Effectiveness Research of Curriculum Design of Software Courses for Engineering Education Certification

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Abstract. Curriculum design is an indispensable way for students to acquire practical skills, which can cover five of the graduates' requirements in Engineering Education Certification. The article analyzes the problems that existing curriculum design in software course can’t meet the Engineering Education certification requirements, puts forward implementation essentials, such as explanation, process management, acceptance, achievement evaluation and others obtained from practice, to serve for certification.

Introduction

More than 300 universities in our country offer software engineering majors and more than 300,000 graduates are trained every year [1]. In 2017, the demand for software talents was the highest in vocational recruitment posts. However, from the employment results, there is a big gap between the employability of graduates and the demand of enterprises. How to solve the problem of talent demand and cultivate a software engineering talent with strong practical ability? Participation in engineering education certification is considered a good opportunity.

The education certification standard for engineering (2016 edition) [2] has the following 5 points directly related to the professional curriculum teaching in 12 of the students' graduation requirements.

(1) Engineering knowledge: the ability to use mathematics, natural sciences, engineering fundamentals and expertise to solve complex engineering problems.

(2) Problem analysis: the ability to apply the basic principles of mathematics, natural science and engineering science to identify, express, study and analyze complex engineering problems to obtain effective conclusions.

(3) Design / Development Solutions: Capable of designing solutions to complex engineering problems, designing systems, units (components) or processes that meet specific needs and enabling innovation in design processes.

(4) Research: To study complex engineering problems based on scientific principles and using scientific methods, including designing experiments, analyzing and interpreting data, and obtaining reasonable and effective conclusions through the synthesis of information.

(5) Using modern tools: Capable of developing, selecting and using appropriate technologies, resources, modern engineering tools and information technology tools for complex engineering problems, including prediction and simulation of complex engineering problems, and understand their limitations.

The above 5 points make it clear that in addition to theoretical learning, practice teaching plays a crucial role. The standard further clarifies the practice teaching in the supplementary provisions of the computer specialty, points out that the practice teaching system should include "experiment course, curriculum design, field practice", as well as "scientific and technological innovation, social practice, and other forms of practice". Thus, it shows that the certification standard puts students' engineering practice ability in a very important position.
Problem Analysis

Overview

Wisdom derives from knowledge, but knowledge does not automatically reach wisdom. It needs to be "internalized" and "activated" by practical activities. The key role of knowledge is human practice [3].

Curriculum design is a comprehensive practical teaching process. It uses many points of the curriculum, guides students to understand the essence and essence of the course from the overall point of view so as to to apply the learned knowledge to the software development process. Course design has the following characteristics:

(1) Comprehensiveness. The project design needs to integrate the whole course knowledge, even multiple disciplines, to develop students' ability to comprehensively use their knowledge.

(2) Openness. Students explore the problem and learning form is no longer limited to classroom and teachers' guidance.

(3) Autonomy. The course design takes a long time generally. Students are free to learn in groups, according to their own understanding of the imagination, so as to promote the development of students' creative ability.

Status Quo and Problems

Status Quo. The course design is usually arranged at the end of the semester after the end of the course, which lasts one week or two weeks. The implementation process is shown in Fig.1.

![Figure 1. Course Design Process.](image)

Teacher: to releases the curriculum design task, explains the curriculum design request, carries on the necessary attendance and the inspection, solve the problems of the students, check the results of the design, View system demonstration and question and answer, review the lesson report, and last the result of the design is given according to the attendance, system acceptance and report.

Students: Students choose to set up the task; access to information; analysis, design, coding, and realization; get guidance form teacher when need; accept the instructor's inspection and on-site q&a while system design is completed; and last write the course design report as required.

Problem Analysis. Always some anomalies exit in the curriculum design, which are:

(1) Less Topics [4]. A topic is selected by students less than a dozen people, more than dozens of people, resulting in students lazy and plagiarism.

(2) Abnormal progress. Curriculum design is a step-by-step process that includes requirements analysis, data structure design, algorithm design, coding, debugging and testing, and writing reports. However, some students suddenly completed the entire design on the day of acceptance, but they did not know what was involved in the process, only can run the program [5].

(3) Poor reporting [4]. Some students' design report content is only the source program and the running screenshot, and the layout quality is poor, drawing is not standard.
(4) Sheep-like guidance. The whole process has little monitoring and management and little guidance, leaving students to do on their own.

