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Cloud Computing in Education: a Review on Current Applications, Opportunities, and Challenges

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Abstract

The emergence of cloud computing and virtualization was a landmark moment in the history of technology. Cloud computing enables organizations to rent computer resources from cloud service providers rather than establishing and maintaining their own IT infrastructure. The cloud facilitates a shift away from conventional software, reduces the installation and maintenance of costly physical equipment, and relieves overworked IT personnel. Rather than keeping software, data, and other information on a user's computer, these items are instead served up as needed. This opens up the possibility of cooperation, cost savings, and many other opportunities. Both students and instructors may benefit from the cloud's increased efficiency, low overhead, and adaptability in the classroom. As a result, many educational institutions are incorporating this into their operations. This research seeks to discuss the application and limitations of using cloud computing in the education sector. According to the findings, the most promising factors are long-term IT cost savings, optimal resource accessibility, scalability, and enhanced learning environment. This research also found that higher initial investment, downtime risk, less control, and security flaw risk are the major concerns faced by the educational institutions.

Introduction

The advent of technology has brought about dramatic shifts in many aspects of society, including the modes of interpersonal contact, the business, the entertainment sector, and even education. It would seem that students are now, more than ever before, confronted with developments that not only profoundly affect the method in which they study, but also the way in which they live their lives. It is almost hard to deny the significant influence that today's technology has on the next generation of schoolchildren and students [1].

The modern educational system places a great emphasis on the use of various forms of educational technology. When information is shared and received via the use of communication technologies, a stimulating atmosphere is created that is beneficial to the processes of teaching and learning. Because they are able to more readily communicate with their pupils and impart information via digital media, teachers' jobs have been made easier to access and better than they have ever been before thanks to a variety of programs that enable internet learning [2].

When it comes to the cultivation of analytical and deductive reasoning skills, the significance of the role that technology plays in educational settings becomes especially apparent. Students are given the opportunity to articulate themselves in innovative ways, allowing them to arrive at a variety of answers as a result of the many instructional techniques. During that process, they use

an analytical approach to the information by carefully considering each piece of data at their disposal in order to get the intended outcome [3].

Tablets, movies, drawings, the Internet, voice tapes, collages, and other forms of media have taken over the space that was before held by textbooks and notebooks. Because of this, students are able to communicate in a manner that is most comfortable and understandable to them; hence, even students who have difficulty collaborating well or speaking up in class now have the chance to succeed and improve their grades.

Cloud computing is a more productive and cost-effective approach to employ technology. Over the course of the last decade, a growing number of companies and people have turned to cloud-based solutions for their computing requirements. Currently, schools are participating in this trend. Because of technological improvements, a wide range of industries such as such as information storage, education [4], [5], sports, healthcare [6]–[8], and management[9], among others are now embracing cloud computing applications to improve and streamline their operations. These applications are considerably distinct from other digital media applications. These may be accessible at any time, from any location on the planet.

In the past, businesses and other organizations made use of a local network that was comprised of desktop computers linked to the network. They used their own own computer gear to store all of the data. Everything worked as intended inside its own contained structure. Computing on the cloud has brought about this development. The cloud can offer AI systems with all of the information they need, while AI systems may contribute information that can provide the cloud with additional data [10]–[12].

Schools are now able to store data through the internet using servers supplied by a third party, due to the advancement of cloud computing technologies. In light of this, it is no longer necessary for educational institutions to have big physical servers and data centers in operation. Instead, they depend on the technological services provided by a third party, which may include storage and processing capacity, as well as databases, analytics tools, and automated regular procedures [13].

It does seem uncertain that most institutions would choose to host the IT systems locally in the future if cloud provision delivers secure, higher-availability, and cheaper solutions than they themselves may supply. Examples of applications that are offered in the cloud include Moodle and Blackboard [14]. The rising usage of bottom level cloud computing in education, including for data storage, seems to be unavoidable. This is especially true for services where there is less of a concern over security, such as for archives of learning material. It's possible that certain educational institutions, including universities, will want to keep their expertise in hosting computing resources for research and teaching reasons [15]. However, doing so may result in expenses, which is something that most educational institutions would rather avoid.

