Short Research Article

Cloud Computing Technology: An Effective Tool forCurriculum Delivery in Nigeria Educational Process

Abstract

The 21st Century has brought a new set of skills that students will need to be successful in the world around such as critical thinking, problem solving, communication and collaboration. Technology can support the development of these skills and it has also brought change to the way teachers and students go about delivering information and learning. Notable to all, majority of students and teachers have one form of technology or the other, such as cell phones, mobile phones and mini-computers which makes it easy to access the internet at their fingertips. With this development, Teaching-Learning and Research in Education has undergone a phenomenal change which makes the whole process changing so significantly and this can be attributed to new technological changes over the decades. Hence, the adoption of Emerging Technologies such as Cloud Computing Technology in the education sector will strengthen further and reform the system. Because it enables learning everywhere and all the time…..Based on the above, the paper exploredthedefinitions and meaning of cloud computing; The Implementations and Uses of Cloud Computing Model in Teaching and Learning.In addition, Components structure and major types of cloud technologies as a tool in education processwas discussed such as…. The paper equally, identified Advantages as well as Challenges and Risk of the use of cloud computing in education. Lastly, conclusion and recommendations for the improved use of cloud computing in education were highlighted

Keywords: Cloud computing, Technology, Curriculum delivery, Effective tool & Educational process

Introduction

Educationist around the globe have agreed that, the 21st Century has brought a new set of skills that students will need to be successful in the world around and such skills can include: critical thinking, problem solving, communication and collaboration. Hence, it was envisaging that, technology can support the development of those skills and can also brought change to the way teachers and students go about delivering information and learning in school system. Notable to all,majority of students and teachers have one form of technology or the other in them, such as cell phones, mobile phones and mini-computers which makes it easy to access the internet at their fingertips. With this development, Teaching-Learning and Research in Education has undergone a phenomenal change which makes the whole process changing so significantly and this can be attributed to new technological changes over the decades. Hence, the adoption of Emerging Technologies such as Cloud Computing Technology in the education sector will enables it to strengthen further and reform the system. This will therefore, allow educational sector such as universities to reduce the costs of purchasing software licenses and expensive computer parks with large amounts of memory and disks, since the programs used in training sessions, as well as all the results of work done, can be stored in the cloud. The transfer of educational services to the cloud will facilitate switching to a format of "learning everywhere and all the time"(Peter, 2019: Al-Zoube, et al; 2010; Beaumont, 2018; Changchit, 2015;.& Davis, 2017)

In this perspective, the implementation of cloud computing in educational institutions will ultimately help schools to work toward their strategic vision and ensure student success and this is because,hosting educational resources on a cloud platform eliminates physical textbooks and makes them easily accessible to students and teachers alike. Teachers can upload course material remotely and students can acquire all the necessary books and modules with a simple device and an internet connection.Cloud computing is an integral aspect of any computer service and it helps in the delivery of storage, database, software, analytics, networking, and intelligence over the internet or "cloud" for backup storage. It also facilitates flexible resources and economies of scale.(Aigul, et al: 2017).

It has been established by researchers' that, integration of contemporary information technologies into education will enable users to achieve plans only in the case of stable, safe and productive functioning of the entire information technology (IT) infrastructure. Hence, this has to meet the increasing requirements of increased productivity and fail-safety with constant increase of the processed information volumes. Simultaneously, requirements are set to reduce expenses on support and development of the IT infrastructure and enhance its adaptability to changing requirements to the IT of educational institutions. The most effective means of satisfying those requirements is IT development relying on cloud-based computing, which represents one of the most promising innovative information technology trends.(Aigul, et al: 2017)

Definitions and Meaning of Cloud Computing Technology

The term cloud computing was first used in 1996 to describe a computing model where all desktopapplications live on the cloud. Unfortunately, during that time, the technology to deploy cloud computing were notreadily available. The cloud computing model was reintroduced in 2006. At first, the response to this technology isfairly accepted. However, acceptance to cloud computing technology changed when the Internet giants likeamazon.com, google.com, microsoft.com, and IBM started using this computational model and further offer thisfacility to other web users. Since then, various services, software and storage has been implemented based oncloud computing (Van Ommerenet al., 2009).

