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Using Cloud Computing in E-learning Systems

[I]Faten Karim, [II]Dr. Robert Goodwin
[I,II]Flinders University, South Australia
[I]faten.karim@flinders.edu.au, [II]robert.goodwin@flinders.edu.au

Abstract
Developments in computing are influencing many aspects of education. The purpose of this paper is to assess the potential value of cloud computing as a platform for e-learning. In particular, the paper will discuss how cloud computing is different from other forms of computing and what makes it unique. As well is this, the potential advantages and disadvantages of using cloud computing as a platform for e-learning will be outlined. Finally, the requirements of implementing cloud computing will be discussed, along with an assessment of the challenges to implementation, and some potential ways to overcome them.
Providing e-learning services using a cloud-based platform can reduce costs, can be easier to maintain and update, and offer benefits to end users in terms of security and compatibility. However, cloud-based learning systems require fast and reliable Internet access, and issues surrounding the security of a cloud remain unclear.

Keywords
Learning, E-learning, cloud computing

I. Introduction

Technology is increasingly being used both inside and outside the classroom. Embracing new technologies and finding optimal ways of harnessing their benefits is crucial to maximizing educational outcomes. However, in order to gain benefits from technologies it is important to have an understanding of the benefits and drawbacks to their usage, as well as ensuring that they are implemented in ideal ways. The main purpose of this article is to assess the potential for using cloud computing in the field of education, to look at potential challenges to implementation, and outline ways to overcome them.

The article begins with a brief definition of learning and a summary of popular learning theories. Next, a definition is given for e-learning, along with an outline of how it differs from traditional learning. Following this is a brief background on the use of technology in the field of education, and more specifically on the emergence of cloud computing. The concept of cloud computing is then introduced along with its essential features and an outline of the different ways that it can be implemented. An assessment is then made of the advantages and disadvantages of cloud-based computing systems for e-learning. Finally, the challenges of implementing cloud-based systems for e-learning are highlighted, along with some recommendations to overcome these challenges.

A. Defining Learning

The field of learning is full of many theories, with many dating back over 60 years. However, the majority of the currently popular theories are based upon studies that have been conducted during the past 20 years. On the whole, these theories can be categorized into five main types: humanist, behaviourist, cognitive, social learning, and critical reflection. Each orientation has its strengths and limitations, and there are some situations when one theory might be more applicable than another [1].

- Humanists hold the belief that people have unlimited potential for development, and that the objective of learning is to fulfil one's potential. Learning involves an active search for meaning, which is controlled by the learners who know their particular needs and goals. Educators should serve as facilitators of learning, by helping students learn the process of how to learn and teaching them to self-discover learning. Methods that exemplify this approach include self-directed learning, and experiential learning [1-2].
- Behaviorist's focus on skills development and behavioral change. Learning is seen as a change in overt, observable behavior. The process of learning is seen as being controlled by stimuli in the external environment from educators and their curriculum, and not by the students themselves. The educator's role is to manage and control the learning environment by setting specific learning objectives and then monitoring the learner's progress. Behaviorism involves "Stimulus-Response" learning which is derived from Skinner's "Reinforcement Theory." Methods that exemplify the behaviorist educational methods include games and simulations, reinforcement and incentives, and instructional feedback [1].
- Cognitive and constructivist perspectives of learning emphasize the importance of understanding the mental processes involved in learning from the learner's perspective. According to these perspectives learning is seen as changes in the way in which the learner understands or organizes the elements of the environment, and changes in the behavior of the learner are deemphasized. The purpose of learning is seen as the acquisition of knowledge, and the goal of educators is to create the optimal conditions for learning to occur. Methods include the use of metaphors, analogies and simile, chunking (presenting information in "chunks"), and concept mapping. Key figures in this field include Piaget, Bruner, and Bloom[1, 3].
- Social learning theory integrates many of the ideas mentioned in the behavioural and cognitive views of learning. It beliefs that learning is a social process. Most of what people learn is through observations and interactions with other people in a social context. Focus is on the impact of people on people. In this theory the instructor is a model (demonstrator) or identifies and provides effective models, in addition to facilitate social interactions. Examples of educational methods: Demonstrations and trials, apprenticeships, mentoring, tutorials, peer partnerships, on-the-job training [1].
- Critical reflection theory focuses on critical reflection and capitalizing on learners' experience. In general, critical reflection involves the learner identifying and evaluating the assumptions, beliefs and values that underlie his or her thoughts, feelings or actions. This leads to a transformation in how one looks at the

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world. The instructor's role is that of critical analyst, stimulator of critical reflection, and challenger of assumptions. The emphasis is on learner and instructor equality. The educator is simultaneously teacher and learner. Examples of educational methods: Focus group inquiry, critical debate, imaging the future, reflective judgment, scenario building [1].

