DIFFERENTIATING INSTRUCTION OF CDIO: IN LAYERED CURRICULUM AND COURSE VIEW

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ABSTRACT

CDIO approach has been adopted in the computer science and technology program of Chengdu University of Information Technology (CUIT) in China since 2009. To fit the wide range of learning styles and mixed ability levels of students, layered curriculum and layered course are applied in reconstructed CDIO integrating curriculum.

Layered curriculum for computer science is discussed. In the curriculum, several keys courses are taught in layered teaching model. Then, two studies in Data Structure Course are presented in this paper. In the first year, two groups of students enrolled in Data Structure from 2rd year undergraduate students are compared. One group was taught in the reconstructed CDIO class which integrates both Data Structure and Algorithm Project in a single course. The other group was taught in the class which Data Structure course and Algorithm Project course are performed separately. In the second year, all students are taught in integrating Data Structure and Algorithm Project into a single course. In addition, one group was divided in two levels (A level and B level) according to student's pre-requisite-courses performance, learning abilities or subjective desire. Each level was taught by different teaching model with adjusted pedagogy suiting to the student feature.

Exam scores data of Data Structure Course show the layered way achieved significant improvement in average score(average score is 65.7 both in level A and level B compared to average score 57 in the old method) and exam pass rates. The other pleasing result was the overall student satisfaction of the layered course group (88.9% of 135 students including in Level A and Level B), and the students' recognition that the teacher were always aware of their needs, catered to their interests.

This paper argues that layered curriculum and layered course is an effective solution facing students with wide range of learning styles and mixed ability.

KEYWORDS

Integrated Curriculum, Active Learning, Student-centred learning, layered course, layered curriculum, teaching methods

INTRODUCTION

Twelve standards of CDIO to assure that the Initiative reaches its goals set forth in the syllabus. The standards, which are closely associated with this paper, are integrated

Curriculum and Active Learning. Active learning and student-centred learning have been discussed in the literature for long time. However, it is not easy to put the concept into practice. The definition and a range of terms always result in some confusion as to how teacher implementing the concept of active learning. Hence, this paper aims to present an example of transferring student-centred learning into CDIO practice in the design of Integrated Curriculum.

We try to put student-centred learning into CDIO practice for computer science and technology program in CUIT. A layered curriculum is designed, including high level of student choice. Layered course teaching is a vital aspect of layered structure curriculum. Layered curriculum and layered course teaching is a method of differentiating the students majored in same program to fit the wide range of learning abilities, backgrounds and previous learning.

LAYERED CURRICULUM

Student-centred learning is focused on each student's interests, abilities, and learning styles, placing the teacher as a facilitator of learning. The approach puts student's interests at first place, contrasting to traditional education. In student-centred learning classroom, students have more opportunities to choose what they will learn, how they will learn, and how they will assess their own learning. If students have a good choice, they will tend to be active in their own learning process. We design a layered curriculum showing in Figure 1. Three aspects of layered concept are as follows:

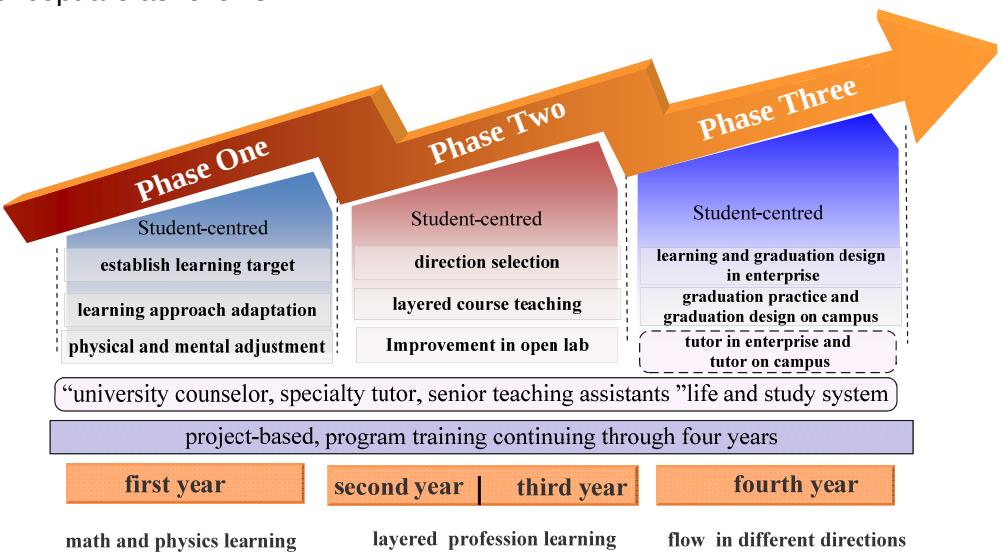

Figure 1 Layered Curriculum for Computer Science and Technology Program

(1) Professional direction selection. In CUIT's Computer Science and Technology program, two major areas are provided for students, which are computer application and computer engineering. Each student has an opportunity to choose the professional direction he or she interested as the major area of furthering study at the end of first year. From the sophomore to senior, most core courses are same for all the students. Meanwhile, students in each direction learn some difference courses, which are shown in Table 1. Computer Application focus on designing of system combining hardware and software, especially for embedded system. Computer Application focus on designing and developing of B/S-based software system, especially for enterprise management system.

