"CDIO-Learn Freely" Bidirectional Teaching Approach Implementation Research

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Abstract— **Through research and implementation on "CDIO – Learn Freely" bidirectional teaching approach, to achieve the goal of enhancing the quality of education. When designing the teaching plan for "Game Software Testing Technology and Tools" curriculum, in "teach" process adopted the CDIO engineering education mode, in "learn" process adopted Jaspers "learn freely" philosophy. Compared with other teaching approach of such course, the students achieved better engineering ability and studying ability. The "CDIO – Learn Freely" bidirectional teaching approach is a creative application in education.**

Keywords-CDIO; learn freely; bidirectional education; teaching approach

So as to encourage educational ingenuity and improving the quality of developing skillful talents, to discover various ways of teaching approach innovation and application, especially the bidirectional innovation of teaching and learning method, teachers reform the "Game Software Testing Technologies and Tools" curriculum based on CDIO engineering teaching approach and Karl Theodor Jaspers' "Learning Freely" philosophy, creating the "CDIO-Learning Freely" bidirectional teaching approach, at the same time implemented application research and the research come to fruition.

I. INTRODUCTION TO CURRICULUM IMPLEMENTED

The curriculum "Game Software Testing Technology and Tools" is a professional mandatory class for game software major students. Within the curriculum system of game design, game art, game programming and game operation, the curriculum is an important course that develops student's game programming and game testing skills. Along with game programming course, it forms student's game software programming module.

The "Game Software Testing Technology and Tools" curriculum's relationship with other courses in the professional curriculum system is shown as figure 1 below.

From the above figure we could see, there are connections between the "Game Software Testing Technology and Tools" curriculum and other major courses. That is to say, game software testing involves contents which mentioned in previous courses such as game design, game art, game software programming and test them in different phases, even game operation need software testing. Therefore, it has the foundation of adopting CDIO engineering teaching approach during "teaching" the "Game Software Testing Technology and Tools" curriculum.
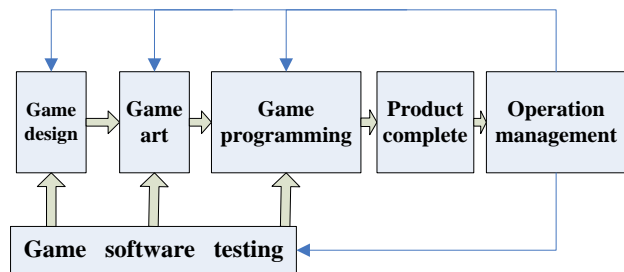

Figure 1. Game software major course relationship diagram.

Moreover, to carry out different game software testing or single game software testing may use various testing mode, method and workload measurement selection and design, which students may freely design according to certain requirements and standard. This is the foundation of the curriculum to adopt Karl Theodor Jaspers' "Learning Freely" philosophy in the process of "Learning".

II. THE THEORETICAL FOUNDATION FOR THE RESEARCH

During the process of implementation research of the "Game Software Testing Technology and Tools" curriculum bidirectional teaching approach reform, our work mainly involve CDIO, Learn Freely teaching method and philosophy, which are briefly discussed below.

A. CDIO Engineering Teaching Approach

CDIO stands for Conceive, Design, Implement and Operate. It uses the lifecycle from product development to product operation as carrier, enabling students actively, practically learn engineering and associate with other courses. The CDIO training outline divides the abilities of engineering students' into engineering basic knowledge, personal ability, team working ability and engineering systematic ability. The outline requires to synthetically educating students to achieve these four aspects [1].

CDIO system suggests 12 criteria that are exercisable ability training, full scope implementation and evaluation, which are listed as below:

Criterion 1: Rely on CDIO as basic environment,
Criterion 2: Learning aim;
Criterion 3: Teaching plan integration;
Criterion 4: Engineering introduction;

Criterion 5: Design/Implement experience;
Criterion 6: Engineering practice sites;
Criterion 7: Comprehensive learning experience;
Criterion 8: Active learning;
Criterion 9: Teachers' ability enhancement;
Criterion 10: Teaching ability enhancement;
Criterion 11: Student assessment;
Criterion 12: Professional evaluation.

B. Karl Theodor Jaspers' "Learning Freely" Philosophy

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What is education? In his book, Karl Jaspers pointed out that "education is the education of soul". Education is production; the mission of education is to become "complete human". To become "complete human" not only need knowledge education, but also suggests equality and respect among teachers and students, suggest Socrates style education mode. Jaspers pointed out that, teachers are guidance of students for self education. The teacher from one hand need to respect students, on the other hand need be respected by the society. During the curriculum teaching, the teacher needs to encourage student to become "complete human" of the course, thus, the teacher not only need to lead the students to master the knowledge, but also the skills and techniques to obtain relevant ability [2].

