Design of Blending Teaching Mode for Software Testing Course

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***Abstract*—Software testing is a very practical course, in order to achieve the teaching requirements of professional ability training as the important target, this paper puts forward the design of blending teaching mode of software testing course from three aspects: teaching method, teaching content and teaching evaluation. Among them, online micro-video teaching is adopted before class, and offline teaching combined with the teaching mode of flipped classroom is adopted in class, running through the teaching methods of graded project-driven and case teaching, and that online recombination test paper is adopted to test students' learning effect after class. This will form a closed loop of pre-class, in-class and after-class learning, giving play to the advantages of online and offline teaching, promoting students' personalized independent learning and in-depth learning, so as to improve students' learning effect.**

Keywords—design of blending teaching mode, flipped classroom, project-driven, case teaching

I. INTRODUCTION

Software testing is a highly practical computer course, which aims to cultivate solid and effective software testing technical personnel, so that they have both theoretical knowledge foundation and engineering practical ability in the field of software testing[1]. However, due to the unitary traditional teaching methods and means, the expected teaching effect is not achieved, which is mainly reflected in the following aspects: Unitary teaching organization form and method, students' learning mode based on mechanical acceptance; Abstract teaching content, which cannot arouse students' interest; Fragmented teaching content, so that students cannot form a perfect testing knowledge system; Simple teaching cases, which cannot meet the needs of different students [2]. Blending Learning is to combine the advantages of traditional learning methods with the advantages of e-learning (i.e. digital or network learning)[3]. It should not only give play to the leading role of teachers in guiding, inspiring and monitoring the teaching process, but also fully reflect the initiative, enthusiasm and creativity of students as the main body of the learning process. Blending education advocates taking students' personalized learning and development as the center, combining traditional classroom face-to-face teaching (F2F Learning) with students' online independent learning (e-learning), which is the organic integration and sublimation of blending teaching and blending learning, and the overall reconstruction of traditional teaching mode and learning mode[4]. To achieve the goal of combination of theory and engineering ability in software testing course , this article puts forward the design of blending teaching mode for software testing course from three aspects of teaching method, teaching content, teaching evaluation, which combines the flipped classroom and graded project-driven and case teaching method, taking the students as the center, to get the best learning effect.

II. RELATED WORK

A. Concept of Blending Education

Through different levels of schools, majors and courses at educational reform and teaching organization arrangement, combined with educational information means and platforms, blending education can not only give play to the leading role of teachers in guiding, inspiring and monitoring the teaching process, but also promote students' initiative, enthusiasm and creativity as cognitive subjects in the learning process through acquisition, experience, reflection and construction, so as to effectively help students realize the synchronous improvement of knowledge, ability and quality, thus obtaining the best learning effect. The comparison between the blending teaching model and the learning model is shown as table 1.

TABLE I. COMPARISON BETWEEN THE BLENDING TEACHING MODEL AND THE LEARNING MODEL

	Blending Teaching Model	**Blending Learning Model**
Conceptual Level	Under the guidance of certain teaching ideas or theories, a relatively stable structure framework and program of teaching activities are established	To explore how to make personal ways to achieve the best learning state
Attention Angle	Take learners as the center and look at teaching from the perspective of learners	Take learners as the center and look at learning from the perspective of learners
Attention Keynote	Attach importance to the interaction of teaching process	Attach importance to students' learning experience
Teaching Design	Pay attention to the design of "teaching"	Pay attention to the design of "learning"

B. System Design of Blending Education

Implementation of blending education is a systematic project, which should be centered on students, oriented by students' learning effectiveness(OBE), closely combining with the characteristics of applied university students so as to promote blending teaching [5] (especially the teachers' teaching attitude, teaching preparation, teaching mode). It should strengthen the students' learning motivation beliefs, build information platform systems that meet the needs of teaching , realize the students' comprehensive promotion of knowledge, ability and quality.