In an ordinary sense, the phrase "the cloud" conjures images of puffy, soft things that lack any solid substance, the digital version of clouds is rooted in physical and virtual infrastructure. The cloud consists of a very real, reliable network of infrastructure that host all the provider's data and services. Customers use the internet to access these server-based cloud networks and their resources, including data storage, online streaming content (e.g., YouTube, Netflix, etc.), and infrastructure platforms like Google Cloud, AWS, or Azure**.** Over the last ten years, technology and the important of cloud computing have caused significant shifts in education and how students learn. Previously, teachers could predict careers that students would have in the future and work to prepare them; however, educators no longer have that luxury. By incorporating meaningful technology into the classroom, both students and teachers will see improved outcomes and increased engagement. Today, it is imperative that students leave class with the mastery of essential skills such as the ability to create, collaborate, think critically, and communicate cogently. One way to foster an environment of innovation in schools is through

cloud computing. Cloud computing offers opportunities for innovation and benefits in the classroom that are both safe and cost-effective.(Peter, 2019: Al-Zoube, et al; 2010; Beaumont, 2018; Changchit, 2015;.& Davis, 2017)

Cloud computing technology is increasingly being used by educationist, enterprises and organizations. It basically involves avariety of independent technologies such as hardware virtualization, distributed processing, utility computing,network system, web services, platform as a service, and software as a service. This computing model is based ona service-oriented architecture (SOA) model. Its offers high flexibility, reduce cost of ownership, scalability andservices on request (Baunet al., 2011). This model of computing is an evolution of the Internet-based technologiesand computer networks. There are many definitions of cloud computing. Among them, cloud computing is a form of computing where the IT needs of a consumer can be bought from a cloud service provider. Moreso, it can be define as a computing model based on a customer service needs. The term "cloud" often refers to a cloud-shaped diagramthat is often used to represent the Internet or the web***. In general, cloud computing is a computing model that is able to offer services on demand through a shared computing infrastructure, processing power, storage and networking***. The cloudis flexible and able to accommodate a small scale applicationor alarge scale application(Baunet al., 2011).

Following this development,it is important to note that, the concept of cloud computing has largely altered the traditional approach to delivery, management and integration of applications. So therefore, in comparison to a traditional approach, cloud computing enables running bigger infrastructures, serving various groups of users within a single cloud, and implies dependence on a cloud services provider.Cloud computing in informatics is a model of providing overall and convenient network access on demand for common computing resources (for instance, data-transmission networks, servers, data storage units, application programmes and services – both altogether and separately), which can bepromptly provided and relinquished with minimum operating cost and/or addresses to the provider (Sklejter, 2010).

The main distinction of cloud computing lies in the irregularity of users' requests for resources. In order to smooth out this irregularity and provide service, an additional layer is placed between real hardware and middleware, i.e. virtualization of servers. Middleware control is the software ensuring monitoring of equipment's state, load balancing, and provision of resources for problem

solution. Servers that run applications get virtualized and load balancing gets performed both through the software and the means of allocating virtual servers, real servers. (Sarrab et al., 2015)

Components and Structural Pattern of Cloud Computing:

Cloud Computing as one form of the emerging technology that can be used for effective curriculum delivery have some fundamental layers which makes it user friendly. It was based on this fact that Akshay, (2023) identified the following:

Virtualization

It is a fundamental technology through which virtual versions of computing resources, such as servers, storage, and networking can be created. It allows multiple virtual machines (VMs) or containers to run on a single physical server, maximizing hardware utilization and providing isolation between different workloads.

