



Design and Implementation of Online Teaching Platform for Oil and Gas Storage and Transportation Experiment

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Abstract. With the new form of “Internet + higher education”, online teaching platform has become more and more important, especially for practical teaching courses. In view of the problems of limited space, insufficient openness and low enthusiasm for learning of students in the traditional experimental teaching mode, an online experimental teaching platform based on the WeChat mini-program was designed with the development concept of cross-platform, easy to use and low- investment. The platform consists of 3 basic function modules and 12 sub-function modules, providing rich teaching materials such as teaching videos and courseware, which can meet the needs of experimental teaching and communication between teachers and students. The platform can generate reports of students’ usage feedback information and provide them to managers or teachers for teaching resource adjustment and information management. Since the online teaching platform was put into operation, it has greatly improved the enthusiasm and learning effect of students’ independent learning of experimental courses, and is highly recognized by teachers and students, and the teaching quality has been significantly improved, which has certain promotion value.

Keywords: online teaching platform · experimental teaching · WeChat mini-program · intelligent education · online and offline mixed teaching mode

1 Introduction

With the booming development of modern technologies such as big data, artificial intelligence, and virtual reality, undergraduate education and talent training in Chinese universities are facing the need for change. The relevant documents of the Chinese Ministry of Education clearly propose to promote the deep integration of modern information technology and education teaching, to promote the formation of a new form of “Internet + higher education”, to build a teaching model combining online and offline, and to promote the “transition overtaking” of higher education quality improvement by modern information technology. Experimental teaching in higher education is a key link for students to combine theory with practice and sublimate theoretical knowledge, and it is one of the important links to cultivating students’ practical ability, innovation ability, teamwork ability and ability to solve complex engineering problems [1–4].

The major of oil and gas storage and transportation engineering at Xi'an Shiyou University is the backbone major of the oil and gas industry, the “first-class major” and “special major” in Shaanxi Province, and one of the advantageous and characteristic professional disciplines of our university. Experimentation of oil and gas storage and transportation is a compulsory basic course for undergraduates of this major, which is an important comprehensive practical course for this major and plays an important role in cultivating students’ ability to solve complex engineering problems. At present, the teaching of this course is based on the traditional teaching mode, with a self-prepared experimental guide as the main teaching resource and the laboratory as the only teaching place. After the students enter the laboratory, the experimental teacher will explain the theory and demonstrate the experimental operation to the students, and the students will get the relevant experimental data and process and analyze them and write the experimental report through the actual hands-on operation. This model is influenced by less class time, limited space and insufficient openness, and students are in a passive learning state, with low enthusiasm, low concentration and unclear objectives, resulting in poor learning results. Today, with the rapid development of information technology, the abundant network resources, and the widespread use of mobile terminals, this traditional experimental teaching mode is obviously backward and not conducive to the overall improvement of students’ innovative ability and comprehensive quality.

The online teaching platform is one of the effective means to realize the combination of online and offline and promote the quality improvement of higher education. Meanwhile, the WeChat is one of the popular new media platforms in the new era and one of the most widely used tools by contemporary college students, with a popularity rate reaching almost 100%. In recent years, the WeChat platform has been increasingly introduced into higher education for reforming teaching modes and methods because of its advantages such as convenient operation, timeliness of communication, richness and accuracy of pushing contents [5, 6]. This platform can be used to assist experimental teaching to create an informative, lightweight, and mobile MOOC system. Through this platform, teachers can release learning resources, and students can watch, read, and learn anytime and anywhere using fragmented time to obtain the required knowledge, extending the space and time of traditional teaching. This online and offline deeply integrated teaching mode can play the dominant role of teachers to guide, inspire and monitor the teaching process, but also can reflect the initiative, enthusiasm and creativity of students as the main body of learning, which is a new direction and new idea of experimental teaching reform [7–10]. In view of this, we will design an online experimental teaching platform based on WeChat, comprehensively promote the construction of our university’s informatization experimental teaching platform, explore new modes of experimental teaching, and introduce the practice of the platform since its operation.

