Study on Service Models of Digital Textbooks in Cloud Computing Environment for SMART Education

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Abstract

We live in a knowledge-based information society where a new technology emerges overnight and new information is produced every day. Our current shift towards a more digital world has led to an inevitable increase in the use of Information and Communication Technology (ICT) in education. With the development of innovative technology, educational content, methods of teaching and learning, educational environments, and the roles of teachers and schools can be changed. However, despite numerous efforts to improve educational standards, school systems around the world are struggling to meet the demands of the 21st century learners and employers. Climate change has also affected education. Therefore, the need for learning – and the way people learn – is changing faster than before. The paradigm shift to a world of the 21st century learning is rooted in a set of goals for all learners. SMART education is a creativity-focused, customized system for developing new ways to learn by using up-to-date technology like cloud computing, and enables students to study with various materials based on their aptitudes and intellectual levels using mobile Digital Textbook at anytime, anywhere and on any devices. This paper examines various ways of content development for digital textbook, service provision, and service delivery, and suggests the most suitable model in a cloud computing environment in order to propose a suitable service model for Digital Textbook in the cloud computing environment.

Key Words: SMART education, Smart learning, Digital Textbook, Cloud computing, Service model, N-Screen

1. Introduction

The emergence of Digital Natives has led to changes in communication methods, forms of knowledge, and the ways in which collective intelligence is cultivated for social productivity. These radical changes in the environment are demanding reform in education. Similar to the way in which modern schooling systems had replaced agrarian education, to meet societal demands for a skilled labor force, our knowledge-based society also calls for changes in the education system. In short, there is a need for a radical paradigm shift from the present industrial approach to education to one that supports the rising knowledge-based information society [1].

With the growing demands of society and the increasing uses of technology in our daily lives, new generations of the 21st century will require an education system that attends to both needs. One strategy, that can lead this reform is SMART education. SMART education can be defined as an educational system that allows students to learn by using up-to-date technology and it enables students to study with various materials based on their aptitudes and intellectual levels. The difference between the current education system and SMART education is similar to the difference between regular cell phones and smart phones; while regular phones have programs and systems supplied by manufacturers, smart phones can be customized to meet the users' needs. Current

educational approaches are based on a teacher-centered model where information and knowledge flow in one direction from teachers to students. This one direction approach is unsatisfactory to both students performing at the top and bottom of the class

The problem emerged when it came to educational competency. Korea's ranked 29th in education competitiveness globally, according to a survey facilitated by the International Institute for Management Development (IMD). However, according to statistics by the Program for International Student Assessment (PISA), Korean students are performing at the highest level of achievement. As an alternative to replace the current educational system in an industrial society, proposing SMART education is a global trend and policy. In Finland, a customized education system has already been built and has provided students with an up-to-date educational environment using ICT in education. Recently, South Korea ranked first among 19 countries in the 2009 Digital Reading Assessment for students' problem solving capacity using the Internet, this data was also included in PISA. It was an outstanding achievement considering that the students were high-school students preoccupied with college preparation. It proved that advanced ICT development in Korea, can contribute to reducing the information gap, rather than widening education inequality. Therefore, it is the opportune time to shift toward Smart education in order to prepare for our children's future.

To attain the vision of SMART education, the Korean government has initiated five flagship projects. These five projects are 1)Digital Textbook development and application; 2) promoting online classes and assessments; 3)creating an environment to use educational content safely; 4)building teacher's competency; and 5)establishing a cloud-based education system. Through the implementation of these five main projects, diverse types of educational content will allow students to learn whenever and wherever they please. As students will have access to these resources through all smart devices—PCs, laptops, smart tabs, tablet PCs, and smart TVs, they can learn at their own convenience.

