# Exploration of the Blended Experimental Teaching Mode Based on Engineering Education Certification

Lu Yang

{yanglu@suda.edu.cn}

Institute of Computer Science and Technology, Soochow University, Suzhou, P.R.China

**Abstract.** The demand of society and the rapid development of information technology make the "Internet plus education" mode become the focus of teaching reform of computer courses. The blended teaching mode is currently a hot research direction in the teaching reform of higher education institutions. This paper explores the integration of online and offline blended teaching mode with the experimental teaching systems in universities based on engineering education certification. The advantage of this mode is that students can achieve learning goals efficiently and with high quality.

**Keywords:** computer experimental teaching; blended teaching mode; Internet plus; engineering education certification.

## 1 Introduction

The *Education Informatization 2.0 Action Plan* issued by the Ministry of Education proposes to promote the development of "Internet plus education". It also emphasizes the integration and application innovation of teaching mode and modern information technology [1-2]. With the rapid and significant development of online education, innovative teaching methods spark a new wave of teaching reform in universities. These innovative teaching methods include online teaching resources such as *MOOC*, smart teaching platforms such as *EduCoder*, and several offline digital teaching tools. At the same time, under the impact of the sudden outbreak of the epidemic in recent years, Chinese universities have organized large-scale online teaching, which has advanced the popularization of online teaching by decades. And online education has achieved rapid development. However, the online teaching mode affected the communication between teachers and students to a certain extent. It also hinders the classroom supervision, and affects the improvement and enhancement of teaching effectiveness [3-6]. In recent years, the blended online and offline teaching mode becomes a new hot research direction in the exploration of teaching modes, which is also a difficult topic in the current teaching reform of higher education institutions [7-9].

For engineering majors such as computer science, experimental teaching plays an important role in the teaching process. To improve the quality of experimental teaching is an important content of teaching reform. The integration of experimental teaching and information technology is an important way to carry out experimental teaching reform. The online and offline blended teaching provides a new approach for the experimental teaching in universities [10-13]. For engineering majors, engineering education certification plays an important role to improve the quality of training for engineering and technical talents. The construction of

ITEI 2023, November 24-26, Zhengzhou, People's Republic of China

DOI 10.4108/eai.24-11-2023.2343574

experimental teaching system is an important support and guarantee for the engineering education system, which is important for professional construction in the current context of engineering education certification. Therefore, the construction and exploration of the experimental teaching system for engineering education in universities become a key issue that universities offering engineering majors must consider.

Blended teaching emphasizes the main role of learners, while teachers are more reflected as organizers and guides. Compare to traditional teaching mode, the advantage of blended teaching mode the diverse and flexible forms of the teaching mode. It can be tailored to the characteristics of the course, and meet the individual needs of learners. The purpose of blended teaching is to form a positive interaction between teachers and students. It is beneficial to stimulate students' awareness of self-directed learning and innovation. On the other hand, it ensures smooth communication for completing the course, and it is easy to understand students' learning situation at any time. This paper explores the integration of a blended online and offline teaching mode with the construction of experimental teaching systems in universities based on engineering education certification.

## 2 The current situation of experimental teaching in engineering majors

At present, there are several problems in the teaching of engineering experiments in some universities, as shown below.

(1) There is a tendency of emphasizing the mastery of theoretical knowledge and neglecting the training of experimental practical abilities in experimental teaching in universities. And the students lack the training of experimental practical abilities. So their understanding and mastery of theoretical knowledge are often affected negatively.

(2) The experimental teaching lacks comprehensive and innovative experimental content and training forms, which cannot reflect the development trend of professional technology.

(3) Without sufficient preparation for the preview work before the experiments, teachers are unable to grasp the students' preview situation. The progress of the experiments is difficult to unify, and the quality of the experiments is uneven. So the expected experimental effect is hard to be achieved.

(4) Without timely and accurate feedback on the experiment situation, teachers are unable to understand students' mastery of knowledge and the practice ability, which provide accurate guidance for subsequent teaching.

(5) The mechanism for evaluating the quality of experimental teaching is single. It focuses only on the experiment results and neglects the experiment process, which cannot make a scientific and reasonable evaluation of students' various abilities and learning attitudes. While evaluating the degree of achievement of course objectives, it lacks process evaluation and diversified evaluation. It also takes no account of assessment supervision and the mechanism for continuous improvement. Therefore, it is hard to conduct a more scientific and comprehensive evaluation of experimental teaching.

