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Research and Practice on the Blended Teaching Mode of Programming Courses Based on the Integration of Dual Theory and Practice

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Abstract. Blended teaching based on multiple online and offline modes has changed the way people learn in modern society. In view of the huge gap between theoretical teaching and practical programming in university computer programming courses, the content of theoretical and practical teaching has been reconstructed. The "five-in-one" course teaching support platform of teaching, learning, practice, evaluation, and interpretation explores a blended teaching mode that emphasizes both theory and practice, and innovates a multi-assessment system that highlights practical ability evaluation. better practical results.

Keywords. Integration of theory and practice; Active learning; Blended Learning; Programming courses

1. Introduction

Students are full of aspirations when they first learn programming language. As the difficulty of knowledge increases, the improvement of programming skills requires a lot of onboard practice, however, the inefficiency of practicing on their own after class makes students easily get bored and annoyed, and eventually give up. How to improve the comprehension and absorption of knowledge and make the post-class programming practice efficient has become an urgent problem in teaching. Blended teaching combines traditional offline learning with online learning on the Internet, which can give full play to the leading role of teachers in guiding, inspiring and monitoring, and also can fully stimulate the initiative of students as the main body of the learning process. Currently, computer programming classes have developed in the direction of project-based [1] and blended [2]. Exploring

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the hybrid teaching mode suitable for programming class courses is conducive to the breakthrough and improvement of teaching effect.

2. The Teaching Status of Programming Courses

Fundamentals of Programming is the first programming course for freshmen majoring in science and technology in many universities. Its seemingly English appearance and seemingly mathematical algorithm connotation make many admirers daunted. The emphasis on theory rather than practice has intensified students' fears, and the teaching effect of programming course under the traditional teaching mode is not satisfactory. The specific problems are as follows.

2.1. Poor synchronization of theory and practice

The theoretical aspect of this course is abstract and logical, and the understanding of knowledge needs to be absorbed and digested by practice; in practice, the amount of classroom practice is not enough, and students have little experience in debugging programs and are not proficient in using programming environment and development tools, which leads to the learning process that students are prone to enter the state of "one look will be able to do, one do will be invalid". The learning process tends to be in the state of "can do, can't do", the practical learning is not synchronized to promote theoretical absorption, and it is difficult to stimulate the internal drive of learning. How to reverse this learning state, so that students "interesting to learn".

2.2. Theoretical-practical gap

Students have mastered certain syntax after the introduction, but when they encounter a slightly complex programming problem, they only have some vague ideas in mind, and it is difficult to write a concrete program. However, such courses are usually equipped with a complete set of experimental courses [3], which require students to complement and promote each other's theory and programming practice, and students develop programming skills in writing applications. The current situation is that about 10% of the students are able to program in a flexible language, 40% of the students have a basic grasp of the language, and most of the students can only cope with the exams, and 5% of the students even take the attitude of giving up. How to cross the gap between theory and practice and make students "know how to learn"?

2.3. Evaluation for learning is not strong

As the difficulty of knowledge increases, students will encounter new difficulties and points in the learning process, and need timely and accurate feedback to promote students to overcome difficulties. The traditional course evaluation emphasizes results rather than process, and the evaluation subject is single. The single evaluation subject and evaluation content cannot provide accurate feedback on students' learning effect, and cannot effectively carry out effective teaching reflection and continuous improvement. The third pain point of the course is: how to design an effective evaluation mechanism to make students "learn well".

3. Requirements for Blended Teaching and Learning Program Design

In recent years, the blended teaching model has become an important initiative in the transformation of teaching and learning through the combination of instructional design and classroom modernization, which not only mobilizes students' initiative, but also plays the leading role of teachers in the teaching

process [4]. In domestic research, blended learning is "a mixture of online learning and face-to-face teaching" [5], and the proportion of the two in the teaching content depends on the actual situation. The reorganization of the teaching process in blended learning poses a great challenge to the teaching institution, the teacher, and the learner [6][7]. The characteristics of the programming classroom make the following three requirements for blended instruction.