II. Defining e-learning

According to [4] e-learning is a fast and efficient way to spread knowledge to learners in different parts of the world that provides the following definition of e-learning: "E-Learning uses the Internet or other digital content for learning and teaching activities, which takes full advantage of modern educational technology provided with a new mechanism of communication and resource-rich learning environment to achieve a new way of learning". In addition, e-learning can significantly reduce the time learners spend on learning and it also allows them to access a broader spectrum of learning materials in accordance with their individual competences and situation without the limitations of time and space.

Figure 1 illustrates the building blocks of traditional learning and e-learning to show the fundamental similarities and differences of these approaches. The main difference between an e-learning platform and a traditional classroom is the way in which instruction is transmitted. In an e-learning situation, the learning provider is separated from the learner by cyberspace, and has less visibility of the way the learner is interacting with the educational environment. The ability to adapt, realign, or change the environment is reduced due to this limited visibility. It also makes the educational content very important as the content is now the only differentiating factor between competing e-learning initiatives, assuming there is a level playing field in infrastructure for the provision of service over the internet [5-6].

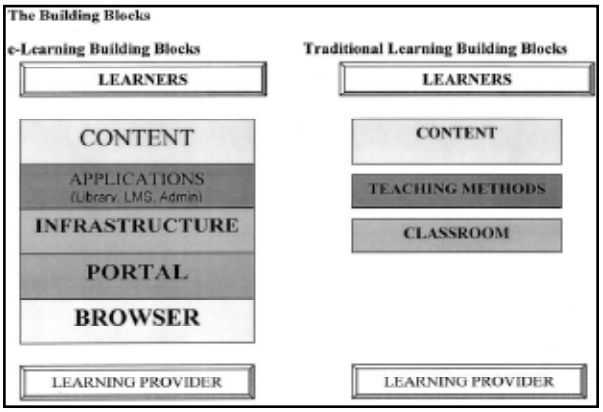

Figure 1: The Building Blocks of e-learning and traditional learning

A. The Emergence of e-learning

Early attempts to use technology in learning such as in 1924, with the Pressey Testing Machine, and Skinner's Teaching Machine in 1954, met with a weak reception. It was commonly held that the high cost of technology would prevent their ubiquitous uptake as an educational tool. Things started to change with the invention of the personal computer in the 1970s. Then, in the early 1980s Computer Assisted Instruction (CAI) and Computer-based training (CBI) began to emerge. Following this, in the 1990s websites were becoming commonly used to facilitate distance learning and learning management systems (LMS)[7-8].

III. Cloud Computing

According to [9] cloud computing can be defined as "a new style of computing in which dynamically scalable and often virtualized resources are provided as a services over the Internet." The National Institute of Standards and Technology (NIST) defined cloud computing as " a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."[10].

The cloud can be seen as a large group of interconnected computers. These computers can be personal computers or network servers inside public or private organizations. Therefore, a wide range of end users have access to the applications and data served by the cloud. Access is through the internet and it crosses over different enterprises and platforms. For the end user the technology and infrastructure behind the cloud is invisible and they aren't able to determine whether cloud services are based on HTTP, HTML, XML, JavaScript, or other protocols [11].

A. The Emergence of Cloud Computing

Computing can be seen as going through shows six stages distinct computing paradigms, which are dumb terminals connected to mainframes, personal computers, networking computing, Internet computing , grid computing, and cloud computing [12].

As shown in Figure 2 below, in stage 1, many users used dumb terminals to share large and powerful mainframe computers. In stage 2, stand-alone personal computers became powerful enough to meet the majority of people needs. In stage 3, personal computers and servers were connected together through local area networks and order to pool resources and give each other access to data on each PC. In stage 4, local area networks were connected to other local area networks forming a global network known as the Internet to enable remote applications and data to be accessed. In stage 5, grid computing enabled the sharing of computing resources and storage through a distributed grid system of computing. In stage 6, cloud computing emerged as an easy and scalable way of sharing resources on the Internet [9].