Learning freely means students appropriately select major, course teachers or teaching method according to his/her own understand to the living world and his/her appreciation, specialty and personal condition. This approach will help students to achieve ideal outcome based on personal situation. Jaspers thought "University students, in the free environment of campus, through self education could gain internal freedom. This is the great advantage of university education. If university practiced the teaching mode like military school or monastery, constraining students with strict disciplines, then the advantage was no longer remained". In education, teachers need to consider students as principle subjects, fully encourage students' initiatives, truly implement free hand research; collaboration and practice innovation, hence becomes the master of study, inspiring the learning interest. Hammering knowledge to students is not as good as teaching students studying method and encourage them self education, enabling them to actively observe, experiment, analyze, self-explore, discover and master knowledge, hence forming professional skills.

III. "CDIO-LEARN FREELY" BIDIRECTIONAL TEACHING APPROACH

"CDIO-Learn Freely" Bidirectional Teaching Approach is to adopt CDIO engineering teaching mode in "teaching" phase of "Game software testing technology and tools" curriculum and adopt Jaspers "Learn Freely" philosophy in "learning" phase.

A. The Teaching Mode in "Teaching" Phase

Take Criterion 1, 5 and 6 in CDIO standard as instance, described the teaching mode of "teaching" phase as below.

1) Essential idea of CDIO teaching mode

CDIO criterion 1 states the CDIO essential idea of teaching mode, which is taking CDIO as basic environment. The CDIO criterion 1 describes: In what degree does the university's mission and major objectives reflects the CDIO philosophy, that is in what degree made product, process or systematical plan, design, implementation and operation as the environment of engineering education? In what degree the technology knowledge and skill education take product, processes or system production lifecycle as engineering education framework or environment [1]?

According to above criterion, "Game software testing technology and tools" curriculum is based on curriculums and technology resources from businesses, consolidated and created the engineering education environment which take game software testing as essential for products' conception, design, implementation and operation. It includes 4 sub-environments which are shown in table I below. For technology knowledge and ability teaching practice, the approach forms the framework of taking game software testing process as production lifecycle, and it has 4 sub-frameworks, as shown in table II below. Through constructing and implementing the above engineering education environment and framework, and continuous optimization, the course will fulfill the requirement of CDIO teaching environment [3].

2) The CDIO design and achieving procedure

The design and achieving process of CDIO is mainly through criterion 5 and 6. Criterion 5 design – implementation experience requires whether the education plan is consists of at least two designs – implementation experience (of which one is fundamental level, another is advanced level)? How many opportunities do students have, during the course studying, involve product, process and system conceive, design, implement and operation? Criterion 6 engineering practice site requires the how well do the practice facilities and other learning environment enable student to hands-on and perform direct experience learning? How many chances do the students establish knowledge, ability and attitude rely on modern engineering software and in-lab product developing, test process and system building? Are the practical sites student-oriented, easy to use and access [1]?

According to above criteria requirements, the "Game software testing technology and tools" curriculum designs teaching plan including implementing experience and activities involve product, engineering practice sites inside/outside the class as shown in table III. This course needs further enhancements on students' participation on production activities, modern lab studying and ease of access on labs.

TABLE I.   PRODUCT-ORIENTED ENGINEERING EDUCATION ENVIRONMENT

Serial number	Name	Content
Engineering education environment 1	Teaching material（book "Software test design and implementation"，Peking University Press）	Chapter 1----3: principle technologies、engineering knowledge； Chapter 4----9: separately explains the various testing for 6 different types of software including stand-alone software, network software and game software etc.
Engineering education environment 2	Teachers	Employ engineers from enterprises who have practical experience as part-time lecturer; Curriculum teachers are capable of exercise practical software testing.
Engineering education environment 3	Practice sites	Related enterprise provide off-campus product practice and exercise location The in-campus labs are capable of simulating real environment of enterprises.
Engineering education environment 4	website（http://jpkc.sziit.edu.cn/software/www/st/index.html）	This curriculum builds a curriculum website which is enterprise product and resource oriented.

TABLE II.   PROCESS LIFECYCLE ORIENTED ENGINEERING EDUCATION FRAMEWORK

Serial number	Name	Content
Engineering education framework 1	Process oriented engineering knowledge	According to requirements of ability teaching plan which requires basic scientific knowledge, core engineering foundation knowledge, advanced engineering foundation knowledge, based on process, the engineering knowledge is divided into fundamental knowledge, game software testing design and implementation and game software test implementation and administration.
Engineering education framework 2	Process oriented test phases	Each product testing is divided into for modules according to test phase: test plan and design, test strategy and use case, test implementation and administration, test analyze and conclusion.
Engineering education framework 3	Process oriented engineering skills	Carry out engineering education according to the path of basic skills, career engineering skills and international certification.
Engineering education framework 4	Process oriented career development	Based on software tester, testing engineer, test analyzer as career development framework.

