# Research and Practice of Online and Offline Blending Teaching Mode of "Foundation of Program Design"

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Abstract—Aiming at the poor teaching effect of traditional teaching mode, this paper explored the online and offline blending teaching mode and practice of the course "Foundation of Programming". With "Ketangpai" as the teaching platform, teachers upload teaching resources to guide students to study independently and explore learning, strengthen communication between teachers and students in class and after class, and strengthen the process assessment. The whole teaching process data of a semester was stored in the "Ketangpai" server, with high teaching efficiency. Through the survey of students' satisfaction, we have obtained a good evaluation of the online and offline blending teaching mode of the course "Foundation of Programming". Through the analysis of the final examination of the course "Foundation of Programming" for two semesters, it was found that the students' test scores under the mode of online and offline blending teaching were better than those under the traditional teaching mode.

*Index Terms*—online and offline blending teaching, autonomous learning, communication between teachers and students, teaching reform

# I. INTRODUCTION

Under the traditional teaching mode, college students generally have problems such as narrow knowledge, passive acceptance of knowledge, poor learning effect, weak awareness of autonomous learning, lack of team spirit and so on [1]. In order to change the disadvantages of traditional teaching mode, Chinese universities and government actively promote the teaching reform in order to improve the quality of university teaching.

In terms of colleges and universities, they are promoting the reform from teacher-centered to studentcentered, from teaching-centered to learning-centered, from classroom lecturer to classroom interaction, and from classroom teaching to the combination of autonomous learning, so as to better cultivate students' autonomous learning, cooperative learning, innovative consciousness and innovative ability [2]. The traditional teaching mode cannot realize the above-mentioned changes and reforms, and a new teaching mode must be explored [3]. The online and offline blending teaching mode enables teachers to upload teaching resources to the internet teaching platform. Students can learn the course content in advance through the Internet platform. Teachers explain the key points in class and discuss with students. Combined with the Internet teaching platform, all teaching activities such as classroom attendance, classroom interaction, classroom testing, students uploading homework, data analysis and so on can be carried out pre-class, in-class and post-class. Therefore, online and offline blending teaching provides a direction for the teaching reform of college courses [4].

Since 2010, the Chinese government has issued a series of documents aimed at promoting education and teaching reform based on information technology. For example, the ten-year development plan for educational informatization (2011-2020) [5], the 13th five year plan for educational informatization [6], the action plan for educational informatization 2.0 issued by the Ministry of education in 2018 [7], and the code for the construction of digital campuses in colleges and universities issued by the Ministry of education in 2021 [8]. These documents provide policy guarantees for information teaching reform and promote the development of blending teaching.

At the same time, the introduction of various information teaching platforms also provides technical support for the development of blending teaching [9]. Blackboard platform in the United States, Moodle platform in Australia and Yuketang, Ketangpai, Chaoxing and Duifenyi platforms in China all provide pre-class, inclass and post-class teaching management, which can be used to carry out online teaching, online and offline blending teaching based on these platforms.

# II. RESEARCH STATUS AT HOME AND ABROAD

## A. Research Status Abroad

Foreign research on blended teaching began at the end of 1990s. The concept of blended instruction was first

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proposed in the "White Paper on Educational Technology in the United States" in 2000. Since then, foreign research on blended teaching has been highly concerned. Taking the United States as an example, online education has developed rapidly in recent years, and pure online learning has gradually changed to blended learning. At present, foreign research on blended teaching focuses on the following topics: online learning platforms, social networks, mobile devices, mobile learning. Foreign research on blended teaching theory is very rich, such as interaction theory, connectionism, community, finishing theory, transformational learning theory. These theories have obvious characteristics of social constructivism, and they are constantly evolving, developing and integrating in the research. The mode and learning effect of blended teaching have been the focus of researchers [10].

