Research on Digital Teaching Materials Under the Mode of "Educational Cloud Service + Cloud Terminal"

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Abstract. With the popularization and development of cloud computing technology and intelligent terminal, the "Educational Cloud Service + Cloud Terminal" (referred to as the "cloud + terminal" mode) mode, which is composed of educational cloud service and intelligent learning terminal has opened up a new teaching scene and learning situation for digital teaching materials. First of all, this paper introduces the educational cloud service system and the "cloud + terminal" model; Then, on the basis of deeply analyzing the elements and characteristics of personal learning environment, this paper constructs a model of personal learning environment oriented to digital teaching materials under the mode of "cloud + terminal", at the same time, the paper also introduces its main functions; Finally, the paper designs a learning system for the digital teaching materials under the mode of "cloud + terminal" from four aspects, that is, the terminal equipment, the tool software, the contents of digital teaching materials and the educational cloud service platform. The research contents of this paper have reference value and guiding significance for the design, development of digital educational materials and the construction of learning environment.

Keywords: Digital educational materials · Personal learning environment · Educational cloud service · Cloud terminal

1 Introduction

Under the background of "Internet+", digital teaching materials, as a kind of new teaching resource, are the key links and core elements in carrying out the educational reform, starting the wisdom education and improving the teaching quality [1–3]. Digital teaching materials have been popularized and applied in the field of education. However, due to the lack of effective supporting environment and service system in the applying process of digital teaching materials, some problems have been caused, such as the insufficient support for individualized learning, monotonous learning activities and singleness in interactive mode. The combination of cloud computing technology and intelligent cloud terminal device opens a brand new mode of Internet application,

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that is, the "cloud + terminal" mode [4–7]. As a newly emerging IT service mode, the application of "cloud + terminal" mode in the field of education accords with the current concepts of universal learning and lifelong learning, which changes the way used by learners in acquiring and integrating knowledge [8]. In the "cloud + terminal" mode, the function, form and application mode of digital teaching materials have been greatly expanded and changed, so as to become an important approach in building the new digital learning environment.

2 The New Development of Digital Teaching Materials Under the Mode of "Cloud + Terminal"

2.1 Educational Cloud Service System

The migration and application of cloud computing in the field of education gave birth to the educational cloud service [9–11]. Cloud computing has large scale of users and massive data supporting ability, which are able to integrate the distributed educational resources effectively and provide the related resources to users through the virtualized educational service from bottom to top [12]. According to the characteristics of construction, management [13], distribution and application of educational resources, this research constructs an educational cloud service system including general service, educational service and the subject service, as shown in Fig. 1.

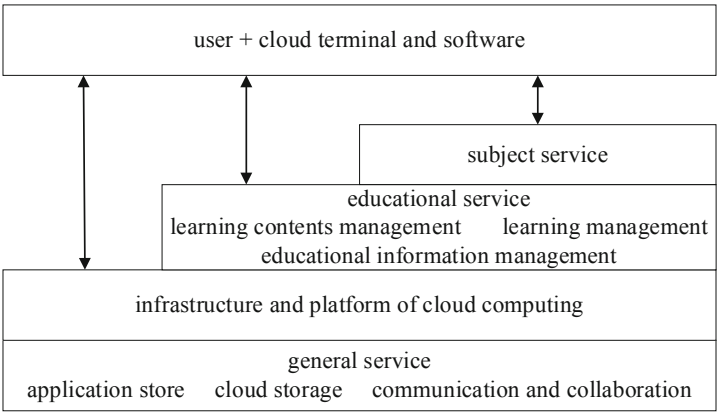

Fig. 1. Educational cloud service system

The educational cloud service system is supported by the infrastructure and platform of cloud computing, which effectively correlates and integrates the educational resources and the basic application software, so as to provide educational information services to teachers, students, parents and administrators through intelligent cloud terminal devices.

In the general service layer, the cloud storage service realizes the secure synchronization, backup and share out of local data and data in the cloud; the application store provides users with the application programs and content resources running on the terminal; communication and collaboration services support multiple forms of interpersonal interaction, including multimedia communication, unified communication, coordination of joint activities as well as the collaborative learning based on common objects.

Educational service layer mainly provides three major services: learning contents management, learning management and educational information management, among which the learning contents management service takes the learning objects as the basic unit, then, creating, storing, assembling and delivering the personalized learning contents; Learning management mainly provides the learning activities and curriculum management for learners, which includes the course registration and arrangement, student registration and attendance, learning progress tracking, homework and evaluation, data analysis and report generation. However, the processed objects of educational information management service are all kinds of data and information related to educational management.