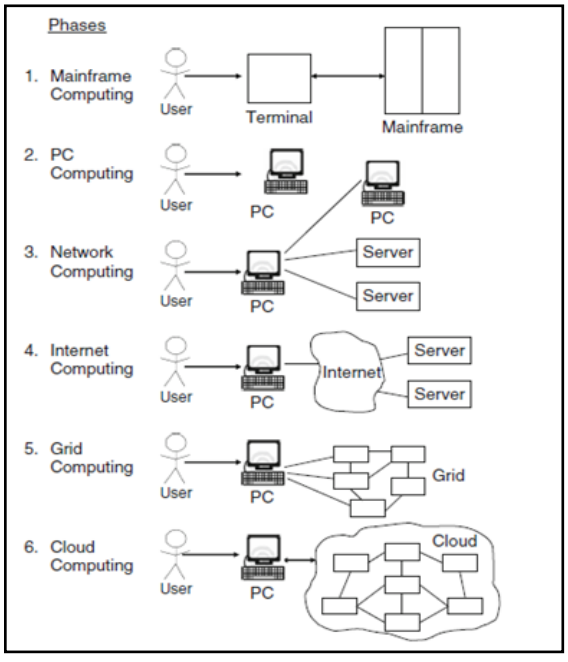

Figure 2: Phases of Computing Paradigms

adapted from [12]

B. Essential Characteristics of Cloud Computing

When looking at these six computing paradigms, it looks like cloud computing is simply a return to the stage one mainframe computing paradigm. However, there are several key distinctions between these two. Mell and Grance [10] state the key characteristics of cloud computing as follows:

- On-demand consumer access: The consumer can access computing facilities, such as server time and network storage, whenever they are needed automatically without the need for interaction with each service provider.
- Broad access to network: Computing facilities are available over a network that can be accessed through thick or thin clients such as smart phones, tablets, laptops, and desktop computers).
- Pooling of resources: The service provider's resources are pooled using a multi-tenant model to balance the loading between multiple consumers. Different physical and virtual resources are dynamically assigned and reassigned to optimize services according to consumer demand.
- Flexible provision of services: Services can be flexibly provisioned and released, automatically, to scale and adjust to the levels of demand. For the customer, the services available usually appear to be unlimited and can be accessed in any quantity at any time.
- Measurement of services: Cloud systems utilize a metering capability to automatically control and optimize the allocation of resources in accordance with the type of service such as storage, and data processing.

C. How Cloud Computing Works?

In a cloud computing system, the local computer only constitutes part of the resources to complete the task, and usually the cloud provides most of the resources and data. The hardware and software requirements of the user's computer are much less important. In many cases all the user needs is a device that is capable to run a Web browser and connect to the cloud, and the cloud network possesses all the resources and data that are needed by the user [13]. As shown in Figure 3, people use their own PC or portable devices, over the Internet to connect to the cloud. The cloud is seen by these users as a single application, device, or document. The hardware and the operating system used in the cloud are not visible to the users.

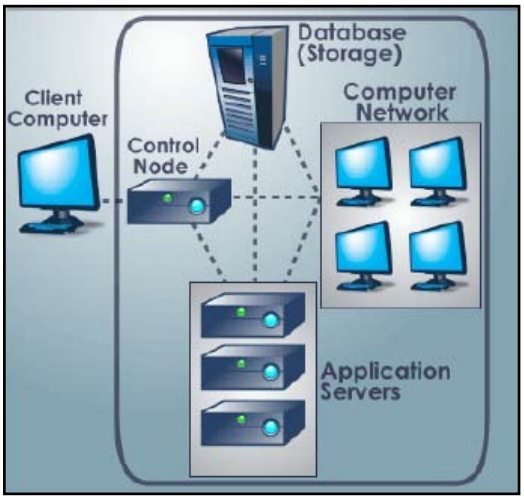

Figure 3: A typical Cloud Computing System [13]

Cloud Storage: Data storage is one of the main applications for cloud computing. In the past data was usually stored on a single dedicated server, while with cloud storage, the data is stored on multiple third-party servers.

Cloud Services: A cloud service can be considered as any web-based application or service offered via cloud computing. Cloud services can include anything from spreadsheets to calendars and appointment books. The application of cloud service is hosted in the cloud and then a user runs the application over the Internet using a web browser [11].

D. Cloud Computing Service Models

The National Institute of Standards and Technology's (NIST) definition of a cloud outlines three ways to access a cloud, which are: software as service, platform as a service, and infrastructure as a service [10].

The most widely used form of cloud computing is software as service. The reason for its popular it is that it can support the delivery of complex applications over the internet, and provides reliable storage. A browser, such as Internet Explorer, is used to access software provided over the Internet. Essentially, the end user purchases the right to access a software package and does not need to be concerned about purchasing the underlying infrastructure to run that software [14].

