Cloud Computing in Education

Matthew N. O. Sadiku

Department of Electrical & Computer Engineering, Prairie View A&M University, Prairie View, TX USA

Uwakwe C. Chukwu

Department of Engineering Technology, South Carolina State University, Orangeburg, SC, USA

Janet O. Sadiku

Juliana King University, Houston, TX, USA

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Abstract: A cloud platform makes it easier for students and teachers to access educational resources. Lesson plans, coursework, and assignments can be uploaded, updated, and accessed anytime by students. It is easy for educators to monitor coursework and access students' progress without having to meet face-to-face. A teacher can work from anywhere, connect their students to multiple programs and applications, and save all their lesson plans and assignments to the cloud. This paper provides an introduction on cloud computing for education.

Keywords: cloud, computing, cloud computing, education.

INTRODUCTION

Education plays a pivotal role in the economic growth of any nation. The world is changing rapidly. Education is consequently changing. The classroom is changing. Teaching and learning are no longer confined to textbooks and classrooms, but involve using computers and mobile devices. Technology and education are closely related. The educational model in many nations has evolved with technology. Today, learners are digital natives and are always connected. They are demanding more technology services from their institutions. From lectures to assignment submission, everything is now online based. There comes the need for cloud computing [1].

Cloud computing refers to a setup of computing resources that can be shared anywhere, irrespective of the location of the users. It is an emerging new computing paradigm for delivering computing services. It is changing the way information technology services are provided. The resources of cloud computing can be network servers, applications, platforms, storage, software infrastructure segments, and services. They are abstracted and provided as services on a network or Internet [2]. The data center hardware and software are what we will call a Cloud. Cloud computing approach relies on a number of existing technologies, e.g., the Internet, virtualization, grid computing, web services, etc. The user does not require expertise and knowledge to control the infrastructure segment of clouds.

Cloud computing is different from other historical IT models in that it focuses mainly on services, rather than technology. Technology (storage, CPU, networking equipment) is not the service, but the building blocks for a service. Cloud computing in education refers to moving a school system's data and IT resources to a cloud server. Several higher education institutions are already taking advantage of the many benefits that cloud has to offer including cost savings, scalability**,** agility**,** and modernization.

CONCEPT OF CLOUD COMPUTING

Cloud computing is a new means of providing computing resources and services. It is an on-demand and self-service Internet infrastructure. It offers large scalable computing and storage, data sharing, on-demand anytime and anywhere access to resources. Figure 1 depicts cloud computing [3].

Cloud computing presents several characteristics such as [4]:

➢ The pooling of resources

➢ Better use of resources

➢ Elasticity

➢ Dynamic (distributed)

➢ Scalability

➢ Virtualized

From a service point of view, cloud computing includes three models: software, platform, and infrastructure [5].

(1) Software as a service (SaaS): The applications are hosted by a cloud service provider and made available to customers over the Internet. As a SaaS, the cloud can offer organizations on-demand hosted services.

(2) Platform as a service (PaaS): The development tools (e.g, operation systems) are hosted in the cloud and accessed through a browser. Using a PaaS environment, Microsoft provides a service to supply providers with networks, servers, and storage.

(3) Infrastructure as a service (IaaS): Cloud service providers set up huge infrastructure like servers, storage devices, hardware, etc. to be used by potential clients.

The cloud computing deployment models [6].

(1) Public cloud: A public cloud is a publicly accessible cloud environment owned by a third-party cloud provider. The service provider makes resources available to the general public over the Internet on a pay-as-you-go basis.

(2) Private cloud: A cloud infrastructure is owned and operated solely for a single organization. Organizations build their own cloud infrastructure for use by their business units. They can also choose between private cloud or public cloud.

(3) Community cloud: A community cloud is similar to a public cloud except that its access is limited to a specific community of cloud consumer. The cloud infrastructure is shared by several organizations with common concerns.

(4) Hybrid cloud: A hybrid cloud is a combination of a public and private cloud

Figure 2 illustrates these cloud computing types [7], while Figure 3 shows some popular cloud computing providers [7]. For example, Microsoft Azure is one of the eminent cloud computing platforms in the market created by Microsoft.

