The Impact of Cloud Computing on e-Learning during COVID-19 Pandemic

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The Impact of Cloud Computing on e-Learning during COVID-19 Pandemic

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Abstract

Education plays an important role in a country's economy and today, the educational model in many countries has evolved with technology. Cloud Based Technology is extensively used by schools and universities in the world. In late December 2019, it was observed that Cloud Based Technologies have been supporting e-Learning during the emergence of the COVID-19 pandemic. This paper (i) addresses the opportunities and challenges of e-Learning through cloud computing and denotes the on-going transition from traditional lessons delivery to online teaching and learning; (ii) focuses on the impact of cloud based technology on e-learning during the COVID-19 pandemic. A bibliometric analysis was used to identify the journals that published articles related to cloud computing and e-Learning from the period 2008 to 2021. The research findings show the key aspects of how technologies have been adapted to this new global challenge and their level of effectiveness that can help policy-makers in the future.

Keywords: Cloud based technology, e-Learning, COVID-19 pandemic

Introduction

Cloud Based Technology has intensively been used since the last decades. Cloud Based Technology or Cloud Computing is a set of servers or databases that provide information and services that can be accessed remotely over the internet. According to Manro et al. (2012), cloud computing platforms provide users with the capacity to create and store data. Each piece of information can be accessed thoroughly on the internet using a digital device. Such technological models have an impact on the education sector (Cheng 2020). Its integration in education has opened up new learning and teaching opportunities. Nowadays, many institutions, policy makers and administrators in the educational field want to adopt and integrate cloud based technology to support lifelong learning (Alajmi et al., 2018). Madhumitha et al. (2021) has reviewed various cloud systems used by schools and educational institutions to communicate and interact with students and educators. This is mainly due to the fact that cloud based computing systems are cost effective, easy to use and reliable. Moreover, data is accessible over a large networking along with enhanced security and privacy. Cloud computing has changed over time and has drawn attention to a diverse range of users who come from different backgrounds, multiple fields and countries. New cloud computing models have been transformed to provide quality delivery and easier

accessibility to online data. As such, technological tools and software such as processors, servers, storage systems and network are often subject to improvement and upgrade. Despite that cloud models are used in several fields, they are most likely to be used in the education sector (Ercan ,2010 & Alajmi et al., 2018). Mell and Grance (2011) defines cloud computing as a model that delivers service in terms of data. Such model enables users to have access to convenient network solutions and different computer hardware including servers and storage facilities. However, the maintenance cost is affordable and users do not require technical support from cloud providers to use cloud based systems. Cloud computing also allows multi-users to connect to a cloud platform or data at the same time. Effective cloud based models have an efficient infrastructure. Mell and Grance (2011) have used the NIST Visual model to define the relationship between the service models and deployment models and how they contribute in offering access to data and cloud systems over a wide network to multiple users.

E-Learning and cloud based technology are the latest models that have been widely adopted in the educational field. E-Learning is an internet-based learning system that uses technology to develop, execute, choose, manage, facilitate, and enhance learning (Dahdouh et al., 2017). However, the role of e-Learning is not to replace traditional teaching and learning methods but it attempts to improve quality and to promote performance in the education sector (Madan et al., 2012). E-Learning is a user-friendly media that allows knowledge to be shared and accessed through technological devices such as mobile phones, laptops and cloud computing systems (Sharma et al. 2014). However, it is very important to understand how the e-Learning environment works and what it resolves around. By definition, e-Learning is a system that supports teaching and learning with the use of technology that enhances the quality of data and knowledge (Fernandez et al. 2014). It also facilitates the distribution and fostering of web-based skills, awareness, ideas and learning capabilities. With the integration of software applications, the internet and other web-based platforms, education is made virtually accessible (Agrawal, 2021). This increases the number of users who can connect to an online-educational platform and interact with multiple users who is not limited to only students or educators (Ashtari and Eydgahi, 2017). Over the last few years, some schools, universities and other educational institutions have integrated an e-Learning system to make teaching and learning proactive and engaging. Basak et al. (2014) also agrees that e-Learning system will allow more interaction between learners and their tutors and there is more sharing and developing of knowledge and skills. This leads to larger number of users being connected to an online educational platform, hence maximizing on a larger community of learners within schools, educational institutions and the society (Alqahtani and Rajkhan 2020).

The emergence of the COVID-19 pandemic has had an undesired impact in many countries. Many schools and educational institutions are obliged to offer online learning and support to their students. Therefore, with the prevailing situation imposed due to COVID-19, schools, universities and educational institutions have to adopt cloud computing so as to offer e-Learning services to their students. One key advantage of using cloud computing technologies is that they offer an interactive online platform whereby educators can communicate and interact with their students through technology enhanced learning. Nasri (2019) and Alhelou et al. (2021) emphasized on the fact that cloud computing has been beneficial for e-Learning in terms of time-effective, low expenses, accessibility, quality and performance. Today, Google's Gmail, Google Meet, Microsoft Teams and

Zoom Platforms are some of the cloud computing applications used by schools and educational institutions (Bhardwaj et al., 2020). However, integrating a cloud computing model in education has been a challenge during the pandemic. Chen et al. (2020) evoked difficulties related to users' reluctance to use cloud-based models and their behaviour, unavailability of technological resources and infrastructures, non-adapted academic programmes and curriculum for e-Learning, poor internet connectivity and little implementation of cloud based e-Learning models in schools and universities (Jin et al. 2021). The need to identify fast and effective teaching methods through e-Learning has become a major challenge. According to Almaiah et al. (2020) & Chen et al. (2020), there has also been a slow migration from traditional methods towards online learning during the pandemic. Firstly, it has taken some times to design a proper cloud system for any school or university. There was insufficient time to train staffs and students on how to use and interact with cloud systems and some users do not have access to a digital device nor to an internet network (Liu et al. 2020; Yang et al. 2020). In many countries, there has been time delay subject to the approval of cloud based education systems by Educational governing authorities, for validity, reliability and patent testing. Many new users felt insecure about sharing their privacy and had a growing concern about data security (Jin et al., 2021).

Hence, the focus of this paper is to provide an overview of the existing research on cloud based technology and e-Learning and their applications in order to determine the impact of cloud computing on e-Learning during COVID-19 pandemic. This is achieved through a bibliometric data analysis which has helped to analyze the trend of the research area.

Methodology

This section discusses the methods and techniques used to retrieve data in order to achieve the objectives of the research. The search was conducted from various online sources to extract articles related to the research theme. To build a resourceful search query, journals and articles were retrieved using keywords that included but not limited to: 'e-Learning', 'cloud computing', 'cloud', 'cloud education', 'online learning', 'cloud based technology' and 'COVID-19'. The search started in February 2021 and publications as from the period 2008 were considered. Articles that discussed about the impact of Cloud Computing in E-Learning during COVID-19 pandemic were compiled and a list of research papers were obtained after doing an in depth analysis. Such technique eliminates the risks of taking irrelevant articles which focus on only one of the above keywords.

