

## COMPARATIVE ANALYSIS OF CLOUD BASED LEARNING TECHNOLOGIES

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### ABSTRACT

*The term cloud campus comes from cloud computing technology. It empowers the accessibility of data all over the internet.*

*Simply put, cloud computing is the delivery of computing services— software, databases, servers, storage, databases, networking, , analytics, intelligence and more—over the Internet (—the cloud) to offer faster innovation, flexible resources and economics of scale. We need to pay only for cloud services we use, thus helping lower operating costs, run your infrastructure more efficiently and scale as your business needs change. With a cloud campus, there is no need for a local drive in our devices. So whatever we create, store or modify will be available to us everywhere and every time with our MIDs (Mobile Internet Device), considering the fact that we have internet connectivity.*

*In this paper, the major focus will be on comparing and analysing the versatile nature of cloud learning technologies and how the successful operation of cloud campuses in otherwise traditional educational institutes benefit students and working professionals alike.*

**Keywords:** *Cloud campus, cloud computing, MIDs, Cloud service provider.*

### INTRODUCTION

According to the National Institute of Standards and

Technology, cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., servers, networks, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

In the simple terms, cloud computing means storing data and programs over the Internet instead of our computer's hard drive and accessing them anytime, anywhere.

Cloud computing allows companies to have a computing resource, like a virtual machine (VM), store or an application, as a facility -- just like electricity—Rather than maintaining our own platform to provide services, we use the services provided by cloud providers for same purpose.

### Types of Cloud Computing Services

Cloud is deployed in education through three service models:

#### Software as a Service or SaaS

Subscription-based e learning solutions in the form of applications and software can be made available on cloud platforms, in different variants, giving users the flexibility to scale operations as per their needs.

#### Platform as a Service or PaaS

This service enables educators to create and customize applications through programming languages, services, and tools that the cloud platform providers. For instance, a professor can design a customized virtual lab for the students using a PaaS. However, for this, he or she needs to possess technical knowledge of how to work it or hire an IT team for application development.

#### Infrastructure as a Service or IaaS

The service providers enables the educators to deploy and run the software, including applications and operating systems. A provision for processing, networks, and storage can also made available.

**Characteristics Self-service**

Most cloud computing services allow self service that too on demand, so even vast amounts of computing resources can be provisioned in minutes, with just a few clicks, making the business flexible with little need for capacity planning.

**Scalability**

Organizations can scale up or down as computing needs increase or decrease. This eliminates the need for huge investments in local infrastructure, which may or may not remain active in future.

**Pay per use**

Users to pay only for the resources and workloads they use as the computing resources are measured at granular scale. The services are free from capital expenditure. There is no huge cost associated with hardware in cloud computing. Users just have to pay based on a subscription plan tailored to specific usage.

**Flexible workload**

Redundancy or duplication of resources is often implemented to ensure reliable storage and to keep users' important workloads running -- often across multiple global regions.

**Migration**

Organizations can move certain workloads to or from the cloud - or to different cloud platforms -- as desired or automatically for better cost savings or to use new services as they emerge.

**24 X 7 Availability**

Most cloud vendors provide reliable services, by maintaining an uptime of almost 100%. Users can get onto the applications needed to work from anywhere. Some of the applications even function off-line like server less clouds.

**Automated updates on software**

In cloud computing, the server suppliers regularly update the software including the updates on security, so that users need not spend their time and effort on maintaining the system.

**Security**

As the data is stored on the cloud server, it can be easily accessed even if something happens to your computer. Even in a case where you suspect your confidential data is exposed, it can be erased immediately from the source location ( on the cloud server) to prevent misuse .

**Carbon footprint**

Cloud computing helps ensure that organizations utilize only the number of resources they need, which helps them to avoid any over-provisioning. Hence, no waste of resources and thus energy.

**Enhanced collaboration**

Cloud applications allow diverse groups of people to meet virtually and exchange information with the help of shared storage.