Therefore, to solve these problems, an online and offline blended experimental teaching mode based on engineering education certification can be proposed. Students can achieve learning goals efficiently and communication with teachers through the mix of learning time, learning space, learning activities, learning methods.

In terms of related work, the research on the blended online and offline teaching mode in the teaching reform of computer science mainly focuses on theoretical courses. There isn't enough exploration of introducing it into experimental and practical courses [14-18]. At the same time, these related work lacks exploration of the curriculum design of blended experimental teaching and feedback after the experimental courses. Based on the experience accumulated from the blended teaching mode of theoretical computer courses, this paper aims to actively carry out teaching reforms in experimental teaching of computer courses. It will explore the feasibility of the blended experimental teaching mode, and enhance the effectiveness of experimental teaching in higher education institutions.

## 3 The approach of the blended experimental teaching mode

This paper preliminarily explores the blended online and offline teaching mode in the experimental courses, e.g. *software sngineering* or *software system analysis and design*. During the teaching process, the following key contents need to be completed:

(1) It will make good use of pre and post class time, achieve horizontal extension and vertical depth of knowledge, and improve the achievement of course objectives.

(2) The students are taught according to their aptitude. It will provide personalized teaching to meet the learning needs of students at different levels.

(3) In the engineering education certification process, more scientific and systematic teaching design, implementation, and evaluation will be carried out to improve students' learning participation.

### 3.1 Research and analysis of pre-class learning situation

We conducted a questionnaire survey on students before classes to find the reasons that affect the effectiveness of experimental teaching. The main results include: (1) weak mastery of prior course knowledge, which affects the understanding of existing knowledge (31.25%), (2) failure to understand experimental requirements before class (53.75%), (3) inability to summarize and review the knowledge in a timely manner (43.75%). 32.5% of students admit to a lack of learning initiative. 77.5% of students are willing to engage in preschool autonomous learning. 86.25% of students are willing to participate in group collaborative learning.

Learning situation analysis can help teachers to understand students' learning habits, learning environment, and learning needs. It provides a basis to design blended teaching mode, and develops appropriate learning process management and learning evaluation methods.

### 3.2 The teaching plan design for experimental courses based on blended teaching mode

To solves these problems, we conduct the teaching reform of experimental courses based on the blended teaching mode. The teaching plan design is shown in Figure 1.

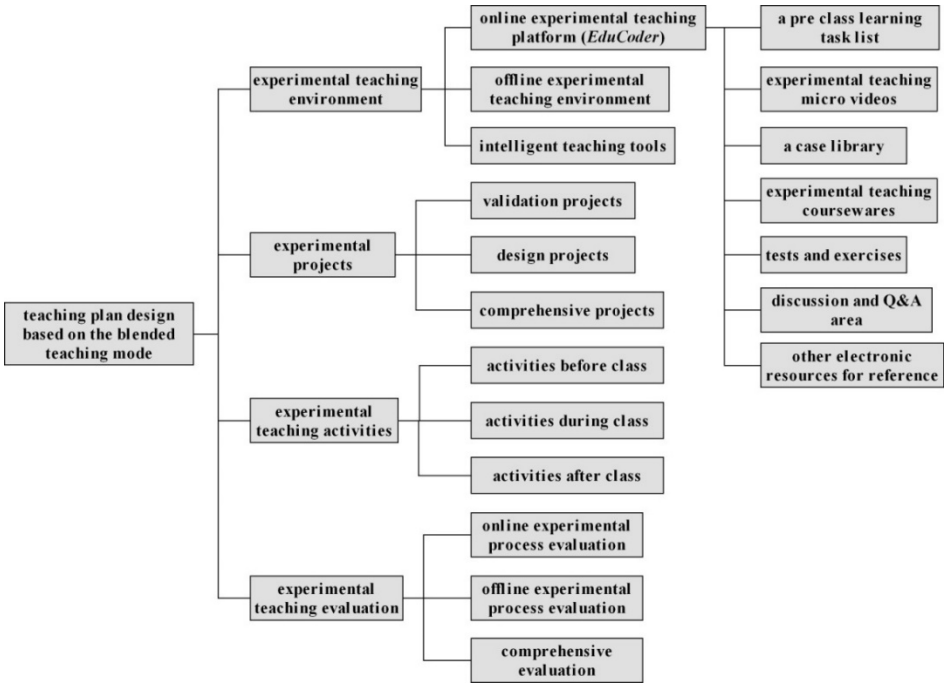


**Fig. 1.** The teaching plan design of experimental courses based on the blended teaching mode.

#### 3.2.1 Experimental teaching environment

The teaching environment of the experimental course includes an online experimental teaching platform, an offline experimental teaching environment, and several intelligent teaching tools.

