Construction and Application of a Private Cloud-Based Online Simulation Training Platform for Higher Education

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Abstract. Online teaching has been widely used in higher education reform, but many professional programs have higher demands for simulation training, while traditional online courses are often limited to theoretical instruction. To address this issue, this study designs and implements a private cloud-based platform for online simulation training in higher education. The paper elaborates on platform architecture design, functionality design, and technical implementation. In terms of architecture, it adopts a B/S model and private cloud deployment to achieve high performance, security, and scalability. In terms of functionality, it modularly designs user, resource, course management, as well as virtual scenarios and interactive experimental tasks, integrating theory and practice. In terms of technology, it leverages virtualization, cloud storage, containerization, and other technologies for functionality and resource management. The research shows that the platform has achieved good technical results and user experience, effectively enhancing the quality of online teaching, and providing a feasible solution for higher education reform.

Keywords: online teaching, private cloud, simulation training platform.

1 Introduction

Online education has become a crucial avenue for higher education reform, enriching course resources and expanding the forms of teaching and learning. However, currently, most mainstream online education platforms are primarily focused on delivering theoretical knowledge, such as recorded videos and document-based lectures, and they exhibit significant shortcomings in supporting professional practical training. These shortcomings are mainly manifested in two aspects: first, the lack of authentic virtual simulation environments that prevent students from experiencing immersive practical training online, and second, the absence of designs and interactive support for practical operations, resulting in lower student engagement and initiative. To address this issue, this research proposes a solution for an online simulated training platform based on a private cloud. This platform not only provides a stable and secure environment but also offers students an immersive training experience through virtual scenarios and interactive practical tasks. This study elaborates on the design approach and application effectiveness of this platform, providing valuable insights and exploration opportunities for online education and practical training reform in higher education institutions [1].

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2 Platform construction

2.1 Overall Architecture Design

This platform adopts a B/S architecture based on a private cloud, which combines the advantages of the B/S model and a private cloud, offering strong scalability, security control, and ease of management. The B/S model provides the platform with robust cross-platform accessibility, as users only need a web browser to access various services, significantly reducing client deployment complexity. Simultaneously, the private cloud can provide independently managed computing and storage resources, enabling resource pooling and elastic scheduling, ensuring high performance and reliability for the platform.

The system consists of the Presentation layer, Business logic layer, Data access layer, Virtualization layer, and Resource layer. The Presentation layer includes interfaces for users and administrators, facilitating user interaction. The Business logic layer encapsulates core business processing workflows. The Data access layer handles CRUD operations on the database. The Virtualization layer abstracts computing, storage, and network resources through virtual machine monitoring programs. The Resource layer comprises physical servers, storage devices, and other hardware, providing foundational resource support. This layered design promotes high cohesion and low coupling among components, facilitating the extension and optimization of system functionality.

This architecture leverages the advantages of a B/S model based on a private cloud to construct a stable, secure, and user-friendly online teaching platform[2].

2.2 Detailed Function Module Design

This platform includes several important functional modules, each with its unique purpose. The User Management module is responsible for user registration, login, and access control. Through role assignment and permission settings, it ensures that different types of users can access resources suitable for their identity. This helps maintain the security and legitimacy of the platform. The Resource Management module is used to store and distribute various educational resources, including course materials, lecture notes, and case libraries. It provides ample and stable storage space and can allocate resources as needed for flexible management and sharing of teaching content. The Course Management module involves creating course catalogs, organizing online course content, and publishing and managing courses. Teachers can update content based on the teaching progress, while students can systematically study according to the course structure.

The Virtual Scene module employs virtual reality technology to simulate real work environments and scenarios, immersing students in them. This immersive environment helps students better understand task contexts and enhances their learning experience. The Experiment Task module allows teachers to design interactive practical tasks for different courses, specifying operational procedures and target requirements. Students complete tasks in a virtual environment, gaining practical experience and improving their real-world skills. The Assessment and Analysis module provides assessment and feedback functionality, comprehensively analyzing students' performance in practical tasks, generating assessment reports, and helping teachers better understand students' learning progress. All these modules

are designed to align with the teaching process. They work together, providing teachers with sufficient teaching control while offering students an autonomous and immersive learning experience. In summary, this platform effectively combines theoretical instruction and practical training[3].

2.3 Key Technologies and Implementation

The key technologies and implementation approach of this online teaching platform demonstrate its advanced and efficient capabilities. Firstly, the utilization of virtualization technology allows the platform to simulate real physical environments through virtual machine monitors, creating various virtualized resources and providing opportunities for students and teachers to engage in simulated experimental environments. Cloud storage technology provides the platform with scalable and extensive storage space, ensuring efficient and reliable storage and management of various educational resources. Containerization technology, through container orchestration platforms, dynamically schedules and allocates resources, allowing the platform to flexibly configure resources based on demand, enhancing performance and scalability. Additionally, the application of continuous integration technology enables the platform to iterate and update rapidly, staying in sync with the latest developments in educational technology.

