

# Curriculum Teaching Process Design and Research Based on TOPCARES-CDIO

Chong Zhang<sup>1,a,\*</sup> and Baocai Zhong<sup>1,b</sup>

<sup>1</sup>Department of Information and Software Engineering, Chengdu Neusoft University, Chengdu, Sichuan, China

<sup>a</sup>zhangchong@nsu.edu.cn, <sup>b</sup>zhongbaocai@nsu.edu.cn

\*corresponding author

## ABSTRACT

A new curriculum teaching process design method with competence training as the core is proposed based on the international advanced TOPCARES-CDIO engineering education idea. Taking the curriculum Web Application Development as an example, this paper describes the whole process from the determination of curriculum objectives to the design of curriculum teaching methods, and finally to the assessment of the curriculum. This method guides activities closely around T-C index, and achieves good results in practical application.

**Keywords:** CDIO, teaching method, curriculum design, competence indicator

## 1. INTRODUCTION

CDIO engineering education model is the latest achievement of international engineering education reform in recent years. CDIO stands for Conceive, Design, Implement and Operate. It takes the life cycle from product development to product operation as the carrier to enable students to learn engineering in an active, practical and interdisciplinary way. The CDIO training outline divides the abilities of engineering graduates into four levels: basic engineering knowledge, personal ability, interpersonal team ability and engineering system ability. The outline calls for comprehensive training to enable students to achieve their intended goals at these four levels. Based on the concept of "Education Creates Student Value" and CDIO, Dalian Neusoft Information Institute creatively constructs the "Eight Competences" index system of TOPCARES-CDIO (T-C) with Neusoft's characteristics, namely: Technical Knowledge and Reasoning, Open Mind and Innovation, Personal and Professional Skills, Communication and Teamwork, Attitude

and Manner, Responsibility, Ethical Values, Social Value Created by Application Practice. Under these eight first-level competence indicators, 34 second-level indicators and 126 third-level indicators are constructed, thus constituting a complete major competence index system. This paper is based on the T-C competence index of the course Web Application Development as an example, and puts forward a complete set of curriculum design and assessment program.

## 2. Course Objective Determination

T-C competence indicators of courses are selected from major T-C competence indicators, which are suitable for centralized cultivation in a certain course. Firstly, we analyze the T-C indicators of Software Engineering Major (which are obtained through market research of software development industry and original T-C indicators system), and select the indicators that need to be trained in the course of Web Application Development, thus forming the T-C indicators set of the course, as shown in the table below.

**Table 1** The Index System Of Course Training Competence-Web Application Development

T-C Indicators Level 1	T-C Indicators Level 2	T-C Indicators Level 3	Capability Indicators Description
1 Technical Knowledge and Reasoning	1.3 Professional Knowledge	1.3.1 Professional Knowledge	1、Installation, Configuration and Web Publishing of Web Server 2、The basics of HTML, CSS, JavaScript, etc. 3、JSP 4、Servlet 5、JDBC, Filter, Listener
2 Open Thinking and Innovation	2.1 System Thinking	2.1.1 Thinking Holistically	Identify and define a system, its behavior, Identify the interactions external to the system, and the behavioral impact of the system
		2.1.2 Emergence and Interactions in Systems	Identify the behavioral and functional properties (intended and unintended) which emerge from the system
3 Personal and Professional Skills	3.1 Engineering Reasoning and Problem Solving	3.1.1 Problem Identification and Formulation	Grasp the overall goal, prioritize matters and formulate solutions

		3.1.5 Solution and Recommendation	Synthesize problem solutions
	3.2 Experimentation and Knowledge Discovery	3.2.2 Survey of Print and Electronic Literature	Choose the literature research strategy Demonstrate information search and identification using library tools (on-line catalogs, databases, search engines)
4 Communication and Teamwork	4.3 Teamwork	4.3.2 Team Operation	Practice effective communication (active listening, collaboration, providing and obtaining information)
7 Ethical Values	7.2 Professional values	7.2.3 Individual and Team Growing Together	Team and Personal Relations Processing in Project Development
8 Social Value Created by Application Practice	8.5 Enterprise and Business Context	8.5.1 Basic Industry Norms	Codes, charts and documents conform to software engineering specifications
	8.6 Conceiving and Engineering Systems	8.6.2 Defining Function, Concept and Architecture	Identify necessary system functions (and behavioral specifications)
	8.7 Designing	8.7.1 The Design Process	Synthesize the final design
	8.8 Implementing	8.8.3 Software Implementing Process Explain	Designing the Implementation Process
8.8.5 Test, Verification, Validation, and Certification		Discuss test and analysis procedures	