2. Backgrounds

2.1. The Definition of SMART Education

SMART Education stands for "Self-directed, Motivated, Adapted, Resource enriched, Technology-embedded". First, "Self-directed" characterizes the change in students roles as recipients to producers of knowledge and the shift of teachers from deliverers of knowledge to learning assistants(mentors). To achieve this, online assessments, academic performance evaluations, and a self-directed learning system will also be implemented. Second, "Motivated" highlights the way in which SMART education will encourage students to take interest in learning. SMART Education emphasizes teaching and learning methods that promotes creative problem-solving and process -centered individualized assessment. Students' learning experiences will be transformed from the typical textbook-based to experience-based. Third, "Adapted" stands for the pursing of education through a customized educational system and a customized teaching and learning system. SMART Education strengthens the flexibility of the educational system and facilitates customized learning in connection with personal interests and future career aspirations. It also helps schools evolve from a place of delivering knowledge to a place that supports personalized learning according to students' levels and aptitudes. Fourth, "Resource enriched" describes the support for rich teaching-learning materials. From a cloud learning service, SMART Education provides free access to rich contents developed by public and private institutions and individuals in education, expands the joint use of domestic and overseas learning resources, and promotes collaborative learning through the contents delivery

platforms. Fifth, "Technology-embedded" illustrates the use of the latest information and communications technology. SMART Education enables students to learn at anytime and anywhere through information technology. By building an educational environment that encourages student-centered learning, students are provided with diverse methods of learning tailored to self-selected areas of interest [2].
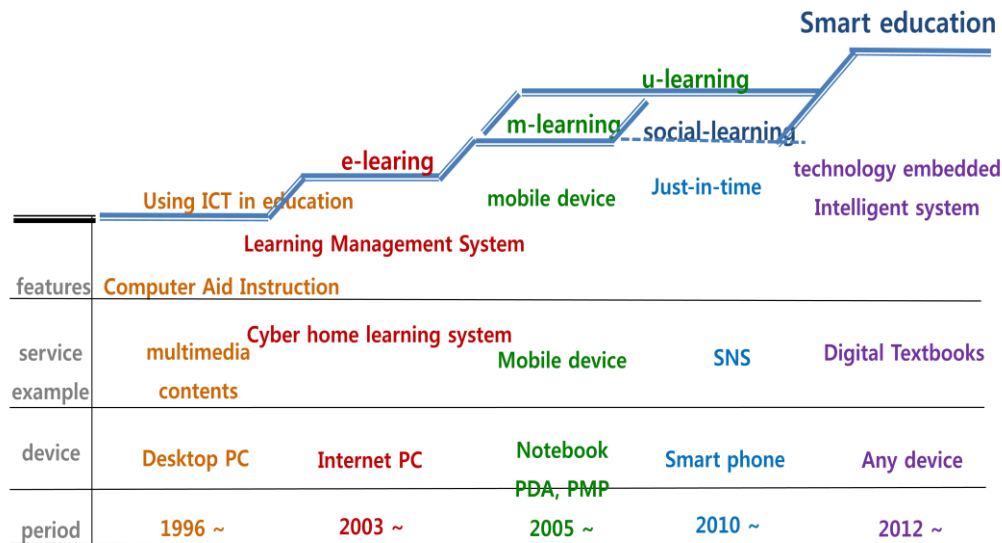

Figure 1. Steps of SMART Education

SMART Education is an extension of the use of ICT in education. Starting in the 1990's implemented since in the early 1990s, e-Learning expanded through the introduction of LMS, and u-learning implemented through the introduction of ubiquitous technologies. It is also institutionalized application of ICT to education as an essential means of a future educational paradigm for the 21st century.

2.2. Digital Textbook

The enormous amounts of digital information that we produce equates to 1.8 zetta-bytes (180 trillion gigabytes), which means that one person can watch a two-hour HD movie for 47 million years. This amount of information consistently increases by more than double every two years while a cycle of information exchange is also shortening. Furthermore, traditional paper-based textbooks are quickly becoming outdated soon after they are published.

The Digital Textbook is a future-oriented textbook that can help students learn in a self-directed manner at anytime and anywhere. It includes learning aids, workbooks, a dictionary, and notebook functions for self-directed studying, in addition to the content of traditional textbooks[3]. As it incorporates and provides advanced multimedia functions including videos, animations, virtual reality, and hyperlinks, the Digital Textbook is suitable for digital natives who are accustomed to the digital environment from childhood. Digital Textbooks allow students to have not only the content from general textbooks but also various customized learning materials such as Figure 2.