2 Design and Construction of Online Experimental Teaching Platform

2.1 Platform Construction Objectives

Under the background of the construction of the new engineering disciplines, in view of the practical problems in the process of experimental teaching of oil and gas storage and transportation engineering at Xi'an Shiyou University, the WeChat platform fully integrates the advantages of classroom teaching, mobile learning and flipped classroom, builds an online experimental teaching platform based on WeChat, provides services for professional experimental teaching, gives a platform for teachers and students to communicate and analyze and discuss, strengthens the interaction of experimental teaching information, continuous communication, and it also provides a platform for faculty and students to communicate and analyze and discuss, strengthens the interaction, continuous communication and resource sharing of experimental teaching information. Pull the distance between the laboratory and faculty and students, strengthens the awareness of teachers and students to actively participate in laboratory management, realizes the comprehensive combination of teacher-led and student-led teaching, explores the hybrid teaching mode of online and offline integration, improves the quality and teaching effect of experimental teaching, and promotes the cultivation of students' independent learning ability and collaborative innovation.

2.2 Construction of the Platform

1) Basic architecture of the platform

The WeChat-based online experiment teaching platform is based on the WeChat mini-program as the basic architecture, which contains two parts: The view layer (View) and the logic layer (App Service). The view layer is used to render the page structure, and the app service layer is used for logic processing, data request, and interface calls. They run in two threads. The view layer uses WebView for rendering and the logic layer uses JSCore for running. The view layer and the logic layer communicate through the WeixinJsBridge of the system layer. The logic layer notifies the data changes to the view layer, triggering the page updates on the view layer, and the view layer notifies the triggered events to the logic layer for business processing. The specific architecture is shown in Fig. 1.

The overall architecture of the online experimental teaching platform is mainly divided into three parts: The WeChat mini program, WeChat server and data management center, and the overall architecture diagram is shown in Fig. 2. The client part of the WeChat mini program mainly uses the MINA framework of applet, which including the WXML, WXSS and JavaScript, and the rich components it provides to complete the client interface design and function implementation, and the client of WeChat mini program interacts with the administrator and student users directly. The WeChat server is a data transfer station, mainly responsible for forwarding user requests to the data management center, which uses the server platform of Xi'an Shiyou University. The platform parses the user request data pushed from the WeChat server and selects the

corresponding logical processing modules for processing based on the data type and content, and the processed data is encapsulated and encrypted and forwarded to the WeChat client through the WeChat server.

2) Functional design of the platform

At present, the experimental course in oil and gas storage and transportation offers 36 experimental projects with a total of 105 credit hours. Students can choose the experiments they are interested in from the 9 module experiments, and a total of 48 credit hours. The course is assessed through attendance, lab prep, lab operation, experiment report and other links. Through the online experimental teaching platform, students can watch videos, experimental equipment, experimental instructions, etc. for pre-testing and writing pre-testing reports. After entering the lab, the teacher gives a brief explanation of the experimental project, and the students perform practical operations in groups and record the raw data; after the class, they write a formal report.