The top-level subject service is directly related to the teaching of various kinds of subjects, such as speech recognition, automatic evaluation composition, mathematical calculation engine and visual learning environment and so on.

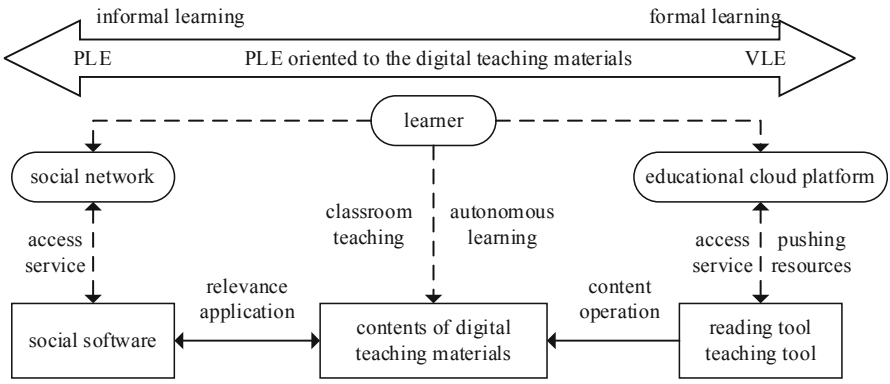

Fig. 2. PLE model for digital teaching materials under the mode of "Cloud + Terminal"

In different learning situations, users obtain the corresponding support from educational cloud service through the cloud terminal and related software.

2.2 "Cloud + Terminal" Mode

The "cloud" in "Cloud + Terminal" mode represents the connection and the educational cloud service; the "terminal" also can be called the client-end or the user-end, representing the cloud terminal and the terminal users. On the one hand, educational cloud service provides all kinds of resources to users dynamically and flexibly

according to their demand by virtual service; On the other hand, the computing and storage functions of Internet software at client-end are migrated from local part to the server-side.

The "Cloud + Terminal" mode is shown with the following several characteristics: the cloud terminal has various means of information and communication, which can access to the educational cloud service efficiently and quickly; supporting the seamless connection between application data synchronization and educational cloud service from multiple terminals and different platform; the educational cloud service platform can actively push resources to terminal users, track users' behavior and enhance users' stickiness.

2.3 The New Development of Digital Teaching Materials Under the Mode of "Cloud + Terminal"

Digital teaching materials are also called electronic teaching materials or electronic textbooks, which are not only the product of textbook digitization, but also the product when e-book is applied to the field of education. The "Cloud + Terminal" mode effectively aggregates all kinds of educational resources and services, in order to provide new functional characteristics, individualized support services and diversified application situations for digital teaching materials, in addition, this mode profoundly changes the generation and application of digital teaching materials. Specifically speaking, the new development of digital teaching materials under the mode of "Cloud + Terminal" is mainly reflected in the following two aspects:

New Function-Two Supports

Providing Support for Ubiquitous Learning and Online Collaboration. Under the mode of "Cloud + Terminal", as the main carrier of digital teaching materials contents, the portability of mobile intelligent terminal directly affects the happening frequency and range of learning behavior. At the same time, the resources of digital teaching materials' contents that are stored on the "cloud" are always synchronized with the local resources, which are downloaded to the terminal devices, in this way, it can realize the fast and real-time updating of the contents, thus effectively supporting the ubiquitous learning and online collaboration.

Providing Support for Context-Awareness and Adaptive Learning. Under the mode of "Cloud + Terminal", the intelligent terminal can perceive biological characteristics of learners, spatial environment, equipment parameter and other dominant situation information, and conducting the adaptive adjust on the contents layout and display as well as the shown parameters of digital teaching materials. At the same time, only through the analysis of hidden situation information, such as learning style, interest preference, affective tendency and cognitive state, the digital teaching materials can recommend the dynamic learning path for learners.

New Characteristics—Two Characteristics

Rich Media Characteristic. Under the mode of "Cloud + Terminal", digital teaching materials are no longer just taken as the multimedia content resources, but gradually developing into the Rich Internet Applications (RIA) that can be read or presented on

demand. The rich media characteristic of digital teaching materials is mainly manifested in rich presenting forms by the media and dynamic behaviors based on time or user interaction. However, the man-machine interaction mode of multi-sensory channel and powerful media processing ability of terminal devices are the important foundation to realize this characteristic.

