Research on the Design and Construction of University Informationized Learning Environment under the TPACK Framework

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Abstract. The rapid development of information technology has broken the traditional teaching methods and learning environment, and the traditional teaching environment is difficult to meet the needs of information-based teaching. Therefore, based on the TPACK theory, this paper integrates the teaching method, information technology and subject content, and uses cloud computing technology to design the information-based learning environment model and framework in line with the teaching characteristics of colleges and universities. Finally, from the theoretical and technical aspects, a learning environment based on cloud computing technology has been established, which provides support and guarantee for the reform of basic information teaching in colleges and universities.

1. Introduction

With the continuous update and development of information technology, more and more new technologies have been applied in the field of education, promoting the reform of teaching methods. Compared with traditional teaching methods, the integration of new technology makes learners' learning become a key topic of education and teaching reform. In 2018, the Education Informatization 2.0 Action Plan of the Ministry of Education put forward the goal of digital campus, teaching platform and resource sharing in the future [1]. In 2018, the Ministry of Education proposed that classroom reform should adhere to the learner-centered policy [2]. The above policies show that the promotion and change of new technology to classroom teaching is the mainstream direction, but the learning environment is not only the condition to provide external support for learners, but also the guarantee of teaching reform. In order to meet the needs of the new teaching reform, the design of information-based learning environment in colleges and universities is also facing important changes. Therefore, based on TPACK theory, this paper integrates information technology, teaching methods and subject content to build an information-based learning environment in line with learners' learning.

2. Basic theory

2.1. TPACK theory

TPACK theory [3] is a new knowledge system formed by teachers' integration and reconstruction of technical knowledge, pedagogical knowledge and subject content knowledge. It is the basis for teachers to use technology to teach effectively. TPACK is a teacher's knowledge structure framework for integrating technical subject teaching knowledge on the basis of subject teaching knowledge
(PCK). It includes the three-core knowledge of teachers: subject knowledge (CK), teaching method knowledge (competition), technical knowledge (TK) and integrated subject teaching knowledge (PCK), integrated technology discipline knowledge (TCK), integrated technology teaching method knowledge (TPK), integrated technology subject teaching knowledge (TPACK) four kinds of compound knowledge.

2.2. Learning environment design
At present, scholars at home and abroad have different definitions of learning environment. Domestic scholars believe that learning environment is the external environment that supports learners' learning, which includes material and non-material conditions such as learning resources and learners' interpersonal relationships. Foreign scholars believe that learning environment is the behavior of learners engaged in learning, and it can find and solve problems by forming a learning community. In view of different understandings, Wu Hongyan [4] makes a comparative analysis of the learning environment, combs the learning environment from a technical point of view, and emphasizes the flexibility and interaction of the learning environment. It also puts forward that the construction of the learning environment needs to be carried out by using information technologies such as cloud computing technology and network technology, so as to obtain the dynamic analysis data and comprehensive evaluation of learning achievements in the learning process.

3. Design of information-based learning environment integrated with TPACK framework

3.1. Construction of information-based learning environment model based on the integration of TPACK framework
The integrated TPACK framework information-based learning environment model is based on cloud computing technology and is composed of physical environment and virtual environment. Through the combination of real environment and virtual environment, it promotes the integration of school, society and family, provides learners with diversified services of formal learning and informal learning, and improves learners' enthusiasm for learning.

Virtual environment is a virtual simulation learning environment developed by information technology, which includes network classroom, community, MOOC, SPOC and three-dimensional virtual experience environment. In the virtual environment, teachers use virtual communities to assist teaching, and learners learn through teacher-guided or autonomous learning. The physical environment refers to the physical environment, which includes schools, training institutions and various learning venues, in which the school environment is taught by teachers in classes, mainly by experiments and examination evaluation. Training institutions are conducted by off-campus teaching enterprises using small classes or one-to-one teaching methods, and learning venues are informal learning activities that are commonly used by science educators to simulate situations to guide learners to learn.

The learning environment based on cloud computing technology integrates the TPACK theoretical framework, makes full use of the characteristics of the virtual environment and the real environment, constructs the teacher group, the learner group and the resource group, integrates the TPK theory into the teacher group teaching method, the PCK theory into the learner group, and the TCK theory into the resource group, so as to build a learning environment that conforms to the information-based practice teaching in colleges and universities, as shown in figure 1.

3.2. Framework Design of Information-based Learning Environment integrating TPACK Framework
The framework of information-based learning environment based on TPACK framework is composed of five layers based on cloud computing technology, which are device layer, data layer, cloud space layer, service layer and teaching environment layer. In the framework of information-based learning environment, the device layer is not only the bottom of the framework of learning environment, but also the guarantee to realize the interaction of data layer. It includes all the devices involved in the
actual teaching process, such as cloud servers, digital resources and mobile devices. CVM is a platform to provide integrated services, and mobile devices are hardware facilities to support classroom teaching. The data layer is not only used to record all the data of learners and teaching processes in the learning environment, but also to record the transmission and release storage space of students' behavior data. It adopts a highly symmetrical architecture to provide comprehensive data services for teachers and learners in the learning environment. Cloud space layer is the core of the whole learning environment framework, which includes three parts: learning resource cloud space, data cloud space and service cloud space. These cloud space resources and data provide personalized recommendation services for the teaching process. The service layer is the main body of the learning environment framework, which can not only meet the normal teaching needs of teachers, but also coordinate and guide learners to learn, feedback and manage learners' learning activities in the teaching process. The teaching environment layer [5] is the physical space in the learning environment, which refers to the places used for actual teaching, such as classrooms, families, studios, laboratories and so on. As shown in figure 2.

