

Interactive e-Learning with Cloud Computing Framework

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Abstract. Cloud computing has been regarded as the most potential technology to realize innovative educational services, because it intrinsically provides massive computing and storage capacities. Accordingly, many researchers have noticed that the potential of cloud computing in driving the educational innovative applications. Despite much research on cloud to education, little effort has been devoted to explore the impacts of cloud computing on educational services. To this end, we intend to unveil those potential impacts and see to how the educational services can be benefited by cloud. Overall, we conclude that with the assistance of cloud computing, the educational services can be identified by five intrinsic major characteristics: *instant, intelligent, multi-sensory, seamless and social*.

Keywords: Cloud computing, Education.

1 Introduction

Cloud computing has been regarded as the most potential technology to realize different kinds of innovative application. It is a computing mode of networks in providing software and hardware resources, placed in a data center, to provide services [2]. If the cloud is accessible to the public, it is called public cloud, while it is private one if for an internal organization [2]. By taking advantages of dynamic massive storage and massive calculation [7], users can flexibly enjoy the convenience of cloud computing.

Of late, many researchers have noticed that the potential of cloud computing in driving the educational innovative applications. They have unfolded some of its applications to education. Sultan argued that the cash-strapped educational institutions can use it to deliver a variety of information technology services due to its pay-as-you-go mode [14]. They indicated that in the educational institutions of some areas, such as Middle East and North Africa, cloud computing is viewed as an empowering tool used to advance the development of the educational technology, since cloud computing can save much time to build and maintain their own information technology infrastructure. Similarly, Wheeler and Waggener also indicated that cloud computing provides much richer

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services over the Internet than before, useful for delivering the information technology services of educational institutions [17]. For example, Google Apps for Education and Google Docs services are tailored to fit the needs of educational institutions. Those services may provide a platform for those institutions to develop their own ones, facilitating teaching and learning purposes. For example, Al-Zoube applied Google Docs service to develop a cloud-based learning system and indicated that many applications such as word processing, spreadsheets, or presentations can be used through web browsers due to cloud computing [1]. Such web-based applications can provide students and teachers with free or low-cost schemes to supersede expensive proprietary productivity tools. More importantly, such web-based applications are innately useful for achieving collaborative learning activities such as collaborative writing [13]. Later, Calvo et al. also applied Google Docs service to develop a cloud-based learning tool to support the collaborative writing, capable of managing collaborative and individual writing assignments in large cohorts [3]. Moreover, Calvo et al. conducted an empirical analysis in order to realize the perspectives of lecturers and students on the tool. Their results revealed that the lecturers considered the tool quite time-saving for distributing assignments, but students took confusing view of it. On the other hand, some educational applications are found by using the private cloud. Dong et al. proposed a framework of private cloud to embrace the benefits of cloud computing [6]. It literally improves the performance, availability and scalability of traditional learning systems and further offers better services for educational purposes. Afterward, Ouf et al. extended the work of Dong et al. to integrate Web 2.0 technologies into a cloud-based learning system for promoting the social interaction among students [11]. Later, Doelitzscher et al. presented a systematic study about how to use private cloud to develop a cloud-based educational system, which involves information technology infrastructure, software development platform, and educational software applications [5]. Recently, Vaquero developed a private cloud called EduCloud to support an advanced computer science course and conducted an empirical analysis to explore whether cloud computing is useful in educational scenarios for computer science students [5]. His results revealed that cloud computing did not help motivate students in terms of performance, but it comes with the advantage of avoiding much effort of setting up the software necessary for course activities.

Despite much research on cloud to education, little effort has been devoted to explore the impacts of cloud computing on educational services. To this end, we intend to unveil those potential impacts and see to how e-learning can be benefited by cloud.

2 Characteristics of Cloud Computing

Cloud computing intrinsically provides massive computing and storage capacities, enabling the delivery of a variety of service [14]. By its intrinsic features, although some researchers have interpreted it in different perspectives [7, 15], most of them state four basic characteristics of it: 1) it is applicable to massive storage and massive calculation; 2) its payment mode is pay-as-you-go, the users only need to pay for actually used resources; 3) it is a computing mode providing services according to requirements, the required resources may not be allocated beforehand; 4) it is a service-oriented architecture, the service scale can be set and provided dynamically

according to requirements [7, 15]. Fundamentally, cloud computing provides three levels of service: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS), as summarized in the following.

IaaS offers hardware infrastructure such as computing power and storage space as services. It enables users to directly rent the hardware infrastructure rather than spending time and budget to build their own [4, 7, 15], with the advantage of the infrastructure being scaled easily to accommodate the future demand [4, 16]. Two well-known examples in this service are Amazon EC2 (Elastic Cloud Computing) for supplying computing power service and Amazon S3 (Simple Storage Service) for supplying storage space service.

PaaS offers software development platform as services. This service enables users to directly design, implement, debug, test, deploy and operate their software in cloud [16]. Unlike IaaS, the users of PaaS do not need to address hardware configurations or software installations, instead, they can utilize PaaS to directly create their own software in cloud. Two well-known examples in this service are Google App Engine and Microsoft Azure that allow users to develop software in cloud without dealing with hardware and software configurations.

SaaS mainly offers software on the Internet as services. This service enables users to directly access software by using the Internet instead of installing special software on their computer [15]. Unlike PaaS, SaaS only hosts completed software whereas PaaS offers a development platform that hosts both completed and in-progress software [4]. Examples of Google Apps for Education and Google Docs belong to this category, which provide web-based educational and office software applications.