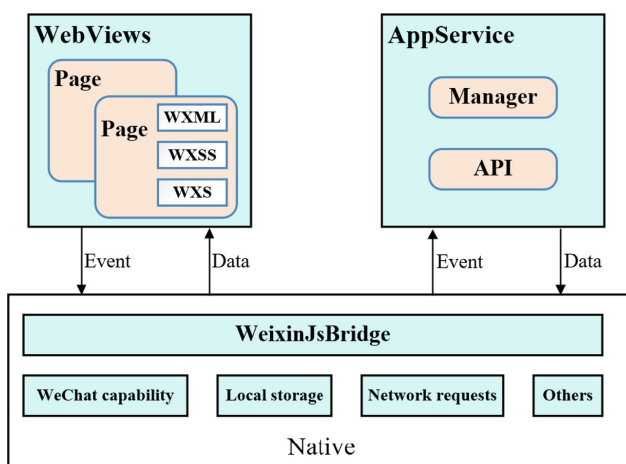


Fig. 1. The basic architecture of WeChat mini program

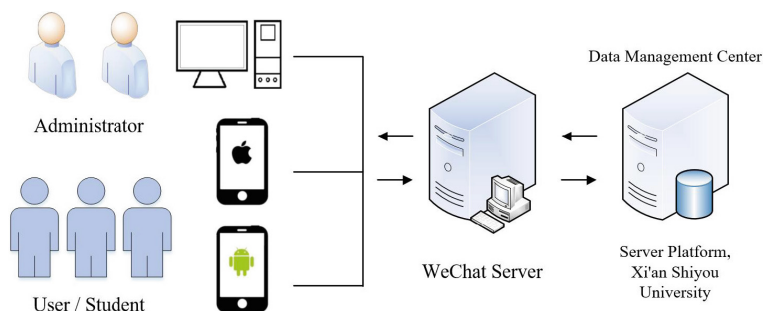


Fig. 2. Architecture diagram of WeChat online experimental teaching platform

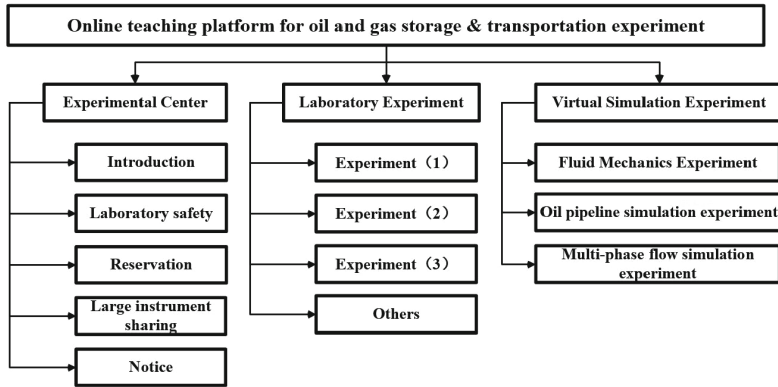


Fig. 3. The functional module architecture of the online experimental teaching platform

The functional design of the WeChat platform needs to meet the characteristics of experimental teaching, including not only the content of experimental teaching at the current stage, to meet the teaching mode, but also the richer information, more three-dimensional content, simple and clear interface, convenient for teachers and students to operate and experience. The basic modules include “Experiment Center”, “Laboratory Experiment”, and “Virtual Simulation Experiment”. The module structure is shown in Fig. 3.

a) *Experimental Center*

It includes 5 sub-functional modules: introduction to the experimental center, laboratory safety, reservation, large instruments reservation, and notice. It mainly introduces the current status of the experimental center, the development history, the teacher information, the safety management, the safe operation and other conditions, so that it is convenient for teachers and students to understand the development status of the laboratory. At the same time, open reservation is made for the regular experimental projects, graduation design, innovation, and entrepreneurship, “Challenge Cup”, “Internet+”, large instruments and equipment, etc., so it is convenient for students to conduct training of innovative experiments in science and technology. Besides, relevant laboratory notices are released to promote learning and communication between teachers and students and realize real-time interaction between teachers and students.

b) *Laboratory experiments*

The sub-functional module includes oil and gas storage and transportation professional experiments (1), (2), (3), and other related experiments. It is used to introduce the teaching videos, teaching PPT, instruments and equipment, operation procedures, safety precautions and other materials of the experimental courses taken by students of oil and gas storage and transportation in our university, so as to facilitate offline learning and increase students’ interest in the experimental classes.

c) *Virtual simulation experiment*

It includes 3 sub-functional modules: the fluid mechanics simulation experiment, the oil pipeline simulation experiment, and the multi-phase flow simulation experiment. It mainly provides virtual simulation experimental operation for the course can be opened in the virtual simulation experiments, so that students can be free to study without time and space constraints, and to experience a relatively real experimental environment.

