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*Research Article*

## Innovative Talent Cultivation Model based on Conceive-Design-Implement-Operate Concept

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### Abstract

Innovation serves as a primary motivity to lead the development of the education cause. Local colleges and universities shoulder a critical mission of foothold on and serve the local areas, and play a vital role in the development of the local economy. They should integrate local resources to do a good job on the innovative talent cultivation for the purpose of delivering some innovative talents for local economic development. This paper, based on the survey conducted for employers and graduates, proposes a CDIO-based efficient innovative talent cultivation model framework and the curriculum system program which integrated the Conceive-Design-Implement-Operate (CDIO) concept thereof. The idea in this paper has a positive significance for future studies on the innovative talent cultivation model.

### Keywords

CDIO Concept • Innovative Talent Cultivation • Local Colleges and Universities

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In recent years, China has witnessed a continuous development in the higher education cause, however, a surge of college graduates exacerbates the employment market in a stark contrast with the shortage of human resources in the society. This phenomenon is rooted in that the talent cultivation model at the college and universities disjoins from the demands of the society. The traditional model for talent culture focuses on the inoculation of knowledge and theory, and lacks the disciplines about students' hand-on and innovation abilities. The initiatives of building an innovative country and implementing an innovation-driven development strategy have been incorporated into the national development plan. Talent is the key to innovation and start-up's, while the enterprise and society starve for some independent and innovative talents. Colleges and universities are important base for fostering such talents, especially local colleges and universities which shoulder the mission of foothold on and serve the localities should also develop their self-value in a high limit to convey innovative talents for local economic development by combination with local resources and conditions. In order to cultivate some market-oriented practical and innovative talents required by the enterprises, this paper, by a way of questionnaire, launches an investigation on what the employers expect to recruit and how the graduates make a comment on the talent cultivation model of colleges and universities. And on this basis, the innovative talent cultivation

Framework and the curriculum system program in colleges and universities is thereby constructed based on the CDIO education concept. In the end, this paper analyzes the problems we further concern and address occurred during implementation of this innovative talent cultivation model. (Andersson, Freedman, Haltiwanger, Lane & Shaw, 2009)

## **Investigation and analysis of innovative talent culture in local colleges and universities**

The innovative talent is defined by many ways, in short, it refers to those who have the innovative spirit, creative thinking and competence. They not only own a sound professional knowledge, but also have a good personality quality and a certain creativity ability (Xiao *et al.*, 2015).

### **Source of survey data**

In order to foster a body of innovative talents required in the society in order to better reform the innovative talent cultivation model, this paper takes Sichuan Province as a study case, and launches an investigation on what the employers expect to recruit and how the graduates make a comment on the talent cultivation model of colleges and universities by a way of questionnaire.

### **Employer's requirements for innovative talents**

In this survey, a total of 215 valid questionnaires were collected. The employers include private-owned enterprises, state-owned enterprises and foreign-funded enterprises, all of which belong to large and medium-sized enterprises. Among them those enterprises with over 900 people account for more than half of the total.

As shown in Figure 1, the surveyed employers have the requirements for qualifications of innovative talents. The results in the survey show that the qualification employers most appreciate the innovative talents is the team spirit of 85%, followed by morality and the sense of responsibility of 68.9% and keen insight of 66.7%, respectively.

As shown in Figure 2 and 3, the employers think what is the role of the innovative talents play in the unit and what is the demand for the innovative talents.

The survey results show that 91.4% of the innovative talents play an important role in the employer, which is why up to 88.2% of the enterprises have a high demand for the innovation talents.