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C. Teaching Mode of Blending Education

Blending teaching is a kind of "online" + "offline" teaching that combines the advantages of online teaching and traditional teaching [6]. Through the organic combination of two forms of teaching organization, learners' learning can be led from shallow to deep. The concept of blending teaching design is guided by students' learning output and giving priority to ability cultivation, and combines offline face-to-face teaching with online learning. In the design process, the factors of classroom teaching and online teaching are taken into consideration for different subjects and professional courses. The teaching process and mode are more diverse and flexible, which can be tracked, managed and evaluated. It fully reflects the central position of learners and teachers are the organizers of knowledge and the instructors of technology and application. In fact, the blending teaching mode is:(1)Through the effective combination of the advantages of traditional learning and network learning, to achieve the purpose of improving the teaching effect and students' learning effect; (2) Give play to the advantages of online and offline teaching, and give play to the leading role of teachers in guiding, inspiring and monitoring the teaching process, to solve the problems of students' learning motivation ,and to promote students' personalized independent learning and in-depth learning, and to improve students' learning effect; (3) Teaching methods and means can stimulate students' interest, guide students to study independently and deeply, take teachers as the leaders and students as the subjects, and give full play to students' enthusiasm and initiative in learning; (4) Through rational integration and optimization of teaching methods, teaching environment, teaching media and teaching strategies, learning efficiency can be greatly improved; (5) Able to track and monitor the course teaching process and master students' learning behavior characteristics and stage teaching effect, and promote teaching improvement and individualized teaching based on certain information.

III Design of Software Testing Teaching Mode Based on Blending Learning

Figure 1 is the blending teaching mode of software testing course.

A. Mixture of Teaching Methods

The teaching mode of software testing course is a mixture of online and offline teaching methods, consisting of three stages: "pre-class-knowledge learning preposition, in-class-knowledge internalization and absorption, after-class-knowledge consolidation and improvement".

Study before class. In the process of constructing the knowledge system of software testing, some knowledge is completed by students themselves in the pre-class learning stage. The teachers explain the unit learning objectives and the assessment form of teaching effect to the students in detail, guide the students to master the learning objectives and key points through "software testing training manual", combining with the blending learning resources such as independent learning resources , exercise library. Students conduct self-study before class under the guidance of the student teaching assistants. In the resources provided to the students, with particular emphasis on micro video learning, students use micro video based on knowledge points for the use of students' self-study before class. Students use online learning platform to preview and test before class. According to the test results, teachers master the achievement of students' learning goals, understand bottlenecks of students. For underachievers, teachers provide them with remedial learning resources and guidance as well as valid answers.

