Cloud Computing: A new paradigm for E learning

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Abstract: The modern education is changing and so is the teaching in the classrooms due to the advent of technology. The students are expecting more and demanding more services from their institutions. Their classes do not get over with the timings but rather their learning continues 24x7 wherein they expect their educational institutions to keep pace with their "on demands". This is where the innovative role of Cloud computing comes in order to meet their requirements. According to Mircea & Andreesu (2015), "Cloud computing is a next generation platform that allows institutions and organizations with a dynamic pools of resource and to reduce cost through improved utilization". Education institutions these days are facing many problems with the increasing need of IT and IT related infrastructure. In such a scenario, Cloud computing can be a reliable solution for fulfilling the need of software, storage services and infrastructure of such institutions as it is based upon existing IT technologies such as Internet, grid computing, virtualization etc (PWC report, 2014). Cloud computing has become a buzzword now days. The objective of this paper would be to explore the role of Cloud computing in Indian educational institution. How cloud computing through its various deployment & service models can help in improving the teaching, pedagogy, agility of an institution? Further it would critically evaluate the crucial risks and challenges which are faced by institutions in taking advantage of this emerging cost-effective technology which has the potential of bringing in a revolution in educational and academic sector. This paper would use the live case studies of various Indian and international educational institutions which are using this technology to meet the ever increasing pressure to deliver more for less as the data for discussion. There are very few papers which discuss the live cases of educational institutes where cloud computing is playing a crucial role and even fewer studies discuss the risks and challenges associated with this technology. Hence this study on cloud computing brings in a real perspective through cases which is of utmost importance for better understanding of this technology in education field. It would provide much clearer knowledge of implications of implementation of this technology.

Keywords: Cloud computing, Characteristics, E-learning, Higher education, Cloud Models, Cloud infrastructure, Cloud Applications.

I. INTRODUCTION

According to Lazowska et al. (2013), "Higher education has always been acknowledged as one of the pillars of societal development. Through the partnerships between universities, government and industry, researchers and students have proven their contribution to the transformation of society and the entire world economy". But commenting on present day education scenario Golden (2012) states that, "At present moment, the universities are confronted with a dramatic increase of costs in higher education, more than the inflation rate and a decrease of universities' budgets, which leads to the pressure of finding some alternative means of reaching their purpose i.e. the education of students and accomplishing the research". Mircea & Andreescu, (2013) suggests that Universities must bring in a change in their way of operating to become much more service oriented, effective and efficient in all their internal and external processes so as to be able to withstand these pressures.

Cloud computing has become progressively more popular in modern businesses as it provides flexible on-demand and dynamically scalable computing infrastructure using internet. Mell & Grance, (2014) termed cloud computing as "silver bullet" in the educational field. According to Jain & Pandey, (2013). " In the academia, cloud computing is a powerful tool that offers great scalability and flexibility, making it possible for students, staff, faculties, administrators, and other campus users access file storage, databases, and other university applications anywhere anytime". Ercan, (2015) states that "Universities especially in more developed and advanced countries have adopted this technology for many reasons ranging from reduced cost of hardware acquisition and maintenance to greater access of web 2.0 applications for teachers and learners and ultimately better academic outputs"

II. OVERVIEW OF CLOUD COMPUTING AND THE MODELS

Méndez & González, (2013), defines Cloud computing "As a computing model based on networks, especially based on the Internet, whose task is to ensure that users can simply use the computing resources on demand and pay money according to their usage by a metering pattern". Therefore, a new business model is being created where the services it provides are becoming computing resources. According to NIS (2016), "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".

A. Service Models:

Cloud computing consists of three Service models (refer Fig 1).

1. Infrastructure as a service (IaaS)

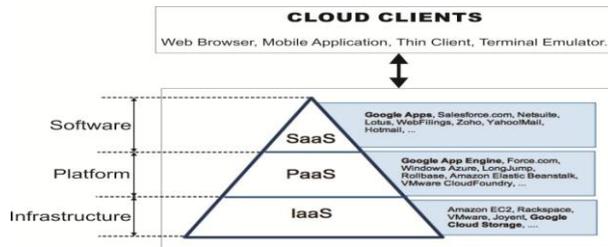2. Platform as a service (PaaS)

3. Software as a service (SaaS)

Fig 1.Cloud Computing Service Models

Adapted from On the Evolution of Virtualization and Cloud Computing: A Review. Oludele, A. , Ogu, E. C. , 'Shade, K. , & Chinecherem, U. (2014).Retrieved from: http://pubs.sciepub.com/jcsa/2/3/1/)