3 Impact of Cloud Computing on Educational Services

Defined as various software applications for education, educational services can be application programs of open source, proprietary or others. Distinguished from traditional e-learning environment, in cloud computing contexts, the educational services intend to provide learners various services with five major characteristics: *instant*, *intelligent*, *multi-sensory*, *seamless* and *social*, as shown in Fig. 1.

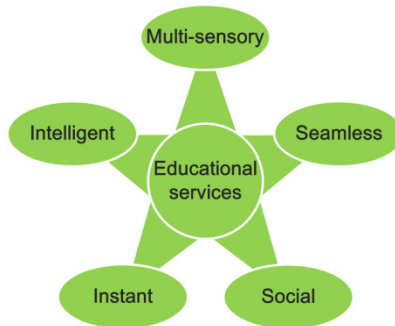


Fig. 1. The impact of c-learning

Instant: it refers to instant services, such as Google Instant [8] and Google Scribe [9]. Google Instant provides an instant searching engine, while Google Scribe provides a just-in-time aid for writing, as shown in Fig. 2. The common characteristic of them is to use cloud computing to anticipate the text being entered every moment, so as to provide the search result or suggested words to reduce the user's input burden and even facilitate alternative options. Accordingly, it can be foreseen that cloud computing is useful to realize instant services so as to promote the learning efficiency.

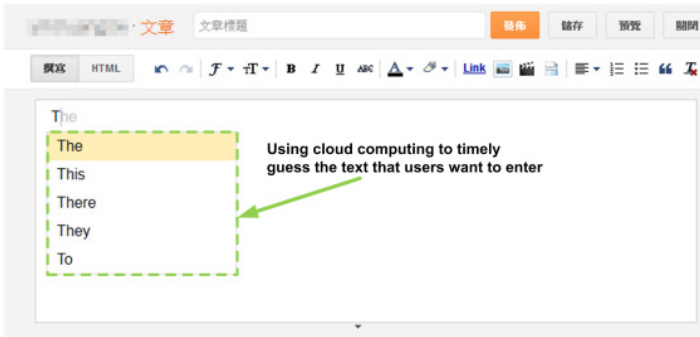


Fig. 2. The Google Scribe

Intelligent: it refers to intelligent services. For example, Google Goggles [10] is an intelligent image searching engine, running in mobile devices to search the photos taken by users. Up to now, it can identify letters, landmarks, books and signs automatically. Specifically, Google Goggles employs artificial intelligence (AI) technology for image recognition, realized by cloud computing to instantly respond the request. Consequently, it can be foreseen that cloud computing is able to fast execute complex AI applications to provide intelligent services.

Multi-sensory: it refers to the service that provides users with multi-sensory experience, such as Qwiki [12]. Qwiki is a search engine that provides narrated slideshows instead of links to give users a multi-sensory experience. Specifically, Qwiki automatically collects associated texts, images, videos, and voices on a subject from cloud and then reorganizes them as a sort of narrated slide show. As a result, users can easily obtain a short and interactive story about the subject from Qwiki. In a sense, cloud computing enables services into multi-sensory experience so as to help learners acquire information in multiple angles.

Seamless: it refers to seamless use of service, such as Google Docs. Google Docs is a word processing service, in which users can directly create and edit documents, spreadsheets or presentations on cloud, so that users can seamlessly access their files. Based on the paradigm, users can have services anywhere through different kind of terminal, such as the browsers of general computers or the apps of mobile devices [18]. Consequently, those services are accessible ubiquitously regardless of end devices.

Social: it refers to the service for social interaction, such as Facebook and Google Docs. Facebook is the most famous social networking site at present, providing users with many functions for social interaction, such as message boards, chat rooms, blogging and games. Thus, users can use Facebook to find their friends, and even know their friends' friends, so as to expand their circles. Even more, Google Docs not only provides users with a word processing service, but also facilitates them with social interaction, such as collaborative editing. During collaborative editing, users and peers can use instant messaging to discuss how to edit a document concurrently, as shown in Fig. 3. Accordingly, cloud computing enables services possess more social interaction elements, bringing learners together.

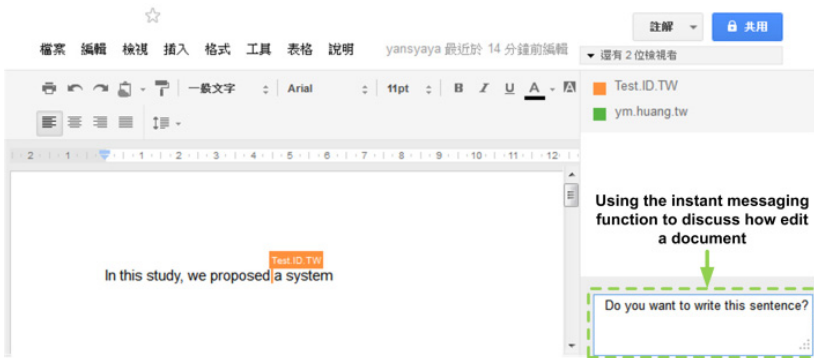


Fig. 3. The Google Docs

4 Conclusions

Cloud computing has a considerable potential for realizing different kinds of innovative application. This paper describes how we explored the impacts of cloud computing on educational services. Overall, with the assistance of cloud computing, the services of e-learning can be identified by five intrinsic major characteristics: *instant*, *intelligent*, *multi-sensory*, *seamless* and *social*. As the major characteristics are involved in educational services, the learners' learning will become more autonomous, convenient and meaningful.

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