3.1. Increased participation in online learning

When implementing a blended teaching model, the effectiveness and participation of students' online learning will greatly affect the effectiveness of blended teaching. While online learning is flexible and fragmented, students can repeat the videos and exercises as many times as they need. But such flexibility is also a double-edged sword, the flip side of it is that some students do not learn in advance as required, which requires teachers to do process control of the whole process in the three dimensions of blended learning: setting of resources, assignment of tasks and teacher's feedback.

3.2. Ensuring the effectiveness of online programming practice learning

The absorption of programming knowledge and the improvement of programming ability largely depend on the effect of the usual online practice, and it can be considered that the online theoretical learning is to ensure the improvement of practical ability, so the online pre-class learning also needs to match the high degree of online programming practice, in addition to the catechism video listening and watching, but also needs the difficult pre-class practice. The online pre-class practice for students needs to be set up in a way that (1) the difficulty matches the difficulty of the self-study catechism videos; (2) the online programming practice can give real-time feedback to students (3) the teacher can get feedback on the degree of completion of the students' programming practice. These three allow students to build up their confidence to a certain extent in the self-study stage, and allow teachers to prepare for offline teaching according to the current status of students' programming practice.

3.3. Improve the integration degree of online and offline classes

How to coordinate the degree of integration between online and offline courses of programming is is a problem that always needs to be solved in the implementation of blended teaching. The degree of integration should be exactly matched with online, slightly higher than online, and connected with online difficult and easy problems, while offline needs to pay more attention to problem solving and skill training in the process of on-line time. The offline classroom retains half an hour of hands-on programming practice, and the offline course is no longer full of indoctrination of knowledge, but a place to increase students' independent thinking and practice. Through the organic integration of online and offline classes, teachers allow students to fully enter into deep learning, gain knowledge and enhance their abilities in practice.

With the help of Super Star Learning Platform and Head Song Online Programming Practice Learning Platform, we establish an online theoretical and practical resource library, carry out a hybrid teaching mode with the integration of online and offline dual theory and practice, carry out a number of active learning modes, build a student-teacher-led teaching and learning model with students as the main body, and teacher-led teaching and learning, help students enter the independent learning state, improve learning efficiency, and enhance programming practice in theory and practice learning. The students will be able to improve their learning efficiency, and improve their programming practice

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through the practical learning.

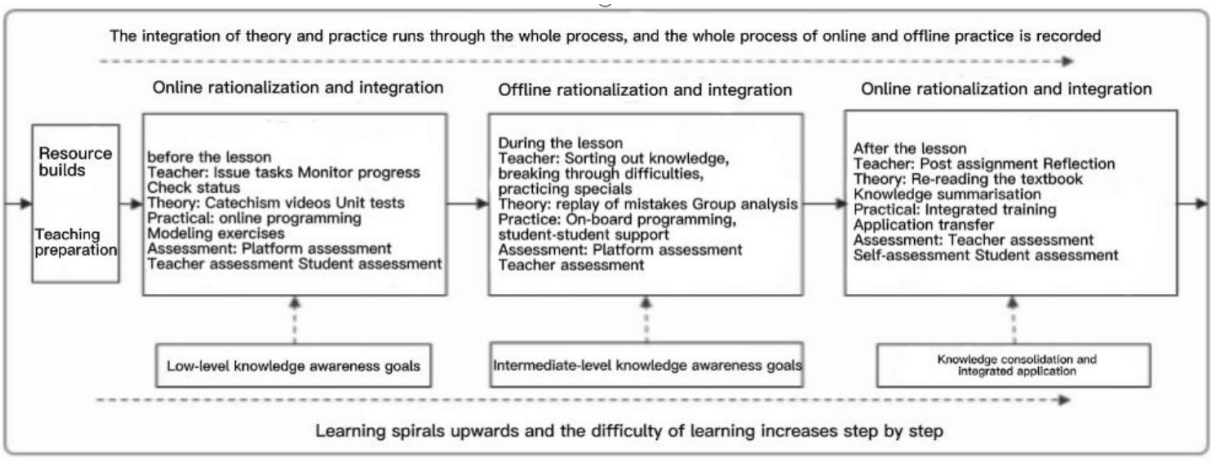

Figure 1. Hybrid teaching mode based on the fusion of two theories and realities

4. Hybrid Teaching Mode of Programming Course Based on the Integration of Dual Science and Practice

The blended teaching mode of programming based on the integration of dual theory and practice relies on the theoretical course platform of Super Star Learning and the online programming practice platform of Head Song, which is a five-in-one teaching platform integrating teaching, learning, practice, evaluation and solution. The offline classroom relies on the feedback data of online theoretical learning and practical operation to carry out the offline and offline theory and practice integration teaching mode.

