The reform of computer experiment teaching based on O2O model

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Abstract
In this work, through integrate that teaching management system, the learn mode of the O2O is used to build a learner-centered frame of the teaching reformation. This frame is supported by the O2O learning platform, with themed practical teaching and O2O model as the main body, and the “Thousand questions plan” and “Teachers guiding” system as two guarantee supports. In order to achieve high quality results, specific implementation plan, including management system and implementation measures has been formulated in teaching reform of O2O platform. The questionnaire shows that this system has mobilized the enthusiasm of teachers and students. By comparing the practice results of the experimental class and the control class, the effectiveness of the O2O teaching framework is verified, and the teaching reform is successful. Finally, this paper provides teaching inspiration and future research direction for educators and researchers.

KEYWORDS
engineering practice, learning with technology, offline to online (O2O), online to offline (O2O), teaching management

1 | INTRODUCTION

In recent years, a problem of experimental teaching in universities has always been a hot topic. It is common for students to play mobile phones or games during the traditional teaching class of computer lab.

In order to achieve the expected teaching effect, university administrators and teachers worked together to solve the problem and formulated a series of measures to prevent students from using mobile phones. Consider that free Wi-Fi covers the entire teaching area and everyone has at least one mobile terminal, college computer labs are open to students outside of class. How do these conveniences turn into a way of learning?

Students tell us that when it is necessary they do not find any problem with sharing documents or working in groups online to develop a project or to participate in an activity. However, if they do not need to do so because the teacher uses a lecture methodology, students will not use it on their own [18], 94% of students felt that mobile learning APPs should be regularly used along with conventional teaching methods [5].

One method is a process of advocating independent learning, collaborative learning, inquiry learning, and guiding students to explore and search for solutions around problems or problems. In this context, technology should provide opportunities of interaction, reflection between teachers and students, and space
for collecting various learning resources [21]. For this reason, the use of online tools (such as MOOC, SPOC, etc.) makes teaching move from offline to online.

We were still trying to understand the second arrived with new notions such as flipped classroom (FC) and Blended learning (BL) teaching approach when the MOOC, SPOC showed up, because of definitional ambiguity [22].

The FC and BL teaching approach is a more and more widespread present-day model of learning and teaching in classrooms around the world [15]. The FC approach includes two main parts: pre-class and in-class activities. The nature and design of these activities varies among different studies, and is currently being debated [3,7,13,29].

Blended learning refers to a learning environment that incorporates diverse teaching styles, delivery means, media formats or a combination of all these [20]. It can also be defined as the integration of various learning activities like online and face-to-face learning [25]. Blended Learning does not replace the conventional learning in the classroom (face to face), but it reinforces the learning model through the educational technology [27].

Now, there is no consensus on a single definition for blended learning. We shift our focus from online, to offline, to online, and now to blended learning environment, afforded by mobile tools. This phase, characterized by the Internet, prompted us to include collaborative learning using technology as way the Internet can be used in a blended learning environment characterizes the third phase [23].

This phase is shaped by fast Internet and integrated with various procedures and practices from the other phases. Borba and Lacerda [2] propose the idea of “one mobile phone per student” as a means of substituting campaigns such as “one computer per student” [2]. This new phase enhances the opportunities for collaborative learning and personalization of the Internet through personal devices.

However, engineering education’s hands-on work is done in the physical space, and the online learning support services of virtual space are provided in the physical space, and it is an auxiliary function. In recent years, the O2O model has been applied to education, with some teaching goes back offline. The concept of O2O was presented by Alex Rampell in August 2010 [24]. It originally refers to a business service model, referred to as Online to Offline.

These modes described above are not independent. There are large intersections and relationships between them. In this article, as defined by the O2O is refers to the effective engineering education mode, the university student centered on “Internet +” era background, make the full advantage of the internet, Education management system, extracurricular experimental teaching, and engineering practice combined with Internet.

The online to offline platform and mobile online learning originated from front-line teachers. Once classroom teaching was introduced, its structure was changed, and its process was reconstructed. We believe that the process of applying O2O should be a top-down educational model reform.

Combined with the reform of teaching management system, this paper discusses how to use online and offline learning platforms to realize process management personalized and diversified mobile learning.

According to characteristics of university computer courses, we carried out some reformations in the model of experiment teaching, and proposed the implementation of this case reformation. This implementation plan is to establish an experimental teaching framework based on O2O model.

This framework is supported by the O2O learning platform, with themed practical teaching and O2O model as main body, and two teaching management system as guarantee support. In order to implement the plan of this case smoothly, we have formulated specific measures. It includes setting up extracurricular practical teaching scenes, learning process management, personalized and diversified mobile learning on an O2O platform and teaching rules.