Platform as a Service (PaaS) gives customers virtual servers to run existing applications. In addition, with PaaS new applications can be developed without the need for maintenance or updating of operating systems. The underlying infrastructure is supported by PaaS which enables software provider to develop and deploy their software without having to worry about aspects such as the operating system [15].

Infrastructure as a service provides virtualized servers, networks, storage, and system software. An IaaS service permits many advantages to organizations and even has the potential to replace an entire data-center [14]. A cloud-based IaaS provide an effective solution against the problem of the reliance on a single server by providing multiple entry points application programming interfaces (API) as a service platform that enables data storage and retrieval from multiple points. Therefore, a failure at one point could be overcome by redirecting the request to a different point. [15].

E. Deployment Models

The National Institute of Standards and Technology's (NIST) outlines four different models of deployment for a cloud, which are public, community, private, and hybrid clouds.

A public cloud includes services that are available by all members of the general public. Applications in public clouds are provided by third parties on the cloud's servers, storage systems, and networks. [15] . A community cloud is cloud infrastructure is an infrastructure that is shared between several organizations with common concerns, such as security, from a specific community. The cloud can be hosted and managed internally or by a third-party. cloud [15]. A private cloud is cloud infrastructure managed and hosted internally or externally by a third-party for a single organization. Private clouds are built for the exclusive use of one client, to enable them to have full control over their data, increase the level of security, and assure quality of service [15]. A hybrid cloud allows institutions to use a combination of the previously mentioned deployment models to run an application or system. For instance, a hybrid cloud can combine multiple public and

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private cloud models.

F. The Advantages of Cloud Computing

There are many advantages offered by cloud computing [11] :

- Improved performance of PCs: When applications are accessed from a cloud, the PC has more resources and it will also start-up up faster and run faster, because there are less programs and processes loaded into memory. Therefore a PC with less programs accessed locally, will have better performance.
- Lower maintenance issues: Cloud computing greatly reduces both hardware and software maintenance for companies. The main reason is because fewer servers are needed by the companies. This lowers the time and expense for the maintenance of servers. In addition, as the software is stored in the cloud, IT staff has no software to maintain or upgrade.
- Lower hardware requirements for users: The hardware requirements are much less as only low-powered computers are needed to run most cloud computing web-based applications. This is because the PC doesn't need much processing power or hard disk space for applications that run in the cloud.
- IT Infrastructure costs are lower: For a large organization, fewer servers are needed as applications and data are stored in the cloud. Consequently, the organization can reduce costs by using the power of the cloud to reduce the need for internal computing resources. It also enables companies to more effectively meet their peak level requirements by using the scalability of the cloud.
- Lower software cost: An organization can lower its costs of providing software to its staff by avoiding the need to purchase software for every PC. Instead the company can pay for only their actual usage of a software package over the cloud. This also reduces the costs of installing and maintaining those programs on every desktop in the organization.
- Increased computing power: A cloud computing system also enables a user to have access to much more powerful computing resources as they have the power of the entire cloud which may permit utilizing the power of thousands of computers and servers. More resource consuming tasks may be complete than with a single desktop PC.
- Unlimited storage capacity: Traditionally, the user was limited to the storage of a single PC or server on a network. Whereas a cloud offers an almost unlimited storage capacity.
- Instant software updates: With a cloud updates happen automatically, which avoids the need for the user or IT department to be concerned with updating the software in their organization. It also makes it more likely that the users will have access to the latest software version.
- Improved compatibility between operating systems: As the cloud is automatically configured to run multiple operating systems, the user can connect to the cloud and share documents with computers running Windows, Mac OS, Linux, or UNIX.
- Increased data security: Data in a cloud is automatically duplicated so unlike desktop computing, a computer crashing in the cloud doesn't destroy the data, which will still be available from other PCs in the cloud. This reduces the need for backing up data locally, and ensures the security of data in the event of viruses or even disasters like fires.
- Accessibility from a range of devices: In today's world where a range of devices are used to connect to the internet such as PCs, notebooks, smart phones and so on, an additional advantage of cloud computing is that you can use a range of devices and even when you switch devices the cloud provides access to all your existing applications and documents you were accessing though a different device.
- Portability of documents: All your documents are instantly available from wherever you are, as long as you have an internet connection to the cloud. This removes the need to backup files and carries around portable hard-drives and suchlike.
- Easier group collaboration: With cloud computing, anyone anywhere with an internet connection can collaborate in real time. The technology enables multiple users to easily collaborate on documents and projects at the same time. It also enables people to collaborate on group projects in different countries as easily as if they were in the same building. The disadvantages of Cloud Computing

