Teaching Reform on Water Supply and Drainage Science and Engineering Based on CCDIO

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ABSTRACT

There is a single mode of talents cultivation for water supply and drainage science and engineering, poor engineering practice and employment competitiveness, it is necessary for teaching reform to meet social needs. The paper analyzes the formation and system construction of CCDIO, cultivating system and curriculum system for water supply and drainage science and engineering based on CCDIO. Career education is integrated into CDIO, CCDIO is the product of a chemical reaction between CDIO and the NPIA cycle of career based on internalization of career. CCDIO means Career, Conceive, Design, Implement, Operate, called CCDIO. CCDIO includes a career system and professional skills system. Career system consists of career needing, career planning, career implementing, career adjusting; Professional skills system consists of conceiving, designing, implementing, operating. Cultivating system is divided into six sub-systems: namely career education system, talents cultivating scheme, curriculum system, engineering practice system, teaching quality assurance system, faculty development system. Curriculum system is divided into four parts: respectively career attitudes and soft ability, engineering foundation, engineering fundamental competence, engineering integrated systems ability, reflecting the requirements of the CCDIO Syllabus with a strong scientific rationality. The paper presents the ***WWH*** approach——"***Three Problems in Life***", which is applicable to our work, life, learning, and other things. Based on career competitiveness model, career competitiveness is directly related to knowledge, skill, attitude. But it is very important for university students to cultivate a positive attitude with good morality. These provide a good reference for talents cultivation of other disciplines or undergraduate specialty.

KEYWORDS

Career education; CCDIO; Water supply and drainage; WWH; Career competitiveness model.

INTRODUCTION

Since 1952, the construction and development of water supply and drainage science and engineering can be divided into five stages in China [1]: First, before 1952, relying on civil engineering; Second, the exploration and growth stage from 1952 to 1965; Third, lag phase of specialty development from 1966 to 1976; Fourth, the stage of development and restoration and construction from 1977 to 1996; Fifth, since 1996, the stage of comprehensive development for specialty construction. At present, the main existing problems of water supply and drainage science and engineering include the similar goal of

the different types of colleges and universities; a separation between engineering education and industrial community, a serious shortage of engineering practice education; disharmony between relatively old engineering curriculum system and industrial structure adjustment; lack of engineering experience for engineering faculty; lack of vocational qualification system of engineer, unsound cultivating system of engineer. “The plan for educating and training outstanding engineers” put forward by the Ministry of Education is a significant measure in China’s higher engineering education, as well as a brand-new “Quality Project” to promote the universities to foster advanced professional talents suitable for the development of society and economy [2]. These provide an important conditions for teaching reform on water supply and drainage science and engineering.

THE REFORM BACKGROUND OF WATER SUPPLY AND DRAINAGE SCIENCE AND ENGINEERING

Outline of China's National Plan for Medium and Long-Term Education Reform and Development (2010-2020), the 18th CPC (Communist Party of China) National Congress, the Decision on Major Issues Concerning Comprehensively Deepening Reforms adopted by the Third Plenary Session of the 18th CPC Central Committee, present the new ideas and new requirements for development of higher education, particularly engineering education reform. Water supply and drainage engineering from 1998 undergraduate catalogue of specialty for regular institutions of higher education is changed to water supply and drainage science and engineering from 2012 undergraduate catalogue of specialty for regular institutions of higher education. Water supply and drainage science and engineering is one of four undergraduate specialty for civil engineering from engineering category. Massachusetts Institute of Technology proposed a “Returning to Engineering Fundamentals” philosophy of education, emphasized on holistic, integrated and interdisciplinary engineering technology. Engineering development has evolved from a single technology system to a comprehensive knowledge-based economy system integrated by a variety of techniques. Shantou University put forward such a conception of engineering education as EIP-CDTO (Ethics, Integrity, Professionalism, Conceive, Design, Implement, Operate), which focuses on taking engineering design as its direction, and cultivation of personal competence, team spirit, and system integration capabilities as its main target [3]. The implementation of KSR-CDIO (Knowledge, Skills, Responsibility, Conceive, Design, Implement, Operate) engineering education mode in Shanghai Second Polytechnic University has positive effect on the shaping and development of students’ personality traits [4]. From here we see that these provide a good reference for the undergraduate talents cultivation mode of water supply and drainage science and engineering.

THE FORMATION AND SYSTEM CONSTRUCTION OF CCDIO

The CDIO initiative is a collaborative framework initially created by Chalmers University of Technology, Linköping University, Royal Institute of Technology (Sweden), and the Massachusetts Institute of Technology (USA) [5]. The CDIO initiative began as a joint endeavour involving four engineering schools in Sweden and the USA, CDIO focuses on four activities-curriculum development, teaching and learning, workshops, and assessment projects [6]. The CDIO standard needs not to be satisfied by every related subject independently, what is required is just satisfied as a whole [7]. There are two batch of CDIO pilot universities amounting to 39 universities in China, focusing on mainly mechanical engineering and electrical engineering. At present, over 100 institutions from all over the

world are currently involved in CDIO. Thus it can be seen that CDIO has been applied more widely around the world, as well as China.