The above indicators are the T-C competence indicators that need to be developed in the course of Web Application Development. However, how to cultivate them in the course, it needs to be refined into each unit of the course. To this end,

we have designed mapping from curriculum competence indicators to curriculum knowledge units and project units, thus taking a practical step for the cultivation of these competence indicators as follows:

TOPCARES (Capability Indicators Level 3)	Course Unit (Knowledge Unit) CU						Unit Project(UP) and Course Project(CP)								
	CU(1)	CU(2)	CU(3)	CU(4)	CU(5)	CU(6)	UP(2)	UP(2)	UP(2)	UP(3)	UP(6)	UP(1/3)	UP(1/3/5)	UP(1/2/3/4/5)	CP(1)
	Course Introduction	Web Pages	JSP	Database Design	Servlet	Filter	Home Page Design	Information Table	web calculator	News Class Design	Authority Management	Internet Chat Room	Verification code program	News Release System	Online Bookstore
1.3.1 Professional Knowledge	M	E	E	E	E	E	E	E	E	E	E	E	E	E	E
2.1.1 Thinking Holistically	L	M	M	M	L	L	M	M	M	M	M	M	M	M	M
2.1.2 Emergence and Interactions in Systems	L	E	L	E	L	L	M	M	M	L	M	M	M	M	L
3.1.1 Problem Identification and Formulation	L	L	M	M	L	L	M	M	M	M	M	M	M	M	E
3.1.5 Solution and Recommendation	L	M	E	E	E	M	E	E	E	E	E	E	E	E	E
3.2.2 Survey of Print and Electronic Literature	L	L	L	L	L	L	M	M	M	M	M	M	M	M	M
4.3.2 Team Operation	L	M	M	M	M	M	L	L	L	L	L	L	L	M	M
7.2.3 Individual and Team Growing Together	L	E	M	E	M	M	M	M	M	M	M	M	M	M	M
8.5.1 Basic Industry Norms	L	E	M	E	M	M	M	M	M	M	M	M	M	M	E
8.6.2 Defining Function, Concept and Architecture	L	E	L	E	L	L	M	M	M	M	M	M	M	M	M
8.7.1 The Design Process	L	M	L	M	L	L	M	M	M	M	M	M	M	M	M
8.8.3 Software Implementing Process Explain	L	E	L	E	L	L	E	E	E	E	E	E	E	E	E
8.8.5 Test, Verification, Validation, and Certification	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M

**Figure 1** Mapping of Training Objectives and Course Contents of *Web Application Development*

In the table above, L, M and E denote Less, Medium and Extreme respectively, meaning the importance of the index, which comes from the research of industry enterprises and the comprehensive consideration of the curriculum system in the major talent training program. For example, it will train students' abilities of the index 2.1.2 Emergency and Interactions in Systems to the greatest extent in Unit 2 Webpages. So we mark this cell as E to show it Extremely importance, while it only can be marked as L which means Less in Unit Project 3 News Class Design, since it doesn't play a very important role in the cultivation of this competence. As for which competences need to be emphatically cultivated in which units, careful design and reasonable layout are needed. In the actual teaching process, different degrees of importance will be given different time weights. Teachers can make appropriate adjustments according to their needs, but not too fine, just need to grasp the contribution of different knowledge units to the training of different competence indicators in mind.

