E-Learning Based On Cloud Computing

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ABSTRACT

Virtualized computing and remote learning are components of e-learning, which relies heavily on online communication networks to assist the teaching-learning process. The use of online learning environments has skyrocketed in the last several years. The use of data mining tools to analyze educational information retrieved from internet databases is crucial for improving the way students learn, particularly in digital classrooms. The scalability and adaptability of cloud computing make it an attractive platform for e-learning applications. When working with large e-learning datasets, in particular, it streamlines the use of data mining techniques in dispersed settings. The research summarizes the present state of cloud computing, discusses examples of cloud computing and e-learning approaches, and highlights infrastructure designed specifically for these systems.

Keywords: E-Learning, Cloud Computing, Virtual Learning, SaaS, PaaS, IaaS

1. Introduction

E-Learning has grown in popularity due to the proliferation of online learning and other digital communication tools, as well as the popularity of distant education [1]. It makes good use of a variety of media and resources to supplement traditional classroom education. Online courses, emails, links, message boards, and other kinds of electronic communication are all part of this category. Online collaboration between students, content makers, and experts has raised the bar for education. Consistency, flexibility, accessibility, and simplicity of access are just a few of the many benefits of using web-based technologies [2].

Following the spread of the COVID-19 pandemic and other technological developments, online education (or "e-learning") has exploded in popularity among IT professionals.On a worldwide scale, E-Learning programs such as Massive Open Online Courses (MOOCs), Blackboard, Desire2Learn (D2L), and university Virtual Learning Centers have gained popularity [3]. Fully authorized virtual programs provide an ideal learning environment, with far more accessibility for online learners, as opposed to conventional in-person sessions [4].

But supporting a big number of online students requires strong infrastructure that can adapt quickly to changing demands. One promising approach to these problems is cloud computing. While cloud computing's original intent was to improve system availability and dependability while decreasing computational costs, it has now expanded to provide scalability, flexibility, and security for a wide range of uses. Cloud computing has an emphasis on transparent mobility and diversified service supply, as opposed to traditional computing grids that only aim to maximize system performance [6]. This includes hosting services and word processing, among others.

The goal of Service-Oriented Architecture (SOA), one of the cloud's guiding concepts, is to help organizations overcome computational hurdles such application integration, concurrency management, and security protocols [7]. consumers may use a variety of services on cloud platforms without having to understand the underlying technological details since these platforms abstract these complexity from consumers [8]. With cloud computing, customers may access programs without having to spend much in

hardware, which is clearly a benefit over conventional installations.

Because of this leeway in allocating resources, companies may simplify their processes and react quickly to changing needs [9].

Educational data mining (EDM) is also a possibility because to the enormous volumes of data produced by large-scale E-Learning systems. In order to better understand student performance and enhance teaching and learning outcomes, EDM uses algorithms to examine this data. This method is fully compatible with computer-based tutoring systems, which provide students with specific comments on their work.

With computers' capabilities constantly improving, cloud hosting is becoming a more practical choice for running data mining algorithms on massive databases. Nevertheless, more investigation into the topic is necessary as scalability issues may be encountered with some data mining techniques. A major obstacle in the fight against the COVID-19 epidemic is the growing trend among educational institutions throughout the globe to use blended or entirely online learning strategies.

By delving into cloud computing services for E-Learning, this study hopes to equip educators to take advantage of the scalability, flexibility, and security that the cloud offers in order to elevate E-Learning. What follows is an outline of the rest of the paper. Section 2 provides an overview of cloud service models; Section 3 delves into the topic of cloud computing and e-learning tasks; and Section 4 outlines the benefits of using cloud computing in the field of education. The problems with cloud computing and schools are detailed in Section 5. Section 6 brings the paper to a close.

2. Review of Cloud Service Models

There are many distinct types of cloud computing, each with its own set of features and deployment patterns. Some examples include the client-server paradigm, grid computing, fog computing, and peer-to-peer computing. Services like Infrastructure as a service (IaaS), Platform as a service (PaaS), and Software as a service (SaaS) are offered by all cloud deployment options [10].