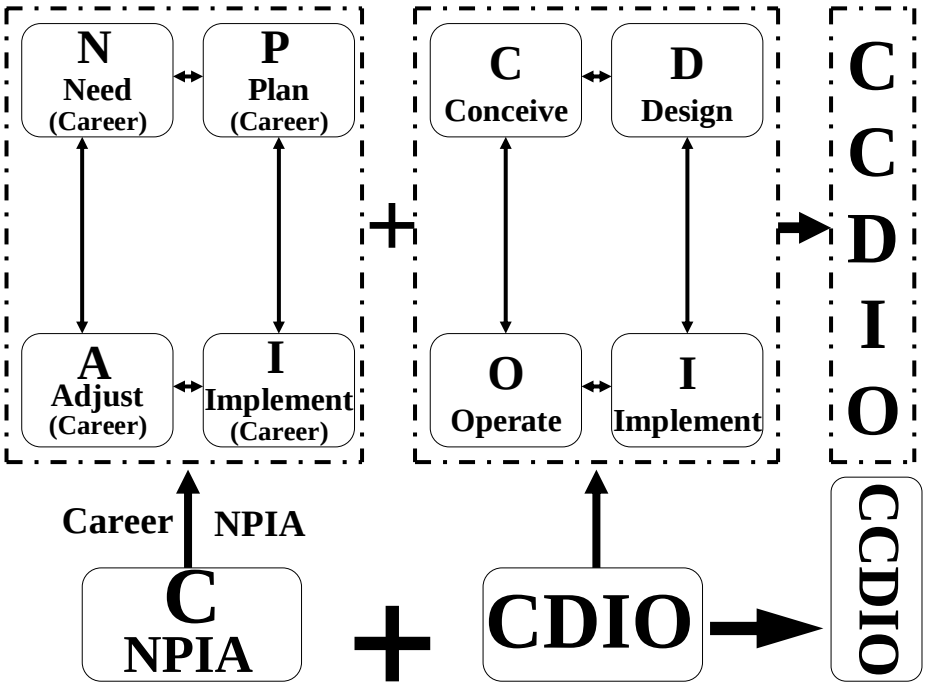

Figure 1. The formative process of CCDIO

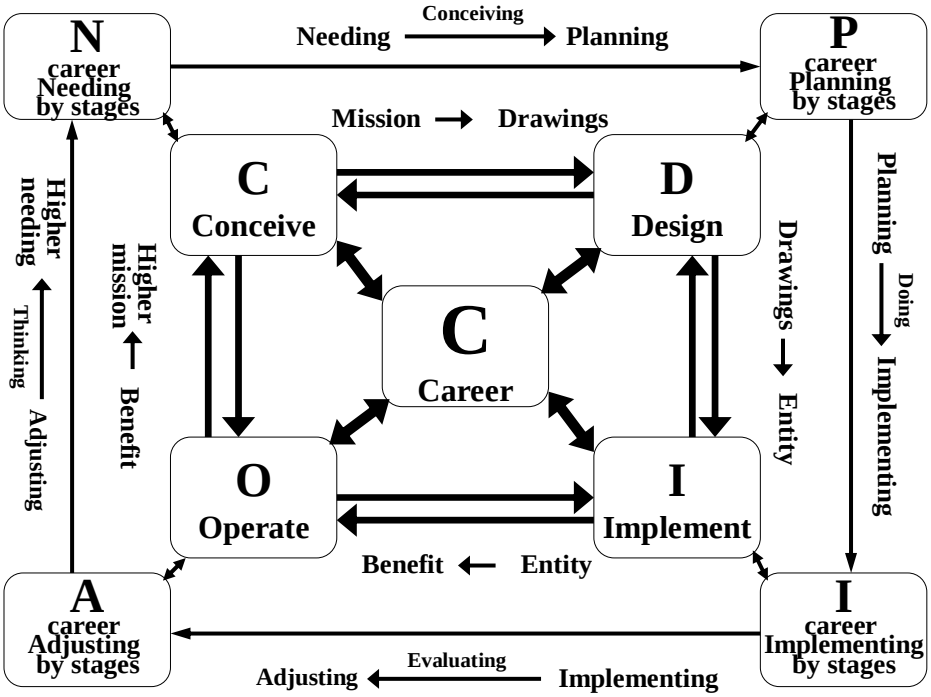

Figure 2. The system construction of CCDIO

However, on the whole, there is a serious examination-oriented education from primary school to university in China, resulting in lack of career education, student learning is short of the incentive role by career objective, so we need to integrate career education into the whole process of talents cultivation of engineering education. Career is the staged cyclic process of needing-planning-implementing-adjusting of career, namely career needing, career planning, career implementing, career adjusting, which is hereinafter referred to as NPIA mode (Called the NPIA cycle of career). Therefore, on the basis of CDIO, career education has been introduced into the whole process of talents cultivation. The formative process of CCDIO is shown in Figure 1, the system construction of CCDIO engineering education is shown in Figure 2. Figure 1 shows that CCDIO is the product of a chemical reaction between CDIO and the NPIA cycle of career based on internalization of career. Figure 2 shows that CCDIO is the cultivation system of talents that is the core of student's career, including a career system and professional skills system. Career system consists of career needing, career planning, career implementing, career adjusting; Professional skills system consists of engineering conceiving, engineering designing, engineering implementing, engineering operating. Therefore, in view of the current status of out-dated Chinese career education, CCDIO engineering education is suitable for Chinese engineering education reform.