### 3. TEACHING PROCESS AND METHOD DESIGN

With the mapping of curriculum training objectives and curriculum content, we can clearly see which unit or units a certain index should be cultivated in and how far it should be cultivated. In the course of Web Application Development, we have designed 6 knowledge units, 8 unit projects and a comprehensive curriculum project to support the cultivation of these T-C competence indicators. However, how to cultivate, we also need to design appropriate teaching methods, combined with different teaching modes, as well as specific activities to achieve the goal. Therefore, according to the characteristics of curriculum unit knowledge, we have selected two main teaching methods, five teaching modes, and combined with a number of different activity designs to complete the training of T-C competence indicators, as shown in the following Figure:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<b>Course Stage</b>	Course Introduction		Requirement Analysis		System Design				System Implementation				System Integration, Testing and Operation			
<b>Teaching Method</b>	Project-based and Problem-based Teaching Method															
<b>Delivery Mode</b>	On-line Self-Study				Discussion Teaching Method				Group Learning							
	Flipped Classroom				Role-playing and Case-based Teaching Method											
<b>Teaching Activities Design</b>	Throw out tasks and problems, and learn online	Personal discussion, exchange opinions, and set up development team.	Teacher gives lecture (summarizing students' opinions and introducing new knowledge)	Further access to online information to identify system needs.	Web Development Project Design Group Discussion	Students collect and share design information.	Debate in groups to determine the design plan.	Teachers evaluate each group and give suggestions.	Team task division, database implementation.	Teacher case guidance.	Background Function Realization	Teacher Case Guidance.	Front-end interface implementation.	Project Integration and Debugging	Project testing and operation	Project demonstration and defense
<b>Corresponding T-C Index</b>	1.3.1 3.2.2	3.1.1	1.3.1	3.2.2 8.5.1	3.1.1 4.3.2 7.2.3	3.2.2 8.6.2	2.1.1 4.3.2 7.2.3 8.7.1	3.1.5	4.3.2	3.1.5	4.3.2 8.8.3	3.1.5	2.1.2 4.3.2 8.8.3	8.8.5	8.8.5	7.2.3

**Figure 2** Teaching Method and Process Design- *Web Application Development*

The figure above shows the teaching methods and modes to be adopted at different stages of the teaching process in the form of time axis, as well as the competence indicators to be cultivated. For example, in the fourth week of the implementation of the curriculum, we mainly carry out the system requirement analysis, using the combination of students' autonomous learning and flipping classroom to complete the training of indicators 3.2.2 and 8.5.1. In the thirteenth week, the group learning method combined with role-playing and case-based teaching method was used to develop the system, so as to achieve the training of indicators 2.1.2, 4.3.2 and 8.8.3. The whole 16-week course learning is based on project-based and problem-based teaching these two main methods. Different competence indicators have matching teaching methods and modes to cultivate in the appropriate time, which requires teachers to have a very rich teaching experience and a profound understanding of the indicators, in order to achieve perfect coordination between them.

### 4. COURSE ASSESSMENT

Since the curriculum is designed and implemented around T-C competence indicators, so the traditional written examination method is far from enough in the assessment process, but should be based on different competence indicators, combined with a variety of assessment methods, to conduct an all-round full coverage of the assessment. In the course of Web Application Development, we have designed two evaluation stages and five different evaluation methods to evaluate students' performance comprehensively. Each evaluation method has a different proportion, and corresponds to each T-C capability index, as shown in the following table:

**Table 2 T-C Index And Assessment Mapping**

Assessment Methods	Formative assessment	Final Assessment	T-C Index Level 3												
			1.3.1	2.1.1	2.1.2	3.1.1	3.1.5	3.1.2	4.3.2	7.2.3	8.5.1	8.6.2	8.7.1	8.8.3	8.8.5
Course Project and Respondents	30%		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Homework and Classroom Performance	9%		✓			✓	✓	✓	✓				✓		
Attendance	6%								✓	✓					
Experiments	15%				✓	✓	✓	✓					✓		
Final Closed-book Examination		40%	✓									✓	✓		
Total Score(100%)	60%	40%													

Course assessment only generally reflects the competency indicators mainly be evaluated by which assessment methods, but does not refine the specific scores of each competency indicators. If we need to reflect the degree of achievement of each index, we need to do further detailed assessment programs, assign different weights to different indicators, which is also the focus of our next research.

## 5. CONCLUSIONS

The method of curriculum design and assessment based on T-C proposed in this paper has been applied to various courses in our college and achieved good results. The difficulties in curriculum design lie in the selection of T-C indicators, the design of teaching activities and the assessment of indicators. Among them, in the determination of T-C indicators, a large number of major research and overall consideration of the curriculum architecture are needed to select a more reasonable curriculum T-C indicators. Teaching activities should be designed according to different T-C indicators, which requires teachers to have rich teaching experience and a profound understanding of the indicators. For the assessment of T-C indicators, a balance between accuracy and ambiguity is needed in order to achieve the accuracy and efficiency of the assessment of indicators.

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