Research on a *2+1+1* IT professional talent training mode based on the CDIO engineering education concept

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ABSTRACT: In order to improve the quality of IT talent and professional skills and to solve the problem relating to the gap between traditional IT colleges' applied undergraduate curriculum system and social needs, this article presents an analysis of the relationship between the professional skills and IT professional courses required by students in employment interviews. A basic optimisation theory framework for improving an IT engineering undergraduate programme in engineering education based on CDIO is proposed and discussed in this article. Based on the CDIO model, the authors explored and built a new system that represents a fusion of the CDIO concept and the *2+1+1* training mode, in order to cultivate science and technology innovative engineering talent. Such an approach can eliminate the blind scheme formulation and effectively improve training implementation results.

INTRODUCTION

In recent years, the disconnection between talent training and the social needs of application-oriented universities has resulted in the requirement for a comprehensive adjustment programme and reform to develop and adapt to the talent needs of business. Higher education is responsible for providing training for the strategic transformation of personnel. The social demands of IT technology talents are that students must not only master the required knowledge, but must also have the ability to improve through life-long learning, have good communication skills and have team spirit. However, the current education model and the development of the modern IT industry cannot meet these requirements for software professionals.

The role of engineering education is to provide engineering and technical personnel for national economic construction. The shortage of engineering and engineering education quality talent has become a common problem facing the world. In order to train more high-quality engineering talent, improve the quality of engineering education in the country, and enhance international competitiveness, countries have carried out engineering education reform to meet the country's need for talent. CDIO (Conceive, Design, Implement and Operate) was born within this context. CDIO is about *doing* and *project-based education and learning* principles. Using the CDIO model to achieve an innovative engineering education model is an achievement of recent years, leading to international engineering education reform in China through the inheritance and development of engineering education reform ideas in Europe more than 20 years earlier. One of the training objectives of the CDIO Standards is education based on innovative engineering and technical talent, and is also a kind of embodiment of educational advancement [1][2].

In this article, an innovative design and IT professional training model based on CDIO is proposed, one in which students conduct research and practical work in software engineering.

THE CDIO ENGINEERING EDUCATION MODEL

For a long time, the debate in engineering education has tended to repeat the same question, about the equilibrium between theoretical knowledge and practical application, including balancing expertise and general knowledge. The way to resolve conflicts in engineering education *theory* and *practice* in the end is to train skilled professionals who have discipline expertise and also outstanding professional competence and communication skills, with CDIO providing the answer. These elements include: lesson plans that not only emphasise mathematics, natural sciences, engineering and technical knowledge areas of expertise, but also include social issues, interpersonal skills and the capacity to devise and build products, processes and systems [3][4]. A core belief is that individual interpersonal skills can help in building capacity products, processes and systems. These must be assured by using real engineering practices and processes to solve problems, and engineering science, engineering knowledge and engineering practice ability

integrated by engineering education methods. To foster all-round engineering development in a modern, teamwork environment, the future engineer requires the use of *thinking of a design implementation operation* strategy to cope with the modern complex requirements of engineering technology. CDIO, therefore, provides a theoretical basis for these requirements [5][6].

THE EMPLOYMENT TYPE *2+1+1* IT TALENTS TRAINING MODE

The Culture System of IT Personnel Based on CDIO

The culture system of IT personnel based on CDIO to achieve comprehensive quality management *ability* is the first principle. The implementation of CDIO engineering education in the *learning by doing* standard, and it is related to the development of students' autonomous learning ability.

Learning according to international CDIO engineering education principles and the practice of advanced concepts and models [7][8], the pursuit of achieving development concept and training model of higher education strategic shift underpin the undergraduate *2+1+1* talent training mode reform, which adheres to the concept of innovation in general, including design innovation, institutional innovation, model innovation, all of that to achieve economic and social development of university service to society.

Following a CDIO *integrated teaching plan*, the two main principles are a *comprehensive learning experience* and the implementation of a school-enterprise cooperation personnel training system. The personnel training programme is based primarily on a system design and the content must include the theoretical teaching for three years followed by a one year internship specialising in systematic professional learning, research, professional practice development and growth. The relationship between CDIO and stereoscopic teaching system is shown in Figure 1.

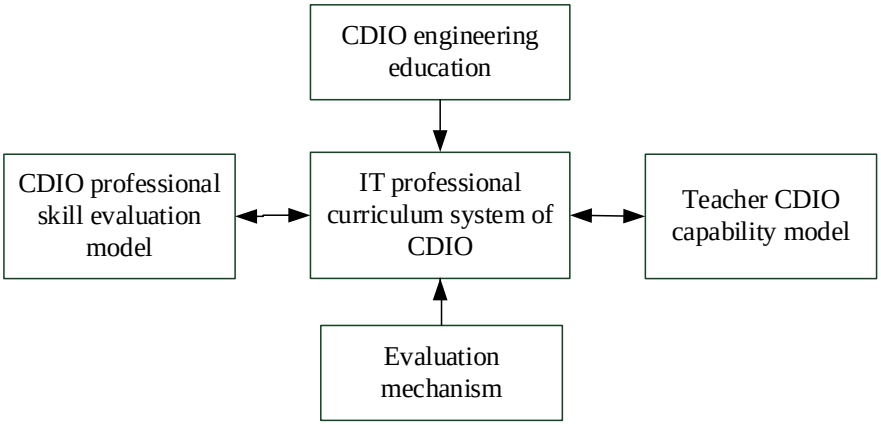

Figure 1: The relationship between CDIO and stereoscopic teaching system.