PROFESSIONAL ENGINEER CAREER FOR WATER SUPPLY AND DRAINAGE SCIENCE AND ENGINEER BASED ON CCDIO

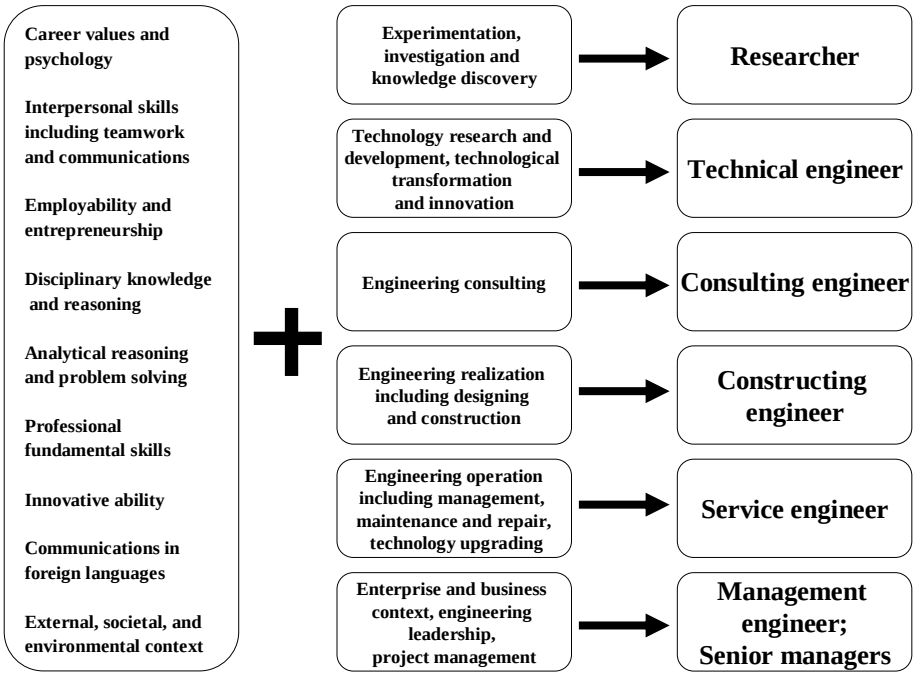

Figure 3. Professional engineering career for water supply and drainage science and engineering in the CCDIO Syllabus

The generic skills applicable to all career tracks for the undergraduate program of water supply and drainage science and engineering include: career values and career psychology; interpersonal skills including teamwork and communications, communications in foreign languages; etiquette; career fundamental skills; engineering leadership; employability and

entrepreneurship; self-management; analytical reasoning and problem solving; professional fundamental skills; external, societal, and environmental context; project management; career integrated systems ability [8]. The tracks, and sections of the CCDIO Syllabus that support engineers, are shown in Figure 3. According to the characteristics of the life cycle of water supply and drainage engineering, Figure 3 shows that there are at least six professional tracks that engineers can and do follow, in accordance with their individual talents and interests. There are six types of professional engineering career for water supply and drainage science and engineering, respectively researcher, technical engineer, consulting engineer, constructing engineer, service engineer, management engineer, senior managers. With regard to the undergraduate program of water supply and drainage science and engineering, these career tracks provide a broad space of career that attracts students willing to choose engineering-related vocation as a lifelong career, with the purpose of achieving self-development of the students by finding befitting career goal in the field of water supply and drainage.

LIFECYCLE MODEL OF WATER SUPPLY AND DRAINAGE ENGINEERING BASED ON CCDIO

<table>
<tr><td colspan="10">CCDIO (Water supply and drainage engineering)</td></tr>
<tr><td colspan="2">Career system</td><td colspan="8">Professional skills system</td></tr>
<tr><td colspan="2">Career</td><td colspan="2">Conceive</td><td colspan="2">Design</td><td colspan="2">Implement</td><td colspan="2">Operate</td></tr>
<tr><td>Mission</td><td>Staged Circulatory System</td><td>Mission</td><td>Consulting</td><td>Preliminary (Technical) Design</td><td>Construction Drawing Design</td><td>Project Preparation</td><td>Project Construction</td><td>Lifecycle Support</td><td>Evolution</td></tr>
<tr><td>Staged career needs</td><td>Career needing: stimulation, consciousness, expectation</td><td>Engineering needs</td><td>Engineering necessity and and objectives</td><td>Requirements allocation</td><td>Requirements verification, design objective</td><td>Materials and equipment preparation</td><td>Tendering and bidding</td><td>Project operation and management</td><td>Technology upgrading and innovation</td></tr>
<tr><td>Reasonable and feasible plan</td><td>Career planning: desire, motivation, self-cognition, staged scheme</td><td>Engineering benefit</td><td>Economic, social, technical and ecological benefits</td><td>Technical index: design objective</td><td>Determining technical index and scheme</td><td>Construction tools, management personnel</td><td>Project construction</td><td>Maintenance & repair</td><td>Retirement</td></tr>
<tr><td>Effective implementation</td><td>Career implementing: practice, objective, evaluating</td><td>Technical scheme</td><td>Technical feasibility, good economy, security and reliability</td><td>Technical scheme: economic and technical comparison</td><td>Design calculation and check</td><td>Construction condition on site</td><td>Investment management</td><td>Personnel training</td><td></td></tr>
<tr><td>Timely adjustment,clear new needs</td><td>Career adjusting: thinking, new stimulation, higher needing</td><td>Project investment</td><td>Capital structure, financial feasibility</td><td>Preliminary design drawings</td><td>Construction drawing</td><td>Construction program</td><td>Project planning and scheduling</td><td>Post project evaluation</td><td></td></tr>
<tr><td rowspan="2">Soft ability</td><td rowspan="2">Teamwork, communications, career morality, business etiquette, employability, self-management, positive psychology</td><td>Engineering impact</td><td>Environmental impact, impact on industrial production and livelihood</td><td>Initial budget estimate</td><td>Construction drawing budget</td><td>Quality acceptance criteria</td><td>Project quality management</td><td></td><td></td></tr>
<tr><td colspan="2">Career needing</td><td colspan="2">Career planning</td><td colspan="2">Career implementing</td><td colspan="2">Career adjusting</td></tr>
<tr><td colspan="10">Internalization of career, providing the learning required by students to become successful engineers</td></tr>
</table>