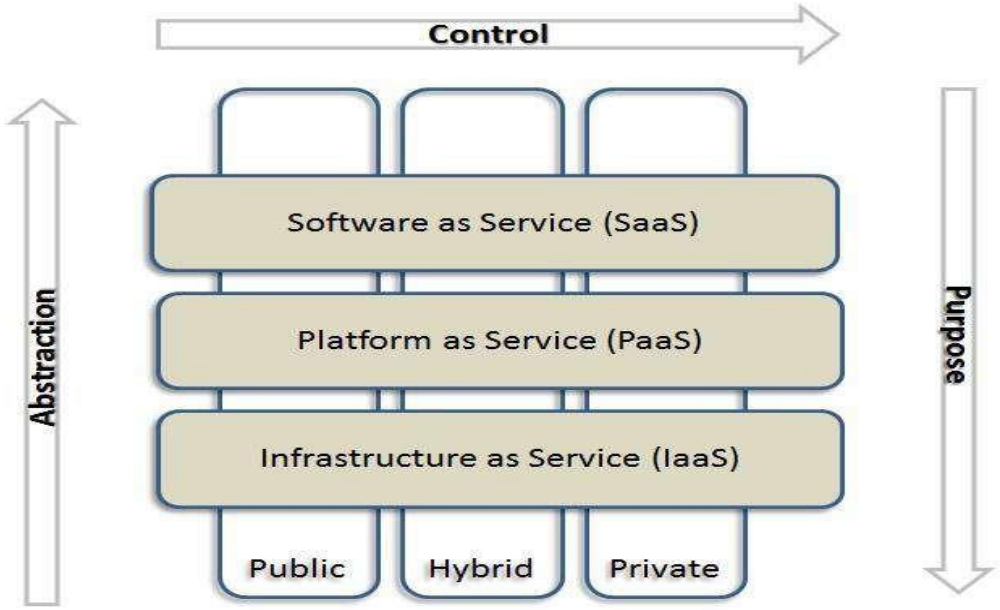

Figure 1: Cloud Service Models

Infrastructure as a Service (IaaS) as a service model in the cloud, where the supplier handles the setup of

the required hardware and internet connections. The user's sole responsibility is to oversee the software—including the operating system—and virtual machines that are housed on this hardware. The software programs operate on top of this, which is shown as the bottom layer in Figure 1. Access to storage, processing power, networking, and support services (virtual servers) is available as needed via this service. Organizations may move their data to the cloud, which users can access over the internet, potentially resulting in the reduction or removal of in-house data centers. Private, public, hybrid, and community clouds are just a few of the many cloud deployment methods that people and organizations may use to implement these services.

Platform as a Service (PaaS) application hosting refers to a type of cloud services in which customers provide the applications they want to install and the provider provides the infrastructure required to operate these applications. See Figure 1 for placement; it is between the SaaS and IaaS layers. Operating systems and application development platforms are made available via PaaS, which may be accessed and used over the internet. Web applications as a service (AWS) may be built, tested, deployed, and hosted by developers on this platform. Google App Engine, Microsoft Azure, and IBM are just a few examples of PaaS providers.

Software as a Service (SaaS) is a concept for providing software and related services in the cloud, where the supplier acts as both the application's owner and operator. With its comprehensive features and user-friendly interface, SaaS aims to provide consumers with a full solution. Accounting and business information services are provided by several web-based ERP (Enterprise Resource Planning) software packages that are housed on the SaaS cloud. Figure 1 shows the cloud computing architecture with its topmost tier. In this layer, the cloud service provider hosts programs such as word processors, video editors, and databases, making them available to customers via the internet whenever they need them. Customer relationship management (CRM), email, and Google Docs are all instances of SaaS.

Community Cloud: It is exclusively for a set of users within closed group having a common goal.