Figure 2. Concept of Digital Textbook

Digital textbooks provide educational content through multimedia such as videos, animations, and virtual reality. They also have interactive functions that implemented to enable learners to learn according to their aptitudes, abilities, and levels. As illustrated in Figure 3, in order to assist with the use of digital textbooks, current digital textbooks have been designed to mirror the format of paper textbooks.
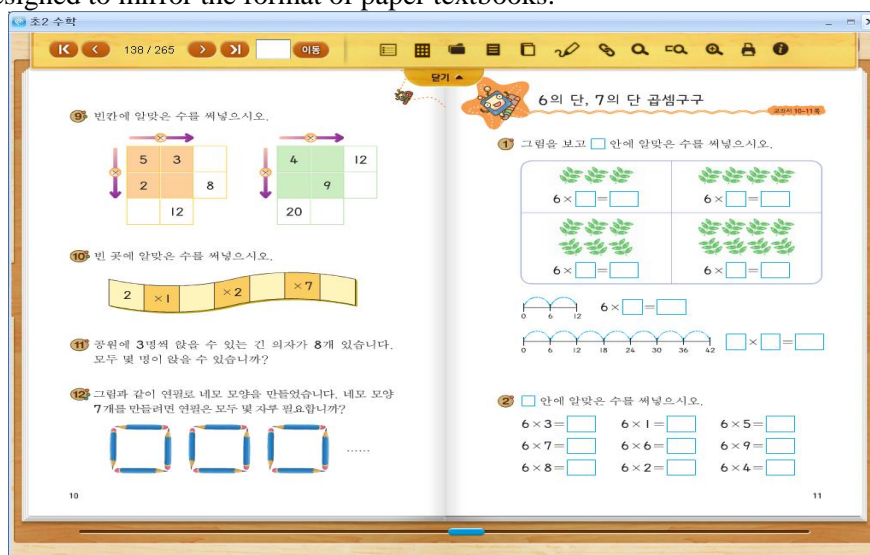

Figure 3. User Interface of Digital Textbook(Mathematics, Elementary School, 2nd Grade)

As for the document format, Digital Textbooks manage PDF image files based on XML and apply the SCORM standard to the object of content. The platforms of Digital Textbooks are developed to support various operating system such as Windows, open software Linux for PC, and iOS, open software Android for smart device[4]. Digital Textbooks consist of 10 detailed functions, such as, viewing, assistive tools, multimedia, search, *etc* (Table 1).

Table 1. Function of Digital Textbook

Function		Description
Learning material function	Text	Writing, memos, navigating and viewing pages, bookmarking
Learning management function and tool	Evaluation tool	Connection with evaluation tools inside and outside the Digital Textbook offering expanded learning materials to reach students' level or understanding
	Authoring tool	Draft, edit, and print document while editing texts, pictures, music, and video clips
	Learning management system	Managing students' e-portfolio managing students' learning progress
Learning support and promotion function	Multimedia	Images, pictures, video clips, audios, animations, 3D, etc, linked to embedded contents or hyperlinks
	Data search	Searching other courses' textbooks and different grades textbook search
	Reference materials	Materials for autonomous learning
Learning support and promotion function	Hyperlink	Various resources linked through the worldwide web for easy references to self-directed learning
	Dictionary	Most up-to-date vocabulary references to include prior dictionary definitions as well as multiple language translations
Interactive and Resources connection function	Resource connection	Connection with national knowledge database connection of contents owned by various political, economic, social and cultural institutions
	Interactive function	Interaction with experts, and other institutes through the web

2.3. Cloud Computing

Cloud computing is the use of computing resources (hardware and software) that are delivered as a service on a network [5]. End users gain access to cloud-based applications through a web browser or a light-weight desktop or mobile app while the business software and user's data are stored on the servers at a remote location. Users claim that cloud computing allows enterprises to update and manage their applications at a faster and more convenient pace. Furthermore, it allows IT to adjust to resources more rapidly to meet changing and unpredictable business demands [6, 7].
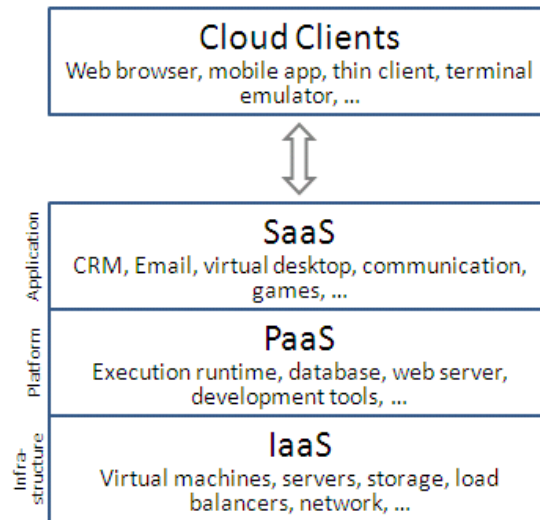
Figure 4. Cloud Computing Layers