Findings

Literature Publication Trend

Table 1 below shows the distribution of journals where articles were published related to cloud computing, cloud based technologies, online learning, e-Learning and COVID-19. The data that is tabulated has been obtained from journals that have different impact factors, starting from lowest to highest. 18 journals were selected because of their data reliability and impact factor. The International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE) has the highest impact factor - 7.488, while the International Journal of Multimedia and Ubiquitous Engineering (IJMUE) shows a low impact factor of 0.23.

The highest number of articles recorded by one journal (IJCSIT) is 787 and the lowest number of articles published is 3. Data from Table 1 demonstrates that countries such as India, USA and UK have a high impact factor along with a high number of published articles. The total number of research articles recorded is 3,913 and the mean number of research articles published is 217. Further to the reliability of the journals from Table 1, a bar chart as shown in Figure 1 has been designed to show the number of articles published from 2008 to 2021.

Table 1. Distribution of Journals that Published Research Papers relating to Cloud Computing and E-Learning

| Name of Journal	Impact Factor	No. of Research Papers	Country
International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)	7.488	421	India
Computers, Materials & Continua (CMC)	4.89	52	USA
International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE)	2.5	20	India
The International Journal of Computer Science and Information Technologies (IJCSIT)	2.28	787	India
International Journal of Advanced Research in Computer Science (IJARCS)	2.080	39	India
Journal of Object Technology (JOT)	1.22	23	Switzerland
International Journal of Emerging Technologies in Learning (iJET)	1.00	341	Germany
International Journal of Distance Education Technologies (IJDET)	0.96	208	USA
Journal of Professional Capital and Community (JPCC)	0.824	11	UK
International Journal of Cybernetics, Systems and Management Sciences	0.811	74	UK
International Journal of Information Technology and Computer Science (IJITCS)	0.765	213	Hong Kong
International Journal of Advanced Computer Science and Applications (IJACSA)	0.712	246	USA
International Journal of Management and Applied Science (IJMAS)	0.51	436	Switzerland
World Academy of Science, Engineering and Technology (WASET)	0.26	367	Turkey
World Scientific and Engineering Academy and Society (WSEAS) TRANSACTIONS on COMPUTERS	0.25	534	Greece
International Journal of Education and Research (IJER)	0.247	108	Australia
International Journal of Multimedia and Ubiquitous Engineering (IJMUE)	0.23	30	South Korea
International Journal of Contemporary Management and Information Technology (IJCMIT)	N/A	3	Malaysia
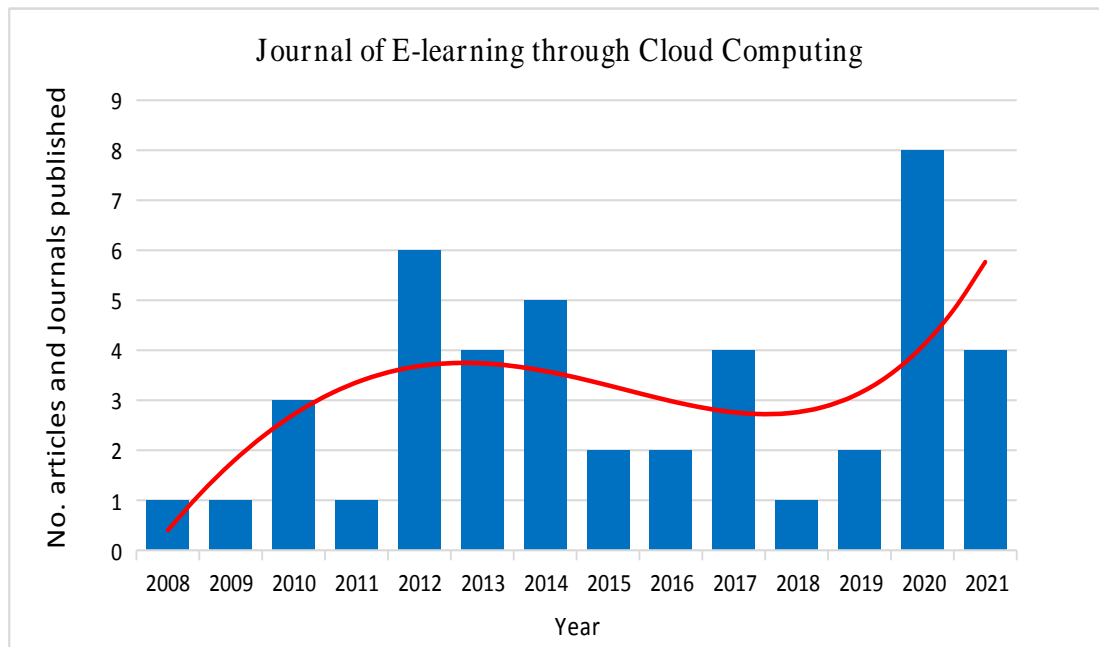
Figure 1. Bar Chart Representing the Number of Articles Published against Years

The above data is based on the research articles that explained the use of cloud computing in e-Learning and its impact during the COVID-19 pandemic since December 2019. In total, there are 44 papers that address on e-Learning using cloud computing and COVID-19 from 2008 to 2021, which represent a 14-year period. The trend-line or polynomial curve in Figure 1 demonstrates that there has been a gradual increase in the number of research papers published in the above related field. However, with the outbreak of the COVID-19 pandemic, more articles have been published to sustain how the pandemic has impacted on the use of cloud technologies in the education sector. This is represented by the highest data recorded in 2020.

Cloud Computing

Cloud Computing or Cloud Based Technology plays a pivotal role in the development of the ICT industry. The term 'cloud computing' refers to a combined system of networks, servers and computer tools that allows a user to complete a specific task or multi-tasks over the internet (Mell & Grance, 2011; Islam & Grégoire, 2012). Cloud computing systems have been accepted, implemented and integrated in various fields, including the education sector where they are used to deliver online education (Bouyer & Arasteh, 2014). In most educational institutions, academics and policy makers are looking for the most efficient cloud infrastructures and platforms that could deliver high quality education, user experience, interaction, knowledge and security in a short time interval.

Moreover, cloud computing is a new technology that can store data on cloud servers, which can be accessed anywhere and anytime on the internet using a digital device such as a mobile phone. Aljenaa et al. (2011) have referred cloud based technology as a system that uses low-cost materials and equipment to construct an online platform in a short time frame. Another factor to consider when using cloud computing is its flexible

deployment capacity. For instance, since less technical work is needed to execute cloud services in schools or institutions, the deployment process is fast (Aljenaa et al., 2011). Within the education sector, cloud based technologies provide a system backup which reduces the risk of losing information (Kaur, 2015). Data such as audio and video files, spreadsheets, documents, apps and software can be stored over cloud systems. These platforms also allow multiple users to work jointly on a same file, hence improving efficiency and performance. However, cloud computing is not a brand-new technological phenomenon. It has evolved over the years. According to Sharma and Trivedi (2013), cloud computing has emerged from a computer network diagram that first illustrated the internet as a cloud. Today, cloud based technologies are used to promote e-Learning in schools, colleges, universities and other educational institutions.