4.1. Reconstructing content

Innovate teaching contents, enrich teaching resources, build one provincial first-class golden course and one school-level catechism course each on the super star platform for theory courses, and open one practical teaching course relying on the head song platform to stimulate students' learning internal drive, guide them to learn actively, give equal importance to theory and practice, and improve the high order, innovation, challenge and fun of the courses.

4.1.1. Theoretical course resources

Online theoretical resources reconstructed the "C program mystery tour" super star learning pass mu class, in the form of marine mystery tour to lead students all the way to break through, the way there are a number of routes such as the introductory route, basic route, through the small white island, teenage island, sailor island, process island and other islands finally arrived at the sea mystery world. Speaking of theoretical knowledge into the process of learning, set with catechism video, unit knowledge testing, testing questions video analysis, practice field and advancement treasure.

4.1.2 Practical training classroom

Online practice resources rely on the resources on Educoder (head song) practice platform to build suitable onboard practice programming projects, and set the practice projects as scoring assessment projects and practice projects. Students can practice programming online on the platform and get

real-time evaluation and feedback from the evaluation system, which effectively helps students solve problems encountered during the experiment. The project adopts the way of game breaking and gives students corresponding points reward, which not only can strengthen the training of engineering practice ability, but also can stimulate the internal drive of students.

4.2. Hybrid teaching organization mode based on the integration of science and practice

4.2.1. Hybrid teaching link setting

The teaching process includes three stages: learning and practicing before class, learning by doing during class and consolidation after class.

(1) Learning and practicing before class

Students aim at completing the test and the task of head song before class, and complete the catechism video, the unit knowledge test and the practice breakthrough exercises on the online programming platform of head song according to the task book issued by the teacher in the learning pass. Video analysis of unit knowledge tests is also set up in SuperStar Learning Pass to help students solve the problems of wrong questions in the tests. To increase participation in online learning, the MU video resources are set up as short videos of 6-10 minutes or less, with a few more task points, fewer task points of medium difficulty, and medium to high difficulty task points reserved for classroom solutions. The teacher gives the task list a week before class and gives feedback on the completion of online learning 2 days before class to ensure that most students have completed their online learning tasks by the middle of class. Before the class, the teacher reorganizes the knowledge points according to the wrong questions of the online test, and integrates the corresponding tasks and cases into the teaching preparation in the class according to the completion degree of online practice.

(2) Learning by doing in class

During the class, teachers take advantage of the traditional classroom to review the knowledge points, target the wrong problems and cases with low completion rate in programming practice, and organize effective classroom discussions. The offline class retains half an hour of on-line programming practice, and arranges in-depth programming problems in the on-line programming platform. The offline course is no longer full of instilling knowledge, but increases students' independent thinking and practice place, and the problems encountered in the process of programming practice are completed on site using the mode of teacher-student discussion, student-student discussion and student-assistance.

(3) Re-consolidation after class

After the lesson, students can take advantage of online teaching to study the project-based application cases again according to their needs, and enter the computer grade test board and the programming competition test board to test their in-depth knowledge mastery. At the end of each chapter, project-based teaching is arranged, such as teamwork to complete the development of C program mini-games, to strengthen the students' sense of acquisition.

The difficulty of the knowledge set in the three stages before and after the class grows progressively, and the degree of articulation and integration needs to be closely coordinated. Through the organic integration of online and offline classes, teachers allow students to fully enter into deep learning, gain knowledge and enhance their ability in practice.

4.2.2. Teaching organization form

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The "learning pyramid[8] (Cone of Learning)" was proposed by Edgar Dale, an American scholar. The study classifies students' states in the learning process into two categories: active learning and passive learning. The theory shows that students can only master 5% of the relevant knowledge if they just listen to the lecture, compared to 90% of the knowledge after multiple modes such as sound and pictures, demonstration, group work, discussion and "learning by doing" and "teaching after learning". In the form of learning organization of programming, multiple teaching and learning modes such as Table 2 are used in the blended teaching of C Programming, where students' active participation, active output, learning by doing and teaching others can improve the learning efficiency and can really realize the further transformation from knowledge to ability.

