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Proposed Object-based e-Learning Framework Embracing Cloud Computing

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Abstract: E-learning is continually evolved in the adaptation of emerging technologies and pedagogies, so does the development of learning objects. Object-based learning approach has been widely adopted in e-learning. The principle concern in the conventional e-learning models is the inflexibility of the e-learning content to assist the use and management of the learning sources which are highly distributed. Rigidity of e-learning content limits its reusability and shareability. Possessing the ability to deliver strong computing power and secure data storage as services, Cloud computing is a promising computing model to promote innovative changes and add notable values to e-learning landscape. The flexibility and on-demand access to a centralized shared pool of computing resources provided by Cloud computing enables high reusability and shareability, hence overcomes the principle concern in e-learning due to the rigidity of e-learning content. This paper describes the design of an object-based e-learning framework embracing Cloud computing. The proposed object-based e-learning framework can be used to form a new education domain that shares the Cloud characteristics of elasticity, flexibility, efficiency and reliability. Principal to the framework design is the development of Cloud-based e-learning objects where learners have the flexibility to access, personalize and deploy them in e-learning environment. Cloud-based e-learning objects are highly adaptable, reusable and easy changeable, hence allowing them to be used dynamically with greater customizability and flexibility in e-learning. Adapting Cloud computing into object-based e-learning is believed to be able to create a breakthrough in future dynamic e-learning development.

Keywords: object-based learning, Cloud-based learning objects, e-learning, Cloud computing, flexibility

1. Introduction

In the digital era where new technologies are emerging in a rapid and drastic manner, innovative e-learning pedagogies have to be facilitated to enable more effective knowledge transmission and engage in lifelong learning. It is the very fact that conventional e-learning methods are insufficient to deliver the needs of upgraded e-learning processes especially in the higher education. Higher education is highlighting more on higher order learning experiences and outcomes which requires a major transformation in knowledge and communication-based society (Thomas, 2011).

E-learning, based on the definition given by Brandon Hall Research Reports (Hall, 2005), is an instruction that is delivered electronically partially or solely via a web browser, such as Netscape Navigator, through the Internet or multimedia platforms such as CD-ROM or DVD. Gradually, when there is higher accessibility on network bandwidth, World Wide Web has been extensively used as a medium for displaying and delivering teaching material, leveraging the Web visual environment and interactive nature. In the current e-learning environment, the events and activities of learning are conducted via various electronic media. Educational and technological aspects have become progressively important facets in e-learning content development. The e-module interface design and the usage of interactive multimedia elements are frequently being focused in designing e-learning content.

In the initiative to increase the effectiveness and efficiency of various instructional design strategies, various e-learning techniques and methods have

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been considered. The most significant breakthrough is the deployment of object-based learning approach, which is a novel thought on learning content. Object-based learning has been widely adopted in e-learning. The central issue in object-based e-learning is the inflexibility of the e-learning content to handle and manage the learning sources which are highly distributed. Rigidity of e-learning content limits its reusability and shareability.

This paper describes the design of an object-based e-learning framework by integrating Cloud computing with the existing e-learning content. The goal of the proposed object-based e-learning framework is to allow learning to be centred on the requirements and benefits of the learners, enable learning to take place anytime, anyplace, and allow for greater customization and flexibility of the e-learning environment. The proposed framework can be used to form a new education domain that shares the Cloud characteristics of elasticity, flexibility, efficiency and reliability. Principal to the framework design is the development of Cloud-based e-learning objects where learners have to flexibility to share, access, personalize and deploy them in e-learning environment.

2. Cloud Computing

Cloud Computing has been gradually emerging in computing paradigm. Cloud Computing is evolving as a key technology for resource sharing (Kalagiakos & Karampelas, 2011). Possessing the capabilities of distributing computation and IT capabilities as services, Cloud Computing is a favourable infrastructure which is able to deliver notable values to teaching and learning landscape (Dong, Zheng, Yang, Li & Qiao, 2009). Applications are able to be delivered as online services, which is known as software as a service (SaaS). Hardware and system software in the data centres that provides services which can be identified as a Cloud (Armbrust et al., 2009). Services provided by Cloud Computing can shape a new education domain that shares the Cloud characteristics of Elasticity, Flexibility, Efficiency and Reliability (Gong, Liu, Zhang, Chen, & Gong, 2010).