Figure 4. The lifecycle model of water supply and drainage engineering

Modern engineers of the 21st century are likely to participate in the full life cycle of the project, including Conceiving, Designing, Implementing, and Operating. At the same time, engineers will undergo multiple rising cycles of career, including career needing, career planning, career implementing, career adjusting. Based on CCDIO, the lifecycle model of water supply and drainage engineering is shown in Figure 4.

Figure 4 shows that career system and professional skills system have a very similar structural system, career system can achieve the organic integration with professional skills system, which provides the learning required by students to become successful engineers by means of internalization of career. The Conceiving stage includes engineering needs, engineering benefit, technical scheme, project investment, engineering impact. The Designing stage focuses on requirements verification, determining technical index and scheme, construction drawing, construction drawing budget. The Implementing stage refers to the transformation from engineering design to engineering entities, including project tendering and bidding, materials and equipment installation and test, investment management, project planning and scheduling, project quality management. The Operating stage operates the completed project in order to give play to project benefit, also including maintaining, upgrading and retiring.

CULTIVATING SYSTEM REFORM FOR WATER SUPPLY AND DRAINAGE SCIENCE AND ENGINEER BASED ON CCDIO

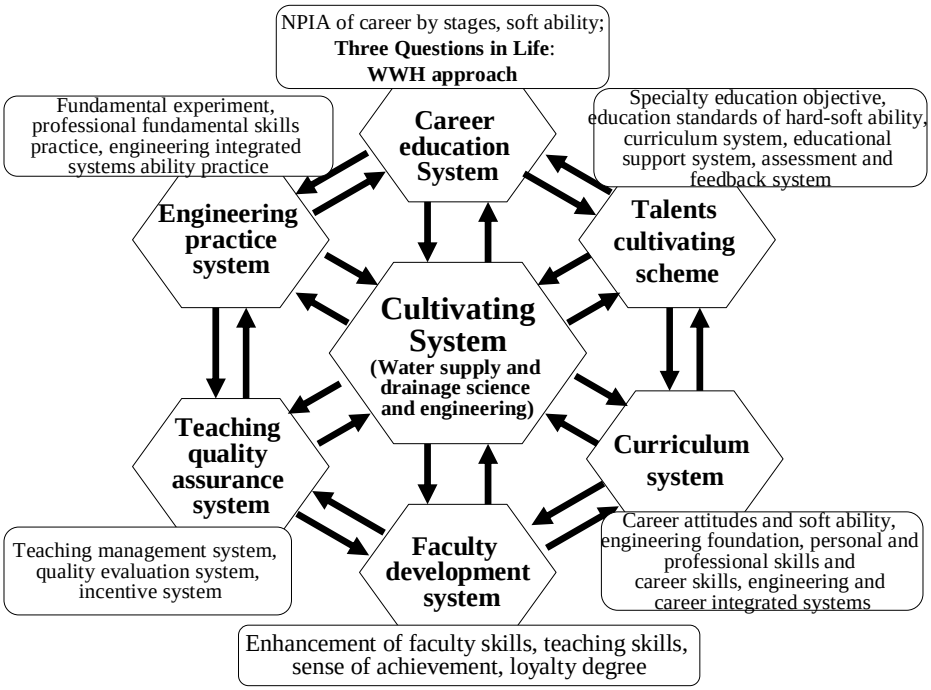

Figure 5. Cultivating system of water supply and drainage science and engineering based on CCDIO

At present, cultivating system of water supply and drainage science and engineering is based on scientific models to educate students to become future scientists, engineering science dominated with a strong emphasis on technical fundamentals. It is very necessary to reform cultivating system for water supply and drainage science and engineering. Under the guidance of career, water supply and drainage science and engineering educating students based on CCDIO has three overall goals: First, mastering a deeper working knowledge of technical fundamentals, and a deeper working ability to soft skills; Second, leading in technology development, design, construction, operation, management, for water supply and drainage engineering, in a modern team-based environment; Third, understanding the importance and strategic impact of research and technological development on society and

water crisis solving. On account of the three goals, we build cultivating system of water supply and drainage science and engineering, cultivating system based on CCDIO is shown in Figure 5. Figure 5 shows that cultivating system of water supply and drainage science and engineering is divided into six sub-systems: namely career education system, talents cultivating scheme, curriculum system, engineering practice system, teaching quality assurance system, faculty development system. Career education system will play a positioning and encouraging role in students learning and working for undergraduate program of water supply and drainage science and engineering, talents cultivating scheme is an important guiding principle, curriculum system is an important carrier, engineering practice system is an important means of hard-soft ability, teaching quality assurance system is an important institutional guarantees, faculty development system is an important support. These will provide a very important teaching foundation for talents cultivation of water supply and drainage science and engineering.