Cloud Computing Model

The National Institute of Standards and Technology, NIST (2011) describes cloud computing as a model that provides rapid and reliable access to resources through networks, servers, applications and services. NIST (2011) uses a visual model to support its definition of cloud computing, as shown in Figure 2 below.
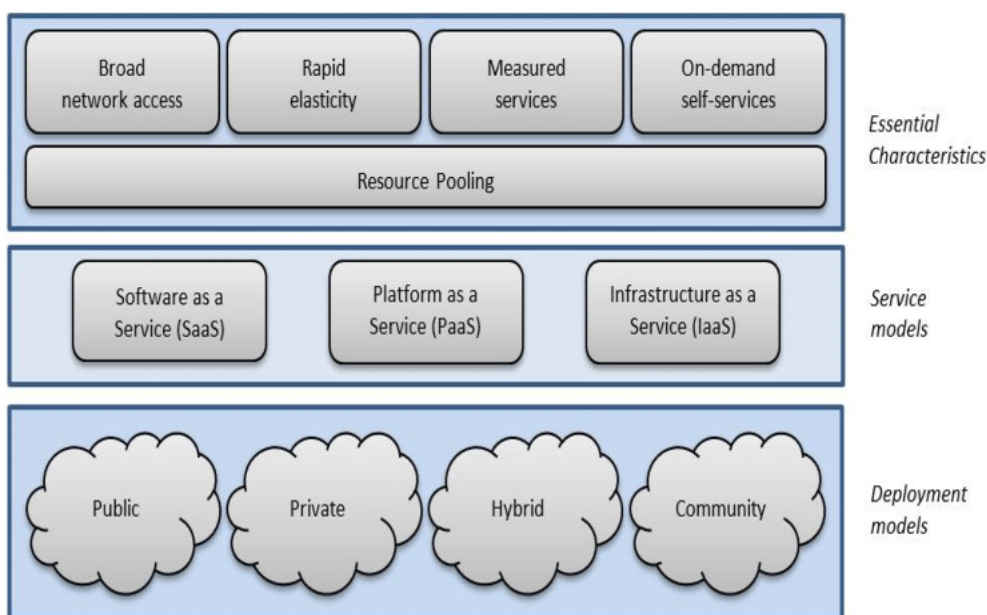
Figure 2. Visual Model for Cloud Computing (*Source: NIST definition, 2011*)

According to the NIST Visual model, cloud computing is a combination of three segments: Essential characteristics, Service models and Deployment models. The Essential characteristics allow users to have direct access to data and the cloud systems through well-defined parameters. The service models provide different platforms and user-friendly models that enhance user experience online. The cloud systems have been designed for both individual and business use. However, the deployment models are the cloud services that enable user to access and store data from any technological devices but have been adapted to the needs of the society, a business or a school.

The five essential characteristics described by Mell and Grance (2011); Naveen et al. (2016); Diaby and Rad (2017) are:

1. **Broad network access**: Cloud computing services are available over a wide network and are reachable to different clients through different cloud platforms.

2. **Rapid elasticity**: This refers to "virtualization" where data can be easily processed and stored. Its storage capacity can be increased and compressed depending on the needs of cloud users.

3. **Measured service**: Cloud Computing offers users and clients a fully structured cloud system. Such systems have a cost saving approach and users only have to pay for the cloud services that they are using.

4. **On-demand self-service**: Cloud models are user-friendly and users do not have to rely on service providers. They just need to be conversant with digital devices and technology.

5. **Resource pooling**: In cloud computing, the best cloud model is offered to clients using different computer resources such as networks and storage platforms.

The three cloud service models consist of Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

Software as a Service is a popular cloud service model that users can access through a web browser or any application software including from a mobile phone. There are many advantages with SaaS. These models do not require a hardware for installation and technical maintenance is not required since all the processes and applications are available on the cloud infrastructure itself. Most SaaS models are free but some might require a monthly or yearly subscription fees to access the complete service. Microsoft Office 365, Dropbox and Google Web-based office applications are examples of SaaS models (Bora & Ahmed, 2013).

Platform as a Service is a cloud model that allows software developers and web designers to create websites without using a software. PaaS models also enable developers to completely develop, test, share, manage and upgrade apps, hence making PaaS a life-cycle model. The application software, the web service or network and the business strategies are the services provided by cloud developers to businesses. Moreover, since the PaaS model can be self-managed, the developer who is also user, can reduce material costs and manage the cloud system efficiently (Jansen 2011). Commonly used PaaS models include EC2 (Amazon), Google Apps (Google) and Force.com (Salesforce.com) - a system largely used for businesses (Lee and Kim 2013).

In **Infrastructure as a Service**, the cloud developers provide users and businesses with hardware such as networks, servers, data storage capacities and other essential computer equipment resources so that users can run their software and system properly. It also allows businesses to access a wide range of online platforms and applications without the need to acquire larger cloud infrastructures. IaaS cloud designers ensure that the Operating system and Virtualization of the cloud model correspond to the requirements computer model or any other technological devices (Fernandez et al., 2012). The mostly used IaaS models are: Cisco and IBM hardware services and S3 (Amazon).

The four **deployment cloud models** referred by Bora and Ahmed (2013) are: Public Cloud, Private Cloud, Hybrid Cloud and Community Cloud.
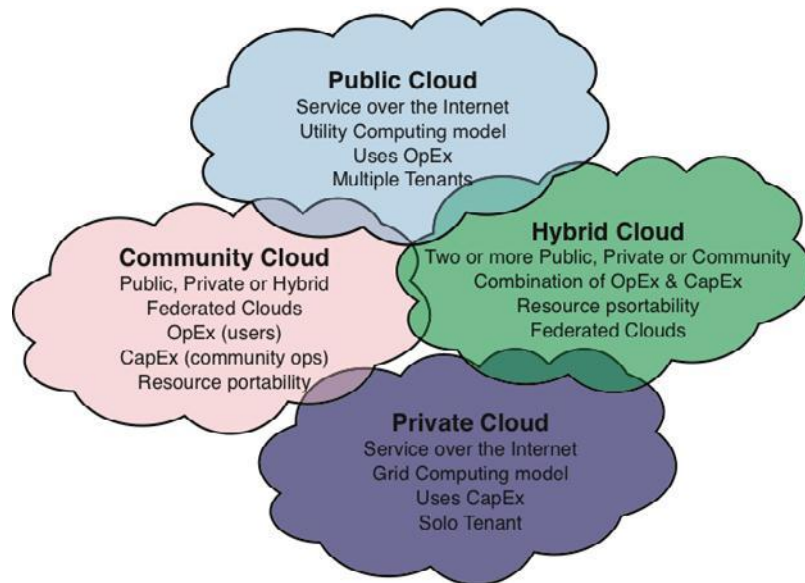

Figure 3. A Cloud Deployment Model *(Source: Bora & Ahmed, 2013)*

Figure 3 represents a cloud deployment model that is regularly used. While all the four systems are adapted for user satisfaction and accessibility of data, they have different features that differ because of annual fees, location of where data is stored, privacy and multi-user accessibility.