1. Infrastructure as a Service (IaaS): IaaS is the lowest layer of cloud computing. At this level, Consumers can use IT infrastructures services and applications such as storage; processing; networks and other hardware resources like processor, memory, and bandwidth and HDD storage on lease for their business operations. Consumers are in a way provided virtual machines for their business operations. Amazon EC2 is an example for IaaS. The key advantages of IaaS to the consumer are: cost savings, system acquisition bypass scalability, portability, better power and control, predictability, expert guidance and enhanced agility

2. Platform as a Service (PaaS): As compared to IaasS, PaaS is a higher layer of cloud computing. PaaS providers offer the consumers a platform to develop, run and manage consumer-created or acquired applications. It thus allows the rapid creation of web applications easily and very quickly as the PaaS provider is responsible for managing the complexity of buying and maintaining the hardware, software and infrastructure underneath it. Example for Paas includes Google App Engine. The advantages of PaaS to the consumer includes easy access to development platform,, reduced costs as consumers do not have to maintain hardware and network infrastructure, easy marketability, lower development failure risk and increased security.

3. Software as a Service (SaaS): SaaS providers offers consumers the software for usage as a service on a pay-per-use basis. Based on own needs the consumer can choose the software to use and access through the Internet on his web browser, PDA, etc. Examples of SaaS include Google mail, Google doc, SalesForce.com etc. The consumer benefits of SaaS are easier administration as infrastructure maintenance and software updates is managed by the SaaS provider, global accessibility, easier collaboration and compatibility.

B. Deployment Models:

The four kinds of deployment models (Refer Fig. 2) are

1. Public Cloud
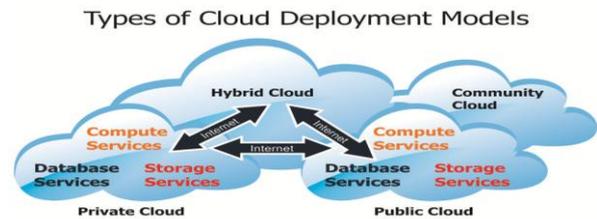2. Private Cloud
3. Hybrid Cloud
4. Community Cloud.

Fig 2. Types of Cloud Deployment Models

Adapted from Choosing your Cloud Computing Deployment method (2016). Retrieved from: http://www.edureka.co/blog/what-is-cloud-computing.

Public Cloud: In Public cloud deployment, General public are offered cloud services for open use over the public Internet. The terms & conditions as well as costing and value are defined by the service provider. Some of the most common examples of public cloud services are S3, Amazon EC2, Google App Engine, etc. *Private Cloud:* is a cloud model which is specifically for the large number of employees/users of a single organization. It is managed by the organization itself or a third party. It helps in maximizing and utilizing existing in-house resources as well as maintains data privacy and trust for security. Academic institutions mostly have their own private cloud, which are utilized for teaching purpose and research.

Community Cloud: provides for a specific group of persons or organizations who have a common interest or shared concerns such as common mission, security & policy requirements etc. The cloud resources are shared by several organizations that support the concerns. Central banks, government departments often use community clouds.

Hybrid Cloud: is a mix or a composition of two or more clouds (Public, private, community).For eg for very sensitive data processing private cloud maybe used whereas for less sensitive data public cloud maybe used by a consumer. Some examples of hybrid cloud are Force.com and Microsoft Azure.

Consumers, keeping in mind their own requirements, can thus choose one or more services provided by the third parties. They do not require any technical knowledge of IT. They are simply leasing or accessing the needed services from the providers using the cloud. Sultan (2015) states that "Cloud computing is highly scalable and creates virtualized resources that can be made available to users. The quality of the service becomes a crucial factor of the cloud computing success."

III. CLOUD COMPUTING IN EDUCATION

Cloud computing is being increasingly used Academic institutions. According to Sasikala and Prema, (2012), "Within the present economical context, the use of Cloud Computing becomes a necessity and not an option for many universities. This aspect is due to a multitude of factors such as costs increase, the pressure of income increase, students' success, institutional performance and competition in development from an educational point of view, the cloud is a balance between control and economy of scale, offering a lower total cost of ownership model". The main advantage of cloud computing is cost effectiveness in terms of implementation of both software and hardware. Katzan (2010) proclaims that, "Cloud computing can be used to develop quality, low cost education on a global basis".