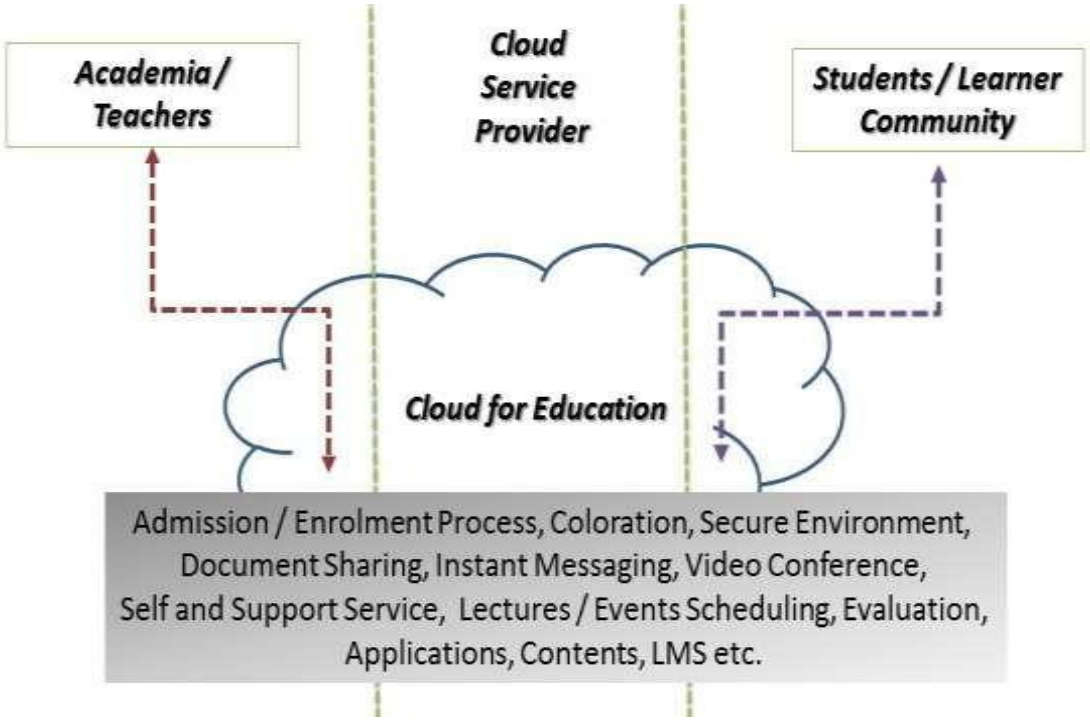

Figure 2: Cloud for education

Complete degree programs in online learning are offered by several educational institutions via the use of hybrid cloud models. The IT infrastructure of these educational institutions is powered by cloud computing. Electronic mail, scheduling, teamwork, video conferencing, enterprise resource planning (ERP), and LMS are the most common applications that make advantage of cloud-sourcing. For schools that cannot afford to buy, operate, and support their own software and hardware, it makes sense to outsource the supply of learning management systems (LMSs) like Blackboard or Moodle to a third party. Collaboration between academics and students is made possible by such a learning management system. The role of instructors cannot be fully filled by online learning; rather, it is only a venue for innovation, ideas, and tools that provides fresh content, concepts, and methods for teaching.

3. E-Learning Tasks and Cloud Computing

The trend away from traditional classroom settings is fueling the meteoric rise of online education, which in turn has increased the quantity and quality of courses offered, the breadth of support services, and the ease with which students may access course materials [11]. Selecting a platform that can efficiently handle growing demand, control costs, and optimize processing, storage, and communication requirements is of the utmost importance. Here, cloud computing is crucial, since it allows for the easy transmission and retrieval of material and information.

Adopting SaaS apps offers the potential for strong and all-encompassing distant learning in comparison to conventional classroom settings, illuminating the technical and educational advantages of cloud computing. There has to be preparation for a transition to this approach in order to make good use of online resources and interactive services including recordings, instructional materials, and peer training.

Cloud computing has a bright future since many schools are currently using it [12]. In the United Kingdom, projects like JISC (2012) are working toward the goal of creating a cloud for educational resources that has all the features needed to store and manage data. Knowledge acquisition E-learning platforms that take use of cloud computing are known as software as a service (SaaS). Users can quickly install it because of how little hardware it requires. Furthermore, it frees up the provider from system support and maintenance duties, letting them concentrate on their core business operations, all while using Web 2.0 technology to ensure automated upgrades and supply critical resources.

Educational technology's consistency, coherence, effective resource use, and long-term stability depend on the design of e-learning systems and how they integrate with cloud computing. Researchers in [13] laid out the effects of creating cloud-based e-learning technologies. At the outset, there is a greater need for web development abilities because the application is accessible 24/7 from any location. As a result, institutions save money, deploy more quickly, and need less IT staff since subscribers save money on software, deployment, and server administration. In cases when time is critical, like as the COVID-19 pandemic, this becomes even more useful.

Programs in the education industry may benefit from paying for content per use since it allows for the accessibility of more advanced programs and essential applications. Software as a service (SaaS) servers are ideal for many schools since they are cloud-based and have inherent scalability. Even as the number of students using the program rises, its performance stays the same. Security must be a top priority for SaaS providers if they want to win over customers and give them with a satisfying experience. There is an increasing need for education-focused platforms and data integrators to help unify customer data that is scattered across different services in order to provide a more complete picture of the company.