CURRICULUM SYSTEM REFORM FOR WATER SUPPLY AND DRAINAGE SCIENCE AND ENGINEER BASED ON CCDIO

Organizing principle of water supply and drainage science and engineering based on CCDIO

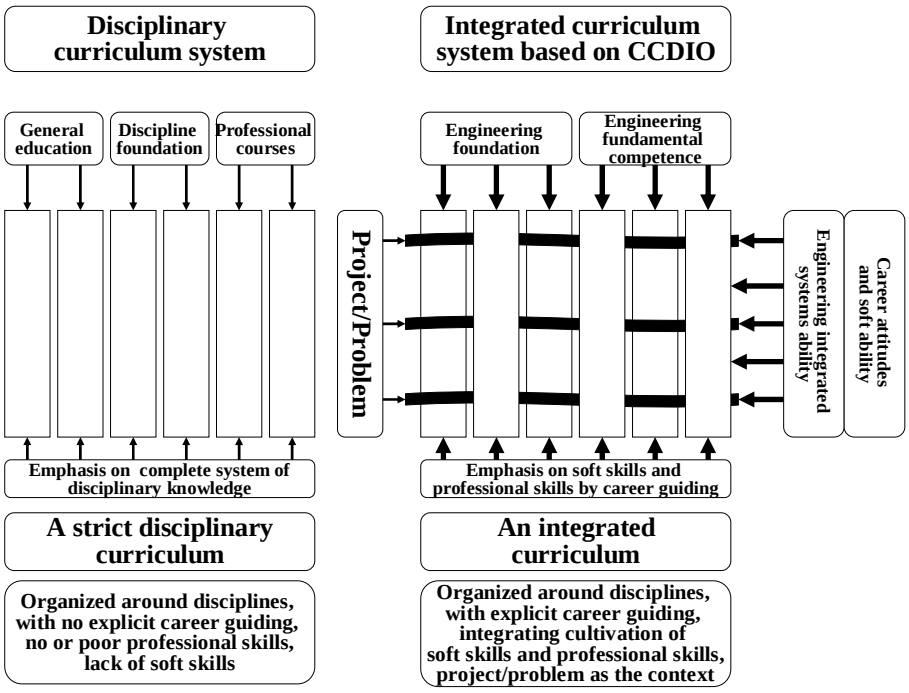

Figure 6. The comparison between disciplinary mode and integrated mode

At present, the organizing principle of curriculum system includes mainly four modes for engineering education, respectively disciplinary mode, integrated mode, problem/project mode, apprenticeship mode. However, apprenticeship mode is mainly used to cultivate skilled personnel, disciplinary mode, integrated mode, problem/project mode are mainly used for higher engineering education. China is still mainly disciplinary mode for cultivating engineering talent, the drawbacks of this model has become increasingly prominent. Since many universities have a pre-existing disciplinary organization, it may be difficult to transform

an existing program to one with a comprehensive problem-based organization. Problem/project mode is widely used in developed countries, especially project mode. Comparison between disciplinary mode and integrated mode is shown in Figure 6. In the figure, disciplines run vertically, and projects and skills including soft skills and professional skills run horizontally.

Figure 6 shows that disciplinary curriculum system emphasizes disciplinary knowledge system, integrated curriculum system emphasizes professional skill cultivating. Disciplinary curriculum system organized around disciplines includes mainly general education course, discipline foundation course, professional courses. The result shows that there are with no explicit career guiding, no or poor professional skills, lack of soft skills. Nevertheless, projects as the context, the integrated mode organized around disciplines has explicit career guiding, integrating cultivation of soft skills and professional skills, based on CCDIO. Therefore, choosing integrated mode is suitable for the current situation of water supply and drainage science and engineering based on CCDIO.

Curriculum system of water supply and drainage science and engineering based on CCDIO

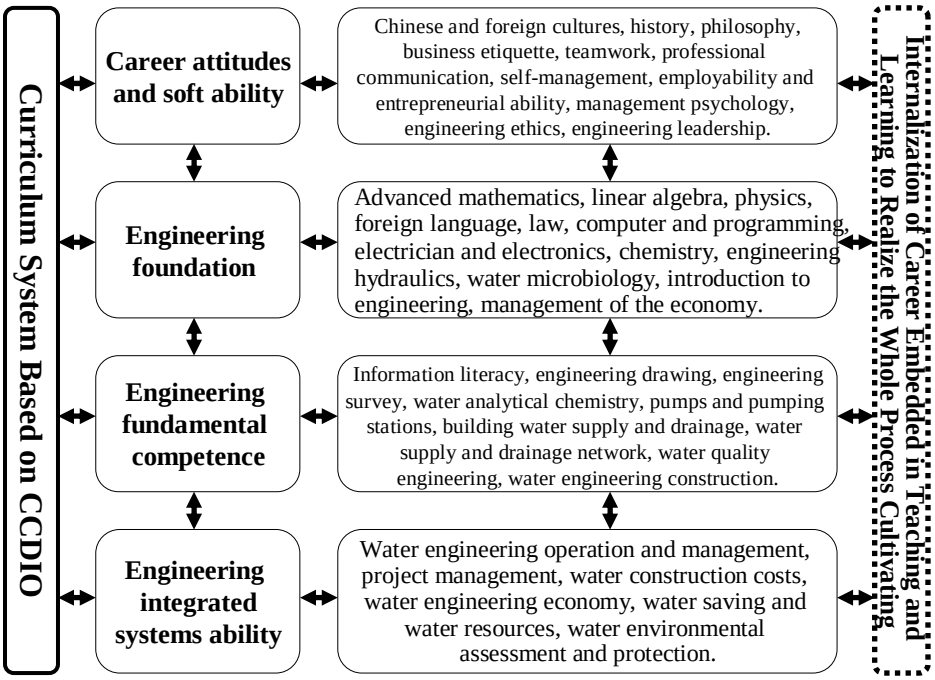

Figure 7. Curriculum system of water supply and drainage science and engineering based on CCDIO