Cloud computing providers offer their services based on three fundamental models:[8, 9] Infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service(SaaS) IaaS is the most basic and each higher model abstracts from the details of the lower models (Figure 4).

First, in the Iaas model, cloud providers offer computers, as physical or more often as virtual machines, and other resources. Second, in the PaaS model, cloud providers deliver a computing platform typically including operating system, programming language execution environment, database, and web server. Finally, in the SasS model, cloud providers install and operate application software in the cloud, while cloud users get access to the software from cloud clients. The cloud users do not manage the cloud infrastructure and platform on which the application is running. This eliminates the need to install and run the application on the cloud user's own computers simplifying maintenance and support. Cloud computing can give us benefits to reduce the cost of replacing hardware that has long been viewed as flawed, concentrate on managing licenses, make it easier to provide software(Figure 5), and expect to have superior security.
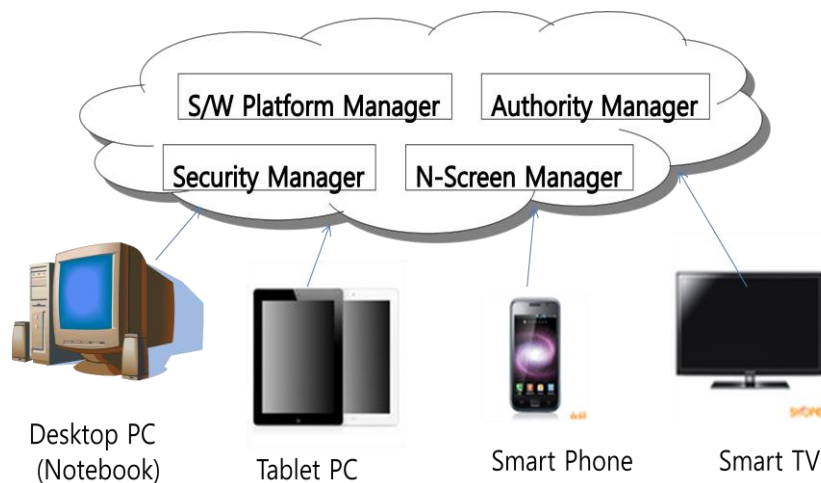

Figure 5. Cloud Computing Service

3. Service Model of Digital Textbook in Cloud Computing Environment

3.1. Types of Content Development

There are three general types of content development for Digital Textbooks: single packaging type, HTML and CSS-based browser type, and content plus viewer type, which embeds exclusive player or viewer in the application itself such as Figure 6[10]. The first type of content development, single packaging, is the most general development method in which the application itself becomes the content by including metadata of content in the application. As data are processed inside the application, this type is fast in response speed and easy to develop, but it is difficult to update. Therefore, single packaging is suitable for games or unilateral information delivery services. The second type of content development, browser type, is a commonly used method of Web-based content development suited for portal, news, and advertisement services. This type is compatible with multi platforms, but response speed is slow. The last type of content development, content plus viewer type, is used to implement content by embedding it in a player or viewer dedicated to content. This development method is suitable for providing service such as film or music and content service such as e-Books.
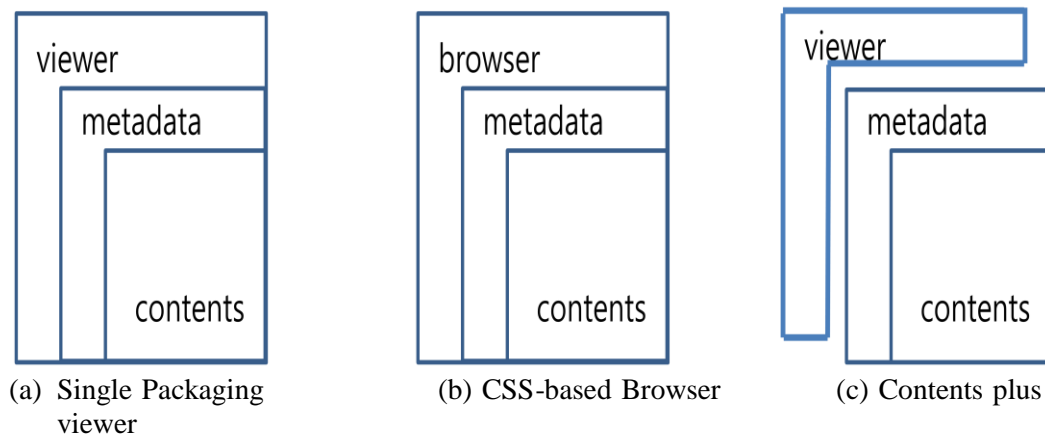