According to Sultan (2015), renowned universities all over the world have realized the efficiency cost effectiveness and potential of the cloud. He gave examples of universities from UK, Africa U.S and others such as University of California, Washington State University, Deakin State University, London college of Business where cloud computing technology is being utilized. "Cloud Computing offers to universities the possibility of concentrating more on teaching and research activities rather than on complex IT configuration and software systems through a fast IT implementation", said Wyld (2012).He further stated that Higher educational institutions are nowadays either developing their own cloud resources or environment or they leasing or purchasing these cloud resources from the third party service providers.

Further, Flinders (2011), in his research found that, Governments are playing a very crucial and supportive role to higher education institutions by funding their cloud computing initiatives. Colleges and universities are migrating to cloud computing environments for a variety of reasons, particularly economic. Commenting upon complexity in pedagogy these days, Tout et al. (2013), stated that, Cloud Computing can help in reducing the complexity in education sector. According to Thorsteinsson et al.(2011), "Cloud solutions can be used to support cooperative learning and socially oriented theories of learning, using computer technologies to support collaborative methods of instruction". Pocatilu et al.(2009) commenting on the benefits of Cloud computing said that it offers many advantages and beneficial results to e-learning solutions. They elaborated how the technologies such as virtualization, centralized data storage and facilities for data access monitoring, as well as availability of the infrastructure; platform and educational services directly through cloud providers and by using have tremendously helped the educational institutions.

Lab Wyld,(2012) in his research gave example of Commonwealth countries where many colleges and universities had collaborated at the formation of Virginia Virtual Computing which allowed these educational establishments to not only improve the availability of IT resources and assets to students and researchers but also reduced their IT expenditure and further allowed them to maintain their own data centers. Similarly, Mell & Grance (2013), gave example of North Carolina State University which by utilizing cloud services could substantially decrease their software licensing costs as well as saved on employees costs as they could reduce the number of employees from 15 to 3 required to maintain IT resources on Campus. (Bristow et al., 2010) studied the Hawaian University and their cloud based community-source project named Kuali Ready whose aim was to provide a business continuity planning service. Cloud computing has become so very important in educational field.

According to Méndez & González, (2013), "In order to ensure success in e-learning, universities use metrics systems adapted to measure the effectiveness of e-learning solutions based on the cloud. Currently, there are many practices and examples regarding the use of cloud computing".

Universities and higher educational institutions can greatly benefit from Cloud. For example through IAAS, the university administrators can use cloud as a digital place where data and servers can be stored and protected. This would provide them much better cost effective and more efficient control of their resources. With leasing of PaaS resources universities can to use it as a platform to not only develop their own unique services but also be able to access other more advanced applications and services.

Lastly with the renting of Software as Service universities and their students would be able to use a huge and wide range of software's and applications online. SaaS will allow users to access thousands of useful applications available on the internet, Goel et al. (2011) states that, "Most of the cloud computing structures used by universities are hybrids that is they are eclectically modified to serve the institution in the most efficient way possible. And, provided that some minor details are resolved, cloud computing will definitely redefine the whole educational process itself". Mircea & Andreescu (2011) point to the importance of analyzing this trend from the point of view of both benefits and potential drawbacks. As outlined in the Table 1. Below, they identified the nine major benefits and limitations of using cloud computing in education.

Table 1. Benefits & Limitations of Cloud Computing in Higher Education

Benefits	Limitations
Access to applications from anywhere	Not all applications run in cloud
Support for teaching and learning	Risks related to data protection and security and accounts management
Software free or pay per use	Organizational support
24 hours access to infrastructure and content	Dissemination politics, intellectual property
Opening to business environment and advanced research	Security and protection of sensitive data
Protection of the environment by using green technologies	Maturity of solutions
Increased openness of students to new technologies	Lack of confidence
Increasing functional capabilities	Standards adherence
Offline usage with further synchronization opportunities	Speed/lack of Internet can affect work methods

Adapted from Using Cloud Computing in Higher Education: A Strategy to Improve Agility in the Current Financial Crisis. Mircea, M. & Andreescu, A. J. (2011). Retrieved from: http://ibimapublishing.com/articles/CIBIMA/2011 /875547/875547.pdf

Praveena & Betsy (2013) states that, "There are iterative benefits of connecting universities through the infrastructure of the cloud. There are also efficiencies to be gained in aggregating IT services, including personnel, licensing, expertise, and business continuity". According to Sultan (2015) proclaims that, "The pressure to reduce costs and rapid advances in technology are compelling arguments for cloud computing adoption by colleges and universities. Cloud computing improves efficiency, cuts costs, and is convenient for the educational sector. Cloud computing involves a paradigm shift for university IT departments". Supporting the idea, Laisheng & Zhengxia,(2011) stated that because Cloud computing is proving to be a low cost elearning solution for faculty, students and researchers therefore it is being increasingly used in e-learning systems in colleges and universities.