Table 1. Classroom organization model based on the integration of dual science and reality

Learning Status	Learning Mode	Knowledge absorption rate	Learning Mode
Passive Learning	Lectures by teachers	5%	In-class teacher teaching
	Read for yourself	10%	Distribution of reading materials and teaching materials
	Sound image	20%	Teacher catechism video images Student self-study before class
Active Learning	Demonstration demonstration	30%	Teacher Case Show
	Discussion Learning	50%	Online hands-on programming discussion Offline practical group discussion Hands-on discussion between students and faculty
	Practice Practice	75%	On-line programming practice
	Teach others	90%	Student classroom teaching In-class practical lectures Recorded video lectures Mutual help small teacher perseverance

4.2.3. Information-based tools for learning

The functional diversity of the platform fully supports the needs of the classroom teaching process in many forms. For example, the unit test of Super Star Catechism is used for accompanying tests, pre-class and post-class tests. Discussion function, questionnaire, workshow, classroom selection, etc., realize multiple roles of interactive information-based teaching. The most enthusiastic part of the teaching process is the cell phone terminal of Super Star Catechism - "Learning Pass", where students are enthusiastic to participate in the selection process, and the selected students can basically complete their tasks in time.

4.4. Evaluation and feedback of blended teaching

Evaluation is the key to the closed loop of continuous improvement of teaching and learning. The learning evaluation of this course consists of two parts, in which the process learning evaluation [9][10] accounts for 50% and the final summative evaluation at the end of the period accounts for 50%. The thematic aspect of the evaluation is set up with a multi-subject evaluation of teacher evaluation and

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student-student mutual evaluation. The theoretical learning process evaluation data consisted of the process learning data of Learning Pass, including the degree of viewing of the catechism video, the unit test, and the usual discussion. Experiment performance consists of head song online experiment performance data and offline experiment data. The platform for online experiments and unit tests for immediate feedback, to promote students' independent learning and solve most of the problems.

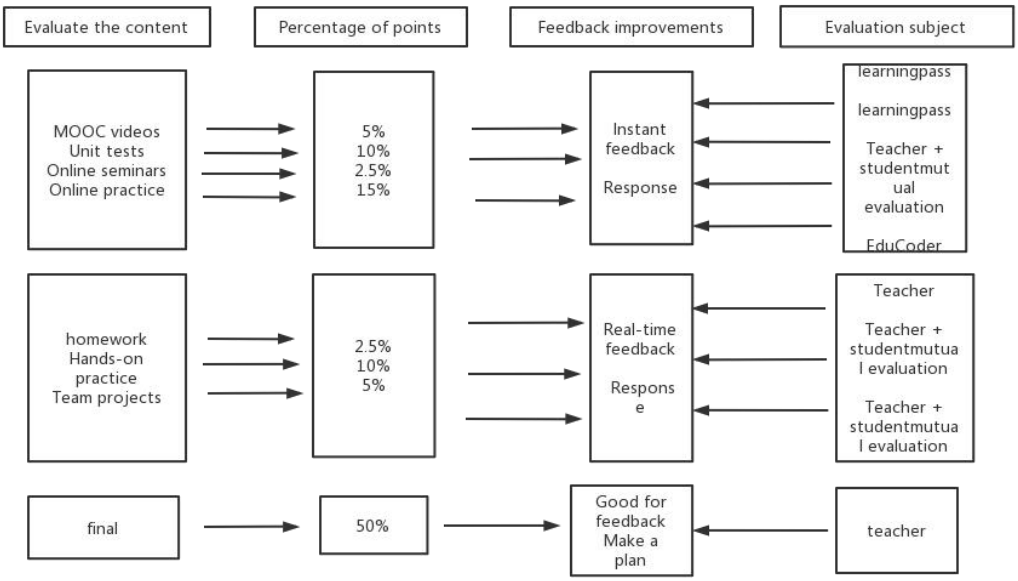

Figure 3. Relationship between course activity evaluation and teaching process feedback.

5. Learning Effect Analysis

5.1. Course participation level

The online and offline blended teaching of this course is targeted at the control class of the course, which is a total of 42 students in the class of 20 electronic 401, and the class of 20 electronic 402 as a parallel class offline.