(a) Single Packaging viewer	(b) CSS-based Browser	(c) Contents plus

Figure 6. Types of Contents Development

As Digital Textbooks feature easy development of content in the unified format and easy application of paper and multimedia materials, Digital Textbooks are currently developed using the content plus viewer type development. This type can be proposed as the most suitable method of content development in the future cloud environment as well.

3.2. Ways of Service Provision

The methods of providing Digital Textbook service can be classified by four ways: native, mobile, Web, and hybrid applications such as Figure 7. In the native application setting, students can immediately use the Digital Textbook embedded in the application regardless of network access. Also, as this model has a high usage of device function, it is possible to implement the Digital Textbook which enables learning offline based on easy application of various types of content, fast speed and high performance. However, as native application depends heavily on devices, it has weaknesses of additional development for each OS and high development cost. Mobile Web is a method of storing all data and applications in the Internet server and transmitting in HTML when users get access to the server through the browser. Despite its slow speed, this type can be used in all devices with one single application. Web application is a method of providing Web services through App calls embedded in the server. It is easy to develop and has a low

dependency on devices, network access is indispensable and push service is impossible with this type. Hybrid application is a combined development method which implements UI in the native application type and key services in the web application type of the strengths of this type include fast operation speed and reduction in OS development costs, but its service speed is relatively slow[10].
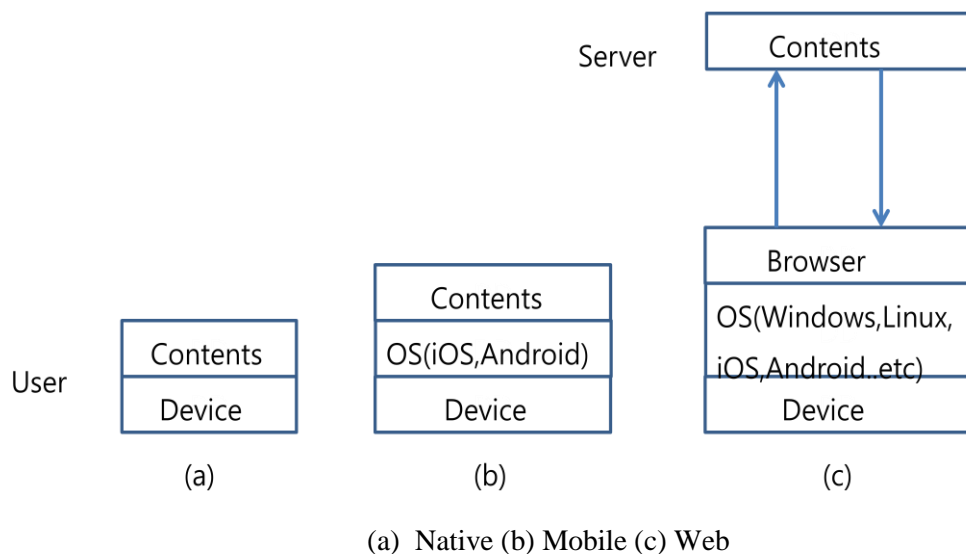