Different definitions of Cloud computing have been described in various literatures. According to Anthony Sulistio et al. (2009), Cloud computing provides services in term of infrastructure and software (IaaS and SaaS) on a simple pay-per-use basis. They introduced their work in constructing a private Cloud in order to support various Quality of Service (QoS) objectives, such as availability, reliability, and security. Ian et al. (Foster, Zhao, Raicu, & Lu, 2008) presented the basic perceptions of Cloud computing. Differences of Cloud and Grid computing were also presented. The crucial element of Cloud computing is its component-based nature, such as reusability, substitutability, extensibility, customizability and scalability (Vouk, Averritt, Bugaev, Kurth, Peeler, Schaffer, Sills, Stein & Thompson, 2008). In addition, Armbrust et al. (Armbrust et al., 2009) presented a good summary of Cloud computing by emphasizing its issues and offering solutions to solve the issues.

Possessing its characteristics of having great scalability, flexibility, and cost effectiveness, Cloud computing has obtained significant recognitions in numerous fields. Cloud computing has been used to support cooperative learning and remote e-learning based on the Cloud computing environment and the transformation of computer fundamental curriculum in universities (Lin, 2011). Various benefits are offered by Cloud computing to e-learning by providing the infrastructure, platform and educational services directly through Cloud providers.

3. Existing Cloud-based Frameworks

Anthony Sulistio et al. (2009) of Hochschule Furtwangen University, Germany established CloudIA (Cloud Infrastructure and Application) framework to form private Cloud to run e-Science and e-Learning applications in the university. In CloudIA framework, Cloud Management System (CMS) is deployed to specify the components used in building private Cloud. The strength of this framework is the incorporation of Monitoring and Management component and Security components across all layers to guarantee high reliability and secured services. However, there is no efficient load balancing algorithms used in the Cloud and more number of virtualization technologies has been specified in this framework.

Bo Dong et al. (2009) presented an e-Learning framework called BlueSky Cloud framework to offer an e-learning platform based on Cloud computing for the basic education throughout China. In order to deliver a scalable, cost-effective and reliable IT education services, load balancing and data caching are incorporated in this framework. Subsequently, resource utilization and scalability issues in e-learning are resolved. Core components of BlueSky Cloud framework are mainly located in Capability Layer, Data Information Layer and Virtual Infrastructure Layer. Virtual resource pool, Image

repository, Monitoring, Trigger, Provision manager, Router, and Data caching are the core components to perform their respective operations and services.

In the same year, Bo Dong et al (2009) also presented an e-learning ecosystem based on Cloud computing infrastructure. Cloud computing is introduced into an e-learning ecosystem as its infrastructure to build a sustainable and flourishing e-learning ecosystem. The e-learning ecosystem is able to track resource configuration in a timely manner, distribute resources upon requests, and completely utilize resources. Furthermore, it also promotes the development and evolvement of the learning contents.

Shaik Saidhbi (2012) presented Cloud framework called Ethiopian Universities Hybrid Cloud (EUHC) to serve students in Ethiopian Universities to improve the teaching-learning and service delivery. This framework adopts hybrid Cloud computing for their higher education institutions, which offers the joint benefit of public and private Cloud. This framework is very much customized to suit the current Ethiopian Universities IT infrastructure which may not necessarily be compatible for e-learning IT infrastructure in other countries.

Madhumathi and Gopinath Ganaphaty (2013) proposed an academic Cloud framework for adapting e-Learning in universities using Cloud computing in order to help the students, faculties, research scholars and administrators of the university to better utilize their infrastructure. Their proposed framework specifies the virtualization technology to be used to build an academic Cloud above the existing university infrastructure in order to use the resources more effectively and also to support the QoS (Quality of Service) objectives in the service models (IaaS, PaaS, SaaS) of the Cloud. The framework consists of six layers where each layer has its own set of components within it. It is best suited for academic institutions which are ready to use Cloud in their institution. These layers incorporate the three services offered by the Cloud within them. The framework also supports various deployment methods in adapting Cloud within their academic infrastructure. Each layer in academic Cloud framework consists of various components. Security, Monitoring and Management are incorporated across all layers to ensure QoS objectives. This is one of the most complete academic Cloud frameworks. However, detailed specifications on learning content in Cloud environments have not been discussed.

Kaur and Chawla (2014) proposed Cloud based E-Learning (CEL) to provide a platform to implement advance Java e-learning in the Cloud. Their proposed framework utilizes Web 2.0 to develop, test and use the e-learning applications. Three types of Clouds, namely private Cloud, public Cloud and Hybrid Cloud are deployed in Cloud Model Layer through which users can access their resources. Service Model Layer consists of various services provided by Cloud such as Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (Iaas). One of the worth-mentioning modules is the well-defined learning content such as content creation and content delivery in the Learning Application layer. This framework very much suited for advance Java e-learning.