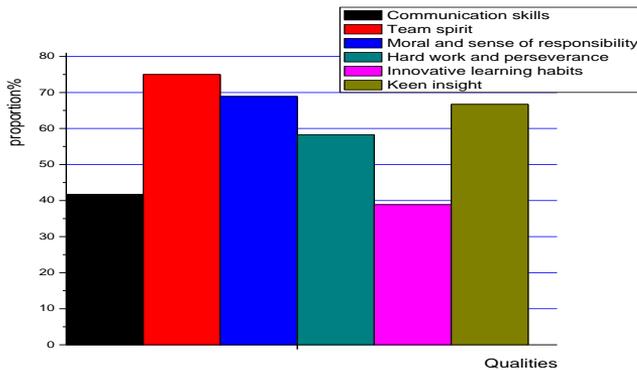


Figure 1. Employers believe that innovative talents should have the quality.

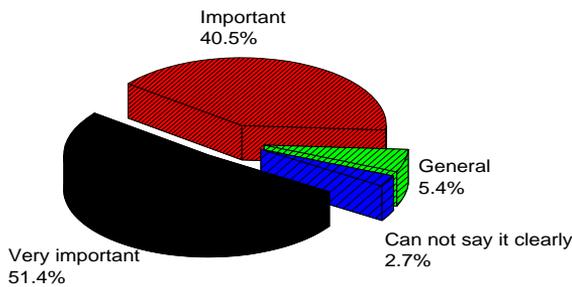


Figure 2. The evaluation of the function of innovative talents in employer.

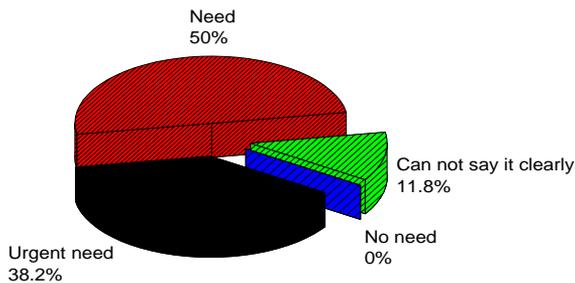


Figure 3. Employers' demand for innovative talents.

### Comments of graduates on the innovative talent cultivation model in colleges and universities

The survey randomly selected some 2000-2015 graduates in all majors, of which some students from all colleges and universities in Sichuan Province were included. A total of 1697 valid questionnaires have been collected in the survey. The findings can be available from the survey after the collation of data.

The evaluation of students graduated in different years on the indicators involving the innovative talent cultivation in the colleges and universities by 1-5-point scale, i.e. representing very dissatisfied, relatively dissatisfied, generally satisfied, more satisfied and greatly satisfied. The survey results reveal that the satisfaction graduates hold with practical instruction and lecture quality gradually decreases, while slowly increase with the access condition for scientific experiment facilities and library materials.

The comments made by graduates on instruction model improvement, among which the top three that students think to be improved substantially are the course content practicality and timeliness, which accounts for 28.15%, the practice internship, accounting for 26% and the curriculum quantity and type settings, accounting for 14.14%.

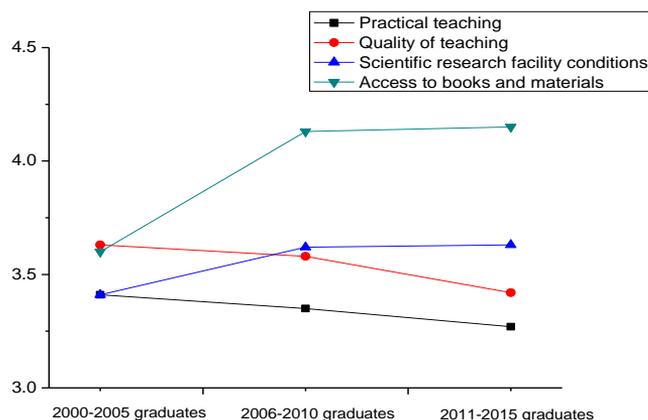


Figure 4. Evaluation of the relevant indicators by graduates of different graduation years.