According to Bora and Ahmed (2013), in **Public Cloud** models, cloud applications and storage facilities can be accessed by the any user on a public cloud software over the internet. Most of the apps and programs are free but some might be subjected to a monthly or yearly subscription depending on additional features or components that the user wishes to acquire. However, such cloud models are usually owned and managed by the cloud developers themselves such as Google Gmail. **Private Cloud** platforms are normally designed for a single business with multiple users who have exclusive access. Public cloud models are usually purchased and managed by either the business itself, a third party, or a combination of the two. Such models do not require any specific location to operate. **Community Cloud** systems combine their technology and share it with different groups, companies and organizations so as to oppose serious challenges related to privacy, security and law among others. A **Hybrid Cloud** model is a combination of at least two cloud models (public, private or community). Despite the fact that hybrid cloud based systems operate independently, yet, they are interconnected so as to provide the best deployment models to businesses, organizations and users.

Since 2008, cloud based technologies have evolved from normal delivery, sharing, accessibility and storage of data in the form of text document. Nowadays, along with traditional practices, users can access, share and store data in the forms of multimedia (music, video and images) and spreadsheets (Microsoft word, excel and PDFs). These files can be accessed on cloud models through remote servers such as iCloud, which is a cloud computing

model designed by Apple Inc. It allows users to store music, media and IOS apps on any digital devices. Other cloud-based services that are often used include YouTube, Drop box and Google Applications (Kiran, 2014).

Today, cloud based technologies are massively used in the education sector, especially with the outbreak of the COVID-19 pandemic where schools and educational institutions had to close and lessons be delivered through online learning platforms. For example, cloud computing systems have been adopted by higher educational institutions because they are either free or cost-effective and they engage both educators and students to collaborate and interact during the teaching and learning process. By way of illustration, Parmeswar et al. (2017) have demonstrated how the Open University of Mauritius has integrated the MOODLE (Modular Object Oriented Dynamic Learning Environment) learning platform to sustain quality education. Moodle is an effective cloud computing model used by educators, educational administrators and students. It supports group learning, individual learning and delivers a wide range of integrated features such as data storage and can be accessed from any location (Wang et al., 2004).

e-Learning

Electronic learning or E-Learning is an educational system that focuses on new approaches in teaching and learning that uses digital devices. It can be described as the delivery or sharing of knowledge, data and skills using an electronic device and the internet. Generally, e-Learning applications and strategies project the users into an interactive-based learning. Thus, the user can interact online to share, store and assimilate knowledge and information at any pace. Arkorful and Abaidoo (2014) have termed e-Learning as an educational model that uses Information and Communication, Technology (ICT) to facilitate online learning and teaching while knowledge can still be accessed anytime.

Nowadays, academics and software designers are working closely to create new and improved teaching methods through e-Learning using cloud based systems. E-Learning can be described as an education software that delivers a service. A fundamental justification for cloud computing being used in education is because cloud based models allow more users to connect, share and store data using a digital resource through a cloud platform. According to Alajmi et al. (2018), cloud technology modeled for education allows more researchers to identify the best cloud models within a shorter time. This contributes towards the growth of a better society. However, the advancement and availability of technological resources have paved the way for efficient e-Learning services.

e-Learning Infrastructure

Nowadays, many educational institutions especially higher educational institutions or universities can offer online learning and coaching to their students. For example, this can happen through a cloud app which students and adult learners can either access or download on their mobile phones, hence keeping up with the university facilities provided off campus. Therefore, e-Learning or online learning can be referred as a network-based method of teaching and learning that requires the integration of technology. However, for effective e-Learning to happen, the proper infrastructure in terms of adequate cloud computing technologies and equipment should be

used. By way of illustration, Mathew (2012) has referred to a cloud computing service model that is suitable for universities.
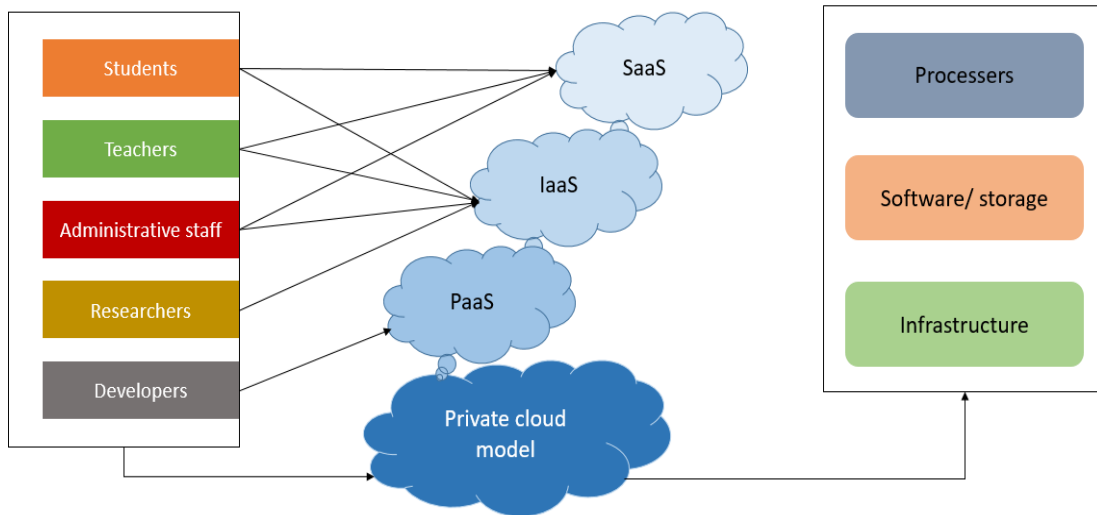
Figure 4. Cloud Computing Service Models (*Source: Mathew, 2012*)

Mathew (2012) has supported a private cloud model for education as a prerequisite. In the model from Figure 4, schools and other educational institutions can create their own cloud based system and adapt them as from their existing data. This model opens opportunities for universities to join and develop a hybrid system where resources and knowledge can be shared over a large network. This allows end users such as students, lecturers and teachers to benefit from the wide range of data as resources, storage capacities and an operative cloud for education.

Figure 5. Architecture for Cloud Education Model (*Source: El-Sofany et al., 2013*)