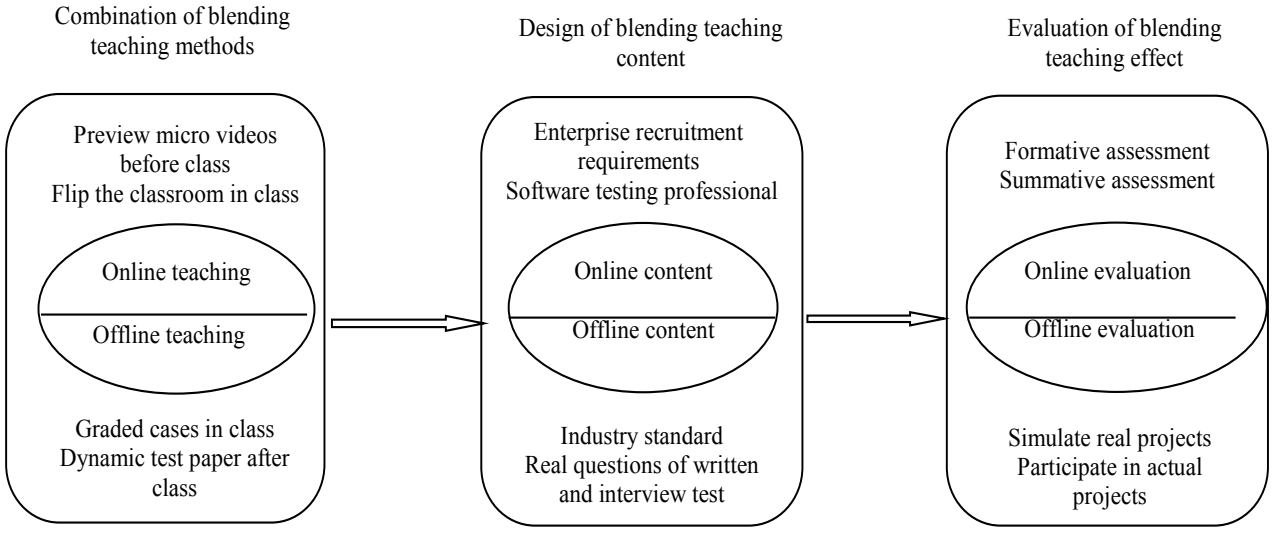

Fig.1. *design of blending teaching mode for software testing*

Learn in class. Through a variety of ways of pre-class learning, students have basically mastered the required methods and concepts, and students need to internalize and absorb knowledge in class. In the classroom teaching, unit teaching is conducted in the order of "check homework - learn new knowledge - model learning - improve summary", and the teaching is conducted in the real case based on the industry standards. Carry out "student-centered" classroom demonstration, teacher explanation, group discussion, classroom questions, classroom tests and other classroom activities. Combined with the characteristics of the software testing course, the blending teaching methods of graded project-driven and case teaching are adopted. In terms of the design of teaching cases, in order to promote students' personalized independent learning and in-depth learning, the primary, intermediate and advanced cases are designed, which are implemented from easy to difficult and guided by teachers in each progression. In order to solve the problem of students' learning motivation, teachers should design online shopping, games and other cases that are close to reality and easy to arouse students' interest. Interest and meaning come first instead of documents, so that students can get more interested first and it can improve students' learning effect. In the process of students' classroom presentation, the teaching method of flipped classroom is adopted. On the basis of self-study before class, teachers answer students' questions and difficulties in the process of self-study, organize students' discussion, forming a fast and effective communication and feedback between teachers and students, and improving students' critical thinking ability in the discussion. Teachers firstly create micro-videos of lectures, and then students watch the videos before class to complete the learning of knowledge, while the classroom has become a face-to-face communication place between teachers and students and between students and students. With the division of the teaching syllabus as the main line and the knowledge points on the electronic courseware as the basic unit, it is proposed to use the screen video software to record the process of writing the electronic courseware and the program to form the teaching video. The length is controlled at 10-15 minutes. "Flipped classroom" is student-centered. Students are the main body of knowledge absorption, and teachers play a guiding and leading role. Students actively study at their own pace, think independently, find problems and study and solve them. Students can also dig deeper and expand more widely according to their interests and abilities.

Study after class. After class, students watch micro videos to consolidate the project knowledge ability, and assign online examination papers and homework tests to deepen the study of software testing knowledge. According to the classroom test results, students learn about their own knowledge blind spots, and then use the exercise library and exam library to complete various learning tasks and carry out independent review after class. According to students' test results, accumulated problems, as well as the records of learning and practice process, sort out the papers for the high incidence of problems, so as to achieve continuous improvement and in-depth learning, and improve the learning effect. Considering the difference in students' independent learning ability, the course has designed online question-answering methods such as FAQ to ensure the quality of learning. Students can log on the online learning platform to find the Q&A summarized by teachers and get the troubleshooting methods. If no appropriate solution can be found in the platform, students can submit the questions online and wait for the online solution from the teachers. The content of the question and answer will also be incorporated into the Q&A, which can be viewed by other students. Teachers pay attention to use the online learning platform and students' learning behavior is analyzed. Moreover teachers effectively monitor the learning process and task learning process of students and able to give timely and effective evaluation feedback and accurate support to students' task completion and problems. In view of the students to grasp the weak links, provide online detection means, give full play to the advantages of online and offline integration.

B. Mixture of Teaching Content

In order to ensure that the current course content truly meets the current market demand for software testing talents, a comprehensive mixture of learning content and teaching resources are conducted in the teaching content.

(1) The mixture of learning content is more in line with the market demand for software testing talents. Through a long-term review of the recruitment requirements for software testing talents in online recruitment websites, and combined with the offline visit of the school-enterprise cooperation internship base describing the demand for software testing talents, I have grasped the current situation of software testing talents in software companies.

(2) According to the examination outline of Qualification Certificate of Computer and Software Technology Proficiency---Software Testing Professional combining with National Computer Rank Examination---Software Testing Engineer, the teaching content of software testing course is rearranged, and the construction of course content is required in combination with the connotation of professional qualification examination of software testing post.