Strong Interactive Characteristic. Based on the technologies of multi-touch, natural language recognition, etc. of intelligent terminal, digital teaching materials can realize the man-machine interaction mode in a more abundant form. At the same time, through the work of sensors in light, gravity, acceleration and so on, the intelligent terminal can perceive the external environment information and users' behavior data in real time, thus providing a more realistic and natural man-machine interaction experience, so that enhancing learners' immersion, participation degree and the adhesion of resources.

3 Personal Learning Environment Oriented to Digital Teaching Materials Under the Mode of "Cloud + Terminal"

Constructing the personal learning environment (PLE) oriented to digital teaching materials on the basis of "Cloud + Terminal" can effectively link up and integrate formal as well as the informal learning, which is an effective way to promote the popularization and application of digital teaching materials.

3.1 PLE Elements Oriented to Digital Teaching Materials Under the Mode of "Cloud + Terminal"

The construction of PLE is not limited to one particular technology or tool, but through the interrelation and interaction of various elements, so as to provide learners with an environment in which they can solve practical problems. It reflects the learner's initiative and creativity to act on the environment.

Under the mode of "Cloud + Terminal", PLE, which is oriented to digital teaching materials, has completely overturned the way of information aggregation and data processing existing in the traditional Internet era, and it has created a completely new learning environment in which educational information is liberalized and learners are diversified. Therefore, its main elements should include:

Learner, which is the main body in developing learning activities and the core element of PLE. Learners construct and manage their own learning environment according to individual learning needs, at the same time, they acquire, create and share knowledge.

The content resource, which is not only the carrier of knowledge information, but also contains abundant teaching design ideas. Through the learning activities in PLE, learners not only can acquire content resources, but also can participate in the creation of content resources.

Tool refers to the collection of various kinds of tools that are required during the process of carrying out learning activities. According to the PLE under the mode of

"Cloud + Terminal", the tool includes two parts, that is, the hardware terminal and the software tool. Hardware terminal mainly refers to the terminal devices that can obtain educational cloud service, including PC, smart phone, tablet computer and so on; Software tools include reading tools, teaching tools, cognitive tools, communication tools, etc.

Services include the general services provided by educational cloud service platform, such as resource storage, automatic evaluation, learning management and analysis, etc., and it also includes personalized services for learners, such as personalized resource push, online guide and answer questions, etc.

The social network refers to the relatively stable relationship system between learners and learning community, which is formed because of the interaction. Under the mode of "Cloud + Terminal", the communication and cooperation between learners and partners become more efficient and smooth, which is helpful to broaden the learners' vision, strengthen their construction of knowledge and promote their acquisition of knowledge as well as the ability.

3.2 PLE Features Oriented to Digital Teaching Material Under the "Cloud + Terminal" Mode

The "Cloud + Terminal" mode provides a new model for construction of PLE, reflecting a higher socialization, openness, autonomy and sharing, which is conducive for learners to actively construct, create and share knowledge when they fully enjoy the autonomy. The PLE of the digital materials under the "Cloud + Terminal" mode, with the learner as the center, the resource as the core, the learning task as the goal, and the collaboration as the form, supports the teacher's mixed teaching and student individualized learning, shows the following characteristics:

Promote the Integration, Co-construction and Sharing of Learning Resources. There are various educational resources in the Internet, but it also exists problems such as high dispersion and low aggregation. It is difficult for learners to quickly locate the required content from a large number of network resources. Under the support of "Cloud + Terminal" mode, the basic elements of PLE such as learning content resources, tools, services, etc. can achieve "on-demand, ready-to-use, fast aggregation", which is conducive to the effective integration, co-construction and sharing of learning resources.

Personal Learning Environment with Efficient Access. Under the "Cloud + Terminal" mode, each learner can create an individual PLE on the cloud platform and access it anytime and anywhere using any terminal device, thus greatly reducing the cost and difficulty of using internet learning resources and services. It is conducive to the seamless integration of learning in a ubiquitous situation, which enhanced the continuity and stability of teaching and learning.

Diversified Collaborative Learning Methods. Compared with traditional network collaborative learning, the "Cloud + Terminal" mode supports more diversified collaborative learning methods. The collaborative communication between learners is not only the synchronous or asynchronous information exchange based on the network

platform, but also the collaborative editing of shared resources, such as collaborative editing of documents or collaborative programming, which greatly stimulates the creativity of learners.