APPLICATIONS OF CLOUD COMPUTING IN EDUCATION

Cloud computing is an emerging technology that relies on transferring computer data storage and processing power to the cloud (or Internet). It refers to the physical structure of a communications network, where data is

stored in large data centers and can be accessed anywhere, at any time, using different devices. It offers many advantages to education, from K-12 schools to university students. Common applications of cloud computing in education include the following [8,9]:

➢ *Teaching:* Cloud-based services offer an ideal platform for hosting lectures and providing feedback to students. Cloud-based technologies can significantly change how education works, whether it is in traditional classrooms, online course, or blended learning. Teachers can use cloud-based technologies to aid understanding of course materials and engage students in the learning process. They can also keep track of their students' progress any time, thereby creating opportunities for personalized learning. They may also use cloud computing to create new and creative classroom structures.

➢ *Learning:* Today, learners and teachers have access to computers and mobile devices that are always connected. In order to access cloud-based resources, students need a laptop, tablet or any mobile device plus an internet connection. The cloud guarantees that students, educators, personnel, guardians, and staff would have access to basic data utilizing any gadget from any place. Nothing beats the ease of having learning at your fingertips, and cloud technology allows you to do so. Cloud computing makes it possible for students who have trouble attending traditional learning institutions to pursue their education.

➢ *E-learning:* This is a concept that integrates information technology in teaching and learning. It is an Internet-based learning system that uses technology to develop, execute, choose, manage, facilitate, and enhance learning. Cloud-based technologies supported e-Learning during the emergence of the COVID-19 pandemic. They are essential for e-learning, especially mobile learning, distance learning, and web-based collaborative learning. Instead of traditional classrooms, cloud computing facilitates online learning through virtual classrooms.

➢ *E-textbooks:* The problem with printed textbooks is that schools and students need to constantly purchase new books to get an updated edition. E-textbooks are beneficial particularly in subjects that constantly change such as technology. Cloud-based materials can reduce the volume of paper that schools have to print for handouts and assignments and consequently reduce the cost of education. Users of cloud-based materials can highlight and edit text and write notes easily.

➢ *Higher Education:* Today's higher education students come to campuses with many digital devices, looking for opportunities to use them. Cloud computing creates endless new possibilities to transform education through innovation and to drive student success. Colleges and universities need a solid technology partner that is preferably "on-cloud" to manage its complexity and keep the stakeholders connected, productive, innovative, and efficient. Cloud computing in higher education provides an online platform for educational institutes through various applications and subscription models. It transforms the way higher education institution run and serve their community. Higher education institutions are rapidly embracing the power of cloud computing technology to augment the way it serves their constituents. Figure 4 shows the reasons higher education should adopt cloud computing [10]. Coursera offers a variety of online courses from established universities and instructors through its cloud platform. Massive Open Online Courses (MOOCs) are cloud-based educational platforms with a promise of transforming higher education. Figure 5 displays cloud-based higher education system [11].

BENEFITS

Education providers and seekers can greatly benefit from the cloud. The 21st-century classroom needs more flexibility in terms of design and layout. Cloud computing can make learning more convenient, cost-efficient, agile, and flexible for both students and teachers. Easy accessibility, collaboration, and community

development in a safe environment is easy with a cloud-enabled educational model. The 21st-century classroom needs more flexibility in terms of design and layout.

The benefits of cloud computing for the education sector are many. They include [12-14]:

➢ *Accessibility:* The potential of the cloud is unmatched when it comes to accessibility. A user has access anytime, anywhere, making life so much easier and convenient. With learning materials residing in the cloud, students can have 24/7 access to their courses through multiple devices such as desktop, laptop, tablet or smartphone anytime. They have access to their files from anywhere there is an Internet connection. This adds an element of convenience to the whole learning process and eliminates spatial and temporal limitations.

➢ *Convenience*: Cloud-based applications can be accessed by users from anywhere and with any device, making it convenient and easy to use. The only requirement is a digital device that can access the Internet.

➢ *Cost:* A major advantage of cloud computing is the capacity to increase storage for less cost. Cloud computing can improve efficiency, cost, and convenience for the educational sector. It reduces the cost of IT to organizations and freeing them from hassle of having to install and maintain applications locally. Users of cloud computing are more likely to reduce their carbon footprint. With digital materials stored on cloud, schools can tremendously save on paper, ink, and toner.