From a technical standpoint, several writers have thoroughly investigated the benefits of cloud-based curricula.

Although most people think about how much it will cost, there are additional considerations when using cloud services. There is no longer any need to use physical hard disks for data backups or transfers while utilizing cloud storage. With a data reservoir, students may save their knowledge for as long as they need it and let it develop with them. Since there is little chance of data loss in the event that the user's device malfunctions, data recovery after a crash becomes practically unnecessary in this case. Furthermore, virtualized applications allow students to work from anywhere and access and edit their data, which has been very useful for schools during lockdowns.

This provides educational institutions with an affordable option for their students, teachers, and staff.

The cloud eliminates the need to manage hundreds of computers spread out across a wider region, making it easier to monitor data access from a single, central place. Additionally, cybersecurity updates and upgrades may be rapidly analyzed and applied using the cloud since it maintains a single database for all users [14]. From an academic perspective, one of the main benefits of the cloud is its accessibility. However, there is currently continuing effort to identify how cloud-related pedagogies effect learning evaluations. Its mobile-friendly design makes it easy to collaborate from any location, which means more students can be reached and their needs can be met outside of the typical classroom. Because of this increased availability, more students in more settings may have access to more useful knowledge. In relation to e-learning, Figure 2 shows the characteristics of cloud computing.

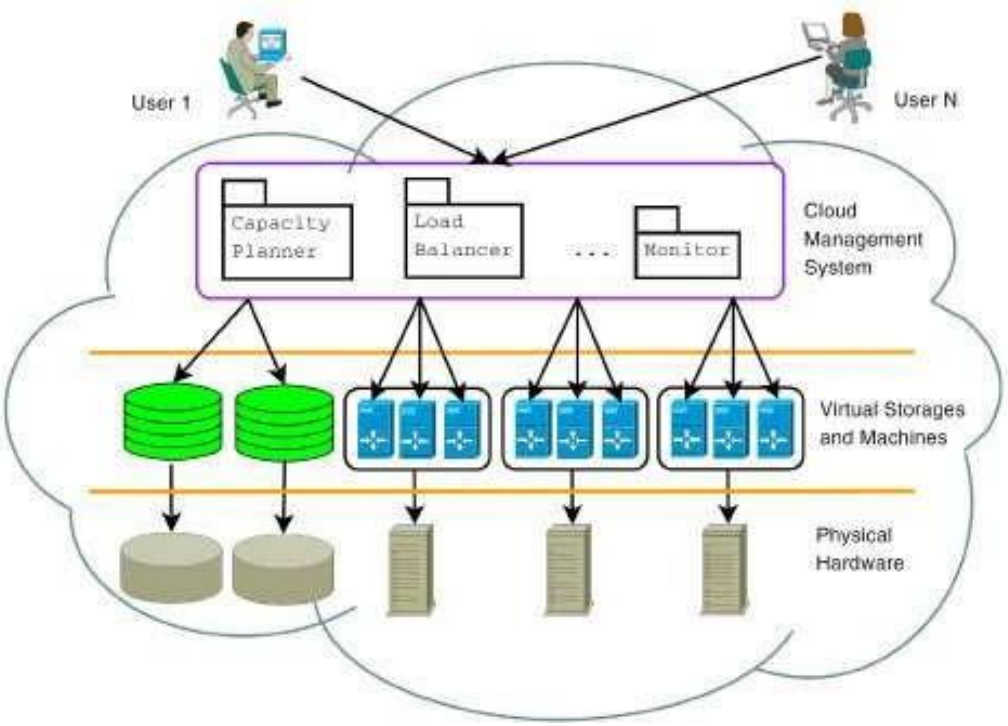

Figure 2: A glimpse of Cloud computing for E-Learning. Source [15]

Figure 2 makes it clear that the three primary components of cloud e-learning approaches are a virtualized platform, a cloud management system, and services. For the purpose of instruction, two sets of computers are utilized: one with a thin client running C, and another with a server pool that runs the hypervisor, with the private cloud architecture being built using vSphere. With only a web browser, you can monitor and control any service and host in the virtual infrastructure in real time.