3) Specific implementation of WeChat mini program client

a) *Create a WeChat mini-program client project*

Login to WeChat public platform: <https://mp.weixin.qq.com/>, and register a mini program account, then get the mini program AppID in the “Development Settings” option after the registration is completed. Open the WeChat web developer tools, and enter the project name, directory and AppID in the “New applet project” dialog box to create a default WeChat mini program. It contains the pages directory for storing pages and the utils directory for storing shared application logic libraries, as well as the mini program’s startup entry file app.js, the global configuration file app.json, the global style file app.wxss, and the project configuration file project.config.json. Each page file subdirectory contains a.js page scripts that implement the page business logic, a.json page configuration file to configure the current page effect, a.wxml page template structure file to build the interface, and a.wxss style sheet file to beautify the interface.

The online experiment teaching platform mainly consists of 4 pages: login, study, messages and me. These 4 pages all belong to the tabBar class page. When creating a project, you need to add the wxml file of these 4 pages to the tabBar configuration item in the app.json global configuration file.

b) *Login page*

The users can log in after entering their name, the student number and password on the page as shown in Fig. 4. After logging in, you can click “Study”, “Messages” or “Me” at the bottom of the page to switch to other interfaces, otherwise the wx.showModal() function will be called to pop up a warning message.

c) *Learning page*

After entering the learning page shown in Fig. 5, you can see 3 modules: experiment center, laboratory experiment, and virtual simulation experiment. Students can enter the corresponding module for learning according to their own needs. They can watch teaching videos, instruments and equipment, operating procedures, etc., and can also make reservations for various experiments and interact with teachers, etc.


4) Design and implementation of the backend database


The student login information and teaching materials access information is stored in the form of a database on the server platform of Xi’an Shiyou University, which can provide real-time data and file storage. The application database built by the server platform can store multiple different types of data such as String, Number, Boolean, Date, File, Array, Object, etc. The developers can create a database and download the corresponding version of the SDK to introduce it into the utils folder of the WeChat mini-program project. After initialization with the code, the database can be added, deleted,

China Telecom 9:49

× Login ...

Login

 Experiment Center of Petroleum and Natural Gas Engineering



Please enter your name

Please enter your student number

Please input your password

Login Reset

If you have any questions, please contact us,
Tel: 029-81469676

Login Study Messages Me

Fig. 4. Login page

changed, queried, and other operations similar to the local database through the WeChat server.

3 Application Practice of Online Experimental Teaching Platform

3.1 Platform Application Data

After the platform was built, it was first put on line for a trial run by the teachers of oil and gas storage and transportation engineering and the teachers of the experimental center of our university, and then gradually improved according to the feedback from the teachers after using it, and then applied to 34 students in one class of undergraduate 2018 in oil and gas storage and transportation engineering, and further improved according to the feedback from the students after using it, and finally let all the students of the major pay attention to this platform through the QR code. Up to now, the public platform has been open and running for teachers and students for nearly 18 months, with more than 1,200 accumulated users, covering almost all students in three grades. According to the background statistics of the online teaching platform, the average monthly number of frequent users is 381, accounting for 31.8%.