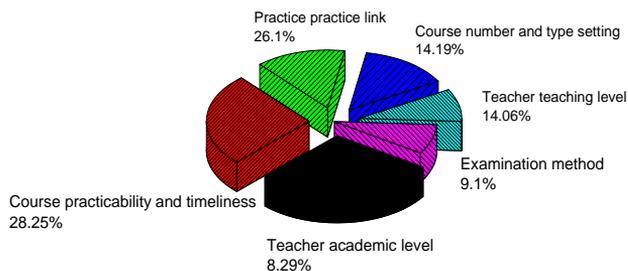


Figure 5. Graduates' views on improving teaching patterns.

## CDIO-based innovation talent cultivation model in local colleges

### Model framework

From the survey on how employers and graduates evaluate the innovative talent cultivation model in colleges and in universities, it is found that enterprises have a high demand for innovative talents. The major problems occurred in the cultivation of innovative talents in colleges and universities include: the curriculum and the contents are set unreasonably; there are few internships and development of students' innovative qualities lacks. In allusion to the above defects, this paper proposes the basic framework of innovative talent cultivation model in colleges and universities, as shown in Figure 6. The core of the framework is to foster students' innovation capabilities. Students get a certain knowledge and competence structure by accumulation of professional knowledge, based on which to develop the potentials of students, including practical hand-ons, teamwork and self-study capabilities, thinking ability, etc., assimilating these into their own qualities, and ultimately enable students to have the creative thinking and innovation genius required for innovative talents (Wei, Feng Zhang, 2017; Wong, 2008; Nugent & Kulkarni, 2013).

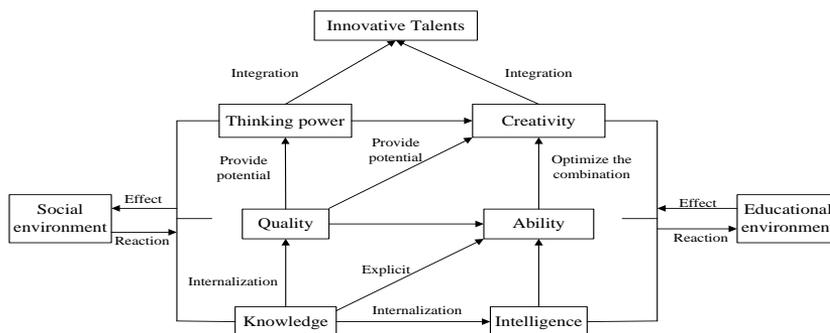


Figure 6. The basic framework of cultivating innovative talents in colleges and universities.

### CDIO education concept

Jointly founded by four universities including MIT (Massachusetts Institute of Technology) in 2000, the CDIO education concept refers to the Conceive-Design-Implement-Operate process, and comprises the full life cycle of a product from development to operation. The CDIO education system is shown in Figure 7. In general, CDIO is an adaptive simulation learning in a real world where the full life cycle of product, i.e. the practical engineering project is taken as a carrier in combination with theoretical knowledge in textbooks. It is not only learning by doing but also an organic combination of learning knowledge and task response. In this way, in addition to gaining theoretical basics, students also exploit their potentials such as autonomous learning, practical hand-ons, teamwork competence, which follows that CDIO's educational idea has an important significance for leading the innovative talent innovation model (Svensson & Gunnarsson, 2013; Mälkki & Paatero, 2015).