**CLOUD SERVICE PROVIDERS**

To compare, we have considered the services provided by three of the most popular cloud service platforms and then analyse how their educational services fare in fulfilling the needs of universities and institutes.

| Sr. No. | Cloud Service Provider | Free –Tier/Free- Trial | Salient Features |
|---------|------------------------|------------------------|------------------|
|---------|------------------------|------------------------|------------------|

|    |                       |  |  |
|----|-----------------------|--|--|
| 1. | Goggle Cloud Platform | <ul style="list-style-type: none"> <li>● 20+ free products for all customers.</li> <li>● 300\$ for 90 days with free services usage up to 12 months.</li> <li>● Verified business accounts get additional credits.</li> </ul>  | <ul style="list-style-type: none"> <li>● Google workspace.</li> <li>● AI-powered learning platform.</li> <li>● Security analytics and operations.</li> <li>● Backup and disaster recovery.</li> <li>● Interactive tutor.</li> <li>● 24/7 student support.</li> <li>● R&amp;D Labs for research, development and prototyping.</li> <li>● Collaboration and productivity tools.</li> <li>● Big Query Sandbox((free for students)- storage (10GB) and for analysis 1TB/month for free usage.</li> <li>● Learning paths for skill enhancement courses and certifications.</li> </ul>   |
| 2. | AWS Cloud             | <ul style="list-style-type: none"> <li><input type="checkbox"/> The AWS Free Tier provides customers the ability to explore and try out AWS services free of charge up to specified limits for each service.</li> <li><input type="checkbox"/> The Free Tier has following types:             <ul style="list-style-type: none"> <li>○ 12-month Free Tier,</li> <li>○ Always Free offer</li> <li>○ Short term trials.</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>● Modernize administrative operations and student information systems (SIS)</li> <li>● Scale capacity and resources as needed and lower costs with pay-as-you-go pricing</li> <li>● 24x7 accessibility.</li> <li>● Set up powerful virtual computer labs, intelligent digital assistants, innovative voice technologies, and extended reality environments.</li> <li>● AWS Cloud Practitioner Essentials- Free 6 hour foundation course</li> <li>● 500+ free digital training on AWS Skill Builder.</li> <li>● Free AWS certification.</li> <li>● AWS Cloud Sandbox             <ul style="list-style-type: none"> <li>○ Account Isolation</li> <li>○ Hands-On Learning.</li> <li>○ Secure Administration.</li> <li>○ Data Movement</li> <li>○ Zero Infrastructure Cost</li> <li>○ Automated Deletion System</li> <li>○ No Hidden Charges</li> <li>○ Product Technical Support</li> </ul> </li> </ul> |

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|  |                 |  |   |
|--|-----------------|--|---|
| 3.   | Microsoft AZURE | <ul style="list-style-type: none"> <li>● 200\$ free credit for 30 days + free popular services for 12 months and 55+ services always.</li> <li>● Azure for Students Get USD100 in Azure credits and free access to popular cloud services and developer tools with Azure for Students. No credit card required.</li> </ul> | <ul style="list-style-type: none"> <li>● Only for high school or secondary students*                         <ul style="list-style-type: none"> <li>○ Develop web and mobile app scenarios.</li> <li>○ Access and download professional developer software.</li> </ul> </li> <li>● Learning paths for free courses and certification (Microsoft Learn).</li> <li>● Microsoft Learn provides sandboxes (limit - 10/day, 4hrs each) which let us use certain azure products for free within the scope of the course exercise we have opted for.</li> <li>● Azure Lab Services-We can set up training labs and classes that the students and users can access 24x7.                         <ul style="list-style-type: none"> <li>○ Simple user experience</li> <li>○ Cost optimization and tracking</li> <li>○ Automatic remote management and scaling</li> </ul> </li> <li>● Windows Virtual Desktop                         <ul style="list-style-type: none"> <li>○ Deliver Windows 11 desktops and applications virtually anywhere</li> <li>○ Built-in intelligent security</li> <li>○ Deploy and scale in minutes</li> <li>○ Reduce cost using existing licenses</li> </ul> </li> </ul> |
| <b>Table 1. Comparison of Cloud service providers.</b> |                 |  |   |

From the given table, we can analyse the capability of the cloud service providers in assisting educational institutes.

