Exploring The Virtual Simulation Teaching Mode of Programming Course

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Abstract— With the outbreak of COVID-19 in early 2020, conventional teaching methods have been altered, and the focus has shifted to network-based teaching. An essential component of incorporating technology into education is teaching experiments using virtual simulations. We propose a teaching method based on applying virtual simulation technology to programming experimental courses in order to address the problems of decoupling theory and practice, poor practical teaching effect, and inadequate experimental resources. This study's research approach was design thinking. In this article, we discuss how to construct a teaching platform for a virtual simulation experiment that consists of a server and an experiment terminal and is based on the campus network. The administrative layer, the service layer, the application layer, and the display layer are the five tiers of a platform system design. An experimental teaching resource sharing mode is introduced, and the experimental results through the use of platform applications are demonstrated. The teaching practice has proved that the students' professional interest and innovation consciousness have been significantly improved after the virtual simulation experiment teaching, and the transformation from "teaching experiment" to "experimental teaching" has been realized.

Index Terms—*Driving Virtual Simulation Teaching Mode; Programming Course; experiment teaching*.

I. INTRODUCTION

The development of virtual simulation systems and digital technology advancements have aided in the gradual emergence of the new era[1]. Despite the fact that certain schools and universities have undertaken or are undertaking experimental teaching reform trying to apply new teaching resources to realize online experimental teaching [2]-[6], but it has not been fully popularized, and the reform process of colleges and universities in some remote areas is slow. Starting in 2020, COVID-19 was widespread around the world. Many schools and universities implemented various steps to jointly execute and ensure online education in order to realise the vision of "classes halted but learning and instruction proceed." As a result, progress in altering the way virtual simulation experiments are taught has been made significantly more quickly [7].

The creation and exploration of virtual worlds in virtual reality technology may be done using a computer simulation system (VR). Due to its capacity to mimic the immersive environment of real life, users may encounter a variety of sensory stimulation and a kind of immersive experience[8]. The use of virtual reality technology to aid in teaching by doing has rapidly increased over the last several years in China and throughout the globe [9].

Degrees in computer science and information technology, AI, internet security, and building computer networks are widely available from universities and other educational organisations. As shown by the following features, the majority of colleges and institutions' current laboratory apparatus and tools fall well short of what is needed for an instructional experiment [10]-[11].

Limited configuration of experimental equipment. Nowadays, many universities have multiple campuses distributed in different places. For the experiment of the same course or the experiment using the same software platform, teachers can only open the experiment in multiple different campuses. For some experimental courses that need to install large-scale software, due to the limited configuration of experimental equipment, students need to go to and from multiple campuses, so the sharing of development platforms cannot be realized, which occupies part of the experimental time.

The gadget has a low configuration due to the large number of students and majors engaged.. At present, the hardware equipment configuration of computer experimental center is low, which can not keep up with the development of computer hardware and software technology. Experimental instruments and equipment are expensive, and the number of them is small, but the requirement for practical operation ability is high, which makes it difficult for students to learn and use the above experimental instruments and equipment in the limited experimental class hours.

Few times are available for classes. Due to a poor

evaluation method, insufficient class time, and other issues, students in the experimental class are unable to comprehend and digest the material completely., and the large amount of students taking part in the experiment makes it even more challenging, so it is difficult to repeat the experiment in the laboratory. Therefore, when students encounter problems in reviewing or writing experimental reports, they can only recall the experimental scenes.   Therefore, this could result in inaccurate experimental results, which could lead to errors in future experiments or equipment failures.

The above problems require teachers to abandon the single teaching model of conventional experimental teaching, high cost of experimental equipment, high consumption of experimental process, a flawed assessment system and other issues. Furthermore, they lack the time to conduct studies on the use of digital technologies in experimental education as well as the combination of theoretical and experimental instruction. The benefits of virtual simulation software outweigh the drawbacks of on-site deployment circumstances and operations. These benefits include intuition, interaction, as well as repetition. Utilizing virtual simulation experiments, instructors may help students develop their practical abilities while accelerating the pace of educational reform[12].