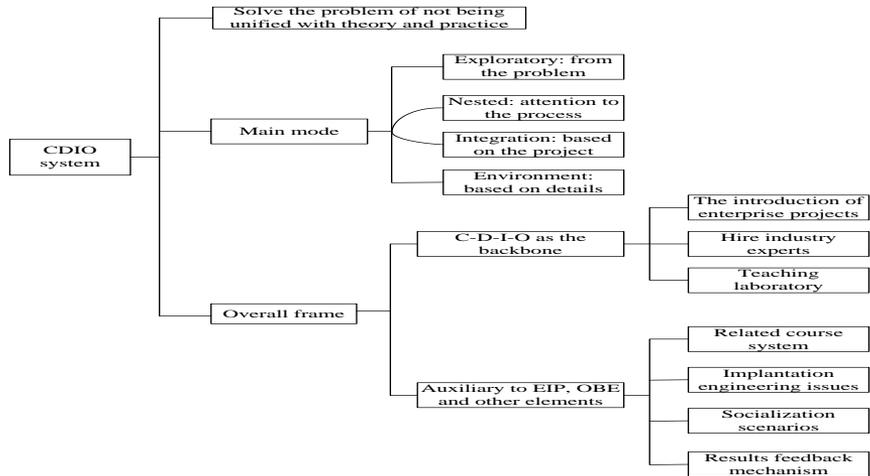


Figure 7. CDIO education system map.

**CDIO-based innovative talent cultivation model**

**Establishment** Since the students’ competences and qualities cultured with the CDIO education concept coincide with that of innovative talents, this paper, based on CDIO and the innovative talent cultivation framework in colleges and universities, proposes the CDIO-based innovative talent cultivation program around basic elements in question, as shown in Figure 8 (Jiang, Zhang, Shao, Sui & Zhang, 2014).

This innovative talent cultivation program is designed by several procedures as follows: (1) analyze the knowledge, students’ competence and qualities as required in the national and industry standards; (2) decompose the work tasks in the industry production processes, from which the required knowledge, competence and quality requirements are extracted; (3) the above items are based to set the objective for talent cultivation as required in the industry, which includes the knowledge, competence and quality developments; (4) With the guidance of this objective, the curriculum system and curriculums itself should be designed. The curriculum design should take practical tasks as carrier, and focus on students’ expertise and occupational qualities while imparting general knowledge.

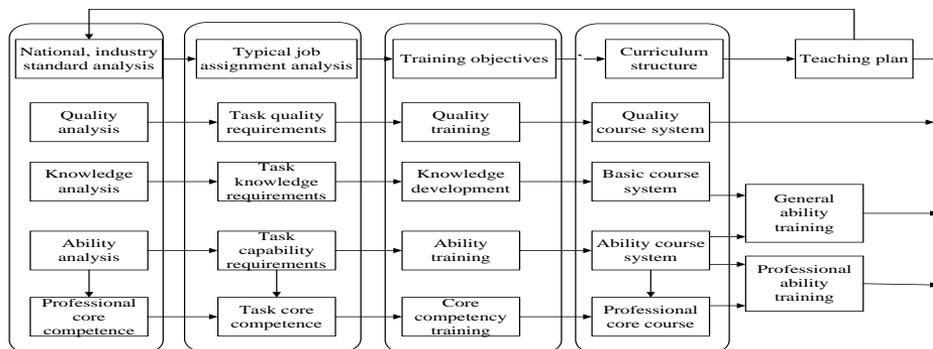


Figure 8. The training scheme of innovative talents in colleges and universities based on CDIO Idea.

Based on the innovative talent cultivation program shown in Figure 8, after a full investigation on demands for talents is conducted, the professional talent cultivation objectives will be developed for every major. No matter which major is concerned, curriculum is always the core of personnel cultivation. A good curriculum system can not only make students attain solid knowledge and hand-on capabilities, but also build up students' teamwork spirit and develop their innovative thinking and other overall qualities (Wang, Qi, Li & Zhang, 2011).

It is therefore required that the construction of innovative curriculum system should be compatible with the industrial business environment evolution and the demands for talents with practical work tasks as a carrier, provided that students' competence to discover, analyze and solve problems are developed. The decentralized and independent curriculum resources available should be integrated so that students can make appropriate contemplation and exploration while systematically comprehending and learning the most about their future occupations, so as to develop students' self-learning and innovative thinking competences. A CDIO-based innovative curriculum system architecture is shown in Figure 9 (Nyström *et al.*, 2012).

The existing disciplines underlie the innovative curriculum system which, with the practical work tasks as the principal line, drills down the knowledge and competence required for the tasks, and integrates existing curriculum resources and subject knowledge based on the analysis results. A learning situation for easy-to-difficult work tasks is thereby designed to cover the knowledge and qualities of middle school students as the objective of innovative talent cultivation.