El-Sofany et al. (2013) have discussed about several layers in a cloud model that are prerequisite for Cloud Education. Figure 5 illustrates the architecture of a cloud computing model that supports e-Learning. There are four layers that are monitored by a management system and a security system namely: Physical hardware layer (server, storage devices, internet access), virtualization layer (cloud online storage and application system), education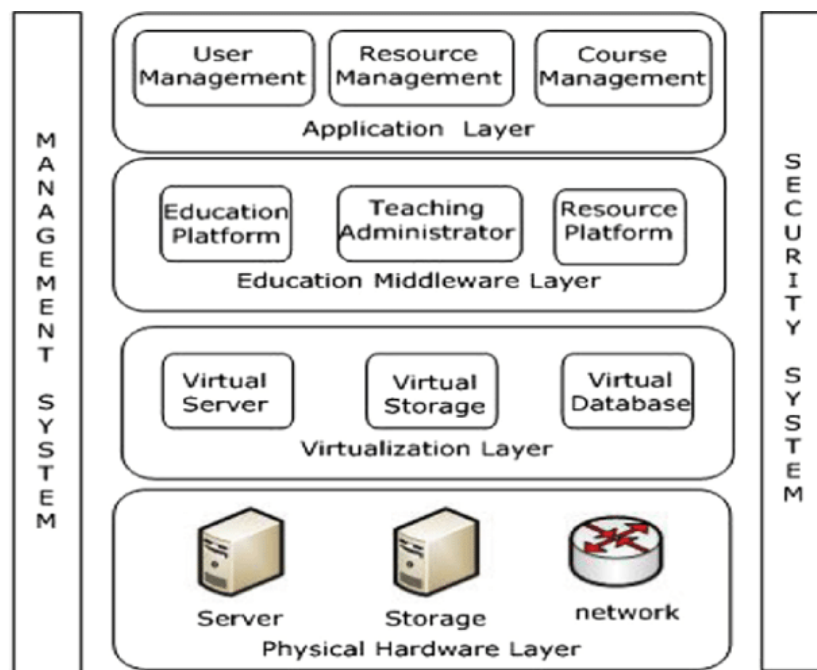 middleware layer (teaching and learning platforms) and application layer (where the hosting service takes place). This is illustrated in Figure 5. The diagram gives an insight about the users who are involved.
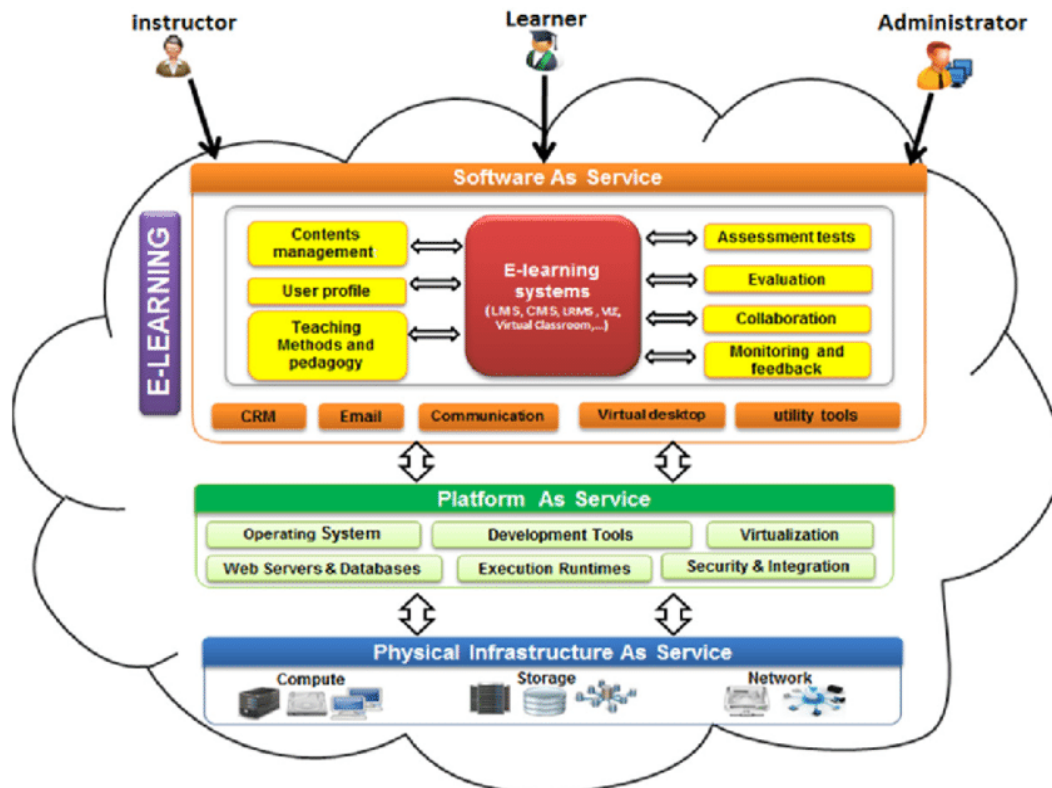
Figure 6. A Proposed e-Learning based Cloud Approach (*Source: Dahdouh et al., 2017*)

However, e-Learning should not replace the role and position of educators or any educational instructors. E-Learning is a blend of traditional teaching techniques and technology so as to enhance the quality of education. Thus, it should be viewed as a modern e-Learning system that uses affordable resources such as network, hardware, storage cloud, a server and other technology-related equipment which can be accessed virtually, that is online. Therefore, e-Learning through cloud based technologies has many opportunities. The diagram in Figure 6 displays an e-Learning based cloud approach based on Dahdouh et al. (2017).

The above diagram demonstrates how the three service layers are prerequisite in a cloud based e-Learning model. The Physical Infrastructure as Service supports a more dynamic hosting host pool while Platform as a Service provides the model and resources to create and run the cloud applications. The Software as a Service are service layers that offer features such as the content, access to content, collaborative learning and monitoring. facilitates interaction among students, teachers and educational institutions (Dahdouh et al., 2017). As an example, students can have online examinations and submit their assignments. Teachers can regularly monitor

students' works and performance and they can send feedback through emails or online messaging. The model allows higher user experience, reliability and accessibility

Application of Cloud Computing in E-Learning

Since 2008, there have been various researchers who researched on how cloud computing has been used in the education sector. In the early 2008-2009, Plummer et al. (2008) and Won (2009) demonstrated how cloud computing was an important service provider which would benefit the future generation. From 2010 to 2015, emphasis was laid on the development of a cloud computing structure for Education. The idea was to promote IT skills and knowledge through e-Learning as supported by Niall (2010) and Fernandez et al. (2012). In a Special Focus Paper, El-Sofany et al. (2013) added "Hardware-as-a-Service" (HaaS) and "Database-as-a-Service" (DaaS) as additional service models to the commonly used SaaS, PaaS and IaaS. In June 2017, after an analysis was carried on the cloud deployment models and their uses (Diaby & Rad, 2017), accessibility and cost reduction were among factors that encourage the use of cloud computing. Elnajar et al. (2019) described MOOCS and VLES as cloud application systems used in universities. As at date, schools, universities and other educational institutions are using cloud platforms such as Zoom, Microsoft Teams and GoogleMeet to connect to the community of students, educators and academics (Azorin, 2020). Finally, cloud-based mobile learning also supports e-Learning (Ahmad et al. 2020). According to Alhelou et al. (2021), today, cloud based applications are accessed in several forms such as Email services (Gmail and Yahoo mail), Cloud Storage Platforms (Google Drive and Dropbox) and Functional Cloud Applications (Google Docs, Sky drive and Office365). Table 2 below displays research titles based on the use of cloud computing in e-Learning from 2008 to date.