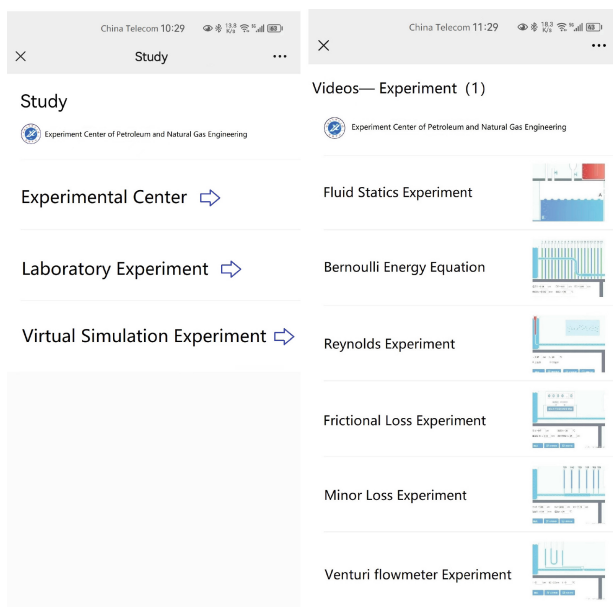


Fig. 5. Learning page

In the application process of the platform, most students can read and learn the teaching contents pushed by the teacher for the course in time, and complete various learning activities through the designed interactive menu. During the learning process, students can click the corresponding menu according to their learning needs, open the corresponding experimental project video, photos or courseware and other materials for independent learning, familiar with the experimental principles, experimental instruments, hands-on process, background knowledge, etc., understand the relevant content and then enter the laboratory will not feel unfamiliar, and no longer at a loss when carrying out experimental operations. The statistics in the background show that the cumulative number of times the video is played is 8,658, the per capita number of times it is played is 7.2, the per capita number of times the courseware is consulted is nearly 8.4, and the per capita number of clicks on the submenus of laboratory experiment and virtual simulation experiment is more than 3.3, which achieves the expected goal and shows that students have a certain sense of independent learning and are more active in active learning before class.

In addition, some students have made reservations for experiments on the platform according to their free time and laboratory opening hours. You can enter the reservation platform by clicking “Experiment Center” → “Open Reservation”, select the experiment item and enter the reservation interface, select the experiment time, enter your name, class, student number and phone number, and then you can make a successful reservation. Through the statistics in the background, teachers will summarize students’ applications and then announce the experiment time to students and remind them to come to the lab on time. In addition, students can make reservations for the use of laboratory

instruments and equipment according to their own needs when they are conducting graduation design, participating in innovation and entrepreneurship projects or innovation and entrepreneurship competitions, “Internet+” design competition, and other innovative experiments in science and technology. Since the platform has been running, every student in the class has made reservations for experimental projects before class, with a coverage rate of 100%. However, for innovative experimental projects such as graduation design, innovation and entrepreneurship, and “Internet+”, the number of reservations is low. The reason for this is that students usually do not have the demand for innovative experimental projects and do not need to use the laboratory instruments and equipment, but usually wait until the competition starts to have certain demand.

In order to prevent laboratory safety accidents, students are required to learn safety knowledge independently before entering the laboratory. In the function of lab safety, students can access the safety education documents, related knowledge, and videos by clicking “Experiment Center” → “Laboratory Safety”. However, since the platform has been running, the submenu of “Laboratory Safety” has been clicked 2.5 times per capita, which has achieved the expected goal, but there is no assessment link to evaluate the learning situation of students’ safety education, which is the direction that the teaching platform needs to be improved in the next stage.

3.2 Evaluation Effect of Teachers and Students

In order to test the operation effect of the public platform for teachers and students for nearly 18 months, feedback from 650 users (630 students and 20 teachers) was collected through a questionnaire survey. The results showed that: 100% of the teachers thought that the online laboratory teaching platform helped to improve students’ learning enthusiasm and stimulate their learning interest, and was willing to participate in the operation and management of the platform to improve students’ learning effect and to provide their own experimental teaching materials made or collected for students’ learning. 100% of the students thought that the online laboratory teaching platform had improved their interest in learning laboratory courses; 82.1% of the students The remaining 17.9% of students thought it was helpful; 100% of students watched teaching materials such as videos and PPTs before class, and only 3% of students thought it was a waste of time to pre-study before class; 97.3% of students thought that after watching the materials, they improved their knowledge of experimental instruments and operation steps, and improved their proficiency in doing experiments. The remaining 2.7% of the students thought that the teachers still needed to explain the experimental apparatus and operation steps in detail during the class; 96.8% of the students hoped that the online teaching platform would be used in other experimental classes to improve their interest and learning effect.