Among the three, Google Cloud Platform stands out in the additional credits for verified business account feature and the ample cloud storage provided on the Big Query Sandbox. Apart from that it provides an Interactive Tutor and AI powered learning platforms for enhanced learning. Also, its services are comparatively cheaper than AWS and Azure. It lacks

in the number of free services provided compared to AWS Cloud and MS Azure.

AWS Cloud free tier does not provide monetary credit which is the case with Google Cloud Platform and MS Azure. But the free tier offers a wide variety of options to choose from. We can select the application or resource we want try for free and the time limit or storage limit is based on the specific resource we have selected.

The most advantageous service provided by AWS Cloud is the Skill Builder which offers more than 500 free digital courses. Apart from this, there is a free 6 hour foundation course – AWS Cloud Practitioner Essentials which will get you started with AWS Cloud Development. But the drawback is that you cannot combine multiple free tier services. Only one free tier service can be used per account. Even if you create multiple accounts, the services subscribed to, using those accounts cannot be merged for collaboration. In the Google Cloud and MS Azure free tier, a combination of services is provided for free trial which can be utilised up to the credit limit and duration. This is a point AWS Cloud needs to update its free tier policy to include a combination package with a token credit limit so that users can try out more than one service at a time in collaboration with other free tier services. Also, its pay-as-you-go services charge higher costs than Google Cloud and MS Azure

When we look at the features of Microsoft Azure, it seems more students centric in its services as compared to Google and AWS which are more business oriented. For example, apart from the generic free account which provides a credit of 200\$ for 30 days with the 12-month and always-free services included, it also provides a student account with 100\$ of credit for 12 months of use which includes more than 25 free services. The best part is that this account can be renewed at the end of 12 months if you are still a student and have a valid student mail id, absolutely free of cost. Also, you don't need a credit card to create this account. MS Azure stands way ahead in this regard when compared to Google Cloud and AWS.

There are also exercises in the learning paths in Microsoft Learn which let you create free sandboxes some of which allow the user to use Azure products or services for free without the free subscription, provided that the service in question is included in the sandbox of that particular exercise.

The User Interface though, is not as easy to use as AWS or Google Cloud. Also cost management feature is quite complex as you may not be aware of the additional resources that go with the main service that you are using. Improvement in portal navigation is also needed to enhance the user-friendliness.

All the cloud service providers discussed here have their share of advantages and disadvantages. Which one we choose to implement in our campuses depends on the specific needs and teaching-learning goals of the particular institution. It doesn't mean we are allowed to implement and use the services of just one service provider. We may include the best services of multiple cloud service providers to optimise costs and implement the functionalities to suit the needs of various departments in an educational institution.

#### **IMPLEMENTATION OF CLOUD CAMPUSES AT EDUCATIONAL INSTITUTIONS**

- Enables students to coordinate with classmates, faculty, school administrators and family as they have a variety of online tools from different sources to choose from.
- It can use co-branded email so that students feel connected with their academic community.
- Free hosted email with storage – for use throughout graduation and beyond.
- Provides online companions to word processing software like for eg. in Gmail.
- Consistent user experience – promotes working in teams as files / data can be accessed 24x7 using a variety of devices.
- High quality communication capabilities enable students to work on projects with fellow students aided with real time document sharing and management.

- Mobile Learning Platforms can be deployed to get access to learning resources - round the clock, round the globe.
- Enables faculty to coordinate their work with their colleagues, students and faculty real time.
- We can build a closed campus supervision policy, helping administrators prevent students from sending or receiving emails from unapproved sources.
- Review and monitor student online activity.
- With multiple offerings such as calendaring and document share etc. faculty can schedule and share lessons and assignments with students online- real time. They can Create, Upload and Deliver online courses easily.
- Using communication tools for effective teaching, teachers can extend learning beyond the classroom and engage with students better.

As pointed above, cloud campuses are a good bargain when it comes to providing best in class learning and teaching environments for the stakeholders. Here are a few institutions that have successfully implemented cloud learning in their campuses.