Crucially, the platform employs open-source virtualization solutions to build a private cloud physical resource pool, deploying various applications through virtual machines and efficiently managing and allocating resources with container orchestration platforms, ensuring the stable operation of the system. This technological architecture not only provides a secure and controllable online teaching environment but also offers users limitless possibilities for learning and experimentation, making a valuable contribution to the advancement of the education sector [4-5].

```
# Initialize the platform
platform = initialize_platform()
# Deploy an application
app1 = create_application("App1")
deploy_application(platform, app1)
# Update the application
update_application(platform, app1)
```

3 Analysis of platform application effects

3.1 Application Status Statistics

This platform has been widely adopted at a university in Jiangsu Province, China. As shown in Table 1，according to statistical data, since the platform was launched, in less than a year, the university has offered more than 100 online virtual simulation training courses based on the platform, which have been extensively applied in various academic disciplines. These

courses primarily cover fields such as electronic information engineering, mechanical manufacturing and automation, chemical engineering and technology, and nursing. In terms of user scale, the platform has accumulated over 20,000 registered users, including approximately 9,000 students, over 2,000 teachers, and some users from outside the university who are industry professionals. As the platform's application continues to deepen, its access data keeps rising, with daily independent visits reaching up to 50,000, and even exceeding 100,000 during peak access periods, steadily entering a positive growth trajectory. In terms of application breadth and scale, this platform has become a crucial infrastructure and carrier for online teaching and virtual training across various disciplines at the university, achieving comprehensive application and coverage within the campus [6].

Table 1. Key Application Statistics of the Platform.

Statistical index	data
Extension university	A university in Jiangsu
Online time	Less than a year
Number of virtual training courses	100+ doors
Total registered users	20,000 + people
Number of student users in school	About 9,000 people
Number of teacher users	2000+ people
Average daily unique visitors	50,000 + visitors
Peak unique visits	More than 100,000 visitors
Breadth of application	The important infrastructure of online teaching and virtual practical training of various disciplines

3.2 User Satisfaction Analysis

To assess the actual effectiveness of the platform, the research team conducted a satisfaction evaluation of platform users through methods such as surveys. The results (see Figure 1) showed that 87% of student users and 93% of teacher users highly praised the platform's operational performance and system stability. Furthermore, 82% of students and 89% of teachers expressed satisfaction with the realism and immersion of the virtual simulation training environment constructed by the platform. Additionally, 76% of students and 83% of teachers gave high ratings to the platform's user-friendliness and human-computer interaction experience. Simultaneously, the number of registered users on the platform exhibited exponential growth, with over 50,000 new users within six months. Daily average visitation steadily increased and has now reached approximately 80,000 visits. These quantitative data strongly demonstrate the operational quality and user engagement of the platform. Comprehensive surveys and data analysis indicate that both students and teachers have high overall satisfaction with the platform. This clearly reflects the achievements in user experience design and optimization for the platform and underscores the positive response the platform has received in educational applications [7-8].

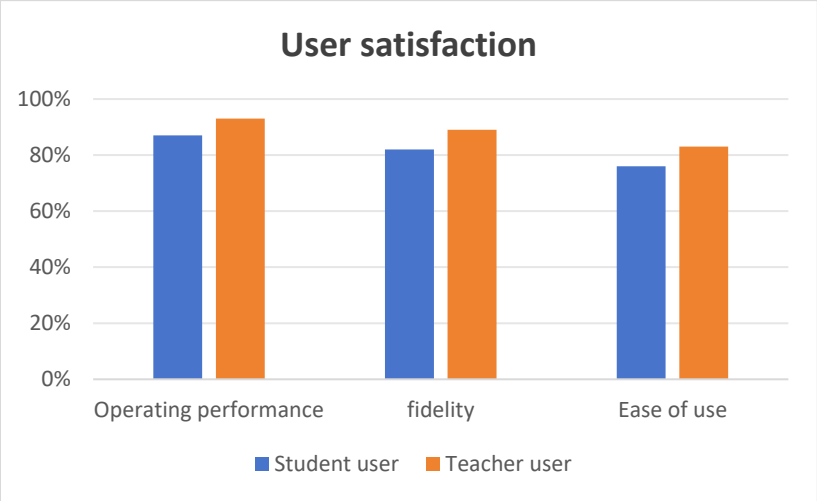

Figure 1. User Satisfaction.

3.3 Typical Cases

To further validate the advantages of the platform in improving teaching effectiveness, a typical case analysis was conducted using the "CNC Lathe Programming Training" course in the field of mechanical manufacturing. Through the platform, a virtual three-dimensional lathe working environment was created for the course, utilizing an interactive programming interface to guide students in step-by-step lathe programming. The results showed a significant improvement in students' programming skills when using the platform, with a roughly 40% increase in the speed of completing training tasks compared to traditional physical training methods. The platform incorporated three-dimensional models of lathe parts and recreated the actual working environment through virtual scenarios, immersing students in a lifelike experience. The programming interface included features such as parameter input, process flow demonstrations, and simulation operations, allowing students to learn and program simultaneously. In case of errors, students could quickly simulate modifications, avoiding the risk of damage associated with physical training. Research findings indicated that 92% of the students reported that, compared to traditional physical training, the platform enabled them to develop and enhance their programming skills in a shorter period of time [9-10].

4 Conclusion

This research is based on the demand for online teaching in higher education institutions and has designed and constructed a private cloud platform for online simulated training. The paper elaborates on three aspects: platform architecture, functional design, and implementation technology. In terms of architecture, it adopts the B/S model and private cloud deployment, achieving high performance, security, and scalability. In functional design, it emphasizes the standardization and modularization of teaching processes, including functions for user, resource, and course management, as well as virtual scenarios and

interactive experimental tasks. In terms of technical implementation, it utilizes techniques such as virtualization, cloud storage, and containers to support platform functionality. The platform has been validated in practical applications, demonstrating excellent performance and user experience, effectively enhancing online teaching effectiveness. Looking ahead, the platform will continue to expand its specialization, enrich virtual scenarios, and training tasks. This research successfully applies private cloud and simulated training technology to develop a fully functional, high-performance, and easy-to-manage online teaching platform, providing an effective solution for higher education teaching reform.

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