THE *2+1+1* PERSONNEL TRAINING MODE

The realisation of innovative type mode in the CDIO concept leads to IT professionals acquiring knowledge, abilities and social skills, with all three dimensions together comprising comprehensive ability, which is the goal of cooperative education. The three-dimensional software talent training mechanism functions as the carrier, enabling closer contact between software professional education and industry to complete software technical personnel training and social adaptation that are required by modern enterprises.

Under the impetus of school-enterprise cooperation, by building a *line enterprise school* cooperation mechanism, schools and enterprises will eventually intersect. Relying on close cooperative enterprises, and based on the CDIO concept *2+1+1*, IT talent training mode will carry out school-enterprise cooperation as a main line and will lead to *job knowledge, job training* and *job replacement.*

The *Three Gang* approach will alter engineering practice, and create *fusion training, industrial development, professional skills and job integration capability, internal learning and enterprise integration work, professional teachers and integration of enterprise technology backbone, campus culture and corporate culture integration, integrated* educational environment, plus the *basic capabilities*, specialised basic ability, professional key competencies, professional development ability and comprehensive ability to *carry out* a job. Progressive attainment of these *abilities* is combined *with the establishment of engineering 2+1+1* training mode. Combination of engineering IT professional *2+1+1* training mode is shown in Figure 2.

The first year: a *three semester, segmented* training mode *to arrange a semester class as a unit in batches into the enterprise*, campus training base should be one to two months smart posts *to enable students to adapt to production*

management requirements and to form basic professional ethics. Another two semesters are planned in school classrooms and training rooms to complete the basics of learning and skills training.

Second year: students are trained in the school, *Xi Gang* principles are applied, and students' basic skills and key professional skills are developed. Also, the ability to develop software according to the requirements of the job, to operate in a corporate real production environment, to advance professional skills and job ability, through the integration of campus culture and corporate culture are cultivated during the training.

Third year: graduate design and internships are undertaken; students' comprehensive ability and professional comprehensive ability are further developed. By *Three Gang* practice, students constantly update their knowledge, improve skills, test what they have learned in practice and deepen those skills learnt in school.

In the construction period, one to two months or more of *real post internship* and six months or more *internship* to cover all students are required.