Infrastructure as a Service (IaaS)

This is a cloud computing service model that provides virtualized computing resources over the internet. Also, the users can rent virtual machines, storage, and networking infrastructure and have to pay for what they use. It offers flexibility and scalability, allowing users to provision and manage resources as needed.

Platform as a Service (PaaS)

It is a cloud service model through which users get a complete platform and environment to develop, test, and deploy applications. It includes all the necessary tools, development frameworks, databases, and middleware, abstracting the underlying infrastructure from developers and allowing them to focus solely on building applications.

Software as a Service (SaaS)

SaaS is a cloud service model that delivers software applications over the internet on a subscription basis. Users can access and use these applications through a web browser,

eliminating the need for local installation and maintenance. Popular examples include Google Workspace, Microsoft 365, and Salesforce.

Cloud Storage

Cloud storage services offer scalable and distributed storage resources over the internet. Users can store and retrieve data from these services, and they often come with features like data replication, backup, and access controls to ensure data durability and security.

Cloud Networking

Cloud networking refers to the infrastructure and services that provide connectivity between various cloud components. It includes virtual private networks (VPNs), content delivery networks (CDNs), load balancers, and other networking components to ensure efficient and secure data transfer.

Cloud Security

Cloud security encompasses a set of practices and technologies designed to protect cloud-based systems, data, and applications from unauthorized access, data breaches, and other cybersecurity threats. It includes authentication mechanisms, encryption, access controls, and monitoring tools.

APIs (Application Programming Interfaces)

APIs are interfaces that allow different applications and services to communicate and interact with each other. Cloud providers expose APIs that enable developers to integrate their applications with cloud services and access various functionalities programmatically.

Multi-Tenancy

Multi-tenancy is a concept in cloud computing where a single instance of software or infrastructure serves multiple customers or tenants. It ensures resource efficiency and cost-effectiveness by sharing computing resources among different users while maintaining data isolation and security.

Service Level Agreement (SLA)

An SLA is a contract between the cloud provider and the user that defines the agreed-upon level of service, including performance metrics, uptime guarantees, support response times, and other service-related terms.(Akshay, 2023)

Types of Cloud Computing Services and How TheyFunctions

There are three major primary cloud computing services hosted by third-party providers and offered to customers through the internet. Each service expedites user data flow from front-end clients via the Internet to the cloud provider's systems, then back again. However, each cloud service performs these functions differently. Hence, they include the following:

- **Public Clouds**

Public Cloud is a virtual environment partitioned and redistributed to many customers, often referred to as "tenants." These clouds are usually created from IT infrastructures that the customers don't own. Amazon Web Services (AWS), Google Cloud, Microsoft Azure, Alibaba, and IBM are popular examples of public cloud computing. Although public clouds are typically run off-site, some cloud providers have begun offering customers cloud services that reside in the clients' on-site datacenters. This practice has blurred the lines of ownership distinctions and locations.

- **Private Clouds**

As the name suggests, private clouds are cloud environments exclusively dedicated to a single group, entity, or user set behind the customer's firewall. Any cloud located in an IT infrastructure isolated from the public and dedicated to one client (one person or a group) is automatically considered a private cloud. Private cloud offerings include HPE, VMWare, IBM/Red Hat, and OVHcloud.

Private clouds aren't limited to on-site IT infrastructures these days. Clients can build private clouds on off-site, rented, vendor-owned data centers. As a result, private clouds now have two sub-categories:

- Dedicated Clouds: This is a cloud within another cloud, located either in a public or private cloud. For example, an organization's Research and Development branch could have a dedicated private cloud in the company's private cloud.
- Managed Private Clouds: These clouds are configured, deployed, and managed by a third-party vendor but created and used by customers. Managed private clouds are ideal for organizations that lack the resources for an entire IT staff to run their cloud infrastructure and services.
- **Hybrid Clouds**

Hybrid clouds are a single IT environment consisting of multiple settings linked via application programming interfaces (APIs), virtual private networks (VPNs), local area networks (LANs), and/or wide area networks (WANs). However, there isn't a single accepted "hybrid" definition. The requirements and characteristics are as varied as the number of people you ask. Here's a list of possible traits:

- Two or more private clouds
- Two or more public clouds
- At least one private cloud and public cloud
- A virtual or bare-metal environment connected to at least one private or public cloud

But whatever definition you use, it is safe to say that any type of cloud system gets classified as a hybrid when applications can move between different yet connected environments. Some of the environments must be derived from scalable, consolidated IT resources. Furthermore, all the environments must be managed through a single environment via an integrated management and orchestration platform.