Establishing a rational curriculum system is the focus and difficulty of water supply and drainage science and engineering, is directly closely related to the quality of talents cultivation. The undergraduate program of water supply and drainage science and engineering is shown in Figure 7. Figure 7 shows that curriculum system of water supply and drainage science and engineering based on CCDIO is divided into four parts: respectively career attitudes and soft ability, engineering foundation, engineering fundamental competence, engineering integrated systems ability. Career attitudes and soft ability is fully integrated into the cultivating process of engineering foundation, engineering fundamental

competence, engineering integrated systems ability. In the process of educating students, internalization of career is embedded in the whole process of teaching and learning to enhance the students' ability to learn consciously. Under the guidance of students' career, soft ability and professional ability can realize synchronous cultivation. This is an important characteristic of the integrated curriculum system based on CCDIO.

Water Supply and Drainage Science and Engineering	CCDIO Syllabus																				
	Career Attitudes and Soft Ability							Engineering Foundation and Career Foundation		Personal and Professional Skills and Career Skills						Engineering and career integrated systems				
	Career values	Career psychology	Interpersonal skills	Etiquette	Engineering leadership	Employability and entrepreneurship	Self-management	Disciplinary knowledge and reasoning	Career fundamental knowledge	Analytical reasoning and problem solving	Experimentation, investigation and knowledge discovery	System thinking	Attitudes, thought and learning	Innovative ability	Professional fundamental skills	Career fundamental skills	Extemal, societal, and environmental context	Enterprise and business context	Project management	Engineering integrated systems ability	Career integrated systems ability
Chinese and foreign cultures	4	3	3	2	3	3	3	2	4	2	1	3	4	2	2	3	5	3	5	4	4
Chinese and foreign history	4	3	3	2	3	3	3	2	4	2	1	4	4	2	2	3	5	3	4	3	3
Philosophy	5	4	4	3	5	5	5	2	5	2	2	5	5	5	3	4	3	4	5	5	5
Advanced mathematics	1	1	1	1	1	1	1	5	1	5	2	4	3	2	3	1	1	1	1	1	1
Linear algebra	1	1	1	1	1	1	1	5	1	3	2	4	3	2	2	1	1	1	1	1	1
Probability and mathematical statistics	1	1	1	1	1	1	1	5	1	3	2	3	3	2	3	1	1	1	1	1	1
Physics	1	1	1	1	1	1	1	5	1	5	2	4	3	2	2	1	1	1	1	1	1
Chemistry	1	1	1	1	1	1	1	5	1	3	2	3	3	2	3	1	1	1	1	1	1
Foreign language	2	2	2	2	2	3	2	4	2	1	1	1	2	1	3	2	2	2	2	2	2
Computer and programming	1	1	1	1	1	1	1	4	1	2	1	3	3	3	3	1	1	1	1	2	1
Introduction to engineering	3	3	3	3	5	4	5	3	3	1	3	3	4	4	4	3	3	3	4	4	3
Business etiquette	3	4	5	5	5	5	4	2	4	1	1	2	2	2	2	5	3	4	5	5	5
Positive psychology and psychological consult	5	5	5	5	5	5	5	3	5	2	1	4	3	4	3	5	3	5	5	5	5
Teamwork	5	5	5	5	5	5	5	3	5	3	1	5	5	5	5	5	3	5	5	5	5
Professional communication	5	5	5	5	5	5	5	3	5	3	1	5	5	5	5	5	4	5	5	5	5
Chaos Theory of Career and counseling	5	5	5	5	5	5	5	2	5	2	1	4	5	4	3	5	3	3	5	5	5
Electrician and electronics	1	1	1	1	1	1	1	5	1	3	2	1	2	2	1	1	1	1	1	1	1
Engineering hydraulics	1	1	1	1	1	1	1	4	1	2	2	3	3	2	5	2	1	1	2	2	1
Water microbiology	1	1	1	1	1	1	1	3	1	2	2	2	2	2	3	1	1	1	1	2	1
Management of the economy	4	3	4	5	5	5	4	5	4	3	2	3	4	3	4	5	4	5	5	5	5
Law	3	4	4	3	5	5	4	3	3	2	2	3	3	1	3	5	4	5	5	5	5
Information literacy	4	4	4	4	5	5	5	3	3	2	2	4	3	4	3	5	4	4	4	5	5
Engineering drawing	1	1	1	1	1	1	1	3	2	1	1	2	2	1	4	2	1	1	1	3	3
Engineering survey	1	1	1	1	1	1	1	3	2	2	2	2	2	2	4	2	1	1	1	3	3
Water analytical chemistry	1	1	1	1	1	1	1	3	2	3	3	2	3	2	5	2	1	1	1	3	3
Pumps and pumping stations	1	3	3	3	3	3	4	5	3	3	2	3	4	3	5	3	3	2	4	5	4
Self-management	5	5	5	5	5	5	5	5	5	3	3	5	5	4	3	5	5	4	5	5	5
Employability and entrepreneurial ability	5	5	5	5	5	5	5	5	5	3	4	5	5	4	4	5	5	5	5	5	5
Engineering ethics	5	5	5	5	5	4	5	5	5	2	1	3	3	1	5	5	5	5	5	5	5
Building water supply and drainage	3	3	3	3	4	3	4	5	3	3	2	5	4	4	5	3	4	3	5	5	4
Water supply and drainage network	3	3	3	3	4	3	4	5	3	3	2	5	4	4	5	3	4	3	5	5	4
Water quality engineering	3	3	3	3	4	3	4	5	3	3	2	5	4	4	5	3	4	3	5	5	4
Water engineering economy	3	3	3	3	4	3	4	3	3	2	1	5	3	2	5	3	4	3	5	5	4
Water environmental assessment and protection	2	2	2	2	4	3	4	3	3	3	1	3	3	2	4	3	3	3	4	3	3
Water saving and water resources	3	3	2	2	3	2	5	3	1	3	3	5	4	4	5	2	2	4	3	3	2
Management psychology	4	5	5	5	5	5	5	5	5	3	1	5	5	4	5	5	5	5	5	5	5
Engineering leadership	5	5	5	5	3	5	5	5	5	3	2	5	5	5	5	5	5	5	5	5	5
Water engineering construction	2	3	3	3	3	3	3	3	3	2	1	3	3	3	5	3	3	3	5	5	3
Water engineering operation and management	3	3	3	3	5	4	5	4	5	3	1	5	5	5	5	3	3	3	5	5	4
Project management	4	5	5	5	5	5	5	3	5	4	2	5	5	5	5	5	4	5	5	5	5
Water construction costs	2	3	3	3	3	3	3	3	3	2	1	3	3	2	5	3	2	3	3	4	3