Educational institutions may acquire new insights and enhance operations by harnessing the computational power of cloud computing. Every day, enormous amounts of data are gathered from endpoints, cloud apps, and the students that engage with them. Cloud computing enables enterprises to access massive amounts of organized and unstructured data in order to extract values [16]–[18].

Applications of Cloud computing in education and performance

Robust platforms for online education.

Schools and other educational institutions may provide students access to online classrooms due to cloud-based technologies. The proposal significantly reduces the expenditures required to set up the necessary infrastructure. Costs associated with hiring and training full-time faculty members

may also be minimized. Instead, companies may save money by teaming up with seasoned trainers who can contribute from afar. Teachers, however, are not limited in their ability to reach their pupils because of their location. Virtual examinations are an additional way for students to save both time and money.

Cloud computing promotes changing options for all users. Teachers may link their pupils to numerous programs and apps, enabling them to demonstrate mastery of requirements in unique ways. For instance, a student may reply to an exercise by uploading a recorded video, snapping a photo of a work of art they created, or sharing a paper they collaborated on with classmates. The cloud enables students to exhibit their learning through a variety of technologies while allowing them to use their speech and personal preferences. Through the cloud, instructors and students may tailor assignments to fit the unique requirements of each student.

In the same way that technology is molding and transforming the employment of the future, the classroom design and layout of the twenty-first century must be more adaptable. Through cloud computing, teachers may also use new and creative classroom architectures. The cloud streamlines innovative classroom models such as mixed and flipped classes. Both methods let teachers to spend more facial expression time with pupils at school, while students use the cloud to access classes and homework from home. The cloud facilitates the creation of really creative, contemporary classrooms.

The convenience

When it comes to accessibility, the potential offered by the cloud is unparalleled. Course materials, associated software, and user data are all readily available online. They have the option of taking classes and joining in on organized events. The cloud guarantees constant, faultless content transmission, eliminating the effects of distance and time. In addition, it transmits material to mobile devices, allowing students to study anywhere, at any time. Students must grasp the capability to cooperate well with others. The cloud facilitates simple resource access across different platforms for all users, providing a solid basis for the development of collaborative abilities. For instance, students may work together on a project while their instructor offers immediate comments. Students can only achieve their objectives with the assistance of constructive comments. Cloud computing enables instantaneous evaluation and feedback, which simultaneously helps both students and instructors. Students no longer are required to be in the exact place to collaborate on a team project since the cloud allows them to view their assignments from anywhere [19], [20].

Educators also benefit from simplified collaboration. With the cloud, instructors and administrators can quickly collaborate and share lesson ideas from any location. Various schools and districts may overcome hurdles that prohibit them from working via the use of messaging services and other media, therefore creating a more globalized educational community. The use of cloud computing in the classroom has the potential to save both students and instructor’s valuable time. Everything from studying for tests, collaborating on group projects, and assessing student work may be done in real time.

When users have the option to do a variety of activities from their own devices, they are free to do so whenever it is most convenient for them, whether it during their daily commute, after hours, or even on the weekend. Activities connected to school may be done at any time, so there's no need to attend to school. In addition to reducing the workload of other IT-related duties, the simplicity and ease of use of cloud-based applications and platforms makes them ideal for usage in educational institutions.

Significant reduction in expenses.

One further feature of cloud computing that can not be overlooked is the huge reduction in expenses. It's a win-win situation for both the students and the teachers. Because of the availability of these tools on the cloud, students may save money on textbooks and software. Providers, too, may help reduce management costs by streamlining activities like enrollment and assignment administration [21]. As was previously said, this also results in lower costs for the necessary infrastructure. The best aspect about cloud technology is the ability to "pay as you go".

Users may save costs by switching to cloud computing. Because of the cloud, school districts might reduce the size of their IT departments and focus instead on supporting teachers and students. Schools and districts may be able to cut costs on licensing, hardware, electricity, and maintenance by using cloud computing. Furthermore, schools will have access to textbooks in digital form, allowing them to save money and guarantee that students are using the most up-to-date materials [22]. Paper use and associated expenses for photocopying may also be reduced thanks to cloud computing.

