Research on the Construction and Application of A Cloud Computing Experiment Platform for Computer Science General Education Courses

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Abstract. Cloud computing is a new type of service computing model that has developed rapidly in recent years. This paper analyzes the common problems in the experimental teaching of computer science general courses in colleges and universities and combines the significant advantages of cloud computing in dynamic allocation and flexible sharing to build a cloud computing experiment platform for computer science general education course. The platform of general education curriculum, design platform structure and experimental system model are designed, and then the practical effects and advantages of the platform are analyzed. Practice shows that the platform has certain application values, and it can effectively stimulate students’ interest in learning and enhance teaching effect.

1. Introduction
The computer general education courses are a basic education in colleges and universities. Experimental teaching is the most effective method and means in computer education, and it is an important link in cultivating students’ application ability and innovation ability[1]. With the concept of “Internet Plus” widely applied to all walks of life, the current market demand for comprehensive talents familiar with computers is becoming more and more urgent, and the importance of computer general education courses is increasingly valued by universities[2]. Cloud computing is a new type of service computing model that has developed rapidly in recent years. It has the characteristics of centralized management, on-demand service, dynamic allocation, and open sharing. In recent years, many universities in China have done research on cloud-based applications[3]. This paper combines cloud computing technology with computer generalization courses to build a cloud computing experimental platform for computer science general education, and analyzes the practical effects of the platform.

2. Analysis of the Current Situation of Computer Science General Education Courses
The current computer science general education course has changed little in the background resources and teaching mode for a long time, and it has been difficult to meet students’ need in fragmentation, mobilization, and individualization[1][2][3]. For instance, our school Jinan University is a 211 comprehensive university. The computer science general course groups consisting of “University Computer Foundation”, “Program Design Basis”, and “Information Technology” are open to undergraduate students from all campuses and schools. In the teaching process in recent years, according to the follow-up survey of the experimental teaching series of courses, as well as the investigation and analysis of relevant literature resources, it was found that the following problems are common.
2.1 Students are not Good at Setting Up an Experimental Environment.
According to the teaching plan, the general computer science courses are generally opened in the first year. The course is taught to freshmen whose major is not computer science from all the schools. Their computer foundation is generally weak, and they are not good at configuring the experimental environment. However, professional software environment requirements are high, students need to configure more complex environmental parameters to learn, and this consumes unnecessary time and energy.

2.2 Experimental Practice Environment and Time are Limited.
The duration of the experimental teaching in each class is often 2 to 3 sessions, excepting the allotted time for the teacher to explain and demonstrate, leaving little time for the students to operate autonomously. Under the existing condition of traditional experimental teaching, students cannot carry out their own activities after leaving the public experimental environment. Since the experimental teaching environment cannot be accessed anytime and anywhere, so many students not having completed the current experiment have to start new experiments.

2.3 The utilization Rate of Computer Science Laboratory Resources is Low.
There are currently five campuses in our university. Students are widely distributed in various campuses. The total number of students is more than 4,000 per year. The computer science general education courses are available to all undergraduate students’ experimental classes. In order to meet the requirements of experimental teaching in each campus, the experimental platform needs to be applicable to each campus. Repeated reconstruction and configuration of the campus’s laboratories has resulted in a low utilization rate of experimental resources.

3. Cloud Computing Experimental Platform Construction

3.1 The Concept of Cloud Computing
Cloud computing technology is a new computing model generated in the context of the continuous development of information technology[3][4].Wikipedia defines cloud computing as an Internet-based computing approach in which shared hardware and software resources and information can be provided to computers and other devices on demand. The core idea of cloud computing is to use high-speed networking to bring together computer hardware resources to form a service cluster, that is, a large “resource pool”. All program software and data storage run in this “resource pool”, which is based on user requirements. The dynamic allocation method provides services, and users can access these services through ordinary terminal devices that can connect to the Internet regardless of time and place[5].

3.2 The Overall Structure of the Experimental Platform
Applying cloud computing technology to the experimental teaching of computer general education courses can effectively solve the above problems[6]. First of all, we must build a cloud computing experimental platform, the overall structure is shown in Figure 1. The bottom layer of the cloud computing platform is a server cluster composed of servers and dedicated storage[7]. Virtualization technology is used to form the underlying physical resources into a unified virtual resource pool. By constructing a cloud resource management service platform, users, data and services are managed in a unified manner. The access mode of the experimental platform is more flexible. During the course, students connect the computer terminals to the cloud platform in the laboratory. After class, they can get access to it anytime and anywhere through ordinary terminals (such as smart phones and tablets).
3.3 Experimental Teaching System Model

According to the overall structure of the cloud platform, we designed an experimental teaching system model based on the cloud computing platform[3][8]. As shown in Figure 2, there are four layers, including infrastructure layer, system management layer, application service layer and user access layer. Based on the cloud computing experimental platform, diverse teaching services and requirements are deployed on the platform.