To compare the learning effects, the authors counted the results of the laboratory classes of the 2018 undergraduate students of oil and gas storage and transportation engineering (114 students) in the two semesters after using the public platform and before using the public platform, as shown in Fig. 6. It can be seen that most of the student’s grades were concentrated above excellent. After learning through the platform, the percentage of excellent increased from 2.6% to 7.0%, the percentage of a good

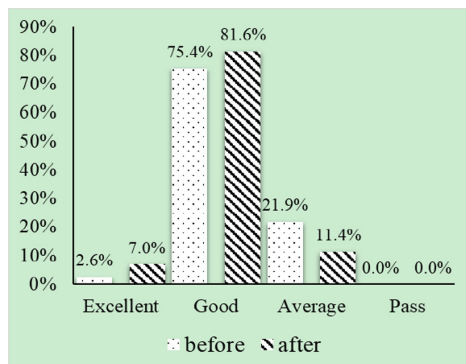


Fig. 6. The comparison of students' performance in lab classes before and after using the online teaching platform

increased from 75.4% to 81.6%, and the percentage of excellent and good increased by 10.6% in total, and the learning effect was improved compared with before.

The above evaluation results show that teachers and students highly recognize the WeChat-based online laboratory teaching platform for supporting laboratory teaching, which not only improves students' learning enthusiasm and stimulates classroom vitality, but also greatly enhances students' learning effect. The students give a high evaluation to the platform in terms of knowledge learning and ability improvement, and teachers also feel that students are more confident and active in the lab, and their enthusiasm for learning and classroom vitality has improved significantly.

3.3 Continuous Improvement of Platform Operation

Since the platform has been running, although certain achievements have been made, a few students who are not active still need to focus on the classroom, and their experimental operations should be patiently guided in the classroom. At the same time, some students hope that the teacher will explain more about the design method and design process of the experimental scheme and other teaching materials that are not provided in the platform, and also put forward their own opinions on the problems that arise in the experimental process, which indicates that there are still many students with a high degree of thirst for knowledge and a strong desire for knowledge. In the teaching process, teachers need to teach students according to their abilities, not only to take care of the "indigestible" students, but also to guide the "underfed" students to explore actively and innovatively.

At present, the teaching materials provided on the platform are still limited to the regular experimental teaching items required by the syllabus, and less involved in the design and innovative experimental items. The next step is to increase such experimental items to facilitate the improvement of students' creative awareness and innovative thinking. At the same time, it is necessary to provide more display and introduction of instruments and equipment in the laboratory, so as to facilitate students to develop new functions of experimental instruments, design and complete more valuable innovative experiments

in scientific research by using the existing laboratory conditions, and improve the ability of independent innovation.

4 Conclusions

The online experimental teaching platform of oil and gas storage and transportation based on WeChat designed and built in this article is a product of the integration of experimental teaching and mobile Internet under the guidance of the document of the Chinese Ministry of Education and the background of the construction of new engineering disciplines, which is an effective tool to realize the reform of teaching mode of online and offline deep integration, expanding the space and time of traditional experimental teaching. It has practical significance to promote the reform of experimental teaching and the improvement of teaching quality. In the process of operation and practice, the platform has been unanimously praised by teachers and students, and the students' learning enthusiasm has been greatly improved and the learning effect has been enhanced. At the same time, the psychological and spatial distance between the laboratory and teachers and students has been brought closer, the awareness of teachers' and students' active participation in laboratory management and operation has been strengthened, and the interactive and continuous communication range of teachers and students' information has been expanded, which has achieved the expected construction goal of the platform.

In the subsequent operation process, it is necessary to further explore the reform of flipped classroom teaching mode in combination with the platform, transfer the initiative of learning to a greater extent from teachers to students, provide students with experimental teaching design mode with practical guidance, transform the original experimental classroom to obtain better teaching effect, and provide the basis for cultivating and promoting students' independent learning ability and innovation consciousness. To make contributions to the professional certification and the construction of first-class majors of oil and gas storage and transportation engineering, and add bricks to improve the quality of higher education personnel training.

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