(2) Layered course teaching. For some core courses are taught in two level . We will discuss in detail later.

(3) All-round improvement in open lab. Open labs are available to students who intent to further improve not only professional skills but also all-round quality. Some training for improving essential skills and attributes, such as communication skills, presentation skills, management skills, responsibility, will be provieded in the lab. Strengthen practice improve the comprehensive ability of students.

Table1 Different Courses of Two Major Fields

Major Area	Different Course for Each Majior Field
Computer Application	Java Programming, Design of Java-based and Software Engineering, Principles of Database System, Web Database Access Technology (J2EE), Experiment of Operating System(Linux), Application Technology of Database(Oracle), User Experience Design, Engineering Practice for B/S Information Managment System
Computer Engineering	Embedded Technology and Application, MCU-based, Application Design Technology, Mobile Terminal Programming , Mobile Terminal Project Development, Base of Electronic Practice, Embedded Microprocessor and Application, HDL & PLD (Programmable Logic Device), Engineering Practice for Combining Hardware and Software

Table 2 Layered Teaching Meachod is Used in Some Core Courses in the Program

Course name	Credit	Assessment	Teaching Reform
Data Structures and Algorithm	4	Test in paper	The courses are lectured with layered teaching model in two levels. Each student will perform a project individually in Classical Algorithms Design and Implementation, which is designed for student to practice basic data structures and algorithms in software development project.
Classical Algorithms Design and Implementation	2.5	Project achievement-based assessment	
Java Programming	3	Test in paper and programming on PC	The courses are lectured with layered teaching model in two levels.
Base of Electronic Practice	2	Project -based assessment	Perform a project with single chip microcomputer system in teaching model in two levels, including design circuit using Protel, schematic design, PCB layout and other process of CDIO.
Principles of Operating System	4	Test in paper	The fundamental principles of operating system are lectured in two levels. In order to understand how an operating system works and its architecture, each student will perform Linux Experiment.
Experiment of Operating System(Linux)	**2**	Practice test on PC	

LAYERD COURSE TEACHING

The number of the students enrolled in computer science and technology program is more than 200 each year in CUIT. Therefore, students enter one classroom with a wide variety of learning ability and different levels of prerequisite for the course. Teaching students with a range of prior experiences and ability of learning all in the same classroom is a difficult task. Usually, teachers focus on the requirement and desirability of middle students in one class. It is common that a teacher realize that more than half of the students in this class haven't fit the teaching way in traditional one level. Thus, passive leaning dominates the classroom, and the owner of classroom is primarily with teacher.

Layered teaching in one course will giving students a choice to choose the right level suitable to individual ability and leaning background. All the enrolled students in Computer Science and Technology program divided in two level according to their earning abilities, backgrounds and previous learning. Each level was taught by different teaching model with adjusted pedagogy suiting to the student feature. So far, layered teaching has been used in many core courses in the program as shown in Table 2. As one of the most important subjects in computer science and technology program, the layered teaching reform of this course is presented in the following pages.

GOALS OF LAYERED COURSE TEACHING OF DATA STRUCTURE AND ALGORITHMS

The teach reform object of data structure course is as follows：

(1) Each student receives a teaching method suitable to his learning style and ability.

The layer in which student are not very strong in programming will spend more time on implementing algorithms in a programming language. The layer in which student are good at C language programming will pay more attention to creating and using the data structure. Therefore, teacher will spend more time instructing which situations are best for each, depending on the type of data to be stored and the running time (computational complexity) of algorithms for insertion, sorting and retrieval.

(2) A secondary aim is to improve programming skills in the student's primary language and arouse the interest programming.

In the past, the course is lectured in one layer. The student whose primary language (C Language) is strong are not satisfy with the teaching plan because the material is easily mastered by them. Meanwhile, the students who are not very strong in programming continually struggle. When the students are divided into two layers, each group learns to use different data structures and algorithms suitable for them in their own code. The coding process will excite their interests on programming, and student’s programming skills will improved.

(2) The third aim is to make improvement in total student performance.

Exam scores data analysis comparing with traditional teaching modal another, comparative analysis of level A and level B and feedback from student questionnaire are enough evidence to support the judgment of student performance improvement.

ASSESSMENT OF LAYERED TEACHING MODEL

Objective data are exam mark, and subjective data come from student questionnaire.

(1) Exam scores data analysis

In the first year, two groups of students enrolled in Data Structure from 2rd year undergraduate students are compared for Grade 2009, including Computer Science and Technology program and Digital Media Technology program. Group One was taught integrating both Data Structure course and Algorithm Project in a single course. For Group Two, Data Structure course and Algorithm Project course are performed separately.