(1) The online experimental teaching platforms include *EduCoder* and experimental course resources om it.

(2) The offline experimental teaching environments include *Rational Rose*, *Jazz*, etc.

(3) During the teaching process, intelligent teaching tools such as *Rain Classroom* and QQ course group are used to carry out teaching activities.

We use *EduCoder* as the online experimental teaching platform in the course. *EduCoder* is an online practical teaching service platform, which is widely used in universities. As a practical teaching platform, *EduCoder* integrates online and offline service. The advantage of *EduCoder* is that it emphasize the integration of professional knowledge and engineering capabilities, provide different types of experimental environments and resources, and construct a teaching resource system, etc. Therefore, the services provided by the platform can be used to design teaching methods, extract teaching results, analyze teaching data, and share

teaching materials and case studies in experimental courses. Due to the integration of the teaching-practice-evaluation process by *EduCoder*, it also plays an important role in engineering education certification.

In terms of construction of the online experimental course, we develop online teaching resources which is suitable for this course on *EduCoder* to support students' autonomous learning and deep learning. The teaching resources include,

(1) a pre class learning task list

(2) experimental teaching micro videos

(3) a case library for experimental teaching

(4) experimental teaching coursewares

(5) tests and exercises

(6) discussion and Q&A area

(7) other electronic resources for reference

The support of *EduCoder* provides students with personalized learning channels and clarifies the use of online resources.

### 3.2.2 Experimental project design

In experimental teaching, it is necessary to meet the learning needs of students at different levels. Tteachers conduct practical teaching in a hierarchical manner based on the difficulty of "validation projects → design projects → comprehensive projects", from easy to difficult.

(1) Validation projects focus on understanding UML diagrams.

(2) Design projects focus on using software modeling tools to draw various UML diagrams and the application of UML diagrams in actual software analysis and design processes. These projects alse introduce analysis and design principles into software modeling, and implement forward and reverse engineering.

(3) Comprehensive projects emphasizes the comprehensive application of UML software models. These projects not only focus on describing the relationships between multiple UML diagrams of a system, but also consider the correlation among different knowledges, e.g. software models, databases, software architecture, and program design.

### 3.2.3 Experimental teaching activities

The teaching activities of the experimental course include activities before class, during class, and after class, as shown in Table 1.

**Table 1.** Design of experimental teaching activities based on the blended teaching mode.

| | | |
|---|---|---|
| Before experimental class | Teachers inform the preview requirements befire class | 1. publish the pre class learning task list sheets on *EduCoder* |
| | | 2. publish the self-learning videos of experimental prerequisite knowledges and experimental operations |

| | | |
|---|---|---|
| | | 3. publish the experimental the knowledge point test |
| | | 4. publish the questionnaire survey before class |
| | Students use experimental course resources to understand the experimental requirements | 1. watch teaching videos based on the pre class learning task list, and learn experimental principles and operations |
| | | 2. complete the knowledge point test |
| | | 3. complete the questionnaire survey to provide feedback before class |
| Teachers collect feedback before experimental class. | | |
| During experimental class | Teachers give the experimental tasks, and provide guidance and Q&A. | 1. explain the key and difficult knowledges based on feedback before class |
| | | 2. explanate and demonstrate comprehensive case studies |
| | | 3. guide students to engage in deep learning by proposing diverse experimental tasks |
| | | 4. provide experimental guidance and Q&A. |
| | Students complete the experimental tasks. | 1. have a group learning and discussion |
| | | 2. complete the experiment, including group collaboration tasks and individual tasks |
| | | 3. complete the experimental report |
| Teachers collect feedback during experimental class. | | |
| After experimental class | Teachers summarize the progress of students' experiments and Q&A situations promptly. | 1. evaluate and summarize the experimental results, including common problems that students are prone to encounter and difficult problems that need to be emphasized |
| | | 2. give comments for the experiment, and display excellent experimental reports |
| | | 3. provide extended learning resources in *EduCoder* platform to the needs of students at different levels |
| | | 4. publish the questionnaire survey after class |
| | Students summarize the experiments and do extended learning. | 1. do extended learning (optional) |
| | | 2. discuss in the online discussion area of *EduCoder* (optional) |
| | | 3. complete the questionnaire survey to provide feedback after class |
| Teachers collect feedback after experimental class. | | |