Figure 1. Overall structure of the cloud computing experimental platform

Figure 2. Cloud-based experimental teaching system model
3.3.1 Infrastructure Layer
The hardware devices of the cloud platform are composed of a high-performance server cluster, a dedicated storage cluster, and a network switching device, providing computing resources for users, and forming physical resources into a unified virtual resource pool through virtualization technology. Take VMware, one of the mainstream virtual engines in the current market, as an example[9]. A VMware ESX Server in the underlying server cluster is set up to configure the server virtualization environment and separate the application and operating system from the underlying hardware.

3.3.2 System Management Layer
The virtual desktop is deployed and configured on the cloud computing node to dynamically plan and manage the cloud platform resources, and provide functions such as virtual resource management, service configuration, and real-time monitoring. Deploy core service components of the VMware vSphere cloud platform, including server virtualization infrastructure (ESX/ESXi), centralized management (vCenter), client connectivity (vSphere Client), browser connectivity (vSphere Web Client), and other management tools [7]. VMware vSphere leverages virtualization to transform data centers into cloud computing architectures, enabling physical machine shared storage, virtualizing servers, storage and operating systems, and managing virtual machines and end users online.

3.3.3 Application Service Layer
It mainly includes three modules, experimental resource sharing, experimental assessment and teaching quality analysis. Incorporate advanced education concepts such as micro-curriculum and MOOC, integrate high-quality electronic resources (video, courseware, experimental textbooks, experimental reports, literature, and cases) to establish a shared library of experimental teaching resources, and share interoperability in multi-school areas. Establish an open question bank system, provide mock exams and online exercises, so that the experimental habits of teachers and students are not limited by time and place, and meet the needs of users’ diverse learning. The online assessment method is used to replace the traditional routine assessment method, which provides a more scientific and effective experimental assessment mechanism for the development of experimental teaching. Focusing on the computer science generalization course groups represented by the "University Computer Foundation", "Program Design Basis" and "Information Technology", the core knowledge points of the course are deeply explored and streamlined and refined, and the corresponding experimental teaching content is designed. Combining the experimental teaching philosophy with the core of "computational thinking" as a basis and designing the experimental process model of "inspiration-experiment-innovation" to go through the teaching process of the experimental content so as to expand the students’ knowledge breadth gradually.

3.3.4 User access layer
Users can log in to the cloud platform anytime, anywhere through the browser, PC client end, and App client end to apply for cloud resources and personalize the experimental environment. The cloud platform provides a variety of experimental environments including mainstream operating systems, database management systems, software development language environments, distributed data processing, and mobile application development. These systems are characterized by fast-deployment, easy backup and restoration, and local-independence.

4. Practice Effects and Advantage Analysis of Cloud Computing Experiment Platform

4.1. Practice Effects
Computer science general education courses in colleges and universities generally have the characteristics of having many students and therefore there are many courses. Taking the number of students in the class of 2018 in Jinan University as an example, the “University Computer Basics” course had an enrolment of 1966 students, the “Information Technology” course enrolled 1,250, and the “Programming Basics” course enrolled 1,130. In the teaching content, the computer general education courses keep pace with the development of information technology, and the knowledge
points are updated often. According to the teaching plan, students will complete the above courses in the two semesters of the freshman year, not only to learn the basic knowledge of the theory, but also to master computer software skills such as Python, Java, Anaconda, Office, Dreamweaver, Flash, Photoshop, etc. In recent years, how to improve students’ learning efficiency and improve teaching quality has become a hot issue in current computer science general education courses.

In the past, when the traditional laboratory was conducting experimental teaching of the computer general courses, it was carried out in a PC-only mode. The cloud computing experimental platform was put into use in 2016 and has been expanded to accommodate up to 300 users. As shown in Figure 3, the vCenter interface can monitor and count the usage status of the cloud desktop and obtain information such as the ID and IP of the connected user. A screenshot of the vSphere interface is shown in Figure 4. It monitors the CPU and memory status of each server. In recent years, the experimental part of the computer general education course has adopted the combination of cloud platform and traditional single machine.