4. Developing Cloud-based e-Learning Objects

Since the notion of learning objects was introduced by R. W. Gerard in 1967 (Gerard, 1969), various learning frameworks adopting learning objects have been developed. Learning objects deliver a new paradigm in learning landscape. Instead of the traditional "several hour chunk", they provide smaller, self-contained, reusable units of learning (Beck, 2001). Numerous approaches, standards and technologies have been employed in defining learning objects. Figure 1 shows the evolution of learning objects. From Figure 1, it can be observed that the next generation learning object is bundle-oriented. Cloud-oriented learning object is an emerging technology which is the reason for the proposed Cloud based e-learning object being the central to the proposed framework design.

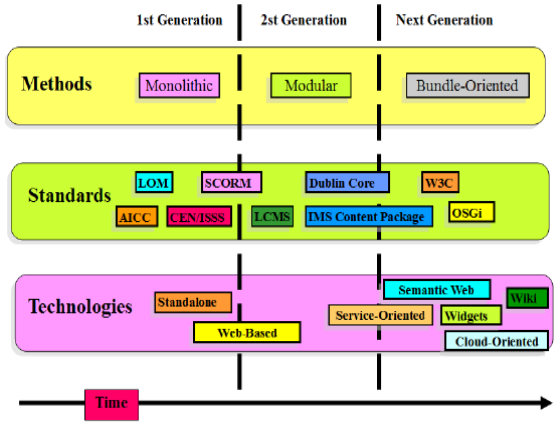

Figure 1 Learning Object Environments (Fiaidhi, 2011)

Object-based learning approach has been widely adopted in e-learning. The advancement and emergence of new technologies empower continuous development of e-learning objects.

Recently, Cloud computing has become one of the emerging technologies that can transform and restructure the learning landscape. Various Cloud tools have been developed and made available online. Despite of the readiness of Cloud infrastructures for collaboration and wide accessibility such as Web 2.0 tools, the development of redefining learning objects to suit e-learning in Cloud environment is not encouraging. Up till now, there has been rather little activity being carried out to ensure that e-learning applications are being designed in such a way that promote flexibility use of the learning content. With the availability of smart mobile technology and Web 2.0 tools, a new form of object-based e-learning utilizing Cloud technology is envisioned. The Cloud based e-learning objects share one of the most significant Cloud characteristics of being flexible which can be easily reused and shared by learners. Consequently they can be deemed as a new approach for knowledge aggregation.

The proposed Cloud based e-learning objects have two main components: Learning Strategy Component and Cloud Based Learning Content Component. There are three main elements namely Learning Objective, Introduction and Summary in Learning Strategy Component. These three elements are designed and incorporated into every e-learning lesson to produce a comprehensive instructional experience. The Cloud Based Learning Content Component comprises Content, Activity and Assessment, which are the main elements used by the learners to achieve the learning objectives (Lau, 2002).

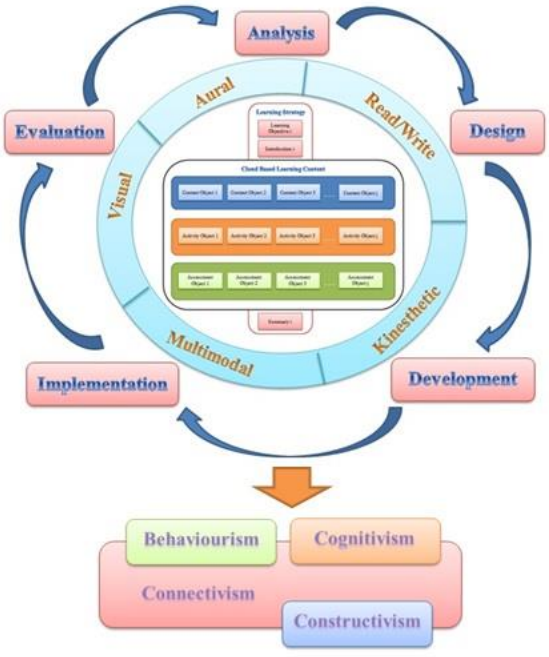

Figure 2 Cloud-based e-Learning Objects

The Content object is the core module that supports knowledge acquisition, performance enhancement or behavioural revolution associated with the learning objectives. There are five learning styles, namely visual, aural, read/write, kinaesthetic and multimodal, which is the combination of two or more learning styles. In order to accommodate various learner needs, each Content object is designed with three presentation formats. The presentation is in the form of text, video and audio. Activity object allows learners to perform certain tasks related to the learning objectives and to obtain feedback on their performance. Activity object can be in the form of game, application and etc. Assessment object present learner with some challenging situations, scenarios, or questions. The results obtained by learners in the assessment closely estimate what the anticipated result is like on the e-learning. As such, learners can be evaluated on their memories on certain theories using multiple choice questions. In order to determine if the learners understand certain processes, an interactive simulation can be deployed. Depending on the level of difficulty associated with the content based on Bloom's Taxonomy, combinations of assessments can be used to help the learners understand the skills or key concepts (Lau, 2002).