# B. Research Status in China

In 2003, Professor Zhiting Zhu of East China Normal University first introduced the concept of blended learning in distance education. In the same year, Professor Kekang He also put forward the concept of blended learning at the seventh conference of global Chinese computer education applications. He actively advocated the introduction of blended teaching into course teaching. In 2004, Professor Kedong Li discussed the theoretical basis, basic principles, process design and application mode of blended learning in his article "Principles and Application Modes of Blended Learning" [11]. In 2021, Professor Zhiting Zhu made an in-depth analysis of the future development direction of blended learning and how to deeply integrate online and offline teaching in his "Technology Enabled Post-Pandemic Educational Transformation: New Patterns of Online-Merge-Offline (OMO) Schooling", and put forward the principles for the design of online and offline integrated teaching mode from the three dimensions of scene, teaching and technology: supporting student participation, driving teaching activities, and connecting technology and teaching [12].

To sum up, at present, blended teaching has attracted the attention of researchers at home and abroad, and has also achieved some research results. However, the research on blending teaching process, teaching implementation, teaching evaluation and other aspects were not in-depth. In particular, how to apply blended teaching to curriculum reform is still lack of top level design methods. A large number of courses use blended teaching are only on the surface, not deeply integrated into the curriculum.

Taking the course "Foundation of Program Design" (i.e. C language program design) as an example, this paper carried out a teaching situation based on the combination of mobile communication equipment, network learning environment and classroom discussion, integrated information technologies such as Internet and mobile terminals into the course content and learning activities, created a student-centered learning situation, carried out blended teaching practice, explored blended teaching strategies, and improved students' the effect of autonomous learning and explore learning.

# III. TEACHING REFORM PLAN

# A. Constructing Three-Dimensional Teaching goals

Carefully analyze the course content of "Foundation of Program Design", and integrate basic knowledge, program analysis and program design ability and value guidance to form a three-dimensional teaching goals. Basic knowledge includes basic knowledge syntax, three programming structures, arrays, functions, pointers, structures and file operations [13]. Program analysis and program design capabilities include the idea of problem analysis, the programming implementation of basic and the programming algorithms, solution of comprehensive problems. Value guidance refers to guiding students to strive for perfection and excellence in the process of program design, so as to make the program design as perfect as possible, and guiding students to build a thinking of personal value realization and social responsibility, so that the program design can better serve the society.

# B. Integrated Online and Offline Teaching Design

According to the teaching objectives of each class, determine the teaching content of the course, the learning content of online students, the focus of teachers' classroom explanation, the problems discussed by teachers and students, the foothold of value guidance, and the silent integration of professional curriculum education and curriculum ideology and politics, so that all links form an orderly whole, and the front and back links are coordinated and smoothly implemented [14].

# C. Construction of Micro Video Resources

In order to fully mobilize students' learning initiative and cultivate students' self-study ability, according to the teaching objectives of each class, the explanation content of each class is made into a micro class video and uploaded to the Ketangpai cloud teaching platform, so that students can learn independently according to the micro class video resources before class, do a good job in the knowledge reserve of classroom teaching in advance, and lay a good foundation for classroom teaching and discussion.

# D. Interactive Problems Design

Through rich teacher-student interaction, fruitful learning can be formed [15]. The course of "Foundation of Program Design" takes the cultivation of students' program analysis and program design as the core competence, while cultivating students' autonomous learning and inquiry learning ability, so as to improve students' innovation awareness and innovation ability. Cultivating students' these abilities needs to be achieved by solving problems on the premise that students have basic knowledge, so designing interactive problems is very important. According to the teaching objectives of each class, design program analysis topics that can fully reflect the basic knowledge of the class and topics that can improve students' program design ability. Through the exploration of these topics, students can consolidate and deeply understand the basic knowledge, and improve students' exploration ability of program design methods. The designed questions were uploaded to the Ketangpai cloud teaching platform in advance. Students can learn, analyze, design and give their own ideas in advance. After explaining the key points in class, the teacher will discuss the interactive problems with the students, analyze the ideas and enlightenment of the interactive program design problems, expand the students' thinking of program design, and cultivate the students' ability to design programs from multiple perspectives.

There are 3-5 interactive questions in each class, of which 1-2 are for the consolidation of basic knowledge, and 1-3 are for promotion. The core purpose of interactive problem design is to promote students' active learning and inquiry learning. The ceiling should be high, but it should also be accessible to most students, and guide students to keep improving and pursue excellence in program design, so as to ensure the smooth development of blended teaching and achieve the expected goals.