- **Multi-Clouds**

Multiple cloud consists of more than one cloud service taken from more than one cloud vendor (AWS, Azure, etc.) — public or private. All hybrid clouds are multi-clouds, but the reverse isn't true. But multi-clouds become hybrid clouds if multiple clouds connect through a form of orchestration or integration through third-party tools.. It involves patching together various SaaS, Iaas, PaaS, and other services from multiple providers (or internal IT) to fit current educational

uses or business objectives. (Peter, 2019: Al-Zoube, et al; 2010; Beaumont, 2018; Changchit, 2015;.& Davis, 2017)

The Implementations and Uses of Cloud Computing Model in Teaching and Learning

In this sub-heading it how the cloudcanbe used in both teaching and learning processes are explained. For instance, a lecturer needs to share a journal paper with fifty of his graduate students.Usingthismethod, a lecturer can e-mail this paper to his students. Another method is by using a client-server basedLearning Management System such as SPIN. The lecturer will upload the paper to the SPIN website and thestudents will download the paper from SPIN.This process is inefficient because all users need to access the SPINwebsite to upload and to download the paper. But alternatively, a client-server based model for sharing reference materials over the Internet using LCMS (Learning Content Management Systemsuch as SPIN).Can be applicable. Suppose a student is asked to share five journal papers with a lecturer and fifty other students. Based on aclient-server computing model, the student can share the papers with the lecturer by uploading the papers to SPIN.However, the student needs to use e-mail to share the papers with other students. This is because SPIN uses theconcept of one-way partnership where a lecturer can share materials with his students and vice-versa SPIN doesn'tallow a student to share material with other students. In this scenario, SPIN doesn't have multi-directional featurethat allow sharing among the students themselves. This sharing process is both time consuming and difficult. (Mohd, 2011; Baun, et al; 2011; and Stanoesyska-Slabeya, et al; 2010)

But with a cloud computing model, we can use a cloud-based storage service to solve the multi-directional sharingproblem. Using this service, each user can easily share materials between themselves. This service refers to client-server based computing model which only allow one direction sharing between a student and a lecturer. This model does not have afeature that allows sharing among students. It allows automatic synchronization between the users and does not require the users to login to any web sites. Oneof the cloud-based storage services is called *Dropbox*. Using *Dropbox*, a user can easily share journal papers,graphics and reference materials with other students and the lecturer. One important feature of this cloud-basedstorage service is automatic synchronization, which is done automatically whenever a user has access to thesecloud. This scenario encourages collaborationand interaction among all the users. With this service, users can share***research papers, journal articles, software, graphics, and other information*** with ease among themselves. The usersdo longer need to use e-mails or secondary

storages for sharing information. This service also eliminates the needto have external storage since the users can access the storage through the cloud.(Mohd, 2011; Baun, et al; 2011; and Stanoesyska-Slabeya, et al; 2010)

Similarly, another scenario of implementation of clouds for learning can involves the development of a web-based application. Typically, a web-based applicationdevelopment requires adequate computing infrastructure such as storage, networking, software, database,operating system, and an application framework. Thisinfrastructure involves monetary investment and technicalknowledge from the users. If the web-based application requires extra resources such as more storage or morecomputing power, the infrastructure needs to be upgraded.These problems of cost and maintenance are solved using cloud computing model. The developers only need todevelop the applications and then hosted the applications on the cloud. They will use the cloud computing services***such as computer processing, storage, networking and application developments.*** Cloud computing alleviates theneed for the developers to upgrade or to maintain their own computing infrastructure.(Mohd, 2011; Baun, et al; 2011; and Stanoesyska-Slabeya, et al; 2010)