TABLE III.   DESIGN IMPLEMENTATION AND ENGINEERING PRACTICE SITES

Serial number	Standard	Practice content
Criterion 5	Include at least two designs – implementation experience (of which one is fundamental level, another is advanced level)	Three type of designed implementation experience during education: Mandatory fundamental level stand-alone software testing; Mandatory advanced level elective software test projects (include 5 elective projects); Optional advanced level self made software testing project
	Student participation on production outside the class	Opportunities for student participation on product testing may have: 1.Teacher's research work; 2.Enterprise software testing tasks.
Criterion 6	The environment support students to obtain hands-on and direct experience through studying	Students' hands-on and direct experience include: 1.Teacher's research work; 2.Enterprise software testing tasks.
	Modern engineering software and lab development	Mainly site seeing
	Practical sites are student-oriented, easy to use and access	The practical sites are designed to enforce group working and easy to use; but the usage of these sites are mainly for in class sessions.

B. "Learning" Teaching Mode

For the "Learning" mode, this paper is discussed as in-class learning and off-class learning:

1) In-class learning mode

Software testing requires thought innovation and active mindset. At present, the in-class teaching and management method is rigid, always ask students to attend class at appointed time and location, and implementing strict attendance administration. However, in our course, the learning process is designed to be divers and not only limited within the class.

Under the instruction of teachers, students are learning freely, this approach could solve the problem of traditional learning mentioned above. In our course the learning freely philosophy is represented in following aspects:

a) Team members are formed freely. Students are grouped into separate learning teams, members for the team are selected freely, could be teamed up based on personality, hobbits, characteristics or test tasks voluntarily.

b) Test modes and methods are chosen freely. After a team has formed, the teams conducts free discussion, check out material together and choose test mode and method accordingly. The teacher instructs students to perform test tasks according to certain conditions separately.

c) Communicate and discuss freely. After test plan has confirmed, the entire class discuss the plans of various groups first, learn experience from each other. Then random

discussion is carried out on freewill, inspiring each other. The teacher instructs during the process of discussion, ensuring the fulfillment of teaching plan.

d) The learning time is arranged relatively freely. In order to implement learning freely educational reformation, we changed the previous two hour class to four hour class. The beginning time and the ending time of the class still abides the traditional class timing plan, but in the class, the time of learning is arranged freely.

e) The learning location is chosen relatively freely. At the starting time and ending time of the class, students are required to present him/her in classroom, but during the class session, students are allowed to use classroom, library, lab or other in campus facilities at will.

2) *Off-class learning mode*

In usual industrial-educational teaching collaboration mode, the implementation requires the participation of industry during the education process, which occupy many valuable time from enterprises. We introduced "industrial" element involvement within the curriculum education, implemented the industrial-educational teaching collaboration in the teaching process [4].

In this curriculum, the "Industrial" element mainly embodies in following aspects:

a) Employ investigation and survey in the class. After a team has formed, they could arrange market surveys. Surveying targets may be enterprises; the entire industry is the best. The survey method could be visits, interviews, questionnaires or internet research. After students have a full view of the scenario, they will gain better understanding to their tasks.

Students could go to game software developing companies to learn testing skills. During the learning session, we arrange students to visit game developing companies and have conversation with game testing engineers and learn skills from them.

b) Encourage students to take part-time job opportunities in related enterprises. During the curriculum session, students could use weekend or leisure time to work part-time in related company, so as to understand the industry and learn company culture. They are also encouraged to be participated in public testing tasks on internet.

IV. BIDIRECTIONAL TEACHING APPROACH IMPLEMENTATION

"CDIO—Learn Freely" bidirectional teaching approach is implemented on "Game Software Testing Technology and Tools" curriculum for three terms and 6 academic classes, we obtained some achievements and sill continuously optimizing.

After reformation of the curriculum, the teaching outcome is improved. After the full session of curriculum study, some student team has reached graduation project standard. The pass percent for the curriculum is as high as 92.6% and eventually achieve full pass. The graduated students first job application achieve 26% serve for testing jobs.

V. CONCLUSION

We now have empirical evidence that "CDIO—Learn Freely" bidirectional teaching approach is feasible and effective. And achieved some result in real application. In the future, this approach will get further optimization, conclusion and implementation. We will generalize to other applicable courses.

It might also be noted that, during the course, the ratio of teacher's lecturing and instruction, along with the increase of students' active learning will decrease [5]. In the process of learn free and industrial educational collaboration, we need to emphasize on teacher's administration and instruction role, pushing every students to get progress.

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