Table 2: Application of Cloud Computing in E-Learning since 2008

Year Published	Authors	Title of article
2008	Plummer et al.	Cloud Computing: Defining and Describing an Emerging phenomenon
2009	Won	Cloud Computing: Today and tomorrow
2010	Al-Zoube et al.	Cloud Computing Based E-Learning System
	Niall	E-Learning in the Cloud
	Pocatilu et al.	Measuring the Efficiency of Cloud Computing for E-Learning Systems
2011	Aljenaa et al.	Towards an efficient e-Learning system based on cloud computing
2012	Masud and Huang	An E-Learning System Architecture based on Cloud Computing
	Madan et al.	E-Learning based on Cloud Computing
	Fernandez et al.	An overview of E-Learning in Cloud Computing
	Majid et al.	E-Learning Based on Cloud Computing

	Manro et al.	Managing e-Learning using Clouds: A cost-effective boon in 21st century
	Mathew	Implementation of Cloud Computing in Education - A Revolution
2013	Radulescu	A perspective on E-Learning and Cloud Computing
	Bora and Ahmed	E-Learning using Cloud Computing
	Jeong et al.	A Content Oriented Smart Education System based on Cloud Computing
	El-Sofany et al.	The Impact of Cloud Computing Technologies in E-Learning
2014	Sharma et al.	Distance Education Technologies: Using E-Learning System and Cloud Computing
	Kiran	Role of Cloud Computing in Education
	Al-Otaibi	Exploring Users Attitudes and Intentions Toward the Adoption of Cloud Computing in Saudi Arabia: an Empirical Investigation
	Arkorful and Abaidoo	The Role of e-Learning, the Advantages and Disadvantages of Its Adoption in Higher Education
	Bouyer and Arasteh	The necessity of using cloud computing in educational system
2015	Kaur and Singh	A Review of Cloud Computing Security Issues
	Riahi	E-Learning Systems based on Cloud Computing: A Review
2016	Kayali et al.	Literature Review of Cloud Based E-Learning Adoption by Students: State of the Art and Direction for Future Work
2017	Dahdouh et al.	Integration of the Cloud Environment in E-Learning Systems
	Diaby and Rad	Cloud Computing: A review of the Concepts and Deployment Models
	Parmeswar et al.	Familiarity of Moodle E-Learning Platform among Open University of Mauritius Students
	Lovedeep et al.	Role of Cloud Computing in Education System
2018	Alajmi et al.	The Effectiveness of Cloud-Based E-Learning towards Quality of Academic Services: An Omanis' Expert View
2019	Asadi et al.	Understanding And Predicting Teachers' Intention To Use Cloud Computing In Smart Education
	Elnajar et al.	Cloud Computing In Education: A Survey on the Adoption and the Challenges for the faculty of IT at the

		Benghazi University-Libya
2020	Kayali and Alaaraj	Adoption of Cloud Based E-Learning in Developing Countries: A Combination of DOI, TAM and UTAUT
	Ahmad et al.	Developing a Cloud-Based Mobile Learning Adoption Model to Promote Sustainable Education
	Bhardwaj et al.	E-Learning during COVID-19 Outbreak: Cloud Computing Adoption in Indian Public Universities
	Hussein and Hilmi	Cloud Computing Based E-Learning in Malaysian Universities
	Azorin	Beyond COVID-19 Supernova. Is Another Education Coming?
	Bao	COVID- 19 and Online Teaching in Higher Education: A Case Study of Peking University
	Chen et al.	The Impact of COVID-19 Pandemic on User Experience with Online Education Platforms in Chine
	Almaiah et al.	Exploring the critical challenges and factors influencing the E-Learning system usage during COVID-19 pandemic
	Dhawan	Online Learning: A Panacea in the time of COVID-19 Crisis
2021	Cheng	A dual-pathway model of cloud-based e-Learning continuance intention and performance outcomes
	Agrawal	A Survey on Recent Applications of Cloud Computing in Education: COVID-19 Perspective
	Alhelou et al.	The Role of Cloud Computing in Improving the Quality of Accounting Education in Palestinian Universities in Light of the COVID-19 Pandemic
	Madhumitha et al.	Impact of Cloud Computing in Higher Education: Amidst COVID-19

Opportunities of e-Learning through Cloud Computing

The integration of cloud computing systems into e-Learning has brought many opportunities in the education field. One main advantage of e-Learning through cloud computing is to provide students and teachers access to data and high quality software through different cloud models. Data can be accessed anytime and from anywhere. It also facilitates teaching and learning during the COVID-19 pandemic. Moreover, the use of digital devices helps to enhance the quality of lessons delivery and creates more interaction between students and educators. In fact, it is the whole education system that benefits from the use of cloud models in e-Learning. Knowledge, skills, awareness, data and software applications can be easily shared, monitored and accessed. They are also reachable from any part of the world through an internet network and by using a technological

device such as a mobile phone. Today, cloud based e-Learning systems are used in primary schools, secondary schools, universities and other educational institutions. The major users of these online based models are students, educators, school administrators, tutors, academics and the service providers. The following opportunities are based on the data received in the research articles from Table 2. Thus, the best advantages that have increased user experience and maximized on storage capacity, quality of data, ICT resources, security, rapid access and privacy have been considered.

(1) Computing Resources and Storage Capacity

There is high storage capacity and efficient computing resources which include a wide range of accessible data from different online educational platforms. Students, administrators and other users can access data and store data using high computing medium (Dahdouh et al., 2017). Adding to that, cloud based e-Learning systems serves as a "cloud service" to multiple students, users and adult learners who access the internet easily from anywhere. Usually, such cloud platforms have fast processing capacity and they are also reliable, fast and user-friendly.

(2) Cost

The integration of e-Learning through cloud technologies equals to a reduction in the cost or expenses. Nowadays, users or learners do not have to invest a lot on highly technological devices or equipment (Dahdouh et al., 2017). Cloud platforms can easily be accessed from simple digital devices such as mobile phones, tablets and PC to illustrate some using a good internet connection (Bora & Ahmed, 2013). Furthermore, since data can be created and stored on the cloud storage system itself, the learner or user does not have to purchase any external storage devices such memory cards or external hard drives, the user can just access the file or data at his own convenience. As for institutions who use cloud computing systems, they save a lot of money. Cloud based platforms enable multiple users to access a different or the same file at the same time and the administrators do not have to pay for individual use.

(3) Availability and Accessibility

According to Kiran (2014) and Dahdouh et al. (2017), there is higher service quality because of rapid processing capacity and large amount of data can be stored. There is also an extra feature with cloud systems that allow them to detect faulty or errors in the network or system itself and to omit the error or faulty, without interrupting the system. Lovedeep et al. (2017) focused on how cloud computing allows easy access to teaching and learning using digital resources.

(4) Security

According to Dahdouh et al. (2017), large amount of data is regularly stored over cloud based technologies. As such, data controllers or system administrators have to monitor data, assign resources, handle workloads, install

applications, monitor the level of protection, and perform accurate real-time adjustment using one or more data centers while ensuring that the users' data are highly secured (Lovedeep et al., 2017). Therefore, confidential information about each user is secured and privacy is kept at high level while file tracking can be done. Such data security facilitates the teaching and learning process.

(5) Virtualization and Computing Process

Virtualization is a key element within a cloud system. Since there is no interrelation between the application software and operational system which includes hardware and other digital resources, virtualization makes it easier to monitor, store and control data (Dahdouh et al., 2017) Moreover, it also allows data to be shared, stored and distributed on demand over larger accessible platforms.

(6) Software updates

Cloud based technologies do not require regular maintenance of its software from the developer or administrator. It has an in-built feature that automatically updates the cloud system. So, users need not to wait for too long for any updates. Moreover, updates on the software are usually managed by cloud developers at different intervals within a year and users which include administrators and learners have a free service software update (Bora & Ahmed, 2013).