Information security

One of the many advantages of cloud computing is the fact that it makes data storage more secure without sacrificing convenience or affordability [23]–[25]. To protect sensitive information, businesses that provide online education over the cloud should use virtual private networks (VPNs). The encryption of traffic and data leaving a network is handled automatically by VPN protocols like IKEv2. Thus, the educational materials may be safely sent to the end consumers without losing any of the original information. VPNs provide students an additional layer of security while utilizing services like Google Drive or Dropbox in the cloud.

Scalability and innovation

The term "scalability" refers to an application's potential to accommodate an increasing number of users. Universities, colleges, and schools are also included in the scope of cloud computing in this respect. This makes it simple for them to expand their access to innovative educational tools and experiences. This allows them to accommodate a larger number of students. In particular, scalability helps companies in dealing with use peaks and traffic surges induced by things like course signups and due dates. At the same time, they may quickly reduce operations during periods of low activity. The cloud also allows for more flexibility and creativity on the part of educational computing suppliers. It allows them to try new things more quickly and often. As a result, they have more room for creativity, resulting in enhanced educational opportunities for kids. That's because it's now easier than ever to build, test, and release updates to existing apps that include improved tools and features.

Extended scopes and Required IT equipment

The use of cloud computing in the classroom opens up new opportunities for learners. Those who are dissatisfied with the status quo of education have the option to investigate the emerging field of online learning. Ideal for anyone thinking about taking online classes or possibly going abroad for further education. Those in the working world who want to further their education but are unable to attend traditional courses might do so via the medium of online education.

Cloud-based software has low system resource needs. These programs run faultlessly on web browsers on desktop computers and mobile phones alike. It is possible for students to study while using their own mobile devices. Educational institutions can take the class without buying a fancy computer. In addition, they may save money on storage space by not buying external drives since they have access to the cloud for free. Nothing could be easier for students to grasp. When it comes

to learning, cloud computing has many advantages. It's no secret that leading service providers are rapidly adopting cloud technology in order to improve the quality of the services they provide to their customers. At the same time, pupils are increasingly seeing the cloud as the superior choice. Nothing beats the simplicity of having a world of knowledge at fingertips, and cloud computing has made that a reality. Everyone in the sector, from huge universities to tiny schools to individual students, is feeling the favorable effects of the cloud, and this trend will only increase in the years to come.

Limitations

In spite of the many advantages it offers, cloud computing is not without its share of problems and obstacles in the field of education. The weak point of using cloud computing in educational settings is that it is dependent on having access to the internet. Online education may be hindered by issues such as service interruptions or low bandwidth, which are not issues that often arise in conventional classroom settings [26]. When partnering with a managed service provider, it is easier to evaluate whether the problem stems from the end user or the cloud provider more quickly. Educational institutions will then be able to enjoy greater access and connection after a solution has been deployed on educational institutions' behalf. Although having access to applications and tools in the education industry (such as Blackboard) is one of the advantages of using the cloud, one of the drawbacks is that educational institutions have minimal control over aspects such as upgrades, training, and other functions [27]. Because the service is being provided "as a service," the cloud provider is in charge of the infrastructure rather than in-house team, and this frees up employees to focus on other tasks. Because everything is maintained off-site, educational institutions will have significantly limited control over the hardware and the way the system is configured. The cloud provider is responsible for taking care of these. The offerings of a single provider are required for cloud technologies to be used in higher education. In most cases, switching between service providers is not an option. Partnering with an MSP may assist in selecting the most suitable provider for organization's requirements. It is very necessary to move the burden associated with education to the cloud before selecting a provider.

A reliable service provider will pay attention to what educational institutions have to say, will comprehend the level of risk educational institutions are willing to accept, and will manage the risk in its entirety, so preventing any unanticipated problems from developing [28], [29]. When educational institutions sign with a cloud supplier, they will often be bound to a service agreement with that provider for the foreseeable future. However, the majority of service providers will allow to get out of a commitment, but they will demand a fee for doing so early on in the agreement. This might not be an issue for the educational institutions if they are happy with the services that have been received, but it is something that should be mentioned all the same. Safety And Security Cloud-based educational technology is safe to use if it is installed and configured properly; nonetheless, there are inherent safety issues involved when all resources are stored online [25], [30], [31]. Inadequately protected cloud computing environments may be susceptible to malicious assaults, which raises the stakes for protecting sensitive data.