Throughout the entire teaching process, there is communication and interaction between teachers and students, as well as between students and students. Timely feedback is arranged between pre class and post class stages. The implementation of these experimental teaching activities is a iterative and spiral learning process.

Diverse experimental tasks can be proposed to guide students to engage in deep learning. Validation projects can be used as pre class learning tasks. Design projects can be used as class practical tasks. And comprehensive projects can be used as post class expansion tasks.

### 3.2.4 Experimental teaching evaluation

The teaching evaluation of the experimental course evaluates students' learning process and effectiveness from multiple dimensions, including online experimental process evaluation before and after class, offline experimental process evaluation, and comprehensive evaluation.

(1) Online experimental process evaluation is based on completion status of the pre class learning task list, process based experimental knowledge tests and questionnaire surveys.

(2) Offline experimental process evaluation is based on experiment results and experiment reports.

(3) Comprehensive evaluation is a summary at the end of the course. The effectiveness of the experiments is evaluate by the perspectives of experimental defense and summary reports.

Among the above evaluation approaches, both online and offline experimental evaluation approaches are process based. The process-based feedback on learning outcomes is based on user logs, experimental knowledge testing, submission of experimental reports, questionnaire surveys on *EduCoder*, and observation during experimental classes. And based on this, the teaching process can be dynamically adjusted. Comprehensive evaluation approach evaluates experimental results from multiple dimensions.The students' knowledge application ability, comprehensive practical ability, and innovation ability are comprehensively evaluated.

In the evaluation process of experimental teaching, the effectiveness of the teaching plan can be verified through teaching practice. The the quality and effectiveness of teaching process can be improved by iterative optimization. This blended online and offline teaching mode analyze the degree of achievement of course objectives, and plays an important role in engineering education certification. The advantage of this mode lies in the process-based evaluation and the diversity of evaluation indicators.

### 3.3 Results analysis of teaching reform

The statistical result of the questionnaire survey after the class on both students and teachers show that the blended online and offline teaching mode has received good feedback from both students and teachers.

Most students (86.25%) have provided feedback that this course has enriched their professional knowledge and improved their practical abilities. This mode is helpful in stimulating learning interest, understanding of knowledge, improving self-learning ability, and improving practical operation ability. Students think the main problems they face in the class are understanding the experiment principles and experiments operations (53.75%). The combination of online experimental teaching platform and offline experimental teaching can effectively meet the needs of students and solve their problems. Therefore, the conclusion is that the blended teaching mode is in line with students' expectations. In addition, this mode promotes positive interaction between teachers and students by providing opportunities for students of different types to communicate with teachers. The standard of evaluating students is no longer only based on teaching and assessment by teachers. Students think this mode has increased their participation (78.75%).

The most teachers (91.25%) also provided positive feedback on the convenience of the entire process of teaching-practice-evaluation. They can use *EduCoder* platform to publish experiment courses, and carry out process management through platform collaboration. This mode can reduce some trivial processes in practical and effectively solve the complex problems in practical courses.

## 4 Conclusions

After adopting the blended online and offline teaching approach, students can fully utilize fragmented time for online learning before and after class, which can solve the problem of limited course time. Before class, students can be provided with pre experimental course requirement and prerequisite course knowledge. Students engage in autonomous learning of pre experimental course requirement and review the prerequisite course knowledge. Through corresponding experimental tasks during class, students improve their ability to design system and solve complex engineering problems in the practical process. Students review promptly after class to meet the learning needs at different levels through diversified learning resources.

The following improvements can be made to this mode:

(1) We will improve the design of teaching cases, experimental tasks, and teaching activities, to inspire students' study interest, cultivate high-level abilities, and solve complex software engineering problems.