Active Push Notification of Learning Resources. In order to locate the required learning resources quickly and efficiently in the Internet massive data environment, learners need to use search engines to achieve personal search and aggregation of information, which is an application mode for actively acquiring resources. Under the "Cloud + Terminal" Internet application mode, the cloud platform and the user have a closer relationship and stickiness. The educational cloud service platform can actively push personal learning resources and customized learning services in real-time according to the characteristics and needs of learners.

3.3 PLE Mode Oriented to Digital Teaching Materials Under the "Cloud + Terminal" Mode

Since the rise of online learning, the construction of Virtual Learning Environment (VLE) has been regarded as the dominant design idea of the network learning environment. VLE, with curriculum as its center, provides a top-down organization and management for the learning process, primarily for formal learning situations within educational institutions. When VLE is playing its role, at the same time, it also shows the disadvantages, such as insufficient personal support and limited initiative of learners. Unlike VLE, PLE follows an open, personal learner-centered construction idea that emphasizes learners' choice of learning tools, content resources as well as collaborative objects, manages learning activities by learners, and integrates different learning situations (including formal learning situations and informal learning situations). However, when PLE gives learners autonomy and openness, at the same time, it also brings many problems. For example, learners have difficulty in planning a clear and efficient learning path in a large and complex knowledge network, in lacking management and monitoring of learning processes and activities.

In response to the above problems, the PLE of the digital teaching materials under the "Cloud + Terminal" mode shows a new concept. It is different from the traditional PLE in which the learner chooses the learning resources and tools, is fully responsible for themselves and manages their own self-learning process. Nor does it completely follow VLE's top-down design idea, which is to dominate learners' learning activities through pre-designed resources or monitoring by teachers or educational management institutions. From learners' individual learning demands, this concept is organically combined traditional PLE with VLE. On the basis of ensuring learners' autonomy, taking digital teaching materials as learning objectives and teaching design as its carriers, the PLE of the digital teaching materials under the "Cloud + Terminal" mode provides necessary learning framework and support. Based on that, this study constructs the PLE mode of the digital teaching materials under the "Cloud + Terminal" mode, as shown in Fig. 2. The PLE of this model combines the advantages of traditional PLE and VLE, and its functions mainly include:

Connecting Formal Learning and Informal Learning. The PLE of the digital teaching materials under the "Cloud + Terminal" mode supports the formal and

informal learning situations at the same time. In the formal learning situation, the "Cloud + Terminal" model has created a smart class-teaching environment. Teachers and students can independently choose various learning resources, tools and services on the "cloud" to support the teaching activities in the classes, thus the traditional form of classes have been broken through and the teaching result and efficiency have been greatly improved. In the informal learning situation, the learning objectives and paths as well as assessment services in the digital teaching materials can provide learners with systematic learning path planning and method guidance to prevent learners from "losing themselves" in the network environment where information overloaded.

Collaboration and Innovation Based on Content Resources. In the process of learning with digital teaching materials, learners will have a large amount of generative resources (such as note information, test answers, etc.). These generative resources are not only stored in the Internet, but are closely related to specific knowledge content in digital teaching materials. Relying on the communication platform and collaboration mechanism provided by PLE, any learner of digital teaching materials can access these relevant generative resources simultaneously, and can modify, update and iterate to carry out collaborative learning about specific knowledge content, problems or projects, and can promote the sharing and creation of knowledge.

Create a Personal Learning Environment Oriented To Digital Teaching Materials. In the process of learning using digital teaching materials, the reading environment settings, note-taking records, highlighting and other related information of the learners are simultaneously stored in the educational cloud service platform, which ensure that learners can obtain personal learning content and interface when they use digital teaching materials on any terminal device. At the same time, through the analysis of learners- content browsing, information retrieval, activity evaluation and other learning behaviors, the educational cloud service platform can actively push personal learning resources for learners.

4 The Learning System of Digital Teaching Materials Under the Mode of "Cloud + Terminal"

Under the "Cloud + Terminal" mode, the concept and function of digital teaching materials have been greatly enriched and extended. It not only represents digital teaching content, but also a digital learning system that effectively integrates content, terminals, teaching tools and services. Based on the PLE model of digital teaching materials under the "Cloud + Terminal" mode, this study comprehensively examines the functional requirements of digital teaching materials from a systematic perspective, and designs a learning system of digital teaching materials under the "Cloud + Terminal" mode, as shown in Fig. 3.