This problem becomes much more serious when consumers access information from a variety of devices. If the credentials for accessing the cloud platform are kept on a device that is later lost or stolen, the platform may be accessed by an unauthorized user. educational institutions will need to put an emphasis on security if educational institutions want to prevent these kinds of problems. This starts with ensuring that cloud infrastructure is set up correctly and that all users are properly educated on the most effective cloud best practices for security. For instance, considering multi-factor authentication through a managed security provider (MSP) or MDM management might

alleviate many of the security issues. Additionally, this would provide increased security against the susceptibility of end-user devices.

In spite of the fact that one of the key advantages of cloud technology in education is the decrease of expenses, there are still some initial fees involved. Based on how many different apps or services educational institutions want to move to the cloud; the migration might wind up being rather pricey. There is also a loss of potential earnings due to the amount of time that must be spent instructing employees on the new security procedures and system. The savings are mostly the result of long-term cuts in operational information technology expenditures; nonetheless, managers will have to be equipped for the long-term cost-reductions it will produce.

Conclusion

In the context of education, cloud computing has significant policy implications at the institutional, regional, national, and even international levels. These implications may be broken down as follows: As was said previously, on a local scale, the duties of computing employees may shift from delivering services to procuring and managing cloud services and relations with cloud computing providers. This is in line with the fact that these positions are likely to grow. The staff will be required to keep up with the fast-changing environment of cloud computing and make advanced preparations for the extension of service contracts. The value of cloud computing in education in terms of enhancing teaching and learning strategies need to be recognized by educational institutions. As a result, they need to provide monetary assistance to educators and make it possible for them to use cutting-edge instruments and make use of emerging technology such as cloud computing in the classroom. As a consequence of this, they will urge teachers to use teaching methods that are learner-centered, so guaranteeing that students are educated in an environment that is favorable to their success.

In order for institutions to make full advantage of the cloud, they will need to set aside their concerns over data security in particular and control the risks by maintaining adequate contractual arrangements with providers. They will also need to come to terms with the fact that users will have an increasing ability to circumvent institutional policies regarding computing provision and that they will have to adapt to a world in which applications are subject to frequent upgrades that are not under the control of the institution. It is necessary for the ownership of the data to be confirmed unequivocally inside the contract. Customers should be able to maintain ownership of their data even after it is uploaded and kept in the cloud, since this should be a requirement of any cloud service contract. After then, educational institutions could decide that they want to reassign ownership of the material to the individual who originally contributed it. If any educational resources are being saved in the cloud, a new clearance for intellectual property rights may need to be performed. Contractual negotiations for cloud computing services may be better handled by regional or national education authorities rather than by individual schools, colleges, or smaller universities that do not possess entry to costly legal services. This is because individual schools, colleges, and universities do not have the resources to pay for legal representation. In this scenario, there may be other benefits, one of which is that several institutions will become a part of a single "cloud," which would make it easier for institutions to share data with one another and work together.

It is anticipated that educational institutions will be slower than businesses to transfer essential services to the cloud due to the inertia of educational institutions and the risk aversion characteristic of educational institutions. They also have specific requirements pertaining to their instructional strategies, examination regulations, funding procedures, government policies, and legal issues, which necessitate bespoke applications that are less suitable for migration than general purpose

services such as email. These requirements make it difficult for them to update their systems to newer versions of software. Although it may continue to be required in certain situations, such as defense research, for institutions to host their own email systems, it is probable that this will no longer be an economically feasible option for such institutions in the future. Students will get increasingly used to utilizing quickly developing web-based applications and storing data online as bandwidth improves throughout the world and more students have access to the Internet, many via mobile devices. Therefore, it is possible that end users, rather than businesses, are driving the demand for cloud applications.

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