South Washington County Schools has around 18,500 students, and needed to provide remote learning access to its students during the COVID-19 pandemic. A major challenge they faced was to continue offering advanced science, technology, engineering, and mathematics (STEM) courses during the pandemic. South Washington County Schools collaborated with Amazon Web Services (AWS) Public Sector Partner Pearson, a global learning company, to build a solution that virtualizes the compute resources needed to deliver STEM content. Amazon AppStream 2.0 is a desktop and application virtualization service that facilitates secure access to data, applications, and resources. Using this solution, students in the district now have the learning environment and support tools they need to continue their education remotely. After working with Pearson to provide advanced STEM learning during the COVID-19 pandemic, SWC Schools plans to keep moving forward with its virtual learning solution and expand access to other district schools.

O.P. Jindal Global University (JGU), which is located in Sonipat, Haryana, India, has been using CollPoll since 2016. There are 10 schools in its system and they have implemented CollPoll's campus help center to provide over 8,000 students with a wide range of services like for examination department inquiry, maintaining an IT help desk, shuttle booking, laundry and courier services , student and visitor gate passes and more. They also the career services module of CollPoll to create and share opportunities with the student community, to manage the application and selection process, as well as get insights into the number of students placed in each company, the roles and companies in which these students are placed the most, and the number of services which are most used by students

Thirteen of the institutions of Dr. D.Y. Patil Pratishthan located across Pune use CollPoll for complete campus automation. The result of this collaboration includes enhanced efficiency and collaboration between multiple stakeholders, transparency at macro and micro levels, reduction in duplication of work, and elimination of errors from data management.

Lafayette College had been using Google Workspace – formerly known as Google Apps – for students, faculty, and staff since 2010. For Lafayette College, features like mobile-device and bring-your- own device (BYOD) management, advanced security tools and IAM administered through the security center dashboard and enhanced support services were important factors while considering Google Workspace for Education Plus for campus management . It is a new edition of Google Workspace for Education that offers additional plus- grade capabilities. Google Workspace for Education Plus allowed them to quickly integrate through the identity system, since they had already functionally deployed Docs and integrated it with their Identity and

Access Management (IAM) stack.

Penn State World Campus provides online courses which can be accessed by students from anywhere. By answering routine questions with a virtual assistant built on Google Cloud, Penn State World Campus's academic advisers can spend more time with their students. They use Quantiphi's Rapid Response Virtual Agent Program powered by Google Cloud Contact Center AI for this purpose. Students use the virtual assistant to email their questions or queries to campus advisers through a secure platform with Single Sign On authentication. Diagflow by Google, is natural language processing tool which analyses these questions, gathering relevant information like the student's last degree, enrollment dates, and campus. Penn State's own secure, local student information system (SIS) database stores the student data which is FERPA-protected. Quantiphi creates the criteria to be used which are then used for training Diagflow. It then designed a custom interface to generate clear, concise, and standardized responses for the defined categories of questions. Any questions which outside the scope of the training criteria are sent automatically to advisers, with the student's information pre-collected for them.

CampusNexus® Cloud by Campus Management Corp is built on Microsoft Azure and provides a proven and agile platform for future innovation and student needs in higher educational institutes, as well as increased integration with Microsoft Power BI , Microsoft Office 365 and other Microsoft applications. Coppin State University wanted to and improve its first-year student experience, allowing the institution to increase student retention and graduation rates and thereby boost enrolment every year. Their research data strongly indicated that retention rates are most impacted by students' first-term experiences. Coppin was keen to implement CampusNexus Engage because it is an enterprise-wide CRM solution suite that has modules to support student recruitment and admissions, student success, and advancement, providing a holistic student profile. It is a modern cloud platform that allows them to engage with students using their preferred method of communication.

## CONCLUSION

Although at a nascent stage, cloud learning is growing at a fast pace as every academic institute plans to migrate to cloud platforms to avail its versatile services and online storage to be able to provide an affordable yet quality learning environment to their students.

Cloud Services are doing their bit to bring about this change in learning .

Cloud campuses are the future of education and as the economy grows, they will be instrumental in making education undergo a paradigm shift from its otherwise traditional roots.

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