Students organize learning teams, if necessary, instructed by teachers and corporate staff. The projects involved in learning situation should be accomplished in the intramural labs or in off-campus internship bases, so that students' competence can be improved continuously.

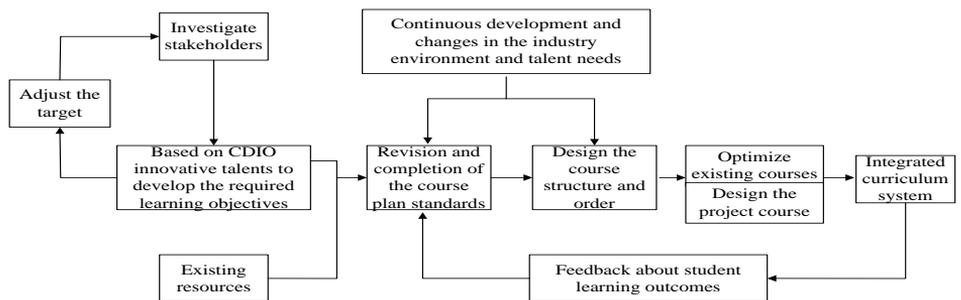


Figure 9. Course architecture.

**Designing curriculum system for innovative talent cultivation model** Note: the meaning of the indicators in the table, A: cognition, focus on knowledge acquisition; B: training, discuss and practice by teacher-led topics; C: practice, student-oriented project operations and other related aspects of practice; D: explore, students are independent to explore and discover knowledge.

This paper elaborates the curriculum system of CDIO-based innovative talent cultivation model by a study case, for example, the electronic information and communication engineering department, Sichuan University where CDIO instruction concept has been implemented. The instructional objective for the electronic technology curriculum syllabus improved based on CDIO concept is shown in the Table 1.

Table 1  
*Optimized Course of Electronic Technology Course Outline Teaching Objectives*

First indicators	Secondary indicators	Compliance requirements			
1. Professional knowledge	1.1 Use basic knowledge of knowledge	A	B	-	-
	1.2 Use core expertise and principles	A	B	C	-
2. Personal ability and professional competence	2.1 Reasoning and problem solving	-	B	C	-
	2.2 The ability to experiment and discover knowledge	-	B	C	D
	2.3 Personal ability and attitude	A	-	C	-
3. Communication ability	3.1 Teamwork	-	-	C	-
	3.2 Interpersonal skills	-	B	-	-
4. Practical ability in social environment	4.1 Enterprise, business, research environment	A	-	-	D
	4.2 System concept	-	-	-	D
	4.3 Innovative design capability	-	-	C	-

Note. the meaning of the indicators in the table, A: cognition, focus on knowledge acquisition; B: training, discuss and practice by teacher-led topics; C: practice, student-oriented project operations and other related aspects of practice; D: explore, students are independent to explore and discover knowledge

The architecture and content of the e-technology curriculum optimized based on the CDIO concept is shown in Figure 10 (Fan, Zhang & Wang, 2012).

Where circuit analysis, microcomputer principle and high-frequency electronic circuit design are new curriculums optimized and integrated by other relevant two or more curriculums as required for work tasks and learning situations.

The CDIO work task organization is shown in Figure 11, which fully reflects the teacher-guided CDIO education philosophy which takes the practical work tasks as principal line, the students as the subject body. When the team of students undertakes the learning task, they make a preparation for relevant knowledge and discussion of learning in an organized way, do it in person with the guidance of intramural and off-campus teachers in the face of problems, fully mobilize the learning enthusiasm of students, while exercising the students learning passion, hands-on practice and teamwork spirit, innovative thinking and other comprehensive competences.