# E. Learning Evaluation Reform Plan

Improve the final examination and strengthen the process assessment. First of all, the proportion of process assessment scores in curriculum scores should be reformed to make the proportion of process assessment scores reach 50%. Secondly, strengthen the design of experimental homework, which is to design basic homework for learning and consolidating the basic knowledge of program design. It is also necessary to design comprehensive homework, which is used to improve students' inquiry ability and innovation ability. Third, improve the connotation composition of the final examination questions. For objective questions (choice questions), it should not be the examination of simple knowledge (by rote memorization), but the students need to use the knowledge they have learned (generally including more than 2 knowledge points) to get the answer after careful analysis and logical reasoning. For subjective programming questions, it should include basic algorithm and comprehensive programming questions to the efficiency and quality of students' assess programming. Fourth, conduct online examinations. The network examination system contains a large number of test questions, which are randomly generated during the examination. Each student's test paper is different, which can ensure the fairness and justice of the examination. At the same time, through online examination, the efficiency and quality of marking test papers can be improved, the workload of teachers' marking test papers can be reduced, and teachers can pay more attention to the design of test questions and the cultivation of students' ability.

# F. Unified Cultivation and Individualized Teaching

"Foundation of Program Design" is a public course with unified requirements. Due to the influence of students' intelligence, interest and other factors, students' understanding will be uneven. When teaching, we should take various measures such as learning situation analysis, teacher-student interaction, and strengthening guidance to make all students meet the unified requirements. For some students who have spare power in learning, through some additional homework, we can improve their programming ability to solve complex problems, and also attract these students to join teachers' scientific research projects. Through participation in research, their scientific research ability and exploration ability can be further improved [16].

## G. Construction of Teaching Community between Teachers and Students

Teachers should change the concept of authority and get along with students in an equal and democratic way. For the development of teaching tasks, we should consider and design from the perspective of students. For the construction of some teaching resources, we should attract better students to participate, praise more students who study hard, and make students' sense of honor continue to strengthen. Make students feel the kindness of teachers in the process of learning the course, and increase students' happiness. Use the form of inspiration and guidance to improve students' ability of deep thinking and deep learning, and make students have a sense of achievement and gain in the completion of homework, project design, etc. Promote the cooperation between teachers and students in the whole teaching process of the course, and teachers and students cooperate to complete the teaching tasks [17].

# IV. ANALYSIS OF TEACHING EFFECT

The course "Foundation of Program Design" is a public course of science and engineering in Foshan University. The students of our school's educational technology, mechanical and electronic engineering, physics, physics (normal), light source and lighting, photoelectric information science and engineering, vehicle engineering, food science and engineering, food quality and safety, machinery manufacturing and automation, electrical engineering and automation, gardening, civil engineering and transportation engineering study this course. In the past two years, I have undertaken two semesters of the course "Foundation of Program Design" and conducted blended teaching practice in three experimental classes. The experimental class 1 was 2020 mechanical manufacturing and automation (robot class, 40 students), the experimental class 2 was 2018 mechanical design and manufacturing and automation (class 3-4, 85 students), the experimental class 3 was 2021 electrical engineering and automation (class 1-2, 55 students). Experimental class 1 and 2 started classes in the second semester of 2020-2021 academic year, and experimental class 3 started classes in the first semester of 2021-2022 academic year. Using the Ketangpai cloud teaching platform to explore the blended teaching practice of experimental class 1, experimental class 2 and experimental class 3, the other classes of the whole school studying this course adopted traditional teaching methods. Through the investigation of students' learning satisfaction in the experimental class and the comparison of the final examination results of the whole school, the experimental class with blended teaching has achieved better teaching results.

#### A. The New Teaching Mode Was More Effective

In the whole teaching process, we should design all teaching links centered on students' learning, and guide students to participate in classroom interaction and in depth learning. In class, students follow the teacher' teaching closely, take the initiative to raise questions and discuss with the teacher, carefully complete their homework after class, and explore the programming problems in depth. Teachers actively guide students to work hard, effectively integrate personal pursuit with reading for the country, and contribute to the take-off of information technology in the motherland. After teaching, the satisfaction survey was conducted on the students of the experimental class in two semesters. The survey results of Experimental class 1 and Experimental class 2 are shown in Table I. The survey results of Experimental class 3 is shown in Table II.