➢ *Collaboration:* Real-time collaboration is an important aspect of cloud computing education. Cloud computing enables effortless collaboration, sharing and transmission of ideas in real-time. It allows multiple users to work on and edit documents at the same time. Teachers can easily share lesson plans and can work on them together at any place or time. They can set-up student groups to work on projects and assignments in the cloud. Cloud software helps to support student communication and create teacher management portals.

➢ Scalability*:* As a business grows, so will its technical requirements. Scalability refers to the ability of the cloud computing applications to match the growing numbers of users. The cloud allows users to scale their resources in real-time, with no hidden costs. Regardless of how many students you have or higher education facilities you manage, your cloud system can grow alongside you.

➢ Minimal *Hardware:* Once all the learning resources are moved to the cloud, educational institutions handle minimal hardware on campus. With cloud-based applications, the requirements of hardware resources are minimal.

➢ *Security:* Security is one of the most important advantages of the cloud computing technology. Service providers invest heavily in securing their cloud-based solutions from any intrusion. Whatever you store in the cloud usually requires authentication (ID and password, for example). Students can be assured that their data is secure. The cloud platform will offer authentication and security features to make sure that learning materials are only made available to the right users. Cloud computing helps academic institutions to meet data protection obligations to ensure student and staff information is kept safe.

➢ *Flexibility: Any user can create, edit, and save files in the cloud according to their needs, like a self-service. The disruptions due to COVID-19 have shown the necessity of flexible technology.*

➢ *Stability:* Cloud computing is a stable technology that one can rely on.

➢ *Trackability:* Cloud computing will save multiple revisions and versions of a document so that you can chronologically trace back its evolution.

➢ *Affordable Education:* The cloud can make education much more affordable for the masses.

➢ *Long-Term Cost Savings:* Cost reduction is a major benefit of cloud education software. Cloud *computing* causes reduced data storage costs and minimal data center maintenance.

➢ *Quick Deployment:* Cloud computing gives you the advantage of quick deployment. Your entire system can be fully functional in a matter of minutes.

CHALLENGES

Despite the benefits, cloud computing in education has several drawbacks and obstacles. As an emerging computing service, there are fears, uncertainties, and concerns about the technology's maturity. The major concerns are related to control, up-front costs, vendor lock, performance, latency, security, privacy, and reliability. Cloud computing's dependency on Internet connection is inconvenient. Other challenges include [12,15]:

➢ *Big Leap:* We are becoming a paperless society. But by nature, human beings are conservative. Going from paper to digital requires a big leap of faith. We can feel, see, and touch paper but not a digital object.

➢ *Less Control:* Users have less control over updates, training, and other features. These are handled by the cloud service provider and cannot easily switch between service providers. Everything is hosted off-site, so you will have less control over the infrastructure and the system setup.

➢ *Data Security:* Data security in the cloud is the primary concern for academic institutions due to non-efficient encryption algorithms of cloud computing. There are inherent security risks when all assets are hosted online and data security becomes a major concern. Securing parents, students, staffs, and teachers data is a concern. Improperly-secured cloud systems may be vulnerable to cyberattacks.

➢ *Up-Front Costs:* There are some up-front costs. IT infrastructure costs are often substantial and are treated as a capital expense. The migration may be costly, depending on how many applications or services you are moving to the cloud. There is also the cost required to train staff on the new system.

➢ *Reliability:* This is an issue for academic institutions using the cloud. In an event of service failure, data recovery becomes a major concern.

CONCLUSION

Cloud Computing is essentially accessing computing services through the Internet. It uses virtualization as its key technology. Its success lies in its easy-to-use computing model and the benefits it brings to the users. While cloud computing is a relatively new concept, it is becoming more and more popular and is already becoming an integral part of the lives of many students. Using mixed media may engage students more effectively and result in improved classroom performance.

The importance of cloud computing in education cannot be overemphasized. Nothing beats the convenience of education at your fingertips. Everyone in the education sector is experiencing the positive impact of cloud computing technology [16]. After the rapid adoption of cloud computing in the education industry, education has become more accessible and educational institutions can now stay relevant. For more information about cloud computing in education, one should consult the books in [17-27].