In addition to recording alarm data and authorization settings, you can also track things like configuration and efficiency. A single hardware host hypervisor is essential for accommodating numerous operating systems. By dynamically assigning resources to each component, the hypervisor guarantees that virtual machines may run autonomously. Here, it's best to use a hypervisor that can communicate with the hardware directly. For consumers of Platform as a Service and Software as a Service in the cloud, this layer acts as a gateway to the outside world. Virtual computers are set up by instructional coordinators, who then choose baseline images and install the software of their choice. Consequently, for individual class projects, common web technologies are created so that students may access their virtual computers across a distant network. Figure 3 shows the individualized online learning paradigm.

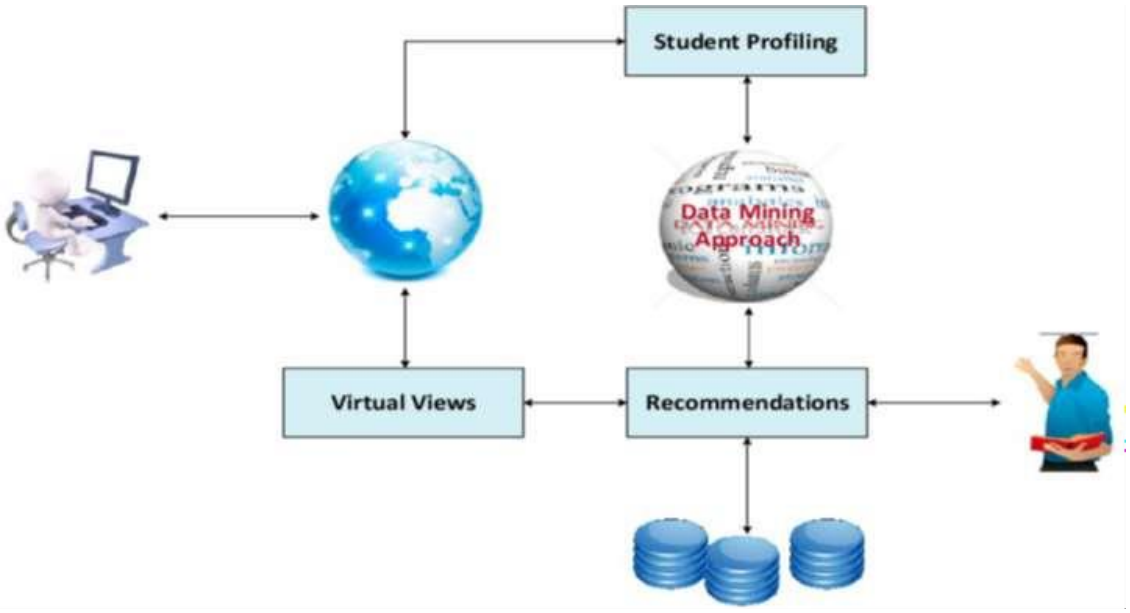

Figure 3: Personalized E-learning Architecture. Source [16]

The rising demand for continuing education has prompted universities to pay greater attention to the integration of cloud technologies and e-learning. Nearly every educational institution saw it as a viable and appropriate substitute for online education. Still, one may build a technique on top of a theoretical base that lacks research. However, the cloud strategy's inherent flexibility may have been emphasized as a major benefit in developing an effective framework for analysis and pedagogy. The literature often associates cloud computing with social involvement and the aim of collaborative learning. Examining how students conceptualize accountability and quality in relation to different forms of engagement in Google Docs is the focus of [17]. Instructional strategies that leverage technology to change and enhance students' collective experience while generating a cooperative assignment. Furthermore, there are a number of cloud-related research that compare the performance of online models to more traditional methods.

4. Advantages of Using Cloud Computing in Education

Any company or organization hoping to survive in today's lightning-fast digital world must adopt cutting-edge practices and tools if they want to be relevant. Similarly, millions of children in faraway places may finally have access to school thanks to digital revolution in the education sector, which has the ability to vastly improve the learning experience. Businesses of all sizes and sorts have found the cloud to be one of the most accessible contemporary technologies. The many advantages of cloud computing in the classroom are as follows.

Accessible educational tools

Putting educational materials on the cloud makes them readily available to both students and instructors, doing away with the need for traditional textbooks. All students need is a basic gadget with internet access, and teachers may remotely upload course materials. Students no longer have to fret about finding enough digital storage for their plethora of course materials, since all schoolwork is now housed online.

Improved collaboration

Students may complete group projects even if they aren't in the same room thanks to cloud computing, which enables real-time communication from any location. With this, even kids who are unable to physically attend school may participate and stay up with their classmates. Educators from different schools and departments may work together more effectively online by sharing lesson ideas and comments.