IV. PROMINENT CLOUD COMPUTING PROVIDERS

Some of the prominent cloud computing third party service providers especially in the field of education includes the following:

A. Microsoft Live@edu for Education:

Microsoft Live@edu is intended for educational needs. It provides a set of hosted collaboration services for the educations institutions. The hosted service includes collaboration services, communication tools, mobile, desktop, and web-based applications. It has the feature of data storage capabilities. Office Live Workspace, Windows Live SkyDrive, Windows Live Spaces, Microsoft Shared View Beta, Microsoft Outlook Live, Windows Live Messenger and Windows Live Alerts are the part of Live@edu suite. By means of free registration process universities, colleges and schools can enroll in the program" (Microsoft Classroom, 2013).

B. Google Apps for Education:

Google Apps is a collection of web-based programs and file storage that run in a web browser, without requiring users to buy or install software (Google for Education, 2016). Users can simply log in to the service to access their files and the tools to manipulate them. The communication tools of Google Apps are Gmail, Google Talk, and Google Calendar and the productivity tools are Google Docs: text files, spreadsheets, and presentations, iGoogle and Google Sites to develop web pages. Google Apps allows institutions to use their own domain name with the service and to customize the interface to reflect the branding of that institution. In this way, a college or university can offer the functionality of Google Apps in a package"

C. Amazon Web Services for Education (AWS):

In Software, AWS Marketplace is an online store that helps customers find, buy, and immediately start using software that runs on the AWS cloud (Start Building on AWS Today, 2016). It includes software from trusted vendors like SAP, Microsoft, IBM, Canonical, and 10gen as well as many widely used open source offerings including Wordpress, Drupal, and MediaWiki.For education, educators, academic researchers, and students can apply to obtain free usage credits and can utilize on-demand infrastructure. Researchers around the world have access to global computing infrastructure and storage capacity of the AWS cloud. Instead of purchasing a large amount of hardware, researchers can get started by simply opening an AWS account".

D. Oracle Cloud Platform Services for Education:

Oracle has introduced three Cloud Platform Services - Oracle Document Cloud Service, Oracle Database Cloud Service, and Oracle Java Cloud Service for higher education institutes to support their endeavor (Oracle cloud platform services for higher education,2015). Oracle Document Cloud Service enables sharing of files between staff and students or between project teams. The documents can be accessed on mobile or on desktop/laptop; online or offline.Since access to documents are rule-based, only appropriate faculties or students gain access to documents, depending on sensitivity of information included. The documents can be customized with the college logo to maintain legitimacy. Through Oracle Database students can easily perform database management and development operations in a cloud model. Oracle Java Cloud Service provides students with an environment to build, deploy, and manage Java applications".

V. USAGE OF CLOUD COMPUTING IN EDUCATIONAL INSTITUTES WORLDWIDE

1. Cornell University US:

Cornell is one of the most respected and prominent institutions of US. It has been one of the first educational institutions to move its resources to Cloud. It leased cloud services from third party vendor offering cloud services; therefore it was able to highly reduce its costs of technology infrastructure. Cloud vendor also allows Cornell to scale up or down the resources as per the change in demand. Cornell can further buy additional services as per requirement or demand. They do not have to anticipate and plan their IT needs in advance as the cloud model allows to Cornell to buy only what it needs and when it is needed. Cornell can purchase a la carte the IT services that it requires. It can now take advantage of economies of scale. Google for example host millions of email accounts of Cornell students and other users less expensively than Cornell can host thousands. Cornell can now focus on its core business – its education, research and outreach missions.

2. Dwara usage in Karnataka Education Department:

Cisco has developed Cisco Education Enabled Development (CEED) 2700 which is an integrated hardware-software cloud solution for education (Refer Fig 3). Code-named Dwara,it is an all-in-one box that aims to decrease the cost of implement cloud solutions to a dollar per child per month. Aravind Sitaraman, president, Inclusive Growth at Cisco, states that "It lowers costs, provides a degree of scalability and keeps the complexity in a central location. If you have a teacher in one location, and she is good at mathematics, this technology can be used to virtualise her to other locations."