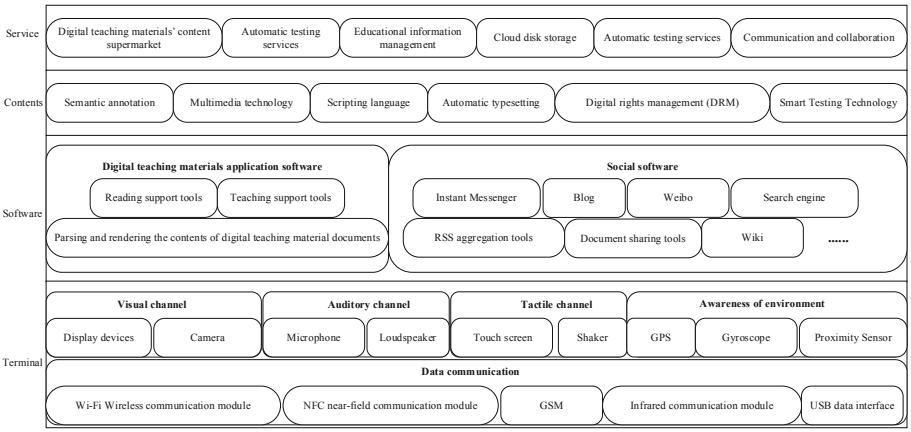

Fig. 3. The learning system of digital teaching materials under the mode of "Cloud + Terminal"

4.1 Terminal Devices

Terminal device is the physical basis and key elements of digital teaching materials' function realization. Its main function is media information processing and communication, which can be summarized into three aspects: 1. Communication between devices. In order to ensure data communication between different devices, the terminal should integrate a variety of data communication function modules. 2. Human-machine communication. In order to create a more natural, real and efficient learning situation, the terminal device needs to have powerful multimedia information processing capabilities, and supports a variety of natural human-computer interaction modes of the sensory channel; at the same time, along with the maturity and application of biometric identification technologies such as iris recognition and fingerprint recognition, virtual reality technology and augmented reality technology, the human-computer interaction mode of digital teaching materials will be further enriched and expanded, and presentation and organization mode of the content will be changed again; 3. Physical context-awareness. Terminal devices should also have the ability to perceive the natural environment and physical context.

4.2 The Tool Software

The tool software includes two categories of digital teaching materials application software and social software. Among them, the digital teaching material application software can parse and render the contents of digital teaching material documents, and provide relevant reading and teaching support tools - the reading support tool mainly sets the reading environment, such as font, color, brightness, etc.; Teaching support tools are used for activities related to teaching and learning, including labeling, sharing, and dictionaries. In addition, as an open learning system, besides digital teaching materials application software, related social software can also provide teaching support and services.

4.3 Content of Digital Teaching Materials

The content of digital teaching materials can be regarded as a fine-grained multimedia knowledge base based on semantic annotation. Through presetting a variety of content presentation templates, it can dynamically perform content layout, and provide various interaction activities that related to learning and recordable learning processes. Software of digital teaching materials uses semantic annotation, multimedia technology, scripting language, etc., combining with a rich knowledge base of subject areas to present content of digital teaching materials in a comprehensive, three-dimensional, intelligent way, providing funny, intelligent, interactive and efficient learning activities and methods.

4.4 Educational Cloud Service Platform

The Educational Cloud Service platform provides a series of general cloud services and educational cloud service functions such as digital teaching materials' content supermarket, learning management, cloud disk storage, communication and collaboration. The Educational Cloud Service Platform provides services to students, teachers, parents, educational administrators and resource providers, which provides a personal learning environment for learners and supports teachers to build virtual interactive teaching environments. It can support educational administrators to evaluate, supervise and manage the process of teaching and learning, and can also support exchanges and interactions between home-schools and schools-companies.

5 Conclusion

The learning system of digital teaching materials under the "Cloud + Terminal" mode is no longer just a simple organization and presentation of multimedia teaching resources, but a learning system that with learning content resource as its core, supported by hardware terminal devices, learning tool software and educational cloud service. With the support of "Cloud + Terminal" mode, new technologies such as big data analysis, virtual reality and augmented reality will further strengthen the personalized and contextualized features of digital teaching materials. There will be a more efficient, intelligent and open learning environment for digital teaching materials.

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