Cloud technologies ensure optimization of such activities as collection, systematization, storage, retrieval, processing and presentation of information, are of general academic significance and can be applied in studies of all educational disciplines. Implementation of cloud technologies into the learning process is of great value since the latter can increase study hours without changing the curricula of educational institutions. At the given stage, the integration of the given technology into the learning process and education is underway and has already yielded favorable results. The teaching staff of the L.N.Gumilev Eurasian National University has been engaged in this issue at the university, i.e. setting up a cluster of high-performance parallel computing on the basis of available computers and networking equipment, using it for solving resource-intensive tasks and introducing cloud-based technologies (Serik &Bajgaraeva, 2014). Scientists of the Russian Federation, Slovak Republic and other university have been dealing with this problem for recent years (Voevodin&Zhumatij, 2007; Kopyltsov et al., 2010; Schmidt, 2016).

Scientists from our country and abroad (the Russian Federation, USA, People's Republic of China, and the Slovak Republic) have acquainted themselves with some of the surveys' results.

Partially the results have already been used at the leading universities of the aforementioned countries and received positive responses. At the Faculty of Information-Processing Technologies of L.N.Gumilev ENU special courses on the subject under study have been introduced into the learning process (three course credits) at all levels of instruction. For instance, in the process of the learning discipline “Fundamentals of cloud technologies” free services are used, i.e. Google (Google documents: online word processing program, tabular processor, presentation mode, and a cloud storage service with file exchange tool); and web-oriented software functioning as a web-browser not requiring installation on a user’s computer. Also during the learning process students learn to create their own cloud storage in a local network with the help of the OwnCloud service, and study the possibilities of its usage in the learning process and their future professional activities. (Voevodin&Zhumatij, 2007; Kopyltsov et al., 2010; and Schmidt, 2016).

In a similar way students have an opportunity to interact both with teaching staff and their group mates. The ownCloud users can grant access to a file to a predetermined group of people. The given concept might facilitate students’ work over a common academic project or any other activities carried out in groups. The concepts also include an opportunity of file distribution among people not registered in ownCloud system - exchange is performed via public links. The change of record is one of the functions ensuring data integrity. A version of a control subsystem enables users to receive access to old file versions with an opportunity to trace down records of their

changes. Students and instructors are able to cancel file updating at any moment and return to the earlier version. Also, when assessing students, a lecturer as an administrator can see which contribution was made by each student during their work on the project, hence they can assess separate student’s activities in an unbiased manner.