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ABOUT THE AUTHORS

Matthew N.O. Sadiku is a professor emeritus in the Department of Electrical and Computer Engineering at Prairie View A&M University, Prairie View, Texas. He is the author of several books and papers. His areas of research interest include computational electromagnetics and computer networks. He is a life fellow of IEEE.

Uwakwe C. Chukwu is an associate professor in the Department of Industrial & Electrical Engineering Technology of South Carolina State University. He has published several books and papers. His research interests are power systems, smart grid, V2G, energy scavenging, renewable energies, and microgrids.

Janet O. Sadiku holds bachelor degree in Nursing Science in 1980 at the University of Ife, now known as Obafemi Awolowo University, Nigeria and Master's degree from Juliana King University, Houston, TX in December 2022. She has worked as a nurse, educator, and church ministries in Nigeria, United Kingdom, Canada, and United States. She is a co-author of some papers and books.
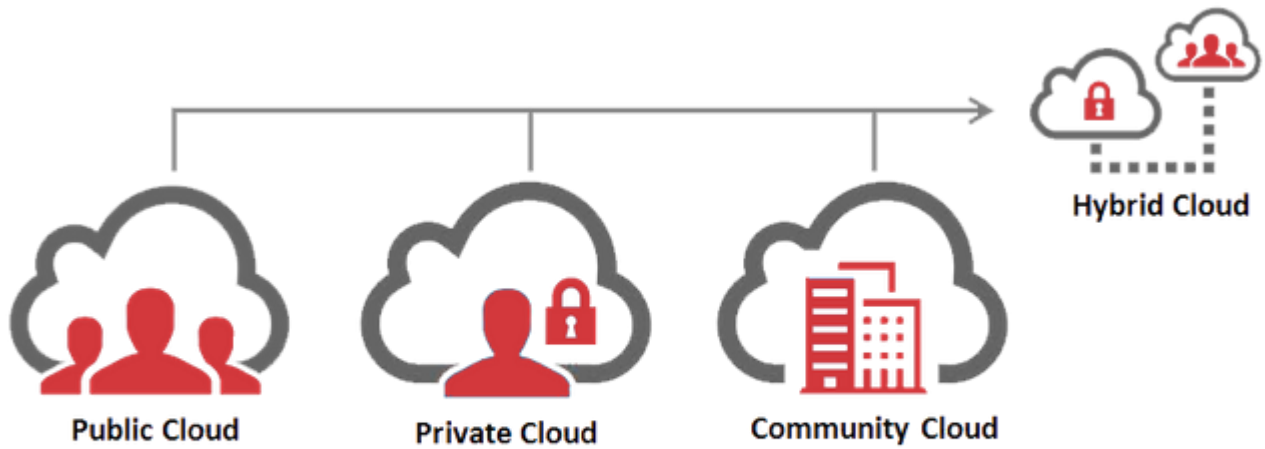

Figure 1 Cloud computing [3].