(3) According to the industry standards, the curriculum system and content of core vocational ability training are constructed. The software testing course aims at cultivating more highly skilled and applied talents. Therefore, the content of professional courses is in line with the industry standards of professional posts, and the curriculum system is set according to the future career development trend of students, and the curriculum standards are formed.

(4) Refer to real questions of written and interview examination in enterprises of software testing posts. The enterprise job demand guides the software testing teaching content, and the occupational scene is integrated into the implementation of the software testing project. Real questions of written and interview examination in enterprise guide content of software

testing examination, so as to ensure that the training objectives of the teaching content meet the needs of enterprises in the software test industry, and train students to maintain sustainable development ability and competitiveness.

(5) Focus on software test engineering practice. According to the demand of software testing industry for talents quality, the training target of software testing professional direction is determined. Due to the differences between software testing courses and software development courses, software testing experiment teaching should set up experiments, practical training, practice and other multi-level engineering practice courses, so as to improve students' professional technology application, problem analysis and problem solving ability by involving students in actual engineering projects. Similarly, teachers need to design and introduce engineering practices of moderate scale, require students to learn to practice as they go through the process of developing test plans, designing test cases, executing tests, and evaluating tests. Through the exercise of the project, students' ability of analyzing and solving problems will be gradually improved.

(6) Encourage students to participate in the competition. Encourage students to participate in the software testing skills competition and other practical activities, to improve students' ability of observation, thinking, communication, practice and collaboration. Proof by facts, racing in the practice, can greatly arouse students' interest in software testing, while in the process of hands-on operation, train innovation ability of students, and promote the further development of students' thinking. Thus students' enthusiasm for software testing courses is unprecedented, and their consciousness of learning is greatly improved.

(7) Provide abundant learning resources, such as micro-videos, cases, projects, experimental reports and so on, so that students have a clear understanding of the subject. Plan teaching resources around teaching design (knowledge framework). First, upload micro-videos on the online learning platform before class, and conduct online tests after class. Second, complete in-class and off-line guidance through project cases. Before the beginning of the course, students are provided with instructions on the use of learning resources, so that students can make clear the nodes and methods of using various resources.

C. Mixture of Teaching Evaluation

If only through the final examination to evaluate students' course results, this single way cannot reflect the real level and ability of students. In order to promote learning by evaluation, improve students' motivation and interest in learning, truly evaluate students' ability of mastering knowledge, finally carry out a comprehensive evaluation in the form of formative assessment (ordinary score) accounting for 40% and summative assessment (final exam score) accounting for 60%. Formative assessment is the real measurement of students' learning process, which consists of pre-class preview, after-class review, project evaluation and so on. Through the combination of online and offline methods, students' learning before class, teachers' teaching in class and students' review after class are tracked and evaluated, so as to objectively understand the teaching effect and timely adjust the teaching arrangement. The formative assessment and evaluation of software testing course is shown in table 2.

TABLE II. FORMATIVE ASSESSMENT AND EVALUATION

Assessment Items	Full Score	Assessment Purpose	Evaluation Standard
Preview before class	10	For the black-box test, according to the effect of pre-class learning, students are required to master the pre-class micro videos and teachers use the online learning platform for the online test.	The assigned preview content is completed to allow teachers to understand the status of students mastering knowledg. Teachers focus on students who lack pre-class learning on class and timely remedy. Accumulate frequently asked questions on the FAQ.
Review after class	10	For the white-box test, students are required to be able to summarize each knowledge point and complete high-quality project documents.	According to the project guidance documents, the project is completed, which is required to be graded according to the function points to test students' mastery of knowledge. According to the completion situation, the key points mastered weakly and generally are teached in class.
Final project	20	Ability to use testing tools to complete projects and focus on students' mastery of standardized testing process and techniques.	Refer to the real enterprise project specification, check the specification degree of relevant documents and tools for software testing.
Attendance	0	Check student attendance.	1 point for being late and 2 points for being absent; Use attendance online system.

In the design of formative assessment items, simulated real testing items and actual testing items are adopted.