Based on the above problems, the purpose of this paper is to design an experimental teaching platform of program courses by using virtual simulation technology, which can be used in the teaching of program courses. At the end of the course, a questionnaire was released to allow students to evaluate the experimental teaching content, teaching methods and teaching effects, and put forward their opinions and suggestions. Through the analysis of questionnaire survey, summarize the effect and deficiency of virtual simulation teaching platform.

II. METHODOLOGY

This study uses virtual simulation technology to design and construct experimental teaching platform, which is used in teaching. At the end of the course, the quantitative analysis of the teaching effect is carried out by means of questionnaire survey, and the influence of virtual simulation teaching platform on the teaching effect of program courses is summarized.Consider constructing experimental teaching resources and sharing an open environment as a fundamental objective, a computer virtual simulation experimental teaching platform is built to cultivate learners' technical application ability and innovation consciousness .

A. Platform architecture and function

The platform is built on the university's network and comprises of a server as well as an experimental terminal. To assist the experiment terminal login application and store the experiment's findings, experimental reports, and other data. The server module has been configured with a virtual administration system for instruction and experimentation. A VR system simulation platform is created for users by the experimentation terminal module. Students can directly input their student number for registration and complete the experiment at any time. Teachers can share experimental

data, teaching staff and laboratory managers can publish courses and manage instruments and equipment, all of which are helpful to realize the networking, digitalization and intelligence of experimental teaching.

The virtual simulation experiment teaching platform is used by students, instructors, system administrators, and others for programming lessons. Five layers represent the system's structure in Figure 1. Management oversees, manages, and administers the whole basic system. The service layer is in charge of maintaining and administering the resources for the experimental project as well as certain general support elements of the virtual experimental education environment. The application layer mainly conducts online classrooms, experiments and experimental scene modeling for course groups, and conducts assessment and analysis for the courses and experiments, and this layer is used to instal certain apps that consumers may access directly. On the digital simulated experimentation education platform, the display layer is mostly used to access experimentation and projects for experimentation.. The access layer provides administration and interfaces for instructors' and students' experiments and evaluations, as well as mechanisms for access to overseas schools and cooperative companies.
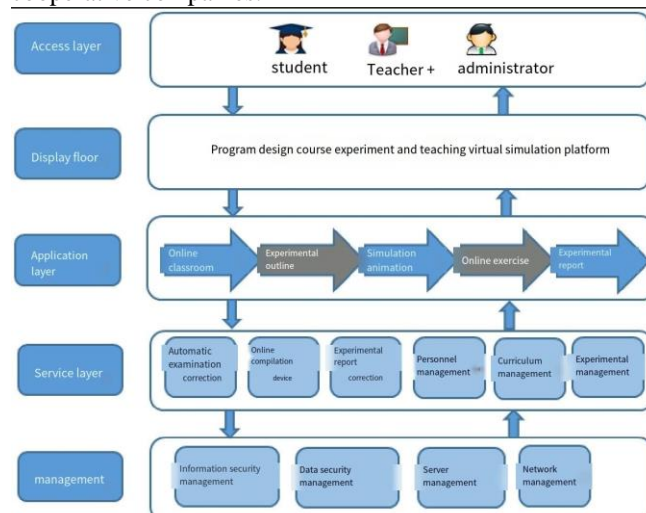

Fig.1 System frame diagram

B. Experimental case

We provide a summary of the specific implementation approach and experimental material of the project in the subsequent paragraph based on the extended experiment "tunnel extensive monitoring system" that was used for the virtual simulation environment.