Figure 1. Information-based learning environment model integrated with TPACK framework.

![Figure 1](image1.png)

Figure 2. Integrating TPACK framework with information-based learning environment framework.

3.3. Construction of information-based learning environment integrating TPACK framework

In the process of information practice teaching in colleges and universities, in the actual construction and application of the information learning environment integrated with TPACK framework, it is necessary to protect the infrastructure layer, middleware layer and cloud service layer, and apply cloud computing technology to the three-tier structure in order to effectively ensure that the learning environment meets the standards and requirements of information practice teaching in colleges and universities.

The infrastructure layer is composed of the management platform OpenStack based on cloud computing technology, distributed system architecture Hadoop and virtual technology Xen [6]. The
OpenStack management platform includes four parts: control node, computing node, network node and storage node. In the process of construction, it is necessary to connect the construction of Glance, Keystone, Horizon, Nova, Neutron, Swift and Cinder of OpenStack nodes, so as to form a perfect cloud computing management platform. Hadoop system architecture needs to combine HDFS distributed file system, HBase distributed storage system and MapReduce to form a perfect distributed system infrastructure. Xen virtualization technology is mainly used to build a virtualization simulation platform. The integration of system architecture and technology in the infrastructure layer, on the one hand, ensures the basic requirements of the information-based learning environment, on the other hand, provides space for future expansion and application.

The middleware layer is the node used to connect the infrastructure layer and the cloud service layer. It can relieve the pressure on the infrastructure layer and the cloud service layer and ensure the process and experience of the learners in the process of using it. The middleware is composed of Linux server and PC, in which the middleware adopts Shell, FTP, Web Service and other technologies, and uses OpenStack platform and database to complete the configuration of resource nodes and service nodes, providing learners with the functions of management, storage, download and sharing. It can also encapsulate the resource information of the infrastructure layer to protect learners' information and data security.

Cloud service layer is the top layer of information-based learning environment, its construction needs to meet the needs of super users, but also to meet the needs of cloud service providers. The cloud service layer adopts MVC development mode [7], uses J2EE architecture and Spring architecture to build Web platform, and combines Servlet program to provide operation interface for superusers to ensure that superusers operate conveniently and quickly. In the cloud service layer, super users have the highest authority to manage and authenticate the identity and behavior of users in the information-based learning environment, and urgently deal with the special situations in the learning environment, so as to ensure the stable operation of the learning environment.

The construction process of the integrated TPACK framework information-based learning environment is based on the infrastructure layer, the middleware layer as the bridge, the cloud service layer as the guarantee, the infrastructure layer transmits data to the middleware layer and provides hardware support, the middleware layer provides communication and encapsulation data to the infrastructure layer, the middleware layer provides teaching demand information to the cloud service layer, and the cloud service layer provides management and authentication, as shown in figure 3.

Figure 3. The construction process of information-based learning environment based on the integration of TPACK framework.

4. Conclusion
In view of the difficulties and problems faced by information-based practical teaching in colleges and universities, this paper combines TPACK theory, learning environment theory and cloud computing
technology to construct an information-based learning environment in colleges and universities, and puts forward a model and framework of information-based learning environment in colleges and universities. Cloud computing technology is used to construct a learning environment framework to provide theoretical support for the construction of information-based learning environment. Finally, by studying the key technologies of the construction of information-based learning environment, we can summarize and sort out the construction process, on the one hand, provide reference for the personnel engaged in information practice research in colleges and universities, and on the other hand, provide theoretical support for teachers to build modern topics and integrate the knowledge of subject teaching methods of technology.

Acknowledgments

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[Fund projects 2] 2018 Young Innovative Talents Project of Guangdong Provincial Department of Education "Research on Interactive Design of 3D Animation Based on Virtual Reality Technology" (Project Number:2018GkQNCX042).

[Fund projects 3] "Research and Practice of Modern Apprenticeship Course Information-based Teaching Based on TPACK Theory". Guangzhou Nanyang Polytechnic College (Project Number: NY-2019CQJGZD-01).

[Fund projects 4] "Research on the digital modern service industry system of Guangdong, Hong Kong and Macao" (Project Number: GDGZ19Y184). "XAPI-based Wisdom Education Cloud Classroom Higher Vocational Teaching Activity Model Research". Guangzhou Nanyang Polytechnic College (Project Number: NY-2019CQJGYB-05).

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