Curriculum design failed to meet the expected goals, arouse teachers' deep thought. Various methods have been proposed to improve the course design, such as project-driven course design [6], heuristic teaching course design [7], in-line course design [8] and so on. Facts have shown that these ideas and methods are not enough to solve the problem. The main reasons for the poor performance of the class are:

(1) Insufficient attention. Course design is generally test course, do not need examinations. Students with poor ability are afraid to endure hardship and often copy. Teachers give practical teaching links with high pass rate, some students have a lucky spirit and do not take lessons seriously.

(2) poor process supervision.

The class is usually arranged at the end of the course or at the end of the semester. At this point, teachers have more professional work, have no much time to take into account. Some teachers think that the curriculum design is different from the class, which should be done by students themselves.

(3) performance evaluation not match with ability

In general, the teacher gives the performance evaluation based on the degree of difficulty of the task, the student attendance, the system operation and the report. In this way, heavy result and light process is easy for student to take advantage of the coincidence, can’t be impartial to the actual ability of students.

Implementation Essentials of Curriculum Design for Certification by Strengthening the Process Control

Explanation on Beginning

On the first day of class, we usually start the lecture. What to say and the effect of explanation will have a great influence on student, besides the task setting, suggest to clarity the following content.

Purpose and Requirements. The objectives and requirements, usually written in the syllabus and implementation plan, but also explain to the students what the purpose of the course design is, what is the minimum requirement? what a good course design is.

Course Design Tasks. Due to the differences of students' abilities, it is a widely accepted method to give different task with different difficulty for students to make their own choices.

Task, cannot speak too simple, to analyze and explain the task model, enlightenment, analysis and design key points, prompt task required knowledge, to help students determine the ease of the task and the right choice of task.

Design Content. In this part, we should clarify the task of the whole course, and guide the students to follow the system development method. For the design of the data structure, the content of the design should be:

(1) Problem analysis and task definition: fully analyze and understand the problem, clear the problem what to do? What are the conditions?

(2) Logic design: Define the corresponding data type according to the operation object involved in the problem description, divide the module according to the principle of data structure, and draw the call relationship diagram between the modules.

(3) Detailed design: Define the corresponding storage structure, write the main algorithm of the pseudo-code, and further refinement the data structure and basic operations.

(4) Programming: To further refine the results of detailed design for programs.

(5) Debugging and testing the program: Divide the module from bottom to top in increments. carefully organize the source code and comments after debug correctly to form a good format and style of source list and results.

(6) Result analysis: analyze the logic correctness, analyze the time and space complexity of the algorithm.
(7) Writing the design report.

**Schedule.** Schedule is the execution sequence of the design task time. A clear schedule, not only further emphasized the contents of course work, but also sets goals for the students' work every day. The instructions are to highlight the design and guide the students to design the system in the correct way. For example, a week of data structure course design, task schedule in Table 1.

<table>
<thead>
<tr>
<th>Time bucket</th>
<th>Task</th>
<th>Stage results</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Determine the task and team</td>
<td>Topic, Teamer</td>
<td>Students choose one lesson from the task. For cooperation with others, to complete the team.</td>
</tr>
<tr>
<td>Day 2</td>
<td>Design the data structure, divide the function, set up the test sample</td>
<td>Logical structure, storage structure, function chart, test case</td>
<td>Modeling for processing objects; Determine the logical structure; Select the appropriate storage mode.</td>
</tr>
<tr>
<td>Day 3</td>
<td>Design algorithm, design interface</td>
<td>Algorithm Description</td>
<td>Design process running process, design algorithm</td>
</tr>
<tr>
<td>Day 4</td>
<td>Coding, debugging, analysis</td>
<td>Source Code</td>
<td>Adjust the program, and use the test case for correctness analysis</td>
</tr>
<tr>
<td>Day 5</td>
<td>Check the system and write a report</td>
<td>System operation, report</td>
<td>Make the necessary queries to understand student creative work</td>
</tr>
</tbody>
</table>

Table 2. Report Contents.