Better learning facilities

For underprivileged kids who can't afford or don't have access to conventional schooling, cloud computing improves educational connectedness. A cloud-based learning system provides students in remote areas with access to education and modern skills. It is worth the expenditure, even if it's a bit of a stretch to think that the connection and technology can reach those locations. Working professionals who are unable to commit to traditional school hours will also gain from educational reforms that make online learning more accessible.

Flexible and efficient processes

Because it is more adaptable, cloud computing has the potential to reduce administrative burdens and maximize efficiency in the classroom. Things that used to take a lot of time and needed both people to be physically present at the school may now be done much more quickly and remotely. Thanks to today's cloud-based apps and platforms, students may study anywhere, at any time, and even have several classes taught by the same instructor. The same holds true for educators; they are not limited to traditional school hours and are given more leeway in carrying out their responsibilities.

Cost efficiency

With the right setup, a cloud-based education system may actually be more affordable than a degree from a well-known university. Because they rely on the cloud for processing power, cloud-based and cloud-native programs may be readily operated on even the most basic devices, so there's no need for faculty, institutions, and students to spend money on the newest technology. Cutting down on paper use also helps save resources by reducing the need for printers, photocopiers, and actual storage space.

5. Cloud Computing & Education: The Issues

While the use of cloud computing to update educational systems has been very successful (as shown in Fig.4) and is on the rise throughout the globe, others worry that it may cause problems in less developed nations as well. [18].

Technological integration

There have been tremendous developments in the software and systems utilized by various cloud-based educational applications, and the cloud itself is a focal point of these developments. Concerns about compatibility and technological integration might be brought to the forefront in this context. [19].

Cost of hardware and technology

Because cloud-based hardware may be expensive when creating private or hybrid clouds, hardware plays a significant role in cloud-based system implementation. When it comes to implementing cloud-based technologies, software is just as crucial as hardware. Nothing but SAAS, PAAS, and IAAS underpin cloud-based learning.

Internet and bandwidth

The educational cloud, like any other cloud-based system, relies entirely on a reliable, fast, and adequately bandwidthed internet connection. This is why it becomes challenging to operate a cloud-based system in areas with inadequate or unreliable Internet.

Remote accessibility

Many individuals in emerging nations, such as India, live in rural and distant places. Consequently, it could be challenging to accommodate any candidate who wants to pursue an online or cloud-based education.

Security and infrastructure

Occasionally completely digital, cloud-based educational systems are associated with a risk to the particular system from cybercriminals. Therefore, for the best outcome, it is necessary to combine network security, online security, and database security.

6. Conclusion

According to the study's high-level summary, using cloud services for online education is a great substitute. The core of e-learning—making teaching available anywhere, at any time, via any device—is cloud adaptability, flexibility, and security, and it enables instructors to take use of these features. The true value of these chances may be achieved when a learning environment that is both specialized and rich in material can be readily adjusted to meet the demands of modern education. There are various advantages to moving an e-learning platform to the cloud, such as more space, faster processing, and better network access. Because of the cheaper licensing prices and greater variety of educational programs offered by cloud-based systems, cutting expenses on hardware and software must be a top priority. Furthermore, the replacement rate is reduced since student computers last longer. The savings are amplified by the fact that IT professionals spend less on software upgrades and computer lab upkeep.

The ability to tailor and personalize one's online learning experience is currently lacking in many e-learning platforms and services. The end effect is that pupils get faceless, impersonal e-learning materials. Implementing and improving cloud-based customized learning across many areas requires new research and development. For each student to get the most out of their education in today's systems, teacher-student communication is vital. You should be able to do both online and real-time training by integrating cloud-based e-learning services like video conferencing or instant messaging. Updated e-learning platforms in the cloud take use of tools like Skype, voice-over-IP, and email to remedy these drawbacks. Most cloud-hosted services still worry about security and privacy, even with these improvements. Several criteria must be considered in order to estimate the size of these problems. Cloud service providers have invested heavily in cloud infrastructure and platforms in response to customer concerns. Data storage on a distant or worldwide level is also problematic from a legal standpoint due to country-specific laws; for example, some governments insist that data be kept inside their boundaries.

Academics have enough of evidence to back the development of cloud-based e-learning frameworks and implementations, according to current study. Future research will focus on quantifying the effects of moving to a cloud e-learning environment on other metrics, including access speed, educational quality, and ROI.

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