 TABLE I.
 Satisfaction Survey of Online and Offline Blended Teaching of "Foundation of Program Design" (Experimental Class 1 and Experimental Class 2, Number of Students Participating in the Survey:120)

	Very Sa	tisfactory	Satis	factory	General S	Satisfactory	Unsati	isfactory
Questions	Number of students	Percent	Number of students	Percent	Number of students	Percent	Number of students	Percent
Compared with the traditional teaching mode, students' participation is strengthened, the classroom is active, and learning attention is more focused.	30	25.00%	72	60.00%	18	15.00%	0	0.00%
It improved students' enthusiasm and initiative in learning.	29	24.17%	70	58.33%	21	17.50%	0	0.00%
The discussion between students and teachers, students and students increased, which improved the students' ability of program design and program analysis	30	25.00%	68	56.67%	22	18.33%	0	0.00%
It improved students' ability of active learning and deep learning.	32	26.67%	73	60.83%	15	12.50%	0	0.00%
Satisfaction with online interaction and discussion.	25	20.83%	65	54.17%	22	18.33%	8	6.67%
Objective, fair and equitable satisfaction with classroom attendance, classroom interaction, experimental assignments, examinations and other aspects.	36	30.00%	74	61.67%	10	8.33%	0	0.00%
Overall satisfaction with online and offline blended teaching mode	30	25.00%	69	57.50%	21	17.50%	0	0.00%

 TABLE II.
 SATISFACTION SURVEY OF ONLINE AND OFFLINE BLENDED TEACHING OF "FOUNDATION OF PROGRAM DESIGN" (EXPERIMENTAL CLASS 3, NUMBER OF STUDENTS PARTICIPATING IN THE SURVEY:52)

	Very Sa	tisfactory	Satis	factory	General S	Satisfactory	Unsati	sfactory
Questions	Number of students	Percent	Number of students	Percent	Number of students	Percent	Number of students	Percent
Compared with the traditional teaching mode, students' participation is strengthened, the classroom is active, and learning attention is more focused.	13	25.00%	32	61.54%	7	13.46%	0	0.00%
It improved students' enthusiasm and initiative in learning.	12	23.08%	31	59.62%	9	17.31%	0	0.00%
The discussion between students and teachers, students and students increased, which improved the students' ability of program design and program analysis	14	26.92%	33	63.46%	5	9.62%	0	0.00%
It improved students' ability of active learning and deep learning.	14	26.92%	32	61.54%	6	11.54%	0	0.00%
Satisfaction with online interaction and discussion.	11	21.15%	27	51.92%	9	17.31%	5	9.62%
Objective, fair and equitable satisfaction with classroom attendance, classroom interaction, experimental assignments, examinations and other aspects.	15	28.85%	32	61.54%	5	9.62%	0	0.00%
Overall satisfaction with online and offline blended teaching mode	14	26.92%	30	57.69%	8	15.38%	0	0.00%

From the survey results of the students participating in experimental class 1 and experimental class 2 in Table I, for the survey questions, " Compared with the traditional teaching mode, students' participation is strengthened, the classroom is active, and learning attention is more focused", " It improved students' enthusiasm and

in learning", "The discussion between students and teachers, students and students increased, which improved the students' ability of program design and program analysis" " It improved students' ability of active learning and deep learning", "Objective, fair and equitable satisfaction with classroom attendance, classroom interaction. experimental assignments. examinations and other aspects", "Overall satisfaction with online and offline blended teaching mode", the sum of the two results of Very Satisfactory and Satisfactory in experimental class 1 and experimental class 2 of these questions were 85%, 82.5%, 81.67%, 87.5%, 91.67% and 82.50%, respectively, and there was no dissatisfaction.