<table>
<thead>
<tr>
<th>Content</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Title of design</td>
<td>Present the design question</td>
</tr>
<tr>
<td>2. Problem Description and Functional Design</td>
<td>Given the problem to be solved, the analysis of the problem, resolve the major problems include small problems, gives the function block diagram</td>
</tr>
<tr>
<td>3. Test cases and solutions</td>
<td></td>
</tr>
<tr>
<td>3.1 test data</td>
<td>Build test data</td>
</tr>
<tr>
<td>3.2 operations analysis</td>
<td>For the upcoming functions, one by one analysis of its possible results</td>
</tr>
<tr>
<td>4. Programming</td>
<td></td>
</tr>
<tr>
<td>4.1 logical structure</td>
<td>Give a symbolic description of the processing object, explaining the relationship between the processing objects (linearity - tree graph collection)</td>
</tr>
<tr>
<td>4.2 Physical structure</td>
<td>Give a description of the store</td>
</tr>
<tr>
<td>4.3 Algorithm Description</td>
<td>State which algorithms are included in the problem solving; give the calling relationships between functions. For each algorithm, given: algorithm functions, algorithm ideas, algorithm descriptions (algorithm steps or algorithm flow or pseudo-code)</td>
</tr>
<tr>
<td>4.4 Interfacial design</td>
<td>If any</td>
</tr>
<tr>
<td>5. Program operation and analysis</td>
<td>According to the function, the screenshot of program is presented, and the necessary analysis and explanation is given, and the correctness of the test case is proved</td>
</tr>
<tr>
<td>6. Summarize</td>
<td>Work summary, improve ideas, work harvest and so on</td>
</tr>
<tr>
<td>7. References</td>
<td>List the references in this design</td>
</tr>
</tbody>
</table>
**Report Requirements.** The ability to write design reports or technical summary reports is not only a requirement that is clearly set forth in professional certification, but also a basic ability that students must possess. To improve the quality of students’ class reports, the report requirements must be clearly and carefully explained. The report requirements are shown in Table 2.

**Grading Method.** The person's goodness, decided that most students will work hard to good grades. At beginning of the class, it is necessary to clarify the results of the assessment criteria.

1. **Pass:** Less originality, the system logic is correct, the progress is normal, the report is qualified.
2. **Excellent:** Innovative, good system quality, normal progress, excellent report.
3. **Fail, medium, good, between the two.**

**Process Monitoring**

The main body of the course design is students, but the main responsibility is the teacher while the class is not up to teaching purposes. Strengthen the process management and process monitoring, not only can solve many problems in current curriculum design, but also can consider students in terms of engineering knowledge required, problem analysis, research, design and solution, and tool usage for professional certification standards.

**Content of Checking.** System development requires analysis, design, coding, debugging and testing, etc. Based on the progress plan (see table 1), the periodic results are checked and the students are guided to follow the standard procedure and understand the process of system development. Every day, the teacher will check the periodic results, summarize the results, and master the progress of each student's curriculum design.

**Summary Sheet.** A summary of the curriculum design for a week is shown in Table 3. Task, completed 1, completed 2, completed 3 will be submitted in sequence before 2,3, and 4 days. The teacher arranges tasks online, students submit online, and teachers gather each morning to check, give back and guide in the machine room.

<table>
<thead>
<tr>
<th>Machine No.</th>
<th>Student ID</th>
<th>Name</th>
<th>Task</th>
<th>Complete 1</th>
<th>Complete 2</th>
<th>Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
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</tbody>
</table>

Daily filling, is the daily work summary, promotes the student's subjective efforts to do more.

**The Coverage of Requirements for Certification Standards Done by Checking.** The periodic inspection urges students to use the learned knowledge to analyze, design and solve the task of curriculum design, and do not cut corners. By strengthening the process supervision of curriculum design, curriculum design can cover 5 of the 12 basic requirements of engineering education certification (see introduction), namely, engineering knowledge, problem analysis, research, design and solution, and the use of modern tools.

**System Acceptance**

With periodic inspection, the work in system acceptance can be reduced a lot. The emphasis is on system demonstration, view the performance of the system and understand students' creative work.

**Grade Evaluation**

In addition to considering task difficulty and workload, system performance, students' innovative work and quality of report, students are advised to give "self-evaluation". The majority of students can give a "objective" score for their work according to evaluation standard.

In doing so, on the one hand, students are to be informed that grades are not given by teachers, but made by themselves; on the other hand, teachers judge the students’ work content, attitude and reporting standards through self-grading.
Conclusion

The engineering education certification clearly states: Curriculum design is one of the ways for students to acquire practical skills. It can cultivate students' ability of independent thinking, communication skills, document writing ability and students' enthusiasm, creativity and team spirit. The curriculum design covers the five student graduation requirements in the engineering standards, and can only be effective if it is effectively done.

Reference