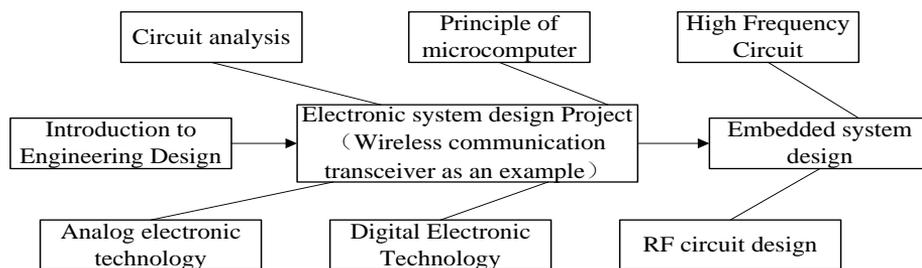


Figure 10. Optimized course and content of course of the electronic technology course group.

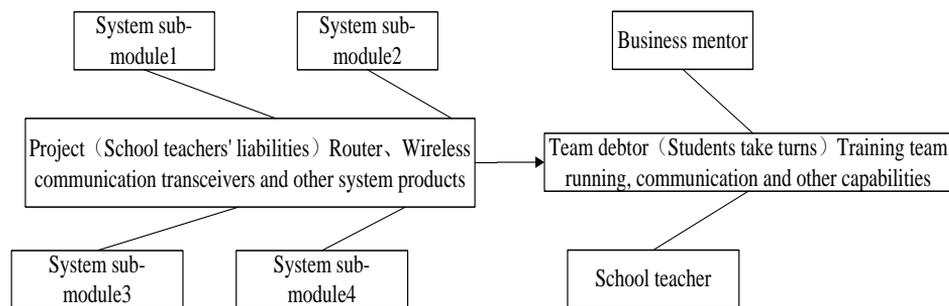


Figure 11. CDIO work mission organization diagram.

### Problems further concerned and addressed

The CDIO-based innovative talent cultivation model proposed in this paper can play a good role in facilitating the innovative talent cultivation. There are some problems that need to be further concerned and addressed in order to truly achieve its expected objectives (Bankel *et al.*, 2003; Wang & Wu, 2014).

(1) Choosing textbooks, in order to better serve the task-based curriculum system, the existing textbooks should be re-integrated to ensure the timeliness and availability of textbooks.

(2) Constructing teaching staff, the qualities of teachers have a direct concern with the success and development of students. The culture of innovative talents requires knowledgeable teachers who not only have a good consciousness and a high capability of innovation but also make clear the latest development trend in the disciplines and industries. Besides the full-time teachers, some industry experts are also employed as part-time instructors to guide students refresh their knowledge and capabilities from the perspective of industry demands.

(3) Reforming the instruction model, the traditional passive instruction model, i.e. teacher imparts and student studies, is transformed the student-centered and teacher-guided proactive learning one. All the learning processes are student-centered, and teachers can initiate a group discussion, the task-driving, role-playing and other instruction approaches to enhance students' autonomous learning competences. Teachers act as the inductors and mentors to let students learn to discover, analyze and solve problems.

(4) Establishing the training base inside and outside the campus, in order to better cultivate students' hand-on and innovative thinking, the intramural laboratory should be set up to allow students simulate the real world for learning and innovating their work tasks; an off-campus training base is also required, which enables students to learn and grow in a real occupational world.

## Conclusion

Innovative talent cultivation involves a variety of elements, as a complex system engineering. This paper takes local colleges and universities as the point of departure to explore the innovative talent cultivation model and draws the following conclusions:

(1) On the basis of the investigation and survey, we set up a framework for the innovative talent cultivation model in local colleges and universities.

(2) By incorporating the CDIO instruction concept, this paper puts forward the CDIO-based innovative talent cultivation model and sets up the curriculum system for it by a study case, for example, the electronic information and communication engineering department in Sichuan University so that its maneuverability is proved thereby.

(3) The problems that should be further concerned and addressed in the process of application of CDIO-based innovative talent cultivation model are analyzed in the end.

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