As shown in table 3, average score of Group One is 62.6 , compared to an average point of 58 of Group Two. Fail percentage of Group One is 34.2, which achieved significant improvement compared to the figure in the old method of Group Two. Exam results show that integrating project and principle in one course is better in student performance.

In the second year, all students are taught in integrating Data Structure and Algorithm Project into a single course for Grade 2010. One group was divided into A level and B level according to student's pre-requisite-courses performance, learning abilities or subjective desire. Each level was taught by different teaching model with adjusted pedagogy suiting to the student feature. The other group was taught in one layer.

Table 3 Comparative Analysis of Exam Score Data of Data Structure and Algorithms

Comparative Group	Comparative item	Fail	60-69	70-79	80-89	90-100	Average score	Total students number
Group One	students number	73	48	60	29	3	62.6	213
	percentage(%)	34.2	22.5	28.1	13.6	1.4		
Group Two	students number	59	28	30	17	1	58	135
	percentage (%)	43.7	20.7	22.2	12.6	0.7		

Table 4 Exam Score Data of Data Structure Course for Grade 2010

Comparative Group	Comparative item	Fail	60-69	70-79	80-89	90-100	Average score	Total students number
Layered teaching model (A level and B level)	students number	36	30	49	20	2	65.7	137
	percentage(%)	26.3	21.9	35.8	14.6	1.5		
no-layered teaching(taught in one layer)	students number	37	18	11	9	1	57	76
	percentage (%)	49	24	14	12	1		

Comparative exam results between layered teaching and normal no-layered teaching are shown in table 4. From the table, we could see that fail percentage of layered teaching is 26.3%, which is lower than average of whole grade 34.2%. The average score of layered teaching group is 65.7, which is 8.7 higher than no-layered teaching group.

Table 5 Analysis of Exam Results of Data Structure Course and Algorithms for Layered Teaching

Comparative Group	Comparative item	Fail	60-69	70-79	80-89	90-100	Average score	Total students number
Level A	students number	11	16	28	13	2	70.4	70
	percentage(%)	16	23	40	19	3		
Level B	students number	25	14	21	7		60.7	67
	percentage(%)	37	21	31	10			

Table 6 Results of Student Questionnaire of Layered Teaching of Grade 2010

Statement	Level A Class（69 sheets）			Level B Class（66 sheets）			Total of Level A and level B（135 sheets）		
	A	B	C	A	B	C	A	B	C
1.It is reasonable to divide level by pre-requisite-courses performance, learning abilities.	34.8	52.2	13	21.2	69.7	9	28.1	60.7	11.1
2.I agree with dividing level by pre-requisite-courses performance, learning abilities.	50.7	43.5	5.8	34.8	63.6	1.5	43	53.3	3.7
3. It is more reasonable to divide level by subjective desire.	36.2	53.6	10.1	30.3	53	16.7	33.3	53.3	13.3
4.I perform better in the layered teaching modal.	24.5	47.8	27.5	16.7	51.5	31.8	20.7	49.6	29.6
5.It is positive to arouse initiative.	43.5	53.6	2.9	22.3	71.2	6.1	33.3	62.2	4.44
6.your classmate agree with the layered teaching model.	46.4	46.4	7.2	19.7	68.2	12.1	33.3	57	9.63
7. To divide level by subjective desire is positive to arouse initiative.	40.6	58	1.4	18.1	72.7	9.1	29.6	65.2	5.19
8. Classmate's attitude and performance will positively affect my activity.	29	65.2	5.8	18.1	63.6	18.2	23.7	64.4	11.9

Exam results of data structure course for layered teaching model are presented in table 5. From the table we can see that the average score of Level A is 70.4, which is 10 points higher than that of level B. Fail percentage and excellent percentage (more than 70 points) of level A is more satisfied. The students enter Level A achieved better performances in pre-requisite-courses, and have strong learning abilities.

From Table 3 to Table 5, we could see that layered teaching model have significant improvement in student performance.

(2) Survey on students

The aim of this survey is to collect students' quantitative information about layered opinion of layered teaching model, and assess the value of reform. The results of student questionnaire of layered teaching of Grade 2010 are showed in Table 6. In the table, A means strong agree, B means agree, and C means disagree. As shown in the table, most of the student have strong positive opinion of layered teaching model in one course.

CONCLUSION

The term student-centred learning is widely discussed in the literature. Although it has thriving future in the education reform, there is a gap between the definition and the practice of this concept. Furthermore, the concept of student-centred learning has profound implications for CDIO curriculum design, and has close relation to active learning.
Instead of provide diverse choices to suit individual interesting, a layered curriculum is presented as a case implementing student-centred learning in this paper. Layered-strategy both in curriculum structure and in course teaching gives student a higher level of choice. The differentiating instruction in one program contributes to cope with the problem of practicing active learning.

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