## 2 | PRESENTATION

Some of the previous reforms have used online platforms, but the dispute over the effects of various models are still continuing. We analyze the reasons from two aspects of personal and technology factors.

### 2.1 | The administrative regulations (personal factor)

The purpose of educational technology is to promote learning by means of technology [14], but we cannot depend on the technology completely. Teaching reform based on the O2O model, the teaching reform should be combined with the top-down education system. Personal factors and technological factors should play a common role in teaching reform. As everyone knows, the object of management is people. “Constraining people” is always emphasized in our teaching management. In fact, “managing people well” is not to simply use, control, or supervise, but more to respect, serve, and communicate. In Educational administration and teaching management, teachers and students are the center [8–10].

1. Teachers are the main body of teaching and students are the object of service. Educational administration and teaching management system can only be carried out around these two centers.
2. From “students are taught by teachers” to “student's success, under the guidance of tutors, through practical innovation and independent learning,” so that students will return to the main position of talent training.

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Of course, educational administration and teaching management teaching affairs and teaching management are not only principles, but also specific operations. Operations are often performed by people, so the “personal factor” needs to be further expanded here. “People” is not only the object of management, but also the executor of management. Their basic literacy and vocational training will directly affect the implementation of management principles. The so-called “man” here is not an abstract group; it firstly refers to the specific person. In the framework of our O2O platform teaching model, a person is specific into a teacher and student with a name and specific surnames. O2O platform support (technical factors).

### 2.2 O2O platform support (technical factors)

The mobile learning management (APP) is used to improve the record, supervision and evaluation of classroom learning process, and promote fair competition learning. Mobile learning applications make classroom teaching management more intelligent. All learning resources and classroom activities are released and all learning behaviors of each student and application are recorded.

The new model is student-centered. According to the learning theory of constructivism [26], we propose that basic knowledge fragmentation learning on O2O platform. For extracurricular extension experiment practice, the loosely coupled collaborative learning method is adopted to create external network nodes through O2O. In order to fulfill various context-related tasks, students are required to establish a mobile community so that they can apply what they have learn to interact and cooperate with each other.

#### 2.2.1 Constructivism

In view of the disadvantages of traditional classroom teaching, the application of O2O platform in traditional college classroom teaching is reviewed with constructivism theory. The autonomous learning is introduced to the process of effective learning.

At routine course, flipped learning reduces classroom time by allowing participants to prepare with introductory content, questions to trainers, and supervisor involvement. Participants may also complete “homework” online, outside of the classroom. This allows the teacher to shift from content delivery mode to coaching mode.

#### 2.2.2 Loosely coupled collaborations

Collaborative learning is built on such learning theories as social connectives and is implemented through cooperative and explorative methods of learning [30].

The emergence of joint problem is solving in online environments where the participants work together for the same themes but at different times and from different places. Collaborations of this sort have been referred to as loosely coupled collaborations [8]. With O2O platform, the theme of learning, summary, demonstration, communication, and evaluation have been promoted.

#### 2.2.3 Hybrid

By using the online-to-line (O2O) learning platform, teachers' work is transformed from preconceived teaching to asking questions, tutoring students, discussing, and communicating problems with students, teachers become full-time tutors.

Online space provides learners with project background knowledge, learning resources, pre project case references, questions from teachers or specific professional experts, and other support information.

The learners collaborate online and offline to carry out hands-on practice, synchronous face-to-face discussion, and receive instruction from teachers and experts. Through the practice of offline physical space, learners finally complete the entire project and display their works.

Teaching mode based on hybrid O2O platform, as shown in Figure 1.

Therefore, it should not be surprising that much of what we have called blended learning is, in reality, blended teaching that reflects pedagogical arrangements [6].

The combination of the highly portable mobile devices with the task log function suggests that the mobile learning is the better blended learning mode. The reason may well be related to its “task log” mechanism that effectively assumes the intermediary role of between the two learning modes (physical and virtual) [11] and facilitating visitors to both retrospective and introspective with respect to the learned content [12,16].

#### 2.3 Reconfiguration of existing patterns by O2O

The O2O-based platform classroom model, by deconstructing the dualistic opposition between knowledge learning and after-class learning deficiency in routine course teaching, integrates online courses and mobile learning with teaching procedures, aiming to infinitely extend classroom teaching and allow every student fully engaged in learning. On the O2O platform, teaching is guided by “teacher guidance” and “student collaboration.”

In other words, problem-based tasks provided by a mobile O2O learning platform were similar to scaffolding which timely supported the students [11].