(a) Native (b) Mobile (c) Web

Figure 7. Ways of Service Provision

Considering the property of Digital Textbook content which includes various multimedia educational materials and additional learning materials at the network speed of current schools and educational field, hybrid application is the most appropriate proposal. However, in a long-term cloud environment, cloud streaming type will be the best choice, as all applications are executed on the Internet server. In the cloud streaming service, devices play the role of simply displaying the screen created on the server and application itself is run on the server. Therefore the service is fast and Digital Textbooks can be used immediately without complicated procedures such as installation. As various types of OS can be installed in the server, cloud streaming type is not restricted by OS and it is very easy for developers to advance or update. Because the quality of network is directly related to the quality of Digital Textbook service, it is recommended to introduce this type when the fourth generation LTE network environment becomes universal.

3.3. Methods for Content Distribution

The methods for distributing Digital Textbook content are one of the most important factors for determining the types of teachers and students use of Digital Textbooks. They have to be certified by school code to download Digital Textbooks from the server such as Figure 8. Content distribution can be understood in three ways: full download, partial download, and Web access. Digital Textbooks are currently distributed through the full download service method through Web.
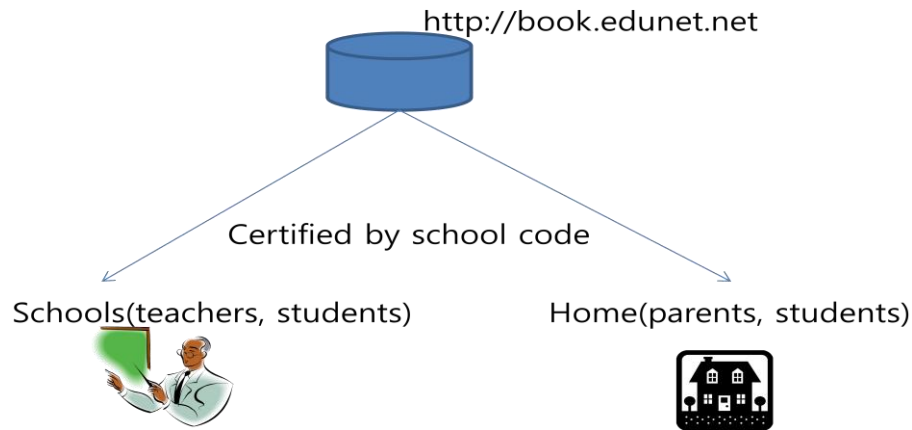
Figure 8. Method of Contents Distribution

However, as one of the primary reasons for introducing Digital Textbooks is to establish a fast system that keeps up to date with our changing knowledge, the content distribution method should be carried out according to these needs. Therefore, content distribution methods should shift from simply using cloud-based storage to a partial download method, which is easier for periodic data updates and ultimately leads to access through online streaming.

4. Conclusion

SMART-Education marks the beginning of a new digital era for our society. Communication has expanded beyond the traditional forms of writing letters to the usage of digital devices, iTunes, and YouTube. Not only the 3R's (**R**ead, w**R**ite, a**R**ithmetic), which has been regarded as the basic capabilities of humans necessary for success in the current century, but 7C's (**C**ritical thinking and problem solving, **C**reativity and innovation, **C**ollaboration and leadership, **C**ross-cultural understanding, **C**ommunication, I**C**T literacy, **C**areer and life skills) and digital literacy have also become a standard in the 21st century [11].

The application of ICT to education has improved teaching and learning methods through various functions that are not available in traditional classrooms. ICT has demonstrated that it allows students to have customized learning experience tailored to their interests and academic capacities. For Digital Textbook service in a cloud computing environment, this study suggested service models by combining the ways of service development, content provision, and content distribution. When implementing these service models, it is important to not only consider the types of content and data, capacity, user's behavior, device, and network environment, but it is also important to view these criteria in light of the strengths and weaknesses of each service model. As countries and regions across the world have different policies on Digital Textbooks, setting standards for its implementation into school classrooms need to be taken into consideration. Not only will Digital Textbooks differ across cultural contexts, but the impacts it has on environmental surroundings will differ as well. Therefore, we should lay the foundations of the educational system through cooperation with various principal agents [12]. Digital Textbooks will not only provide digitized access to printed textbooks, but it will also supplement existing educational content with additional resources and tools for learning.

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