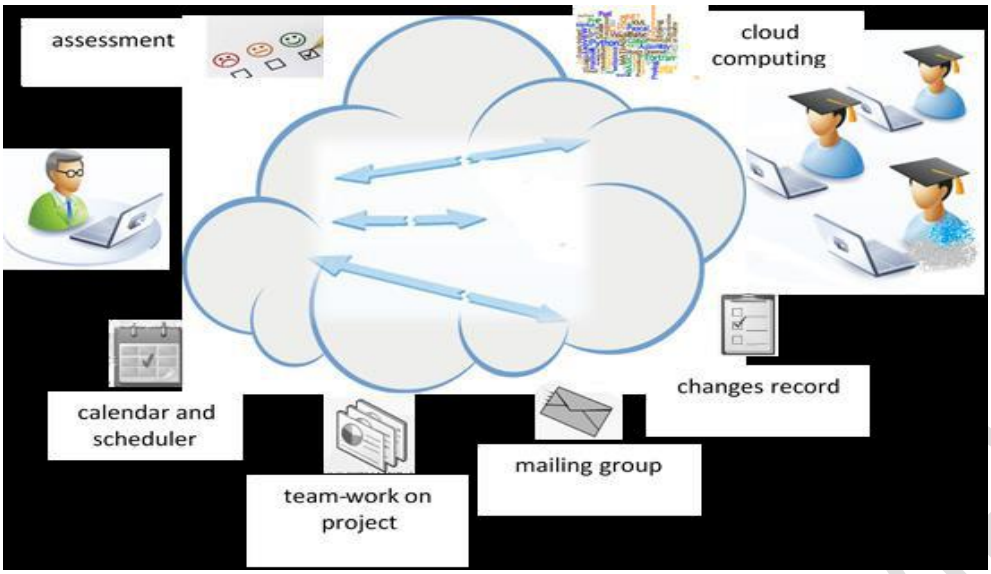

Figure 1: Model of data exchange within personal cloud storage between a student and an instructor. **Source:**(Kopyltsov et al., 2010; and Schmidt, 2016).

At the given moment, we have been considering a possibility for students to carry out cloud computing using the resources of a remote server, so that they could compile a program and receive results not without installing software on their own computers.

Advantagesof the Uses of Cloud Computing for Educational Process

In the current digital transformation in the education sector cloud computing has the potential to significantly enrich the learning process and place education within the reach of millions of children in remote regions. One of the most accessible modern tools for enterprises of all types and sizes is the cloud. Therefore, the identified below are some of the benefits of using cloud computing in education as thus:

i. Accessible educational tools
ii. Improved collaboration
iii. Better learning facilities
iv. Flexible and efficient processes
v. Cost efficiency
vi. Data security

Accessible educational tools

Hosting educational resources on a cloud platform eliminates physical textbooks and makes them easily accessible to students and teachers alike. Teachers can upload course material remotely and students can acquire all the necessary books and modules with a simple device and an internet connection. With every coursework being hosted online, students need not worry about digital storage space for all their learning materials

Improved collaboration

Enabling real-time collaboration from anywhere in the world, cloud computing for education allows students to work together on assignments without physically present in the same classroom. This lets students who can't attend classes to keep up with their peers, even from home. Teachers can also collaborate online to efficiently share lesson plans or feedback with faculty members across departments and schools.

Better learning facilities

Cloud computing in education enhances connectivity in education for marginalised students who suffer without access to traditional educational facilities. Students from rural villages can rely on a cloud-based learning system to gain education and acquire the tools needed to succeed in today's world. While it is slightly far-fetched to assume that the connectivity and equipment can indeed reach such regions, it is worth the investment. Modernising the education system will also benefit working professionals who lack time to attend regular classes and enable them to participate in online classes at convenient times.

Flexible and efficient processes

Incorporating cloud computing in the education sector can save time and effort for both the faculty and the students due to greater flexibility. Processes that once required both parties to be present at the school, college, or university can now be completed remotely and in a fraction of the time. Students can leverage modern cloud-based applications and platforms to learn at home and at their own pace, and several students spread across various locations can learn from a single teacher. Similarly, teachers aren't restricted to school working hours and have more flexibility when performing their duties.

Cost efficiency

Properly implemented, cloud computing education systems can cost less than a traditional education from a renowned institution. Faculty, institutions, and students also need not spend on the latest hardware as cloud-based and cloud-native applications use the cloud for processing power and can be easily run on even the most basic devices. Minimising paper use also saves resources, eliminating printers, photocopiers, and physical storage space.

Data security

With cloud services comes the added benefit of using cloud servers to store information extremely securely. Not only does this eliminate the need for maintaining physical in-house servers for data storage, but the information stored in the cloud is always backed-up and safe in any unforeseen circumstances, from power outages to natural disasters.

A third-party cloud services provider can effectively manage an educational institution's data and IT resources on off-site cloud servers. It also affords faculty and students on-demand data access at any time and across multiple locations. More and more educational institutions are taking note and are directing time and resources towards modernising their systems. As a result, global cloud computing in the education industry held a market value of close to $2.2 billion in 2020 and could hit $8.7 billion by 2027. With the future of cloud computing in the education sector looking up, now is clearly the time for educational institutions to employ the modern tools at their disposal.