The main drawbacks to cloud computing are as follows [11]:

- An Internet connection is needed: Cloud computing requires a connection to the Internet to access both applications and documents; without an Internet connection nothing can be accessed, even your own files. This makes cloud computing impossible for applications in areas where there is no or an unreliable internet connection.
- Low-speed connections limit accessibility: Similarly, a low-speed Internet connection, for instance in remote regions that only offer dial-up services, cloud computing is often too slow or even impossible to run resource intensive tasks. Web-based apps require a lot of bandwidth to download, as do large files. Therefore, cloud computing requires a stable and fast connection to the internet at all times.
- Data security: All data is stored in the cloud with cloud computing. Therefore, the data is only as secure as the cloud is. If an unauthorized users gain access to the cloud they will also have access to any confidential data stored in the cloud.

IV. Cloud Computing and E-learning

Several challenges face the efficient deployment of E-Learning systems, and Dong, Zheng [16] and Aljenaa, Al-Anzi [17] offer some potential solutions that cloud computing offers to overcome many of these as follows:

- Lack of a proper infrastructure: Many organizations lack the proper infrastructure for adopting an E-Learning platform. A modern scalable infrastructure is needed as the creation of new content, which is often rich in multimedia, has high resource requirements for aspects such as bandwidth and storage. [6, 18]. Cloud technology can help overcome these challenges as the centralized infrastructure of a cloud system reduces the need to repeat tasks in each and every school where the system is deployed reducing the cost and time needed to build the infrastructure. Secondly, once a cloud is running in an organization, the deployment process is swift across the organization because of lack of technical work to deploy the services in individual schools. The third advantage is the lower cost of hardware infrastructure in individual schools, as often only computers with low specifications, capable of running a browser, can be used.
- Lack of curriculum: The lack of content that is ready to be imported into the E-Learning system is a common challenge that education institutions often face. Ideally, this needs to be planned up-front along with considerations of the infrastructure that is required [17]. Cloud computing can enhance readiness in two key ways. The first is by providing an easy to use platform for teachers and students to access from anywhere there is a device with an internet connection. The second advantage is

that by lowering operation costs through cloud computing an organization can redirect the saved money toward the development of more in-house content or to purchase content developed by other organizations[16].

• Lack of maintenance and technical support: After an E-Learning system is established the data needs to be updated and the hardware and software require routine maintenance. Many academic institutions do not have the competencies to support their own infrastructure and respond to issues such as network outages or security threats. Technical support time is reduced with a cloud-based system because cloud technology utilizes a centralized infrastructure approach that reduces the need to spend time on issues such as service availability, and application compatibility by providing and delivering services through a browser[19] .

• Change management: One of the biggest challenges of E-Learning is to manage the change process within the education organization, when moving to an online platform. The change affects all stakeholders of the organization, such as the students, educators, decision makers, content developers, and system support staff. Therefore forward planning is essential when implementing such a major change[17]. The first benefit that clouds provide to the change management process is the quicker pace of deployment. With the use of clouds the e-learning system can be deployed and spread over the organization more quickly, and people are more likely to identify the value of the system and to realize they need to utilize it in their daily lives. The second benefit relates to the ease of access. Clouds enable wider accessibility as any system with internet access is able to access the learning platform. This allows educators and teachers to have access to the learning platform from their home, which gives them more ability to test and use the system. Consequently, if more time is spent on the system the resistance to change will be reduced in the organization [16].

V. Conclusion

In conclusion, technology is being used increasingly by institutions to provide e-learning services. These institutions face a wide range of challenges in implementing these systems such as costs, a lack of technical resources, and resistance by key stakeholders to the implementation of systems. Cloud-based learning systems are emerging as an attractive method for providing e-learning services. They can reduce costs due to lower requirements of hardware and software, and less need for on site maintenance. They are also easier to deploy across multiple locations as they are centrally administered. They also offer benefits to end users in terms of accessibility, security, and compatibility. However, the limitations of cloud-based learning systems are that an Internet connection is mandatory, low speed connections reduce the efficiency of the provision of e-learning services, and issues surrounding the security of a cloud remain unclear. As the speed and stability of the Internet are continuing to improve, it seems likely that the popularity of cloud computing for e-learning will increase.

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