Furthermore, it may also extend the interaction period between onsite learning and the online learning, thus facilitating the implementation of the engineering practice activities.

The O2O model based on the mobile learning platform integrates offline learning, online interaction assistance,
venue-based virtual collaboration, and learning quantitative evaluation together. It includes the following three scenarios:

1. Routine course
2. Workshop
3. Challenge Game

The 2 and 3 above are more suitable for engineering practice. This is more evident in engineering practice activities such as Material processing and manual manufacturing, Hardware design and development, Computer modeling and rapid prototyping of 3D printing, shown in Figure 2.

3 | IMPLEMENTATION

The principle of our scheme is to adhere to the practical application, adhere to the problem oriented, timely respond to students’ doubts, change preaching to reason, and indoctrination to interaction, pay attention to the application of Engineering technology to enhance the attraction and effectiveness.

The framework of practical teaching model is created based on O2O learning platform, taking extracurricular practice teaching and mobile learning as the main body, based on the wings of “teacher guidance” and “thousands of questions.” The framework of O2O teaching model is as shown in Figure 3.

3.1 | School administrations establish policies for adopters

We provide tutors for students to promote students’ professional learning, community activities, innovation, and entrepreneurship. Build an open communication platform between teachers and students, by measures like teachers station in student apartments and students join teachers’
research teams, to strengthen daily communication between teachers and students, to guide and help students learn to learn, learn to study, and learn to be engineering.

Through the self-test results of “online” class, teachers summarize the questions with high error rate and form a new question database, which has become the questions that students must answer.

We carried out the “1000 questions and more answers,” which is based on O2O platform, namely by encouraging students to discover problems, how to ask questions, teachers and students can answer this question, it can alleviate the pressure of the teachers to communicate more than once, and to deal with the problem of others to expand their own quality. Our practice proves that members of O2O mobile community can answer each other’s questions.

### 3.2 The description of the platform

The O2O platform is a platform which shares knowledge, spreads learning, connects people, and knowledge, speeds up the flow of knowledge, get everyone involved, share, and harvest.

Using the innovative and hybrid interactive learning method provided by O2O, it is very easy to make various interactive courses in audio and video, and can also initiate research and question at the active learning and training scene, stimulate the sharing of each other, and even use the mobile phone to live broadcast.

### 3.3 The participants of platform

In this study, we enrolled 63 freshmen of computer majors in a one-semester of introduction to computer theory course in first term of the academic year. Students were also observed to have enough knowledge and ability to operate computers (laptop computers) and smart phones. About students’ smart phone skills, they can browse Internet, communicate with others and interact with others. They can also search for learning resources through their smartphones online, download and store these resources to laptop and smart phone.

### 3.4 Data collection and analysis

The data of this study were collected through offline observation and online reflection. Online reflection let us be able to describe and evaluate our impact. Classroom observations help us gain a comprehensive understanding. By applying information technologies to the recording, monitoring, and evaluation of students’ learning behavior and process [1].

### 4 MEASURE

We carried out an exploration on the reform of the O2O teaching model in the experimental class of introduction to computer theory for 2017 freshmen of computer major. Our research focuses on exploration and inspection.

#### 4.1 Management measures

Faculty members who invested efforts in technology integration needed a better reward system for student workload [4].

In the new model, teachers should not only prepare for the traditional teaching mode, but also work both physical space and virtual space, so that the workload of teachers will increase exponentially [19]. To solve this problem, we have established the policy of “student workload system.” It includes student education management, offline activities, network educating work, and participation in guiding students' activities. So we set up the student workload assessment files, regularly release the student workload completion status. Teachers should complete no less than 80% of the students' workload each year. The workload of students completed by teachers is regarded as an important basis for evaluating teachers' excellent performance, promotion of professional titles and performance distribution. Reducing teaching loads and providing extra financial support were feasible incentives [17]. These measures enable teachers to do the work after class is recognized, so that more teachers are willing to pay more efforts for extracurricular teaching.

#### 4.2 New teaching mode based on UMU platform

The “UMU” is a typical O2O learning platform. It means You (U), Me (M), Us (U). We use UMU to make video and video interactive courses. Research and questions are also carried out in the learning activities and training fields to stimulate sharing, live broadcast on mobile phones, and create learning communities, etc.

The process of learning management is as follows:
FIGURE 4  The UMU section contains six types of content forms and nine types of interaction.

FIGURE 5  The structure of UMU “theme”
Step 1: Use smart phones to sign in before class, and record every student's check-in time systematically.

Step 2: Teach knowledge test

Step 3: Class sharing

Step 4: Students' work and style display

Step 5: Students' random speech

Step 6: Excellent students selected

Step 7: Organize activities for teachers

Step 8: Communication and study between teachers.