(7) Compatibility

According to Bora and Ahmed (2013), cloud computing systems allow data to be shared, stored and distributed through different document formats. The user does not have to worry about the fonts or file formats since e-Learning systems can open any file format, fonts and other features over the cloud.

Advantages of e-Learning using Cloud Systems for Students and Educators

The integration of cloud based technologies to enhance e-Learning brings a lot of advantages for both students and educators (Pokhrel & Chhetri, 2020). Students can study from home, access school data or university data at their convenience. They are allowed to submit assignments and projects on the cloud platform and they can also receive instant and regular feedback from their tutors, educators or lecturers (Dahdouh et al., 2017). Since all data are stored over the cloud platform, no works or projects would be lost. However, in case there is any file lost, the administrator can still track and restore the file again. In other cases, students also take online examinations such as Pearson OnVue online proctoring system (Slusky, 2020; Camara, 2020), which allow students to take exams without the need to travel to an exam centre, due to the current sanitary situation with COVID-19 where exam centres, schools and educational institutions are closed.

Educators, tutors and lecturers also perceive a lot of opportunities (Bora & Ahmed, 2013). Along with monitoring students' progress over assignments, homework and projects, educational professionals can also set

online tests, quizzes and exams for students. Tutors can also interact with their learners and provide the best resources for their students. Another factor is that they can also provide feedback directly to their students either through video conferencing or even leave instruction and comments over an email (Bora & Ahmed, 2013). This creates more interaction and facilitates a positive communication between learners and tutors, hence making learning experience approachable and inviting for students (Doucet et al., 2020). Another advantage of using cloud computing to support e-Learning is that access to these e-Learning systems is made available to all students and learners, not taking into account whether the learners come from rural or urban areas. Lovedeep et al. (2017) used the term "Shareability" to demonstrate the effective interaction between students and educators and the quality level of storing data.

Challenges of Cloud Computing in e-Learning

Despite that cloud computing comprises of several opportunities and advantages, the integration of cloud based technology in education also has limitations. This paper identifies the challenges that disrupt user experience and the teaching and learning process when cloud based e-Learning systems are used such as the lack of digital resources, poor internet access and low data security. The selection of data has been retrieved from the research articles in Table 2. It is important to discuss about the challenges of cloud computing in e-Learning so as to maximize on the quality of education, to enhance user experience, to improve cost issues related to the purchase of appropriate technological devices and to better equip learners and educators with the best training facilities, skills and knowledge to use cloud based e-Learning platforms. Identifying the drawbacks of these e-Learning cloud systems, can enable future researchers to look for new strategies to encourage more people to use and adapt with cloud models, irrespective if the user is a digital native or not.

(1) Data Protection and Security

This significant challenge is related to possible data loss, low security and privacy is compromised. These are in fact sensitive data that usually require an in-depth control and continuous monitoring by the developers and cloud administrators. Referring to cloud computing systems that are used in schools or any other educational institutions, there should be a control unit to oversee all the sensitive information. In higher education institutions and universities, the research and development unit is responsible to monitor and handle data in the form of intellectual property, patents and highly confidential information among others (Leavitt 2009).

(2) Low awareness about Cloud Computing

Furthermore, as per Leavitt (2009), there is still a lack of awareness on the advantages that can benefit schools, academics and researches. As such, there is more reluctance by universities and schools to adopt cloud based technologies in the process of teaching and learning. Unfortunately, this leads to a lack of trust by cloud users who work at universities or schools in various positions such as educators, programme managers and administrative staffs along with students.

(3) Speed and lack of technological resources

The internet speed and the lack of adequate internet or network access in institutions could disrupt the proper functioning of the cloud system (Agrawal, 2021). This also interrupts and in some cases might also stop users from accessing the e-Learning platform on the cloud. Therefore, access to cloud computing might become more limited whenever there is a lack or downfall in the number of technological resources and internet facilities (Riahi, 2015).

(4) Digitalization and Political issues

According to Sharma et al. (2014), the integration of cloud based technology to support e-Learning and education, is perceived as a threat to many computing staffs who are afraid of losing their job mainly due to the digitalization of the educational model. There is also a challenging competition between cloud service providers and this can affect the quality of cloud services to users (Sharma et al. 2014). Lastly, there might be some political and legal issues where cloud services need the approval of the government. This is because sensitive data that includes confidential information, intellectual property and patents while being stored and shared might be compromised or lost (Agrawal, 2021).

The Use of Cloud Computing in e-Learning during COVID-19 Pandemic

The outbreak of COVID-19 pandemic has impacted on the global economy and our social life since late December 2019 (Asadi et al. 2019). Many schools, colleges, universities and other educational institutions are currently closed and this impacts massively on teaching and learning (Azorin 2020). This clearly coincides with UNICEF (2021) where the number of students affected by the pandemic has increased from 1.077 billion in September 2020 to 1.284 billion in February 2021. Hence, new educational models have been identified and have been quickly implemented so as to sustain teaching and learning. Moreover, COVID-19 compelled many institutions and schools to adopt an online approach; hence e-Learning is being accessed through different cloud computing platforms (Dhawan, 2020). Despite the on-going crisis, there are many opportunities that come up with the implementation of E-Learning. Students who have to be away from their university or school, can access their institutions' database, they can interact with their educators and tutors and submit tests and assignments. Schools and colleges can communicate to a lot of students at any time and from anywhere around the globe using different online teaching methods. According to Dhawan (2020), several institutions have adopted online teaching and learning methods and started to offer online education only after the pandemic issue. To some extent, it is good to note that more and more institutions are turning towards technology which would certainly increase ICT literacy around the world.

However, using cloud based technology to promote e-Learning has been a challenge. Bao (2020) amplified on the fact that transitioning the traditional delivery of lessons into an online system is a major shift that needs to be organized and planned tremendously. This holds true as migrating into a digital education system will require a convenient e-Learning infrastructure and appropriate deployment cloud models to deliver quality service to

students and educators (Almaiah et al., 2020). Moreover, educators and other users need to be trained, and provided with access and enough support to comply with cloud systems in e-Learning. Another important factor to be considered is the selection of the appropriate e-Learning database (Chen et al., 2020). A research done by Chen et al. (2020) investigated on the influence of COVID-19 on e-Learning users in the Republic of China and their results demonstrated how cloud systems normally used for businesses were adopted in e-Learning. As observed by Chen et al. (2020) during the pandemic, users had to struggle a lot with the platform's accessibility, security, and quality of media being transmitted and shared through video conferencing. Thus, there is a need to identify and use the most efficient cloud platform to counter all these difficulties. Relying on their analysis, Chen et al. (2020) showed that Zoom platform provided the best user experience and support. These are surely very important factors to be considered when developing or integrating a new cloud model in education. Therefore, to boost user experience and support, it is essential to improve the cloud service delivery including video and media transmission, design the model with additional features such as split screen, sound and other type media sharing during the call, which allow more interaction between students and teachers (Almaiah et al., 2020). The features from the software should be user-friendly and designed for easy-use by any individuals. Lastly, the cloud system should have updated resources, data and generate activities in order to motivate students and to enhance students' experience (Chen et al. 2020).