From the survey results of the students participating in experimental class 3 in Table II, for the survey questions, "Compared with the traditional teaching mode, students' participation is strengthened, the classroom is active, and learning attention is more focused", "It improved students' enthusiasm and initiative in learning", "The discussion between students and teachers, students and students increased, which improved the students' ability of program design and program analysis" "It improved students' ability of active learning and deep learning", "Objective, fair and equitable satisfaction with classroom attendance, classroom interaction, experimental assignments, examinations and other aspects", "Overall satisfaction with online and offline blended teaching mode", the sum of the two results of Very Satisfactory and Satisfactory in experimental class 3 of these questions were 86.54%, 82.7%, 90.38%, 88.46%, 90.39%

and 84.61%, respectively, and there was no dissatisfaction.

For the question "satisfaction with online interaction and discussion", 8 students in experimental class 1 and 2 were dissatisfied, accounting for 6.67% of the survey students, and 5 students in experimental class 3 were dissatisfied, accounting for 9.62% of the survey students. The main reason was that the network signal in some places on the campus was not good, which lead to the problems that students need to consult could not be discussed in time, so that students were dissatisfied. This problem will be fed back to the school information and education technology center to strengthen the construction of campus wireless network, so that the signal can cover every corner of the campus and make network teaching smoothly.

From the above survey data analysis, students were generally satisfied with the online and offline blended teaching of "Foundation of Program Design".

# B. Outstanding Examination Results

Examination results are an important means to test the effect of learning. "Foundation of Program Design" is a public course in Foshan University. The final exam adopted a computer network examination system. The number of test questions in the examination question database is large. Each candidate's test questions are random. The computer review the test papers. The exam is objective, fair and just. The examination results of students in the two semesters were shown in Table III and Table IV.

TABLE III. FINAL EXAMINATION RESULTS OF "FOUNDATION OF PROGRAM DESIGN" IN THE SECOND SEMESTER OF 2020-2021 ACADEMIC YEAR

Class	Experimental class 1 40 students	Experimental class 2 85 students	All classes in the school (a total of 44 classes, 1579 students)
Average Score	63. 7	63. 5	58.2

TABLE IV. FINAL EXAMINATION RESULTS OF "FOUNDATION OF PROGRAM DESIGN" IN THE FIRST SEMESTER OF 2021-2022 ACADEMIC YEAR

Class	Experimental class 3 (55 students)	All classes in the school (a total of 30 classes, 855 students)
Average Score	66. 5	60. 6

According to the survey data in Table III, the average scores of experimental class 1, experimental class 2 and all classes in the Foshan University in the final examination of "Foundation of Program Design" in the second semester of the 2020-2021 academic year were 63.7, 63.5 and 58.2, respectively, and the average scores of experimental class 1 and experimental class 2 were 5.5 and 5.3 points higher than the average scores of all classes in the university.

According to the survey data in Table IV, the average scores of experimental class 3 and all classes in the Foshan University in the final examination of "Foundation of Program Design" in the first semester of the 2021-2022 academic year were 66.5 and 60.6, respectively, and the average scores of experimental class 3 was 5.9 points higher than the average scores of all classes in the university.

It can be seen from the above analysis that the average score of the two semesters of the experimental class was more than 5 points higher than the average score of the whole university, which showed that the online and offline blended teaching was better than the students trained by the traditional teaching mode.

# V. CONCLUSION

In order to improve the teaching quality and students' problem-solving ability, we must reform the traditional teaching mode. According to the characteristics of the course and the actual situation of students, fully mobilize students' enthusiasm and initiative in learning, and guide students to deep learning and inquiry learning. As a public course of science and engineering, the course of "Foundation of Program Design" is to lay the foundation for professional courses. We should make full use of the online and offline blended teaching mode, strengthen the construction of curriculum resources, classroom teaching design, and strengthen process assessment, so that students can work hard at ordinary times and better improve students' ability of program design. Through the online and offline blended teaching practice of the course "Foundation of Program Design", students have high satisfaction and good test scores, which should be promoted in more classes in the follow-up teaching.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## AUTHOR CONTRIBUTIONS

Yangqing Zhu designed teaching plan, carried out teaching practice, read and analyzed research references, carried out teaching thinking and wrote this paper. Shenhai Zheng maintenaned experimental teaching equipment and analyzed teaching data.

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