Knowledge of students should not be confined to the classroom, but also a collaborative learning scenario should be built on them.

- Setting up course files
- Interactive combination through UMU
- Learning content consolidation
- Efficient questioning or answer and sharing
- Convenient photos
- Online anti cheating signature
- Light challenge game and entertainment
- Collection feedback and evaluation
- Generation report fast

There are three dimensions in UMU. It consists of three core components: “Section,” “Theme,” and “Project of Learning.” The three parts are interconnected, integrated, supportive, and mutually reinforcing. “Theme” is the axis for learning to construct rich context and application scenarios.

The “Section” contains two categories of content and interaction, which can be applied to a variety of scenes, such as the flipped classroom, the excellent course project, the collaborative learning, the consolidation of the knowledge and the sharing of the teacher's teaching methods, shown in Figure 4.

Teachers or engineering experts issue “theme.” “Theme” is composed of multiple sections, and multiple themes are built into learning projects. A theme can be an experiment, a theme meeting and a practical activity. In every theme, we integrate the content and interaction part according to the actual needs. A theme context is established as a part of this platform. Each venue can have a different set of active and less active participants. The “theme” structure such as Figure 5.

The “Project of Learning” aggregates multiple themes according to actual needs, and set up compulsory and optional contents. Learning projects support the establishment of phased learning. It can also be set up as curriculum design and extracurricular experiment.

The scheme of O2O platform is conducive to students' learning in three main aspects: adding more tasks or practices in class, integrating new knowledge with existing knowledge, and giving real-time feedback.

By using online to offline (O2O) learning platform, the teaching mode after reform is shown in Figure 5.

4.3 | At every stage, every teacher should follow certain teaching rules:

- Employment creation: determine the task, focus on its authenticity, and try to reproduce the actual situation of knowledge and skills in the real society.

| Assessment composition | Ordinary performance | Experimental examination | Final assessment (integrated design course work) | Knowledge point test |
|------------------------|----------------------|--------------------------|-----------------------------------------------|---------------------|
| Achievement            | 10%                  | 30%                      | 40%                                           | 20%                 |
| Examination content    | Attendance, online exercise, online questioning, or discussion, etc. | Online experimental report and experimental results | The actual effect of the work | Question and answer of knowledge point |
| Assessment basis       | Platform statistics  | Validation and demo      | Peer assessment and teacher acceptance data   | Auto-scoring        |
| Assessment method      | Process record       | Process record           | Centralized evaluation                       | Computer-assisted tests |

**TABLE 1** Assessment and academic evaluation scheme

| Stat item                           | A1      | A2      |
|-------------------------------------|---------|---------|
| Teacher's job satisfaction          | 83%     | 71%     |
| Attendance                          | 98%     | 94%     |
| Discipline of lessons               | 96%     | 83%     |
| Experiment 1: make electronic newspaper | 90.3   | 82.4   |
| Experiment 2: manage and count data with EXCEL | 81.3 | 87.2 |
| Experiment 3: create a PowerPoint presentation | 87     | 78.6   |
| Experiment 4: network cable production | 92.7   | 79.1   |

**TABLE 2** Comparisons of experiments learning outcomes

*aAverage score in the percentage.*
Process demonstration: the teacher will demonstrate the detailed process of the whole task.
Practical requirements: the experiment works should have detailed documents, with screenshots and instructions.
Stage acceptance: every student assignment should be checked and accepted in time, and team projects are also checked and accepted at each stage.
Timely feedback: timely feedback to students after acceptance
Presentations: through students’ presentations or online presentations
Teaching summary: at the end of each stage, a summary should be made. Students are given questionnaires to evaluate their teachers and learning content.

These measures not only guarantee the quality of teaching, but also benefit the continuous improvement of teaching model.

5 RESULTS

The data for the case study collected from 125 students in one semester, all from the same major, and the same course—the introduction to computer.

Students were assigned to four design experiments in this term. As the “Workshop and Challenge Game” on the O2O platform was created, students began to do each experiment at the same time. Each student created an account when they first logged into the system, and students are not allowed to use pseudonyms or anonymity. Evaluation scheme is presented in Table 1.

Data were collected from “A1” class using O2O experimental teaching and “A2” class using traditional teaching model. “A1” and “A2” are parallel classes with the same teaching progress.

As shown in Table 2, the class discipline of the experimental class is better than that of the control class. For four extracurricular practice projects, the experimental class is also better than the control class.