Take the class of 2018 undergraduate students from School of Pharmacy and School of Economics as examples. The School of Pharmacy is assigned to the cloud laboratory, and School of Economics is assigned to the traditional laboratory. The fixed 5 time samples are taken every day for two weeks. The statistical analysis and comparison of the resource utilization rates of the two traditional platforms are shown in Figure 5. At the peak hours of 10 and 16 o’clock, the resource utilization rates of the two platforms were at a high level, and more than 80% of the resources were put into use. At 13 o’clock at noon, the utilization rate of the cloud platform is 44.6%, which is much larger than the traditional platform by 5.1%. It indicates that students have the willingness to adopt the cloud platform for self-learning if they have unfinished experimental content after class. The traditional experimental platform needs to be used in the field, and it only takes up very low utilization. At 19 o’clock and 21 o’clock in the evening, it is often the prime time for students to practice themselves. The utilization rate of the cloud platform has been above 60%, indicating that resources are fully utilized and mobilized, and students can use various resources on the platform without time limitations.
Figure 5. Comparison of platform resource utilization

The sampling time of the same five time points is still used for two weeks, and the access mode of the cloud platform is counted and analyzed. The IP address of the management background can be used to distinguish the access points of the user, which are divided into laboratory terminals, dormitory terminals and mobile terminals are shown in Figure 6. At the peak hours of 10 and 16 o’clock, the way to access the cloud platform through the laboratory terminals accounted for more than 60%, and the access mode of the other two methods was less than 40%. At 13 o’clock, 19 o’clock and 21 o’clock, the use of dormitory terminals and mobile terminals to access the cloud platform accounted for the main proportion, while the laboratory terminals were used less, indicating that students are free from the constraints of the location and can access the cloud flexibly and conveniently platform.

Figure 6. Comparison of cloud platform access methods
4.2. Advantage Analysis

4.2.1. Free from time and space constraints, guiding open experimental teaching methods. The professional software and hardware environment on which traditional experiments rely is only open for a limited period of time in the laboratory, and students’ ability to learn independently is limited. The current "Internet Plus" era has brought about changes in students’ learning habits and methods, and has formed new learning habits of fragmentation, mobilization and personalization. The Cloud computing experimental platform in this article enables students to access the experimental teaching platform through any terminal anytime and anywhere without having to configure a cumbersome environment. Log in to the corresponding experimental course and complete various practical activities online to meet the diverse learning needs of the current era and effectively stimulate students’ learning interest.

4.2.2. It helps to improve the quality of teaching and effectively improve resource utilization. Cloud platform infrastructure maintenance and software updates are provided by the cloud. In a comprehensive multi-campus university, each lab only needs to configure cloud terminals to dynamically invoke back-end cloud resources through cloud computing technologies such as virtualization. This approach is highly flexible and shared, leveraging resources. Based on the cloud platform to integrate various resources, an experimental evaluation mechanism is established to promote the cultivation of students’ practical innovation ability, and improve the quality of personnel training.

4.2.3. The platform has a wide coverage, which benefits a multitude of students and has a wide range of applications. The computer science general courses are taught in a wide range of subjects, including the most freshmen. The cloud-based experimental platform is open to the whole school and can serve teachers and students of all campuses. The experimental platform has been implemented for three years. It has been used by students during 2016, 2017, and 2018, and the response has been good. The computer science general experiment courses have also been widely welcomed by students. At present, the platform has been expanded to accommodate 300 users at the same time, which is the first case in the large laboratory in our university. In teaching and research, the platform has a good application prospect and has high application value.

5. Conclusion
In the field of information technology, cloud computing is considered to be another significant change after the personal computer and the Internet, bringing about fundamental changes in the way of working and learning. The combination of cloud computing technology and computer teaching is the development trend of computer science general education courses in colleges and universities[10][11]. It can make full use of high-quality network and teaching resources to achieve efficient sharing of campus resources. In the course of the development of computer general education courses in recent years, some problems have also been discovered. On one hand, cloud platform resources is insufficient in a certain period of time, suggesting that nodes are not enough, and they should be gradually increased. On the other hand, the cloud platform may have a single point of failure in the case of insufficient backup, which should be optimized. In this paper, aiming at the problems faced in the experimental teaching process of computer science general education courses in colleges and universities, we propose a construction plan of cloud computing experimental platform for computer science general education courses, and elaborate the platform structure and system model. On this basis, the platform is analyzed. The practical effects and advantages provide a reference for the further development of the university cloud computing experimental platform.

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