1—No immediate correlation; 2—Weaker immediate correlation;
3—Immediate correlation; 4—Good immediate correlation;
5—Strong correlation.

Figure 8. The corresponding relation between the CCDIO Syllabus and curriculum system of water supply and drainage science and engineering

Curriculum system reflecting the requirements of the CCDIO Syllabus

The CCDIO Syllabus consists of four parts: career attitudes and soft ability, engineering foundation and career foundation, personal and professional skills and career skills, engineering and career integrated systems. The syllabus is the core of CCDIO, the corresponding relation between curriculum system and the syllabus is shown in Figure 8. Each connection was rated on a five-level scale, ranging from No immediate correlation (1) to Strong correlation (5), respectively No immediate correlation (1), Weaker immediate correlation (2), Immediate correlation (3), Good immediate correlation (4), Strong correlation (5). In general, Figure 8 shows that curriculum system should have an explicit corresponding relation with the syllabus. Each item of the CCDIO Syllabus have a corresponding support of courses. In particular, the item of the CCDIO Syllabus has a strong correlation with several courses directly related to the item. For example, disciplinary knowledge and reasoning mainly depends on advanced mathematics, linear algebra, probability and mathematical statistics, physics, chemistry, management of the economy; professional fundamental skills mainly depends on pumps and pumping stations, building water supply and drainage, water supply and drainage network, water quality engineering, water engineering operation and management; interpersonal skills mainly depends on positive psychology and psychological consult, employability and entrepreneurial ability, business etiquette, teamwork, professional communication, self-management, management psychology, engineering leadership. Therefore, curriculum system of water supply and drainage science and engineering can reflect the requirements of the CCDIO Syllabus with a strong scientific rationality.

TEACHING METHODS REFORM FOR WATER SUPPLY AND DRAINAGE SCIENCE AND ENGINEER BASED ON CCDIO

The *WWH* approach—— *"Three Problems in Life"*

NPIA circulatory system of career with an upward spiraling process by stages is divided into four processes: career needing, career planning, career implementing, career adjusting. NPIA cycle of career is applicable to the short, medium and long term period of time such as one hour, one day, one month, six months, one year, two years, three years, five years, 10 years, 15 years, 20 years, 30 years, 40 years, and so on. At the same time, soft ability positioned by *CPS* is the cornerstone of cultivating system for water supply and drainage science and engineering based on CCDIO. *CPS*, namely *Career Positioning System*, can provide direction for the future development of students in order to enhance students' enthusiasm and initiative to learn. It is a very important for specialized course and career education to use *WWH* approach integrated into the whole process of talents cultivation. *WWH* approach is also known as "*Three Problems in Life*". The *WWH* approach is shown in Figure 9. Figure 9 shows that the *WWH* approach has strong applicability, especially career, working, learning and life. "*Three Problems in Life*": The first problem, *Who am I*? The second problem, *where to go*? The third problem, *how to go*? So "*Three Problems in Life*" is referred to as *WWH* approach. If "*Three Problems in Life*" as a system, in fact, Whether it is work or life, each of us has a large number of such subsystems ("*Three Problems in Life*"), which constitutes our entire life in a lifetime. From here we see that *WWH* approach is fully applicable to our work, life, learning, and other things. Therefore, the *WWH* approach ("*Three Problems in Life*") can be widely applied to the activities of teaching and learning, including practical course and theoretical courses such as foundation course, professional courses.