The Karnataka government in collaboration with CISCO has been using Dwara in Govt. schools and Universities. It is being used to train teachers as well as a resource for students. Many other institutions have also adopted this technology for educational dissemination. Schools such as chain of Oakridge International Schools and Nettur Technical Training Foundation have also implemented this technology.
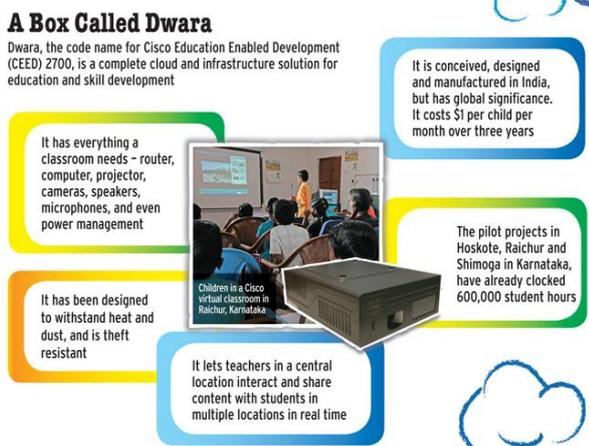

Fig. 3. Dwara: Cloud and Infrastructure Solution

Adapted from A Cloudburst in the classroom. N. Rajan. (2013). Retrieved from: http://www.businesstoday.in/magazine/features/cloud-could-fill-the-gaps-in-india-education-sector/story/197270.html

3. NIIT Campus, India:

The largest on-ground implementation is NIIT's Cloud Campus which has been implemented in more than 150 centers in India is one of the largest on –ground implementation (Rajan, 2013). It provides its students the 24 hr access to course content, faculty, labs and collaborative platforms. Students for big and small cities can reach these educational resources as per their convenience and time (see fig 4). NIIT chief executive G. Raghavan says "Cloud campus basically addresses the need for flexibility and learning on demand. Flexibility will be in terms of when, what and how to learn," he says. "This will be different for each person, so we have to get an optimal mix of pedagogy to get learning effectiveness."

Fig. 4. NIIT's Cloud Advantages

Adapted from A Cloudburst in the classroom. N. Rajan. (2013). Retrieved from: http://www.businesstoday.in /magazine/ features/cloud-could-fill-the-gaps-in-india-education-sector/story/197270.html

4. Deakin University's Custom Cloud Systems:

Deakin University, Australia's web-based system called DeakinSync is an example of major clouds implementation of this type in the education field of Australia (Kruizinga, 2014). DeakinSync makes learning environment and experience more efficient for the students. It provides easier access to shared open resources of the university.

DeakinSync assimilate multiple Microsoft cloud tools which allow the students to manage their assignments, connect their apps and ensure their availability round the clock.point. This tool showed excellent performance in the first trimester of 2015. The idea behind the tool was to increase presence on high traffic. Mr. Roberts, CIO, said, "Besides the custom platforms, Deakin University also uses Microsoft's cloud systems to connect its research and academic community in order to create a functional learning and collaboration environment. The key benefits includes research collaboration improvement, mostly achieved through Lync and SharePoint that represent secure sharing and collaboration spaces, a consistent set of tools for all students and researchers regardless of their actual,

physical location, an enhanced student experience that enables everyone to work efficiently from anywhere and innovative use of technologies among both students and academics."

5. The University of São Paulo:

USP is a global research powerhouse. Brazil's largest and most prestigious public university. Relentless dedication to advancing research in all areas of knowledge and accelerating the time to discovery have helped USP become one of the world's leading research institutions (University Of São Paulo Move To Open Source Apache CloudStack To Power Latin Americas Largest Educational Cloud, 2015). In 2012, USP embarked on one of the most ambitious cloud projects in all of Latin America. The project, now known as "Cloud USP," was to consolidate the university's 150 data centers into 6 and bring all of its corporate, educational, and research environments together in a massive private cloud built on FlexPod. Today, Cloud USP provides access to online education opportunities to more than 150,000 students on campus and across the globe. Students are accelerating learning and enriching their educations with unprecedented access to real-time lectures, fast access to e-mail, and digitized access to the school's library and museum collections. The first and largest educational private cloud deployment in Latin America, Cloud USP is attracting the attention of other educational and research organizations in the region, which now look to USP as a model for cloud in education. USP also has plans to open its private cloud to offer Cloud USP as a service to other research institutions in Brazil. It is confident that when it does, it will be able to deliver the same high levels of service, performance, and security to all of its users

