Original Paper

Research and Practice on Key Issues in Teaching Reform of Application-Oriented Software Engineering Course

Ping Xu[1] & Bin Feng[2]

[1,2] School of Information Science and Technology, Taishan University, Tai'an, 271000, China

Abstract

Aiming at the key problems encountered in the teaching of software engineering, this paper puts forward a series of innovative measures of teaching reform. Rebuild the course content according to the actual demand of enterprise posts; adopt the application ability-oriented "five-in-one" online and offline brand-new mixed teaching mode to create a student-centered deep learning; realize the transformation of academic evaluation from "graded by final examination scores" to "diversified process assessment". The practice proves that the application-oriented software engineering course reform and innovation accord with the requirement of the applied talents cultivating target, and can be used for reference to the class teaching reform of computer courses.

Keywords

Enterprise-level application scenarios, five-in-one mixed teaching mode, course ideological and political education, Value-added evaluation

1. Introduction

Software engineering developed rapidly as an engineering discipline after its terminology was first proposed at the NATO Conference held in 1968 in West Germany (Zhang & Mou, 2013). The software engineering course is the core main course of computer software engineering major. It is set in the fifth semester of the junior year. Its core content is based on engineering knowledge and theory, with engineering practice as the focus. It aims to train students to be able to complete the analysis and design of the applied software system to be developed according to the tasks to be completed in each stage of software development life cycle, applying software engineering principles and comprehensively applying advanced software engineering technology and methods. The students are cultivated tube senior talents in the IT field of "engineering application" for the research and development of software projects who have a good professional and scientific literacy, suited to the

requirements of the posts and serving the society.

Many researchers have put forward teaching reform suggestions for the software engineering course from many angles. For example: Zheng, Liu and Cui (2021) put forward the thought of course reform based on OBE idea according to the professional training objectives and graduation requirements; Liao and Wang (2023) integrated the ideological and political elements into the course design to realize the unification of value shaping and ability cultivation; Zhang, Gu and Liu (2018) put forward the teaching method of competition-driven project-based software engineering course by combining theory with practice. Software engineering course is one of the first experimental courses in the class teaching reform of TaiShan University. Combining with the teaching practice, this paper puts forward new ideas and innovative measures for the teaching reform from the aspects of course content reconstruction, five-in-one mixed teaching mode, ideological and political education integration, diversified process assessment, value-added evaluation, etc.

2. Key Problems to be Solved in Teaching Reform of Software Engineering Course

Question 1: The knowledge of software engineering is relatively abstract, logical and demanding in practice. The teaching content needs to keep pace with the times, and the teaching process needs to be closely combined with practice.

Based on OBE concept, adhere to the principle of "student-oriented + achievement-oriented + continuous improvement", take enterprise-level application scenarios as the carrier, select typical cases, and realize the high integration of theory and practice. At the same time, leading-edge expert reports and special lectures should be added to the teaching content, so as to effectively realize the horizontal extension and vertical deepening of the knowledge, teach students according to their aptitude, meeting the learning needs of students at different levels.

Question 2: Give full play to the advantages of information technology and integrate online and offline modes closely to create a student-centered high-level classroom.

Based on the learning closed loop, the software engineering course has completed the construction of sufficient online resources with course features on the platform of "Superstar Learning", comprehensively implementing the creation of a "online + offline" hybrid three-dimensional teaching space. Firstly, with the help of the "Superstar Learning" teaching platform, self-learning is completed for the basic theoretical knowledge, so as to realize knowledge acquisition and understanding ability cultivation; secondly, centered around students, modern information technology is utilized to comprehensively promote group task exploration (topic discussion + answering + voting + Q&A of teachers and students, etc.), so as to realize the transfer and application of knowledge; thirdly, the practical exercises is jointly completed in the way of project grouping, building and cultivating students' high-level practical ability in actual practice, creating a student-centered high-level classroom.

Question 3: Value building should be closely integrated with knowledge transfer and ability cultivation.

In combination with the education orientation of TaiShan University, the characteristics of software engineering major and the requirements of talent cultivation, course ideological and political education should be implemented, leading students to possess craftsman spirit, comprehensive and meticulous logical thinking ability, innovative spirit of exploration and the mission of serving the country through science and technology in the process of software project R&D, analysis and design, truly realizing the high unification of "cultivating people" and "cultivating talents".