Experimental implementation process of the tunnel integrated monitoring system.The teacher assigns the experimental task. The teacher creates experimental tasks through the virtual simulation teaching system, including clear experimental objectives, requirements, and assessment standards, and provides necessary relevant materials. Fig.2 illustrates this. Then, instruct the students to conduct the experiment.
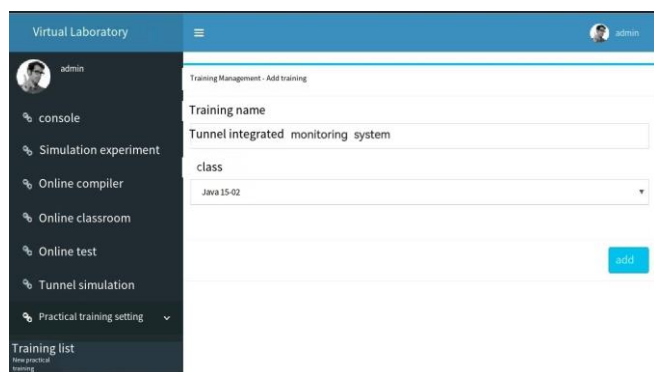
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Fig.2 Creating an Experiment Task

Experiments are accepted by students. Students receive, view, and learn the experimental tasks through the virtual simulation teaching system, and complete the preparation work such as team building, member role assignment, as well as preliminary project study depending on what is required by the assignment.

The experiment is under the instructor's control. In the process of the experiment, the teacher emphasizes software engineering specifications, and inspires students to think independently about the design guiding questions such as the demand analysis, developing and implementing the project; Address student concerns as soon as they arise, keep students interested and open to new ideas, help them become more analytical and problem-solving savvy, and promote teamwork. Observe how well pupils do throughout the procedure and base your assessment of the process on that.

Students finish their experiments. Students may see the results of the example once it has been completed thanks to the virtual simulation teaching method, which aids in their understanding of the precise objectives of the experiment., and develop the project in a team cooperative manner, and complete the task for which they are personally responsible according to the experimental instruction. At any time during the development process, students can use the interactive functions provided by the project examples to gain insight into the implementation of specific functions, as shown in Fig.3.

Fig.3 Example of project interaction

Submit experimental results. By using the virtual simulation teaching system developed by the scheme, students submit experimental reports and experimental results.Teachers review students' experimental reports online, and the relevant data are recorded automatically by the system. Fig.4 illustrates this.
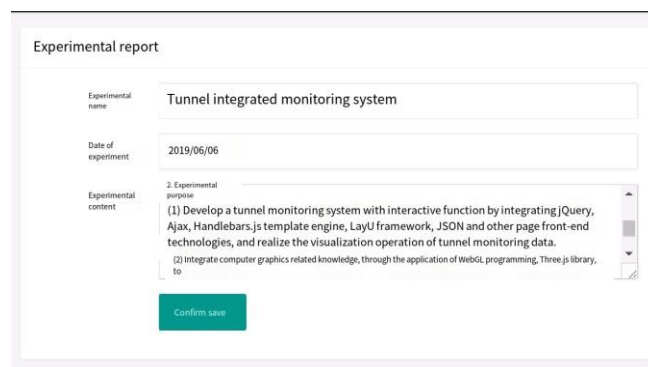

Fig.4 Submit lab reports online

Experimental content of tunnel integrated monitoring system:In order to implement the system, students must finish at least the interactive operations below.2D geometric mapping, including roads, tunnels, traffic lights, lights, variable message signs, channels, emergency phones, security doors, control rooms, etc.; The 2D geometry is then superimposed to generate a 3D tunnel model；Add textures and materials to the 3D geometry to realize the field of view and visual angle transformation of the 3D model; The impact is depicted in Fig.5.

Fig.5 Some 3D geometry

Adjust the tunnel's shape to reflect changes in its attributes, such as changing the lighting to reflect changes in brightness; The information shown on the changeable information signs and the traffic status of the tunnel will vary as the flow of traffic does.Preview the tunnel panorama in Flash animation form through the control room,dynamically read tunnel parameters, such as smoke, carbon monoxide, wind direction, wind speed, light intensity, and display basic information such as tunnel name, construction, design, and maintenance.