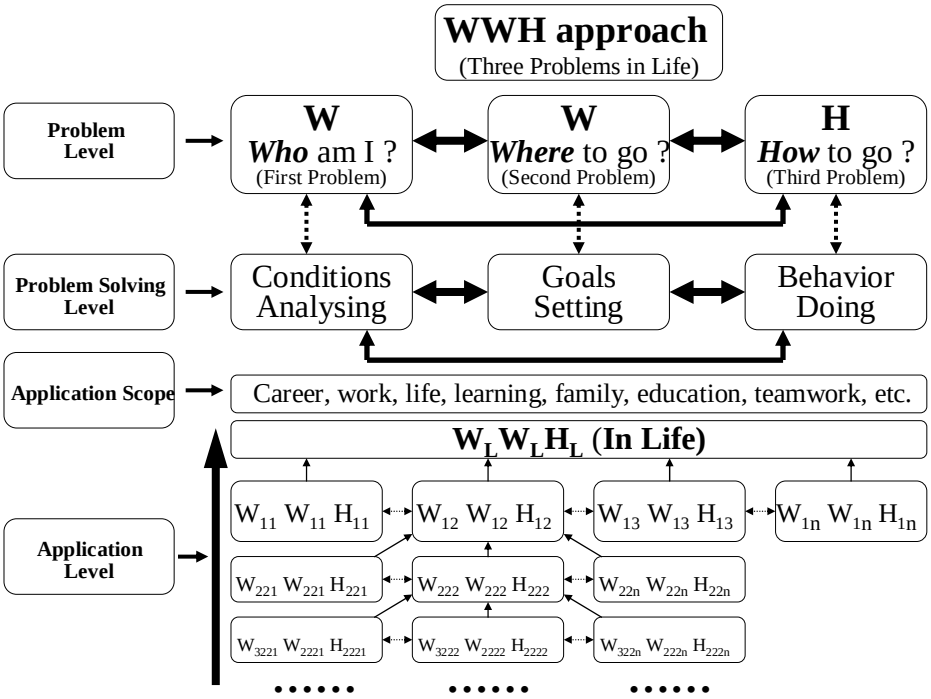

Figure 9. The *WWH* approach——*Three Problems in Life*

Thoughts on the reform of teaching methods based on CCDIO

Teaching methods is an effective catalyst for improving teaching effectiveness, it is very important for engineering programs to reform the traditional cramming method of teaching, especially CCDIO engineering education. According to the characteristics of CCDIO, ***Career Competitiveness Model*** should be referred to in the text in the form Eqn (1).

$$CC = (K_C + S_C)^{A_C} \tag{1}$$

CC ——Career Competitiveness;

C ——Career;

K_C ——Knowledge, effective knowledge based on career;

S_C ——Skill, effective hard-soft skill based on career;

A_C ——Attitude, positive attitude with good morality based on career.

Career competitive model shows that career competitiveness is directly related to the three factors: knowledge, skill, attitude. From here we see that attitude is the core of career competitiveness, can play an exponential role in career competitiveness. Particularly, the impact on personal career competitiveness with positive attitude is vastly different from negative attitude. The impact of positive attitude with good morals on personal career competitiveness or society will play an important positive role in promoting personal and social development and progress; however, the impact of positive attitude with bad morals on society will cause serious damage to society, as an extreme example of wartime Prime Minister Hideki Tojo, Hitler, Bin Laden. Therefore, it is the most important for attitude to

educate students. The reform of teaching methods should be very beneficial to a positive attitude of students with good morality.

At present, the methods of cramming examination-oriented education in China is the main teaching methods that attaches great importance to knowledge system and neglects of engineering practice ability for water supply and drainage science and engineering, especially lack of career guiding. Therefore, it is very necessary to enhance career education and reform teaching methods. The following method may be considered for water supply and drainage science and engineering: *PBL* (Problem/project-based Learning), inquiry method, the WWH approach integrated into classroom teaching for specialized course and career education. At the same time, we can combine two or more methods in order to generate new teaching thought. For example, the combination of *PBL* and *WWH*, the combination of inquiry method and *WWH*, and so on. We need to continue to improve teaching methods to educate students to form a positive attitude with good morality for water supply and drainage science and engineering.

CONCLUSIONS

This paper analyzes the reform background of water supply and drainage science and engineering, talents cultivation is mainly scientific mode, it is necessary for teaching reform to meet social needs. At the same time, on the basis of CDIO, the paper puts forward CCDIO that is applied to teaching reform. We draw some conclusions: First, the formation and system construction of CCDIO. CCDIO is the product of a chemical reaction between CDIO and the NPIA cycle of career based on internalization of career, including a career system and professional skills system. Second, professional engineer career for water supply and drainage science and engineering. There are six types of professional engineering career for water supply and drainage science and engineering, respectively researcher, technical engineer, consulting engineer, constructing engineer, service engineer, management engineer, senior managers. Third, cultivating system reform for water supply and drainage science and engineering. Cultivating system is divided into six sub-systems: namely career education system, talents cultivating scheme, curriculum system, engineering practice system, teaching quality assurance system, faculty development system. Fourth, curriculum system for water supply and drainage science and engineering. Curriculum system based on CCDIO is divided into four parts: respectively career attitudes and soft ability, engineering foundation, engineering fundamental competence, engineering integrated systems ability, reflecting the requirements of the CCDIO Syllabus with a strong scientific rationality. Fifth, the ***WWH*** approach—— "***Three Problems in Life***". The *WWH* approach ("*Three Problems in Life*") can be widely applied to the activities of teaching and learning. Based on career competitive model, the reform of teaching methods should be very beneficial to a positive attitude of students with good morality.

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