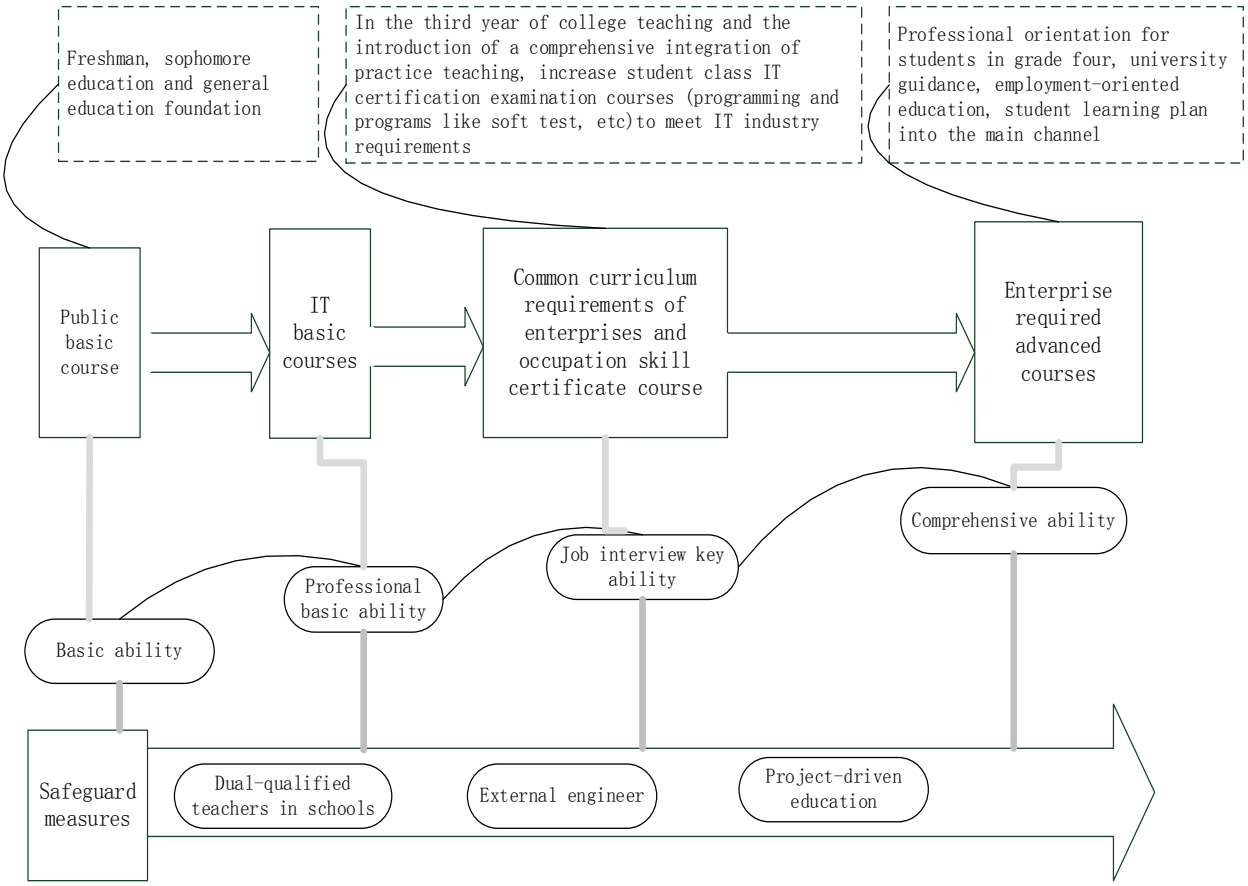

Figure 2: Combination of engineering IT professional *2+1+1* training mode.

Table 1: The three-dimensional teaching system based on CDIO.

First academic year	Second academic year	Third academic year	Fourth academic year
Public basic course	IT basic courses	Common curriculum requirements of enterprises and occupation skill certificate course	Enterprise required advanced courses
General education	Professional skills	Employment skills education	Engineering practice education

CREATE LONG-TERM COMBINATION OF *ORDER TRAINING* MODE

The increase of the IT industry’s demand for talent is the basis for creating close contact with well-known enterprises and establish long and short term cooperative relations that will allow acquisition of business orders for local software companies to develop customised software, which will challenge and test specialised talents. Interaction with software companies is expanding cooperation in the form of long-term training. Consideration of the needs of enterprises will lead to the development of an enrolment plan, determine training objectives, and develop training programmes, joint consultation curricula and teaching plans for long-term training.

THE CREATION OF INNOVATIVE TRAINING SYSTEM UNDER THE *DOUBLE MENTOR* PRECEPT

Double mentoring has been used to strengthen organisation and management to assist in the growth and success of students. Training appropriate numbers of highly qualified skilled professionals, the implementation of school-enterprise cooperation, mutual cooperation and common professional teacher education and technology integration are built on a *double teacher* system, so that schools and enterprises create a complementary quality education team through the *student enrolment employment* system.

By strengthening the *double mentor* teachers, school instructors from related technical enterprises and outstanding graduates from the previous student cohorts combine to improve the practical operation ability to foster good professional ethics. School instructors possess the above-lecturer double composition titles quality teachers, focusing on students' ability to learn, to guide their learning to master a good way to develop students' professional competence.

The working mechanism of the establishment is internal and external supervisor connect collaboration. The implementation of the *double tutorial* system takes different forms depending on the students and the stage of the programme they have reached. In the first grade, it is necessary to implement *school tutor group counselling, school teacher collective guidance*; the second grade is based on hierarchical education according to the students' cognitive ability and skill level. To improve the overall quality of students one has to take the *school tutor + school teacher* approach, expand counselling professional technical ability, match students with school tutors as required, continue to strengthen the professional ability, and take the *school tutor + school teacher* scheme in the third grade in practice. Furthermore, one has to apply *double tutorial software professional assessment methods*, look after and encourage the intramural and extramural tutors to cooperate with each other, improve the comprehensive quality of students, so as to ensure the quality of talent training.

THE IMPLEMENTATION AND EVALUATION OF RESULTS

Since the beginning of September 2011, 238 students have participated in the Yulin University school-enterprise cooperation *2+1+1* personnel training mode. This accounts for 60% of the total number of graduates. The community and employer feedback suggest that this is part of improving a student's high comprehensive quality and professional ability. Despite a general downturn in the job market for college graduates, the employment rate for information engineering college graduates has not decreased, but, in fact, has increased. The range of employment has been mainly in the various types of IT enterprises, service outsourcing, e-commerce, e-government, telecom, bank, securities companies and other units, mainly distributed in Beijing, Shanghai, Tianjin, Guangzhou, Wuhan, Shenzhen, Dalian, Suzhou, Guiyang, Dongguan and Kunshan. Analysis of employment and training students' statistics are shown in Table 2.

Table 2: Statistical analysis of employment training students.

Grade/Year	Number of students in training	Average student wages (yuan/month)	Employment in the city (first/second)
2007/2011	68	2600	58/10
2008/2012	85	3200	60/25
2009/2013	50	3500	45/5
2010/2014	35	3615	30/5

CONCLUSIONS

The CDIO engineering education concept plus the *2+1+1* training mode is based on a project-oriented design, with capacity-building as the main goal. The new model involves using a real engineering environment for its educational background, but it also espouses a new educational philosophy. Evaluating the effectiveness of this type of reform shows that by using the CDIO Standards in engineering education to carry it out, this innovative training mode can assist in developing high-quality engineering talent in a new and effective way.

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