According to the data statistics of the learning platform, students in the process of completing the study, the cumulative course visits reached 9337 times, the average student more than 200 times; the cumulative viewing of teaching videos 335h, the average student 7.9h; the completion of more than 4677 task points, the average student about 111, students online learning video viewing time ratio is 1.32 ± 0.69 on average. the highest time ratio is 3.59, the lowest This shows that the implementation of blended teaching is good for students to complete the online learning tasks assigned by the teacher, and the course participation is high.

5.2. Course assessment results

In order to analyze the impact of blended teaching mode on students' performance in a more scientific and objective way, the mean score of students' assessment in the control class was 75.58±13.32(SD), which was significantly higher than the total score of students in the parallel class, which was 66.55±12.4 ($p<0.01$). A comparison of the percentages of the number of students in each score range was found, as shown in Figure 4. The number of students in the two score bands of 80-89 and 90-100 in the control class was higher than the number of students in other classes, while the number of

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failing students was lower, especially the number of students with scores above 90 was higher. The effect of online and offline hybrid teaching is obvious.

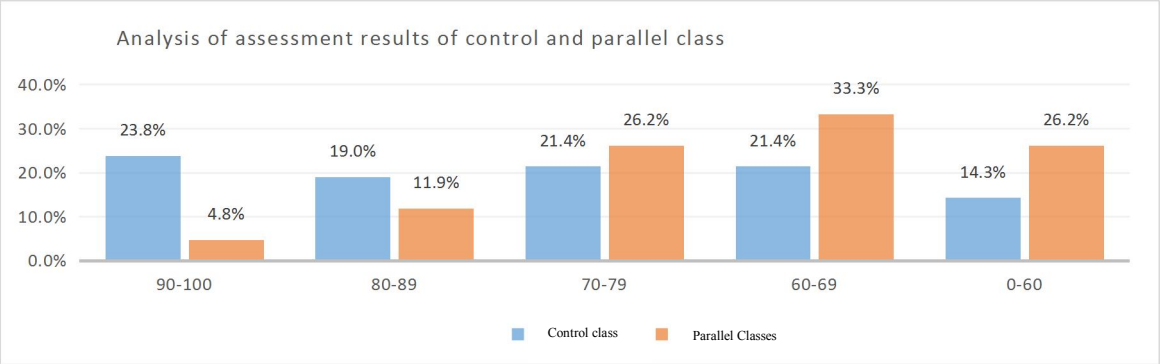

Figure 4. Comparison of course assessment results.

5.3. Correlation analysis of online video viewing task points, length and course examination results Correlation analysis

Therefore, the study assumes that the number of video viewing task points, the length of video viewing and the course examination score are significantly correlated. The Pearson correlation analysis showed that: the number of video viewing task points was significantly correlated with video viewing duration at the 0.874 level (two-sided), indicating that the task points were dominated by video tasks; the number of task completions was correlated with grades at the 0.676 level; and video viewing duration was significantly correlated with course exam grades at the 0.596 level (as shown in Table 2). This indicates that students' completion of task points has a greater impact on the exam grade.

Table 2. Correlation analysis of the number of video task points, viewing hours and course exam grades

	Number of tasks completed	Video viewing time	Exam Results
Number of tasks completed	1	0.874(0.000***)	0.676(0.000***)
Video viewing time	0.874(0.000***)	1	0.596(0.001***)
Exam Results	0.676(0.000***)	0.596(0.001***)	1

Note：***, **, * represent 1%, 5%, 10% significance level respectively

6. Conclusion

Programming courses are rigorous and objective due to their detailed and trivial knowledge points and onboard practical ability testing, and a lot of deliberate practice with feedback is needed to cultivate students' engineering practical problem-solving ability. Based on the online and offline dual theory and practice integration of the mixed teaching mode, students learn to do in the learning process combined with the concept of learning by doing throughout the teaching process. With the help of networked information means, before, during and after class set up multiform active learning mode, fully mobilize students' internal drive, so that students do in class and after class to improve the hands-on

ability, the class is no longer suitable for the teacher's monologue, the main body of students, teacher-led, teacher-student mutual aid, student-student mutual aid, triggering an active classroom system.

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