According to Ahmad et al. (2020), technology has emerged as the only means to support e-Learning and it enables education to be shared on a worldwide scale and this process is supported by Kurelovic et al. (2013) where ICT has supported the education sector over many years. The emergence of e-Learning through cloud computing has made online education a much easy and rapid task to cope with for educators and students during the pandemic. Thorsteinsson et al. (2010) and Agrawal (2021) expressed virtual collaborative systems as an excellent manoeuvre through cloud computing platforms in online teaching and learning. Actually, this is a very good strategy which should have been implemented much before since educators and students can interact conveniently, and using technology enhances the quality of lessons' delivery. This motivates students and hence maximizes student performance. Chang et al. (2017), Ayele and Birhanie (2018), Huang and Teo (2019), Huang et al. (2020), and Jin et al. (2021) have demonstrated how students' grades urged more students to use online learning.

Discussion

Presently, cloud based technology is massively used in the education sector. This is because cloud computing enables a variety of opportunities for the organization using the cloud platform, the users and the service providers themselves. For instance, data is stored and shared on the online web. Through different cloud features, anyone can access data anytime and from anywhere across the globe using any other digital device such as a mobile phone. There are diversified systems and applications that allow schools, universities and other educational institutions to connect with students, educators and administrators (Madhumitha et al., 2021). So as to promote e-Learning as a modern educational model, it is very important to integrate cloud services within teaching and learning. Alajmi et al. (2018) and Madhumitha et al. (2021) stress on the need for efficient cloud systems and professional training be given prior to using cloud based technologies in e-Learning. Hence, there is

a need to train and educate users who are using or planning to use cloud based technologies. Users including educators, students and school administrators have to be equipped with newly technological skills and awareness through workshops. Nowadays, cloud computing is available and accessible to any user from any geographical position around the globe. Earlier, Mell and Grance (2011) have focus on the need to adopt or design an appropriate cloud model. According to NIST definition, a cloud model works best when all the layers are inter-connected in distributing cloud services and deployment models which are backed by essential characteristics. This makes it clear that a cloud based education model need to have all the features as designed through the NIST Visual model. However, it is also important that schools and universities possess the necessary technical infrastructures and digital resources to promote, migrate and integrate e-Learning using cloud computing (Al-Dalaien et al., 2019; Al-Masri et al., 2019). Only then, the use of cloud computing in e-Learning will be efficient. This agrees with Fernandez et al. (2014) and Sharma et al. (2014) who acknowledge the use of technological devices to maximize on the quality of data being shared and accessed. This also leads to larger number of users being connected to an online educational platform, hence maximizing on a larger community of learners within schools, educational institutions and the society (Alqahtani & Rajkhan, 2020). With the current sanitary restriction imposed by governments, schools, universities and users have become dependent on cloud based e-Learning systems. The main reasons explained are related to rapid access, free or low cost, quality, security and storage facilities. According to Nasri (2019) and Alhelou et al. (2021), cloud platforms also allow multiple users to connect over different data sources at the same time and such platforms are user-friendly and just require a basic knowledge of ICT. For instance, allowing multiple students and educators to connect is a good initiative to encourage more students to interact, communicate and share knowledge and skills. Further to the researches, it has been observed that Zoom Platform has been among the most often used cloud applications in e-Learning during the pandemic (Bhardwaj et al., 2020).

On the other hand, the integration of cloud computing in e-Learning has been a challenge. While Chen et al. (2020) stressed on the lack of technological infrastructures, Jin et al. (2021) focused more about the academic impact of not having an e-Learning programme at school level. Such issues represent a challenge to the implementation of any cloud based education. Firstly, it is advisable that schools and any educational institutions invest in technology. Equipment such as computers, servers, software and internet network have to be available. There is a need to have specialists or technical ICT staffs to ensure that the setup is appropriate in terms of database, security, accessibility and high quality user experience before it can operate efficiently (Zang et al., 2020; Agrawal, 2021). Then, adequate training has to be given to educators or tutors to develop new skills on how to deliver lessons online, interact with students and how to monitor and provide feedback on students' progress. Students and learners who are end users have to be given prior demonstration on how to access cloud systems and how to submit assignments. It is therefore important that a proper academic programme is designed for e-Learning if not it will be difficult for both tutors and learners to interact visually online. E-books, teaching and learning PDFs and any educational media have to be input on the cloud database.

However, according to Kayali et al. (2016) and Al-Otaibi (2014), there is also a need to work on the behaviour and attitude of users towards the acceptance of cloud computing. As far as the educational model is concerned, it is more appropriate to use standard cloud platforms to sustain quality and effectiveness of knowledge and

skills, as well as enhancing users' experience and satisfaction. Using information from Table 1, it has been observed that from 2008 to 2012, the researchers' titles focus on the definition and early implementation of cloud computing in education. From 2013 to 2016, authors discuss about cloud based architecture and the adoption of cloud models in e-Learning. As from 2017, the research articles emphasize on the application of cloud systems in e-Learning, the challenges and opportunities of e-Learning using cloud computing. However, in the early 2020, articles focus on the influence of COVID-19 pandemic over the education sector. Moreover, it is observed that emphasis is laid on user experience and how students, schools and educational institutions are using cloud platforms in e-Learning, not taking in account about the impact of COVID-19 on e-Learning and cloud computing. The paper also discusses about the need to have updated cloud models to support e-Learning on the long term and how technology needs to have an integral position in the education sector.

Conclusion

In this digital era, countries depend enormously on the evolution of technology and the mastering of skills and know-how of people through education. Presently, with the outbreak of COVID-19, the world witnesses how schools, universities, teachers and students access education over the internet. Traditional teaching and learning acknowledge a change after many years. Lessons delivery, assignment submission and projects for students and continuous monitoring are available through online applications and cloud systems. According to Christensen (1997), no one could have imagined that technology might one day emerge as a powerful option to facilitate teaching and learning, especially during a pandemic. This paper supports the fact that the use of cloud computing in e-learning, helps students and educators to access, store and retrieve data through a cloud system anywhere and at any time during COVID-19 pandemic. Cloud computing enables educators to improve their teaching skills and effectiveness. Students are encouraged through collaborative e-Learning. There exist many advantages with the adoption of cloud computing in e-Learning such as cost-reduction, high storage capacity and data security. There is a need to instill digital awareness and skills in students, teachers and academics. The research also clarifies the issue related to weak cloud infrastructure, unavailability of technological resources and low internet speed. This paper shows the reluctance of new users who are not digital natives to adopt, use and interact with cloud based technologies in e-Learning. The need to increase user experience is also an important factor to be considered as stressed by Chen et al. (2020). Hence, it is important that schools and universities adopt an appropriate cloud based education model and they need to encourage students and educators towards using cloud systems in e-Learning. More focus needs to be on IaaS, SaaS and PaaS service models as well as deployment models. Finally, this paper recommends to integrate cloud based technology in schools and universities and to improve the capacities of students and educators in e-Learning by using cloud applications.

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