The in-depth analysis of communication within each one was the primary form of analysis [28]. By looking at the system’s event log statistics, we know how students are learning, likes how often they raise questions, how many times they answer questions, how well they answer questions, and so on. The accumulate points of imitated members are used to evaluate students’ usual performance.

The students expressed that implementation of “Thousand questions plan” has made us become active and uncontrollable in it. From Table 3, we find that students answer most of each other. On the one hand, the number of students is more than that of teachers. On the other hand, competitiveness stimulates students’ enthusiasm.

At the end of the semester (18 weeks), many students expressed their willingness to participate in Workshop and Challenge Game by analyzing the interviews and questionnaires in the experimental class.

In the pretest part from Table 4, the P-Value between “A1” and “A2” is greater than 0.05, indicating that there is no significant difference between the two classes.

In the post test part, the Mean in the “A1” and “A2” were 76.85 and 69.87, the SD (standard deviation) was 9.109 and 11.221 respectively. The significant results ($p < 0.001$), indicating that there was a significant difference between the two classes. The average score of student from “A1” class was higher than “A2” class and the degree of dispersion was lower than the control class.

From the statistical data of overall, the effect of the experimental class is obviously better than that of the control class.

### TABLE 3 Q&A classification statistics

| Q/A form    | Type of questions | Q/A process                | Q/A order                        | Questions archive |
|-------------|-------------------|----------------------------|----------------------------------|-------------------|
| Single      | Basic knowledge   | Study and then ask questions | Student asked the teacher a question | Q&A manual       |
| Multinomial | Practical operation| Ask questions while you study | Students ask students to answer questions | Electronic file   |
| Open type   | Learning method   | Ask questions after study   | Teacher asked the student to answer the question | The database     |

### TABLE 4 Comparison of students’ comprehensive achievements

| Period | Class | N   | Mean   | SD    | $p$-value |
|--------|-------|-----|--------|-------|-----------|
| Pre-test | A1   | 62  | 74.81  | 9.779 | 0.911089  |
|         | A2   | 63  | 75     | 9.56  |           |
| Post-test | A1  | 62  | 76.85  | 9.109 | 0.000214  |
|         | A2  | 63  | 69.87  | 11.221|           |

Mean, average value; SD, standard deviation; $p$-value, saliency probability.

### TABLE 5 Distribution map of fractional in each grade

| Each grade % Class | 90–100 (excellent) | 80–89 (good) | 70–79 (medium) | 60–69 (pass) | 0–60 (failing) |
|--------------------|--------------------|--------------|----------------|--------------|---------------|
| A1                 | 10                 | 16           | 30             | 3            | 3             |
| A2                 | 3                  | 10           | 18             | 19           | 13            |
class. That is, the application of O2O teaching class is better than that of non O2O teaching class.

From distribution map of fractional in each score section, we can see that “A1” class is significantly more than “A2” class with score of students in 70 to 80 points and 80 to 90 points, which also supports the above conclusion, show in Table 5.

6 | CONCLUSIONS

In regard to the issue of O2O model, we found extend classroom teaching, a pedagogical tool for knowledge learning and ability training, a learning theoretical foundation, and teaching regulations is crucial for promoting students’ learning effectiveness. However, few studies have investigated integrating framework of O2O platform learning model with concept of teaching and management.

This study proposes a framework to education reform based on O2O model through integrate teaching management system. We conduct experiments in two new parallel classes of computer major. The application effect was verified from the experimental class and the control class (two parallel class students in the computer major).

First, regarding the teaching administrative regulations as a pedagogical foundation, this study extends the application of the social science field to the academic field, allowing it to be applied in computer or engineering education.

With O2O learning platform as the support, themed practical teaching and O2O model as the main body, the practical teaching model framework with “Thousand questions plan” and “Teachers guiding system” as two guarantee support is an effective reform.

Second, with use of O2O platform, this study shows that the engineering education’s hands-on practice is supported by O2O framework.

Finally, this study provides direction for further improving the O2O framework. For students, a few are reluctant to participate in them, and they sign in and get free on the platform. For teachers, some pay more attention to the form, but ignore knowledge in the platform and promotion of students' ability. For these situations, we should also formulate more detailed teaching regulations, such as requiring students to change roles in the collaboration process.

This study has certain limitations. First, the limitations regarding the limited number of research objects and amount of equipments (i.e., mobile devices) made a large-scale research impractical. Furthermore, the participants in this study were restricted to university freshmen. It is recommended, therefore, that subsequent research on the O2O learning frame include different grades and present the content from a more diversified experiment.

It might be stressful and challenging for students and teachers to perform when O2O teaching mode is introduced. Meanwhile, it needs continuous improvement in the future.

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