Challenges and Risks in the Use of Cloud Computing for Learning Process

It has been observed that Clouds Computing have started gaining momentum as regards its usage for teaching and learning processes and this is for the fact that, its applications does not need huge infrastructure and high monetary cost for its effective functions. However, despite these advantages there are some specific challenges or risk that need to be aware of and take measures towards curtailing it for maximum utilizations and these includes:

Security and Privacy

Storing data and applications in the cloud raises concerns about data security and privacy. Organizations must ensure that their cloud providers implement robust security measures, encryption, access controls, and regular security audits to protect sensitive information.

Data Loss and Recovery

Relying on cloud storage and services means that data loss or service outages can occur. Adequate backup and disaster recovery strategies should be in place to minimize the impact of potential disruptions.

Compliance and Legal Issues

Different countries and industries have specific data protection and compliance regulations. Companies using cloud services must ensure that their providers adhere to these regulations to avoid legal consequences.

Vendor Lock-in

Migrating data and applications to the cloud can create dependencies on specific cloud providers. Switching to another provider later may be challenging and costly, leading to vendor lock-in.

Performance and Latency

Cloud services depend on internet connectivity, which can introduce latency and affect application performance. Businesses with critical real-time applications may face challenges in maintaining optimal performance.

Downtime and Reliability

While cloud providers strive for high availability, they may still experience downtime due to maintenance or technical issues. Businesses should consider redundancy and failover strategies to mitigate the impact of downtime.

Cost Management

Users should properly and regularly manage cloud services' because if resource usage is not adequately monitored and managed, it can lead to unexpected costs. Organizations should closely track their usage to optimize costs.

Data Interoperability and Integration

Integrating cloud-based systems with existing on-premises systems can be complex, and ensuring seamless data interoperability between different platforms may pose challenges.

Conclusion

At this juncture it is important to reiterates that, not only is cloud computing inexpensive to implement, but it also allows students and teachers to access information from anywhere at any time, while saving the information automatically. Cloud computing also showed that it can contribute to the development of 21st Century skills such as collaboration and communication. Many applications are now available to facilitate and store teachers’ and students’ work such as

Google Classroom, Google Docs and Google SlidesCloud computing offers an alternative computing model to the traditional client-server computing model. Itoffers two new paradigm in computing: SaaS (Software as A Service) such data storage, computing power andPaaS (Platform As a Service) such as web development platform. This technology offers new innovative methodsfor teaching and learning. It has been discussed how the cloud can be used to facilitate collaboration using cloud storageservice, to deploy web application using cloud infrastructure and to offer multi-mode teaching using videostreaming**. Therefore,** oneof the educational system's tasks in contemporary society is to provide every person with free and open access to education during all life with due regard to their interests, abilities, and demands. Cloud technologies are able to assist in solving these problems since they remove restrictions to usage of operational systems; in fact, with the operating system Linux installed, users can work with any applications and applied programs if they have access to the internet. It can save both material and labor resources. While in the learning process, participants display high interest in some information services, which means that it is advisable to carry out work on introducing cloud technologies into the learning process.

Recommendations

The ideal goal of cloud computing lies in granting remote dynamic access to end-users for services, computing resources and applications which including operating systems and infrastructure via the internet for its effective used. Based on this fact, for improved use of Clouds computing for educational purposes, the following recommendations are made:

- Cloud computing is still a new paradigm shift hence, there is the need for further research on the subject especially around the implementation of its applications into classrooms.
- Educators considering implementing of the cloud into their context for teaching and learning should think about the learning curve of the technology for students and teachers.
- Educators willing to implements clouds computing for learning may also consider how relevant or meaningful the technology is for the students' utilizations.
- Teachers' and students willing to employ Clouds computing should endeavor to be acquainted with the various form available in order to consider the appropriate one in a given learning environment

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