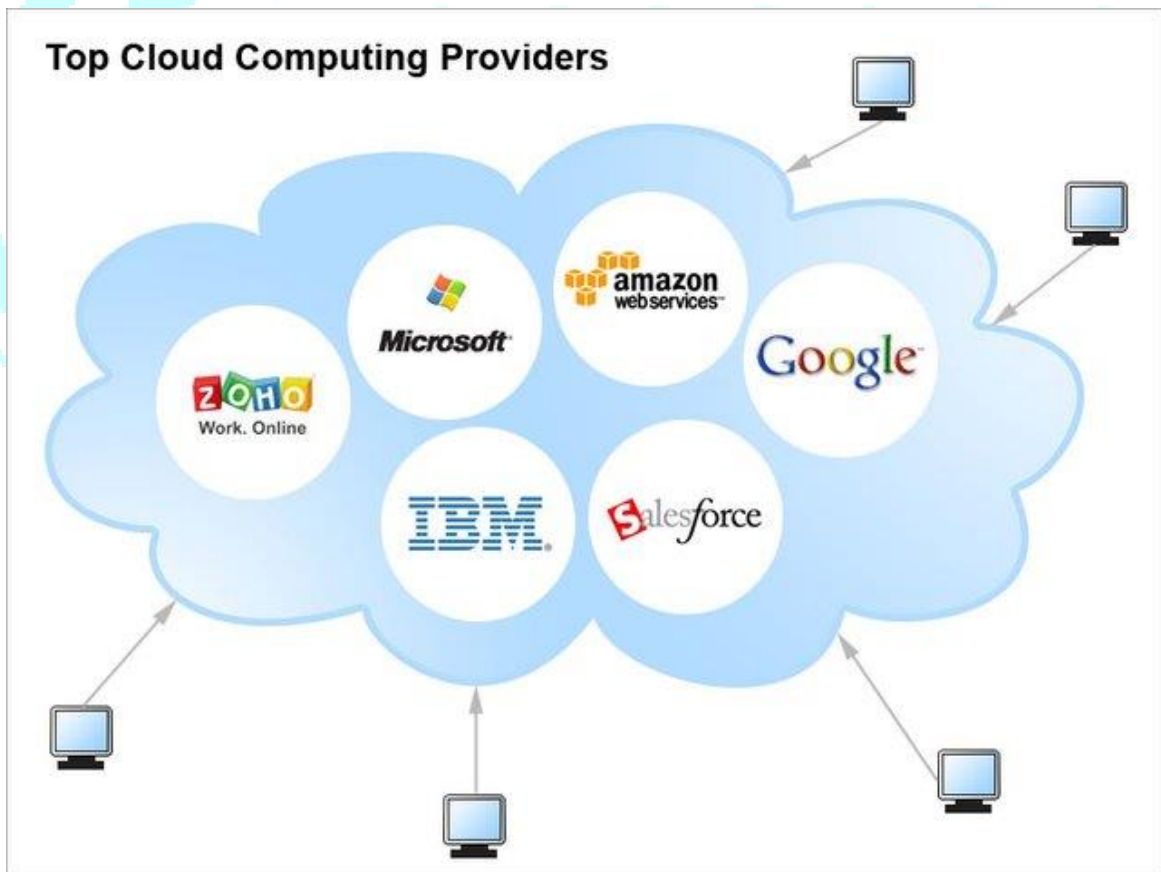Figure 2 Cloud computing types [7].

Figure 3 Some popular cloud computing providers [7].

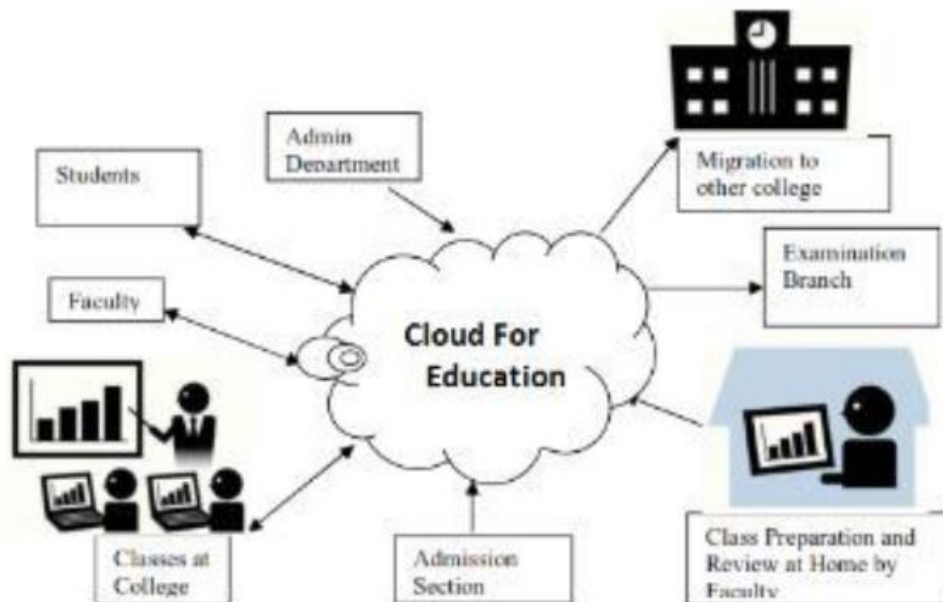Figure 4 Reasons higher education should adopt cloud computing [10].

Figure 5 Cloud-based higher education system [11].