Question 4: Realize the transition of academic evaluation from "graded by final test scores" to "diversified process assessment".

In the traditional assessment, the final examination is mainly made by teachers, focusing on theories and covering 80% of the knowledge points. Before the examination, students can get satisfactory results as long as they review a little, which leads to the students not paying attention to the regular study and the final examination. Based on the idea of achievement-oriented and engineering education, this teaching reform puts forward the evaluation system of "whole-process academic assessment + value-added assessment + final examinations" based on the assessment of application ability.

3. Innovation Ideas for Teaching Reform of Software Engineering Course

3.1 Rebuild the Course Content According to the Actual Demand of Enterprise Posts

Course content reconstruction planning idea: based on OBE concept, increase enterprise-level application scenarios and cutting-edge knowledge, pay attention to using software engineering ideas, principles and technologies to solve practical application problems, fully reflecting the high-level, innovative and challenging degree of the teaching content.

The software engineering course reconstructs the course content by setting the enterprise post application ability requirement point. Progressively, it is divided into two core teaching modules: structured method and object-oriented method according to the different software development methods. Following the software development process, each module is subdivided into requirement analysis, overall design, detailed design and system realization units; referring to the "Golden Course Standard", the teaching content should include enterprise-level application scenarios, special reports and expert lectures on software engineering, so as to cultivate the high-level ability and the ability to solve complex software engineering problems. The reconstruction of the course content is shown in Figure 1.
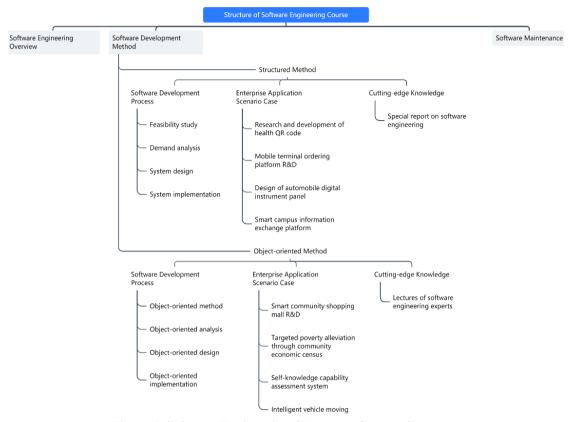
Figure 1. Software Engineering Classroom Content Structure

3.2 Adopt the New "Five-in-one" Online and Offline Brand-new Mixed Teaching Mode Oriented by Application Ability to Create a Student-centered Deep Learning Process
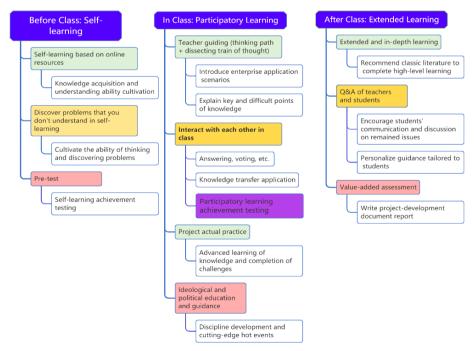
Figure 2. Student-centered-depth Learning Process

The teaching reform of software engineering course puts forward a new "five-in-one" online and offline new mixed teaching mode (self-learning + pre-test + participatory learning + post-test + extended learning) which is oriented by application ability. It is divided into three parts: self-learning before class, discussion in class and extension after class. During the whole teaching process, it is planned to adopt strategies such as heuristic explanation, leading practice and student achievement exhibition and evaluation, and carry out mixed flipped teaching through such paths as problem guidance, case teaching, task-driven, group exploration, team cooperation, etc., and carry out diversified advanced learning activities with students as the main body to promote deep learning. The specific process is shown in Figure 2. Therefore, the students' role of passive receiving knowledge will be transformed into the leading role in the class. Teachers are only the course designer and leader, motivating the students' subjective initiative and innovative spirit using the learning environment such as situation, cooperation and conversation, so as to realize the improvement of students' literacy.

