing construction drawings and identifying engineering materials. During off-campus field practice, students should join the construction sector, participate in construction projects, and combine their theoretical knowledge with practical operation experiences to develop fully their theoretical knowledge and professional skills.

Generally, the curriculum system should be designed on the basis of the following considerations:

- *Updating courses on architectural engineering:*

  Students majoring in architectural engineering technology should have a solid theoretical knowledge of architectural engineering. To this end, schools should establish and offer theoretical courses, such as architectural structure analysis, project management, architectural project surveying and construction technology cognition. These courses require a practical teaching method to enhance students' cognition and operational skills and enable them to apply theory and practice to actual projects.

- *Using practical cases of construction works in teaching:*

  Teachers should explain actual and typical cases to students, discuss and analyse in class the problems encountered on construction sites, stimulate students' enthusiasm and critical thinking, enhance their research and cooperative learning skills, and enable students to master their knowledge and skills. Teachers should employ reflective teaching and allow for reflecting learning by informing students about their common errors in construction processes, improving on students' weak knowledge during the learning process, correcting student misunderstandings and drawing lessons from practical cases.

- *Strengthening the cooperation and exchanges between colleges and enterprises:*

  Architectural engineering technical colleges should establish long-term cooperative relationships with enterprises, invite companies to be involved in the teaching process and transform the actual work content of enterprises into real teaching courses. New knowledge and technology drawn from enterprises should also be introduced to keep students abreast of the latest technology in the industry and provide a practical reference for professional reforms. These approaches can provide students with opportunities to apply for internship in enterprises, learn advanced technology and equipment, and combine theory with practice. Consequently, higher education institutions can better serve the society.

- *Preparing training materials aligned with practical teaching:*

  Teaching textbook theories is an essential approach in the educational reform process. The educational reform in Chinese architectural engineering technology should use reliable training materials, draw lessons from successful experiences featured in local and foreign textbooks, and enrich practical training materials to align them with actual skills training. Using actual cases can make training materials credible and useful. Different training

contents should cater to students with different professional knowledge levels to achieve the training goal in accordance with students' aptitude.

Establishment of Diversified and Comprehensive Talent Cultivation Teaching Methods

Clearly, architectural engineering technology professionals need not only a solid theoretical foundation, but also a rich practical experience. In this regard, this study proposes diversified and comprehensive talent cultivation teaching methods, including the theoretical guidance method, ADIP - Association, Design, Implementation, Practice (site-teaching) teaching system, real scenario simulation method, and setting of core courses:

- *Theoretical guidance method:*

  When giving theoretical lectures, teachers should make a shift from the traditional teaching model, in which the teacher takes a dominant position in the teaching process, by emphasising that students should take an active part in learning. Teachers should encourage students to expand their knowledge, extensively read supplementary materials, allot sufficient time for learning and thinking, actively read, think, analyse and engage in cooperative learning activities to develop independent learning and self-learning initiative.

- *ADIP teaching system:*

  The CDIO-based (Conceive, Design, Implement, Operate) engineering teaching philosophy proposes the *Association, Design, Implementation, Practice (site-teaching)* (ADIP) teaching system. Association (A) means that students should be able to form associations between theory and professional practice, so that they recognise the theoretical basis for practical activities, and know and apply the fundamentals of an implementation method. After students have formed a reasonable idea, the teacher proposes feasible practical programmes in the Design (D) phase.

- After developing the programmes, the teacher should organise the students and make them participate in specific practical activities in teams in the Implementation (I) phase. After students have applied what they have learned to actual practice, the teacher evaluates the students' field practice and guides them to theoretical expansion in Practice (site-teaching) (P) phase. These four phases can fully develop students' thinking and practical skills. In addition, the method of conducting field practice in teams can cultivate team spirit among students, significantly enhance their enthusiasm for innovation and improve their professional skills.

- *Real scenario simulation method:*

  Architectural engineering technology specialty programmes require a strong practical foundation, so students often have misconceptions when learning theories. Teachers should introduce or create a specific scene or context that suits the teaching content, evoke students' emotional experiences, develop students' understanding and stimulate learning enthusiasm [5].

  In addition, higher education institutions, architectural design companies and construction companies should collaborate to establish a real *mobile classroom* and replace a teacher's theoretical classroom with an institution-based or real construction site for on-site teaching. On-site experience will deepen students' understanding of theoretical knowledge, enhance their interest in learning and optimise learning effects.