Simulate real testing projects. The first phase is to expose students to quasi-practice, in which they participate in simulated testing projects to test small or medium-sized software. In this process, teachers give detailed guidance to students in the testing process and guide them to correctly use the testing technology in the testing process. During the implementation process, students are divided into two roles of developer and tester, and the testing phase is divided into unit test, integration test and system test. Through the role

transition from developer to tester, students can experience the psychology of developer and tester and the use of technology in practice. At the beginning of the testing project, students are divided into groups consisting of 2-3 people, and the group leader is selected. A small or medium-sized program is implemented in a programming language to simulate the test process of the actual project. Once the program is developed, it is first unit tested by the developers using unit testing tools, where each team member tests his or her own code. The team completes the test plan document and self-test report. Next, testers test in two phases: integration test and system test. In the integration test phase, piles and drivers programming need to be developed for testing. In the system test phase, a complete process of test planning, test design and test execution needs to be carried out. Finally, the team submits the test report and analyzes the test. The entire simulation phase covers all the test phases, the use of technologies and tools involved in each phase, and the writing of test documentation.

Participate in actual testing projects. The second phase is to participate in the actual larger testing project. We cooperate with the horizontal projects of teachers in the department. Students trained by simulating the real testing projects are directly involved in the actual large-scale software projects. Teachers lead the team and complete the teaching in the practice process. As the software itself is related to the field, there is an open process of getting familiar with the software before the test process begins. In the process of getting familiar with the software, many students have recorded problems and made full preparations for the later test. Because in the previous stage, the students already have a comprehensive understanding of the use of test technology in practice, therefore this stage mainly focuses on cultivating students' practical ability of testing. Teachers don't need to give the answers to the questions in many tests, but let students explore by themselves. We introduce exploratory testing methods according to circumstances at this stage, to make students learn software, design test case, execute testing process simultaneously, and pay attention in the actual test projects to improve students' ability of testing practices. During participation, students are not involved in the whole process, but are responsible for testing a task or module according to the needs of the project. The organization of the testing process is mainly through irregular meetings to guide students to use exploratory testing methods in the testing process. The meetings during the testing process include: irregular reporting of testing situations, understanding and discussion of problems of the software itself, and discussion between developers and testers related to the problems. Meeting minutes are required during each meeting. At this stage, teachers also participate in the test of the project and conduct the test together with students. In this way, on the one hand, it has accumulated rich testing experience for teachers, which is conducive to the later course teaching. On the other hand, it can also timely find and feedback the problems existing in teaching, timely answer students' doubts, so that students can successfully complete the transition from theory to practice. Through the cultivation of engineering practical teaching ability from classroom teaching to practical teaching, students can have a deep understanding of testing technology, and gradually complete the transition from testing theory to testing practice, so as to gradually improve the practical ability of engineering testing.

IV. Result

From September 1, 2019 to March 30, 2020, a total of 500 students majoring in software technology participated in the teaching reform of software testing course.

Through the implementation of curriculum reform, students' learning initiative is generally improved, and most of them actively participate in teaching activities. Most of students can make full use of various network platform resources such as online micro-class, online test, online homework and other offline resources to complete pre-class, in-class and after-class learning tasks, learning communication and learning reflection. It has high resource utilization and good teaching effect.

The evaluation score of this course in the teaching quality evaluation system is higher than the average score of the school. The questionnaire was used to survey the students' comments on the course, and the course receives widely good reputation. According to the accumulation of students' online learning data, teachers can master the students' learning situation at different stages, adjust and improve the teaching in time and teach students well according to their aptitude.

V. Conclusion

In order to make students better attracted to software testing in the classroom, at the same time, to combine the advantages of traditional teaching with the advantages of network teaching, this paper designs a blending teaching mode for software testing course, and puts forward the blending teaching mode in three aspects of teaching method, teaching content and teaching evaluation. In this way, teachers can play a leading role, but also it reflects the subjectivity of students, so as to achieve better teaching results. In the future, how to effectively organize and analyze the blending teaching resources, how to further promote the blending education reform of schools with the help of network resources, how to use the blending teaching reform to realize the in-depth cooperation between schools and enterprises, and how to further standardize the implementation and evaluation of teachers' blending teaching process need to be further studied.

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