3.3 Implement "Course Ideological and Political Education" to Realize the Unification of Content Sublimation and Value Shaping

Based on the core values of socialism with Chinese characteristics, the motto of TaiShan University (virtuous and erudite, practical and innovative) and the characteristics of software engineering major, the ideological and political education of software engineering course is developed. By organizing students to explore the learning content of the course by using online resources, the students can develop their ability to learn and think independently by using modern information technology. By organizing students to participate in topic discussion, answering, voting, brainstorming, etc., in class, stimulate students' competition consciousness and craftsmanship spirit and innovative thinking in problem-solving; through team work, enhance the cohesion of the groups, fostering the sense of cooperation. By introducing the latest academic, leading-edge papers, scientific and technological achievements, back-feed the teaching class, inspiring students' concern for cutting-edge technology and enhance the patriotic enthusiasm and mission responsibility of serving the country through science and technology.

3.4 Assessment and Feedback of Diversified Process Adopted for "Promoting Learning by Evaluation"
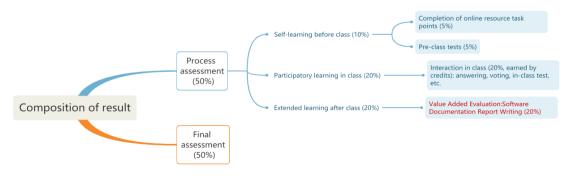The composition of diversified assessment result is shown in Figure 3.

Figure 3. Composition of Diversified Assessment Result

165

Value-added evaluation analysis: Based on the needs of cultivating innovative talents, encourage students to explore the course, do innovations and serve the society. Give a certain score according to the completion degree of the software project participated by the students and the writing quality of the software development documentation report, so as to examine the students' comprehensive mastery and application expansion ability of the course. effectively improving the engineering practice level of the students. Specific arrangement: Students shall draw up project topics in groups, complete project development through group cooperation and enterprise post role playing, and write software development documentation report at their own responsible stage with reference to course progress and the knowledge. Assessment method: intra-group assessment (10%) + inter-group assessment (30%) + teacher assessment (60%).

4. Implementation of Teaching Reform of Software Engineering Course

Relying on self-built course resources, other high-quality course resources, course groups, etc., organically integrate online course resources and traditional class for mixed teaching, and "engineeringly" reform the "Software Engineering" course. The teaching implementation is as follows:

4.1 Self-learning before Class

Teaching method: task-driven + exploratory learning.

The teachers release the self-learning task lists in the "course learning exchange group", and push the preparatory knowledge (videos, PPT, auxiliary learning materials, reference books, etc.) through the online learning platform; the students independently learn through online course resources and complete the pre-tests; the teachers sort outs the key and difficult points of "class teaching" according to the "pre-test" results + core knowledge points.

4.2 Participatory Learning in Class (Flipped Class)

Teaching method: scenario case introduction + task-driven + exploratory learning + team collaboration. Introduce the "enterprise-level application scenarios", the teachers complete the explanation of the key and difficult points around the application scenario (consolidate the independent learning achievements); under the guidance of the teachers, the students complete the knowledge transfer and application through the communication and interaction (such as answering, voting, etc.) through the learning platform (in this process, the teachers timely discover problems and help the students to form the thinking paths, and analyze the train of thought); complete the in-class quiz, testing the participatory learning outcomes; Students are engaged in project practice. Presenting and reporting learning results in groups (advanced knowledge improving, the extent of challenge completing); the teachers analyze the problems of frequent mistakes in the actual practice process in the class; duly incorporate the course ideological and political education.

4.3 Extended Learning after Class

Teaching methods: task-driven + exploratory learning + teamwork.

Teachers push forward the cutting-edge knowledge and feed back the latest academic and scientific

166

research achievements; students complete personalized high-level learning of the expansion module with the help of "Superstar Learning", and the teachers and students jointly complete the topic discussion; the teachers answer questions and solve their questions in the "course learning and communication group". Students complete the value-added evaluation application ability assessment-write and submit a software development documentation report in a team collaboration way.