III.   RESULTS AND DISCUSSION

A. Course assessment method

During experimental teaching practice, teachers continue to refine their evaluation methods and include a greater percentage of process evaluations in their evaluations gradually build a perfect process evaluation system before class. Both in-class and out-of-class assessments should include how effectively students comprehend, apply, and utilise their information as well as their problem-solving skills. Project acceptance, process assessment, and experimental report make up the final evaluation outcome. The specific assessment content and proportion are shown in Table1.

Among them, process evaluation assesses students' experimental process performance and non-technical ability, while lab report assesses students' documentation ability.

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Table1 Course assessment content and proportion

Items	Contents	Scores
Project Acceptance	Completion of experimental tasks; Having mastered front-end page design, system analysis and modelling, software engineering, and Java Web framework technologies, they have completed the requisite amount on their own., knowledge and technology related to software testing	60
Process Evaluation	Serious learning attitude, discipline compliance; The capacity to consider, examine, and resolve issues; ability to work together with others; and the capacity to organise, coordinate, and communicate with others.	20
Lab Report	Reasonable design scheme, accurate lab report, standard diagram	20
Total Score	The following five categories are used: excellent, good, medium, pass, and fail	100

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B. RESULTS

As opposed to conventional offline experiments, virtual simulation experiments allow students to freely design and verify their own ideas in a virtual environment. Therefore, it can greatly enhance their practical ability and innovation awareness. After the course, a course survey questionnaire was distributed to students, which allows them to assess the experimental teaching content, teaching methods, and teaching effects, as well as express their opinions and suggestions. For the survey, 60 students were picked at random.The teaching effect evaluation of students' feedback is shown in Table2.

Table2   Teaching effect feedback form

Evaluation Index	Proportion
Be very interested in virtual simulation teaching experiment	87%
Effectively improved the ability of independent learning	94%
Effectively improved the ability of program design	84%
Effectively improved the ability of practical innovation	91%
Efficient communication, teamwork, self-directed learning, as well as collaboration skills have all considerably increased.	*88%*
The evaluation of practical teaching effect is good	94%

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C. DISCUSSION

In conclusion, instructors have been able to increase their efficacy as teachers by using the virtual simulation experiment platform to teach programming courses, and pupils have improved their understanding of the subject matter and skill development. This is due to the fact that using virtual education tools in the classroom helps lighten students' cognitive loads and hasten their assimilation of theoretical information. In addition, effective teacher-student interactions facilitate teachers' understanding of students' acceptance of new knowledge, allowing them to adjust teaching content, improve teaching methods, create the finest lesson plan possible and enhance the quality and efficacy of their work[13].

This research employs a virtual simulation experiment to teach a programming course in order to get past the issues with conventional teaching techniques. As a result, it becomes simpler for students to actively engage in the learning process, passive learning is transformed into active learning, bold questions, creative exploration, and individualised learning are encouraged, and the students' ability to learn as well as their practical, creative, and innovative talents are all improved. Give pupils a more engaging and efficient learning method[14]-[15].

However, students need to further change their learning concepts, not limited to the study of textbook content, but should take the initiative to complete pre-class knowledge research and after-class extended learning. At the same time, they should be more hands-on, more practical, improve the hands-on ability to adapt to the teaching method of virtual simulation experiment[16]-[18].

CONCLUSION

Simulation experiment teaching offers several advantages, including a safe and risk-free teaching and training process, high efficiency, a real learning experience, the ability to adjust the teaching process, and diversified knowledge points. Reforming computer programming and training techniques, improving training, and coming up with new applications for what you learn are all crucial in the subject of computer programming education . By using the virtual simulation teaching platform, learners can benefit from an advanced and flexible environment. It may encourage pupils to study by helping them develop their own concepts and designs. This has improved education technology, teaching and experimental training settings, teaching procedures, teaching efficiency, and teaching expenses. It has also sped up the development of individuals who are proficient in using contemporary computer programming technology. . Additionally, it will aid in the reform of education and the related research. In the field of computer programming, teaching offers a broad variety of possible applications.

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