(2) We will adjust the proportion of online and offline blended learning and flipped classroom settings, that are more conducive to students' learning.

On the basis of achieving preliminary results of the course, the online and offline blended teaching mode can be further promoted to other courses, majors, and universities through sharing course examples on the *EduCoder* platform.

## References


[1] Ren, C. and Division, I.: Implementing the education informatization 2.0 action plan to accelerate educational modernization:interpretation of education informatization 2.0 action plan(2). e-Education Research. (2018)

[2] Yan, Z.: On the Concept and Mode of "Internet Plus Education". China Higher Education Research. (2016)

[3] Zhang, D., Zhao, J.L., Zhou, L., Nunamaker, J.F.: Can e-learning replace classroom learning?. Vol. 47, pp. 75-79. Communications of the Acm. (2004)

[4] Herlina Karjo, C. and Andreani, W.: E-learning Challenges for Lecturers in Indonesia Higher Education Institutions. pp. 309-313. 11th International Conference on Information and Education Technology (ICIET 2023). (2023)

[5] Altarawneh, M., and Al-Ghammaz, S.: The Journey of E-Learning Technology from Application to Challenges: Evidence from Jordan. pp. 531-536. 2023 International Conference on Information Technology: Cybersecurity Challenges for Sustainable Cities (ICIT 2023). (2023)

[6] AlKandary, A.: The Effectiveness of Distance Learning during Covid-19 Pandemic and its Threats as Perceived by Kuwait University Preservice Science Teachers. Vol. 36, pp. 11-47. Journal of Education/Al Mejlh Altrbwyh. (2022)

[7] Kan, L., Gao, J. and Xu, J.: Exploration and Analysis on 'Online + Offline' Blended Teaching Mode Reform. pp. 726 - 9. 2020 International Conference on Information Science and Education (ICISE-IE 2020). (2020)

[8] Zhu, X.: Blended Learning is a new mode of school organization in the future. China Education Daily. (2019)

[9] Zhu, X. and Lei, J.: Blended learning: The teaching reform in the era of Internet plus. pp. 4. Digital Teaching in Primary and Secondary Schoo. (2018)
[10] Yang, Y., Yang, Y., Li, W. and Li, L.: Research on the Training Mode of Computer Professionals Driven by the Professional Certification of Engineering Education and the Integration of Industry and Education. pp. 233 - 8. 2022 2nd International Conference on Big Data Engineering and Education (BDEE2022). (2022)
[11] GuanBo, F. and Jia Yue: Innovation of Software Engineering Course with the Background of Engineering Education Professional Certification. pp. 628-31. 2021 16th International Conference on Computer Science & Education (ICCSE2021). (2021)
[12] Yin, F., Li, C., Sun, D. and Zhou, L.: Research on Effective Teaching Based on the BOPPPS Model Under the Background of Engineering Education Professional Certification. Vol. 1629, pp. 406-411. Communications in Computer and Information Science. (2022)
[13] Wang, D., Han, F., Zhao, Q. and Lv, Y.: Teaching Practice of Engineering Management Course for Engineering Education Certification under Background of Artificial Intelligence. pp. 12. International Transactions on Electrical Energy Systems. (2022)
[14] Qian, J.: Online and Offline Blended Teaching Mode in China Supported by MOOCs in the 'Internet +' Era. pp. 1-4. 2021 International Symposium on Advances in Informatics, Electronics and Education (ISAIEE2021). (2021)
[15] Yue, Q. and Jiqiong, Y.: Research on online and offline blended teaching mode based on "MOOC +SPOC +flipped class". pp. 42-45. ACM International Conference Proceeding Series. (2020)
[16] Chang, J., Liu, Y., Li, X., Wu, X., Bi, Y. and Huang, Y.: BOPPPS-based online and offline blended teaching mode in computer basic course. pp. 23-9. IET Conference Proceedings. (2022)
[17] Hirata, Y.: A study of flipped offline and online computer programming courses in a Japanese university. Vol. 31, pp. 385-403. International Journal of Innovation and Learning. (2022)
[18] Cheng, D., Zhang, C. and Liu, X.: Research on the Reform of Online and Offline Blended Teaching Mode for Analog Circuit Course. pp. 97-101. ACM International Conference Proceeding Series. (2022)