5. Teaching Reform Effect of Software Engineering

5.1 Course Learning Effectiveness

The application-oriented multi-dimensional classroom teaching reform is adopted in the software engineering course. The average score before the teaching reform is 74.67 and the pass rate is 85.42%. After the reform, the average score is 78.4, and the pass rate is 98%. The comparison of results is shown in Figure 4. The related data shows that the students show the characteristics of deep learning state as a whole. They are more active in learning, more solid in mastering knowledge, more in-depth in thinking, more effective in problem solving, more active in thinking and behavior, and better in comprehensive learning effect and high-level ability.
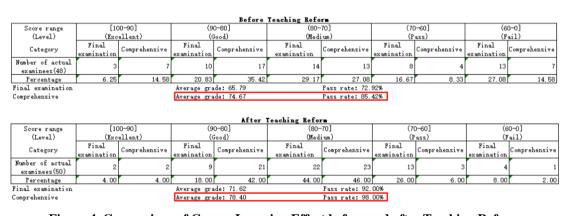
Before Teaching Reform

Score range (Level)	[100–90] (Excellent)		(90–80] (Good)		(80–70] (Medium)		(70–60] (Pass)		(60–0] (Fail)	
Category	Final examination	Comprehensive	Final examination	Comprehensive	Final examination	Comprehensive	Final examination	Comprehensive	Final examination	Comprehensive
Number of actual examinees(48)	3	7	10	17	14	13	8	4	13	7
Percentage	6.25	14.58	20.83	35.42	29.17	27.08	16.67	8.33	27.08	14.58
Final examination		Average grade: 65.79			Pass rate: 72.92%					
Comprehensive		Average grade: 74.67			Pass rate: 85.42%					

After Teaching Reform

Score range (Level)	[100–90] (Excellent)		(90–80] (Good)		(80–70] (Medium)		(70–60] (Pass)		(60–0] (Fail)	
Category	Final examination	Comprehensive	Final examination	Comprehensive	Final examination	Comprehensive	Final examination	Comprehensive	Final examination	Comprehensive
Number of actual examinees(50)	2	2	9	21	22	23	13	3	4	1
Percentage	4.00	4.00	18.00	42.00	44.00	46.00	26.00	6.00	8.00	2.00
Final examination		Average grade: 71.62			Pass rate: 92.00%					
Comprehensive		Average grade: 78.40			Pass rate: 98.00%					

Figure 4. Comparison of Course Learning Effect before and after Teaching Reform

5.2 Student Developmental Effectiveness

Through teaching reform, students' ability to solve complex software engineering problems has been greatly improved. On behalf of TaiShan University, they participated in a number of competitions, including National Innovation and Entrepreneurship Project for University Students, National University Students Data Technology Competition, National University Students Intelligent Application Technology Competition, Science and Technology Innovation Competition for University Students in Shandong Province, Electronic Technology Competition and so on, and have achieved excellent results. Practice has proved that the multi-dimensional teaching reform of application-oriented software engineering course is greatly effective.

6. Conclusions

Software engineering course is a first-class course in TaiShan University. It is one of the first experimental courses in class teaching reform. It plays an important supporting role in the whole curriculum system as a core major course.Based on the development orientation of the school and relying on the national first-class professional construction site of software engineering, the course always adheres to morality and capability cultivation as the guidance, and comprehensively promotes the integrated teaching reform and innovation of teaching content, mode, application of modern teaching technology and diversified evaluation and assessment, realizing the transformation of teaching mode from "teaching-centered" which emphasizes knowledge transfer to "learning-centered" which emphasizes "knowledge + thinking mode + imagination". The mode of cultivation is from "infusion" to exploration and personalization; realizing the transformation of academic evaluation from rote and "graded by final exam results" to independent thinking, "whole-process academic evaluation" and "value-added evaluation"; realizing the transformation of the students' behavior from passive learning and "examination-type" learning to active learning and "innovative" learning.

Fund Project

References

Liao, L., & Wang, L. L. (2023). Exploration of Ideological and Political Teaching Reform in Software Engineering Introduction Course. *Computer Education*, *2023*(4), 79-82.

Zhang, C., Gu, P., & Liu, H. J. (2018). Exploration of Teaching Reform of competition-driven project-based Software Engineering Course. *Computer Education*, *2018*(8), 22-24.

Zhang, H. F., & Mou, Y. M. (2013). *Introduction to Software Engineering* (6th ed., pp. 5-11). Beijing: Tsinghua University Press.

Zheng, W. L., Liu, J. B., & Cui, Z. Q. (2021). Reform and Exploration of Software Engineering Course Based on OBE. *Computer Education*, *2021*(5), 166-169, 173.