- *Setting of core courses:*

  The curriculum is the core in the cultivation of students' professional competence. The establishment of a curriculum can directly affect graduates' future career or development. To establish core project courses and the curriculum system, institutions should consider the requirements of a given professional position, focus on implementing a professional curriculum system, determine the core courses and develop the core curriculum system. The goal of teaching and training focuses on students' employment, particularly on improving their employability and competitiveness [6].

Teaching Evaluation Reform

Course appraisal is an important component of the teaching structure: course appraisal can be used to assess the quality of teaching and learning, teaching content, teaching methods, teaching effectiveness and other information [7]. The evaluation or assessment in architectural engineering technology has many elements, and examination is usually one of the most important elements. However, architectural engineering technology majors are required to master both complex knowledge and certain practical skills; as a result, an examination-based approach cannot fully reflect students' mastery of skills for professional practice [8].

A reasonable course evaluation and examination system should be implemented throughout the entire teaching process and consider students' holistic ability as the object of evaluation.

In this study, on the basis of understanding the students will, teaching reform is proposed with the following aspects considered:

Multiple examinations in various forms to evaluate students' theoretical knowledge: architectural engineering technology has a wide scope, so multiple evaluation methods, such as open-book examination, paper narrative and oral defence, should be used to evaluate students' theoretical knowledge. In addition, the frequency of examinations should be increased, and the final score in the theoretical examination should be based on the mean value of multiple examinations.

Assessment of learning: student performance at ordinary times should also be included in the evaluation and examination system. Assessment should cover classroom performance and after-school performance. The assessment of classroom performance includes the assessment of students' learning status, attendance and participation in the classroom, whereas the assessment of after-school performance includes the evaluation of task completion and participation in actual projects.

Instructors' assessments: when assessing architectural engineering technology students, institutions should also consider instructors' views, maximise instructors' assessments and make an objective overall assessment of student performance by using the usual performance indicators, including students' participation in actual projects.

ANALYSIS OF THE EFFECT OF THE DIVERSIFIED AND COMPREHENSIVE TALENT TRAINING MODEL ON THE TEACHING OF ARCHITECTURAL ENGINEERING TECHNOLOGY PROGRAMMES

Improving Students' Holistic Ability with the Diversified and Integrated Talent Cultivation Model

Students' holistic ability is found to be significantly improved with the use of the proposed diversified and integrated talent training model for architectural engineering technology. The Architectural Engineering Department of Shijiazhuang Vocational Technology Institute is considered a study case.

Two classes of the 2011 grade were selected and divided into the control class and the experimental class. Each class had 43 students. The control class used the traditional teaching model, whereas the experimental class used the diversified and comprehensive talent cultivation model. After the experiment, the following results were obtained:

First, the students in the experimental class gradually improved their basic knowledge. The average pass rate of students in the experimental class reached 70%, whereas that of the students in the control class reached 55%, with a difference of 15% in favour of the experimental class.

Second, the practical skills of students in the experimental class increased. Table 2 shows that the overall practical ability of the students in the experimental class was significantly higher than that of the students in the control class.

Table 2: Internship post and percentage of 2011 grade civil engineering specialty's students accepted for each post.

	Control class	Experimental class
Construction worker	32.1%	52.6%
Cost engineer	3.4%	6.5%
Supervisor	7.6%	9.6%
Documenter	20.4%	38.6%
Quality inspector	8.1%	13.7%

In summary, the diversified and comprehensive talent training model for architectural engineering technology gradually improves students' professional knowledge, and social and practical ability, as well as enhances their holistic ability [9].
Increasing Students' Employment Rate with the Diversified and Comprehensive Talent Training Model

The diversified and comprehensive talent cultivation model for architectural engineering technology can significantly improve students' employment rate. The employment rate of students in the control class is 73%, whereas that of the students in the experimental class is 95%, a difference of 22%. Therefore, the proposed model can improve students' practical skills and enhance their competitiveness in society and enterprises.

CONCLUSIONS

This study considered the Architectural Engineering Department of Shijiazhuang Vocational Technology Institute as the study case for the application of the proposed diversified and comprehensive talent training model for architectural engineering technology. Two classes; namely, the experimental class and the regular class from the 2011 grade, were compared.

The results indicate that that the proposed model has significant positive effects on the cultivation of Chinese personnel with architectural engineering technical talent. It can enhance students' practical ability in project planning and

management, and considerably improve the potential development and employability of graduates. In view of the strategic needs of large enterprises for skilled personnel, the diversified and comprehensive talent training model, which differs from the traditional *elite* training model, should be used in schools.

The proposed teaching model can guide educational institutions in developing new teaching systems and synthesising professional knowledge and practical skills.

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