To ensure flexibility and shareability of the Cloud based e-learning objects over the Cloud, semantic labels are added to the components. Web 2.0 and Cloud tools are used to embed and publish learning content in the Cloud. Learners can easily subscribe and search for the availability of the learning objects. Cloud based e-learning objects being a part of the design for the proposed e-learning framework is expected to promote the flexibility, reusability and shareability of the e-learning content.

5. Proposed Cloud-based e-Learning Framework

Cloud computing empowers new approach of processing, integrating and consuming information. The most important functionality of Cloud-based e-learning objects is the flexibility of being reused and shared to learners. For this purpose, an underlying framework is proposed to describe the Cloud-based e-learning objects. The proposed Cloud-based e-learning framework utilizes Cloud technology in order to use learning resources more effectively and also to adopt Cloud characteristics.

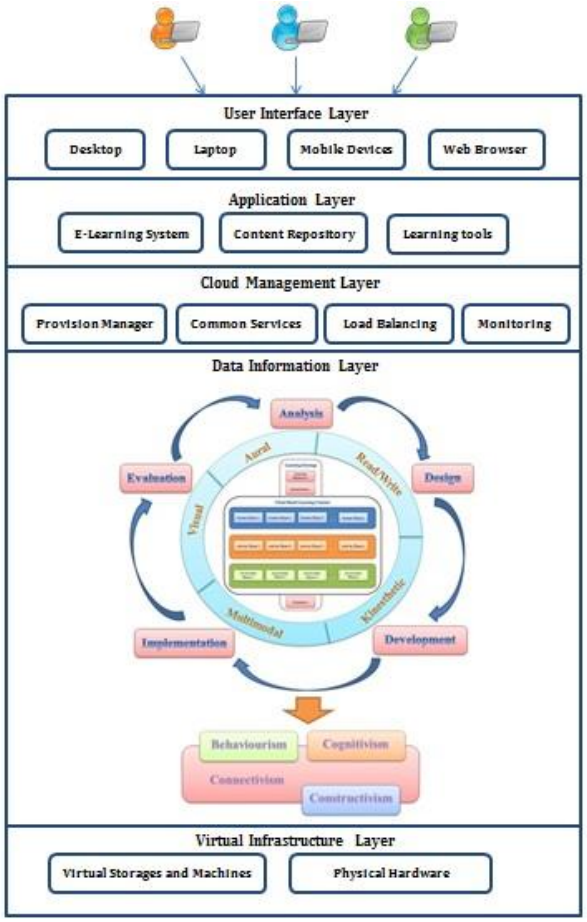

Figure 3 Proposed Cloud-based Learning Framework

The proposed Cloud-based e-learning framework is composed of five layers, which are User Interface Layer, Application layer, Cloud Management Layer, Data Information Layer, and Virtual Infrastructure Layer. Each layer in the framework consists of various components. User Interface Layer acts as interface between learners and Cloud infrastructure. Learners can converse with the Cloud using browser enabled devices such as desktop computers, laptops and mobile devices. Since Cloud-based e-learning objects are embedded and located in the Cloud, web browser provides a path for learners to access them. Application Layer consists of e-learning systems, content repository and learning tools. E-learning system provides functions and interaction interfaces for learners to acquire knowledge and information. For learning tools, various Cloud tools and Web 2.0 can be adopted. The emergence and advancement of Web 2.0 stimulates the evolvement of traditional Internet from mass media to social media. Web 2.0 allows online applications to be delivered via web browsers. Through remarkable application interfaces, pre-built application services or widgets, the interactions between applications and users are greatly improved.

Cloud Management Layer maintains and manages resources of the e-learning infrastructure by the means of four components namely Provision Manager, Common Services, Load Balancing, and Monitoring. Provision Manager manages the execution of resource allocation by deploying resources to learners automatically in a short time. Monitoring component keeps track of the execution of requests, the real-time configuration information and resource utilization levels to verify if the QoS objectives are met across all the layers of the Cloud framework. Data Information Layer mainly contains e-learning content. The proposed Cloud-based e-learning objects are located and managed by this layer. Virtual Infrastructure Layer enhances the transparency of hardware by virtualization, and realizes resources handling. There are two components in this layer namely Virtual Storages and Machines, and Physical Hardware.

6. Conclusion

This paper presented our vision to the future generations of e-learning systems embracing Cloud technology. Central to this vision is the proposal of Cloud-based e-learning objects where learners can reuse, share and access for future knowledge maturing purposes. A comprehensive prototype based on the proposed Cloud-based e-learning framework will be developed for further research.

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