6. Universitas Terbuka (UT), Jakarta:

With 406,000 students, Jakarta-based Universitas Terbuka (UT) is a mega university and ranked the third-biggest in the world by the UK's Open University. What makes UT exceptional is its commitment to provide degree courses to students from all levels of society at an affordable cost, irrespective of what they do or where they live. UT, therefore, has an eclectic mix of students – rural and urban, employed and stay-at-home, young and old. To improve the performance of its core Moodle-based learning management system (LMS), UT transitioned it to Microsoft Azure in 2015 (World's 3rd biggest open university ups learning innovation by moving their OSS LMS to the Microsoft cloud,2015). Today, costs are down 20% and the LMS enjoys world-class security and automated backup. Lecturers are leveraging Azure's openness to create top-grade learning experiences. UT's 406,000 distance learning students now enjoy fast, problem-free access to their online course material. The university has reduced IT costs and IT staff have reduced the time spent on issue and incident management. Today, UT has the

infrastructure it needs to pursue its goal of being a world-class distance learning university. Students, teachers and administrators are all happier because with Azure PTTJJ works flawlessly. The result is that UT is providing a superior service to its students. It can now provide high quality e-learning resources that can easily be accessed by students wherever they live, with minimal delays. Azure's openness and ability to interoperate with a wide range of solutions – open source or proprietary – ensures that UT will be using the latest technology for our long-distance teaching and learning (Azure in Education.n.d.)

7. Edreams, India:

eDreams Edusoft, an education technology company was set up in 2010 in Bengaluru. They found that personalized learning was a critical problem with the Indian education system (Digital Learning, 2015) So as to overcome this problem, they developed and implemented Funtoot. Mr.R.K.Sharma,MD EDreams states that, "Funtoot is an intelligent and adaptive online tutor helps every child by enabling personalized learning. It observes, assesses, identifies, interacts, encourages and tutors each student based on his/her individual characteristics".This lead the company to be an award winner at NASSCOM Social Innovation Honors 2013.

Edreams utilizes both private and public cloud computing using Microsoft software and cloud services. The biggest benefit of Microsoft Azure Cloud technologies for eDreams Edusoft was that it was able to implement Funtoot at a rapid pace with a minimal development time. With Windows Azure, scaling is simple, immediate and at low cost.

VI. RISKS AND CHALLENGES OF CLOUD COMPUTING AND REASONS OF LOW ADOPTION IN UNIVERSITIES & EDUCATIONAL INSTITUTIONS

Katz et al. (2013) stated that as compared to commercial and governmental sectors, cloud computing is still in nascent stage in education sector. Universities are still in "early adopters" phase. Low, Chen, and Wu (2011) and Mircea and Andreescu (2013) found in their work that in spite of the enormous advantages and benefits of cloud computing still the adoption is on lower scale in higher education. The barriers to adoption as identified by them include concerns regarding security and confidentiality of data stored in the cloud, privacy and regulatory compliance, vendor lock-in, location of the data, legal jurisdiction, and reliability of the cloud service provider (Network Online,2011). Their study additionally discovered that "the relative newness and underdevelopment of cloud services" also further acted as barriers to cloud adoption by higher educational institutions.

Some of the associated risks or issues of cloud computing tools includes concerns about:

1. Data and Privacy Protection: Universities tend to lose strict control over their sensitive data and information as their data is stored on third party's hardware. The cloud service providers are the one responsible for the protection and security of data from hackers both internal and external. Due to the very nature of cloud computing, it is very difficult to find out where educational institutions' data is stored, if it has been breached, who has accessed, if it has been moved, and what particular security protocols are in place. There is also a risk of incomplete or unsecured deletion of universities' confidential data, due to multi-tenancy, reuse of hardware and software resources in cloud computing.

2. Isolation and Segregation: Various cloud resources such as network, storage and computing capacity are shared between multiple users. Because of this very basic nature of cloud computing that is built on features multi tenancy and shared resources, there is always a risk of failure of mechanisms separating routing, Memory and storage between different customers of shared infrastructure.SQL injection and side channel attacks become a real threat in cloud computing environment.

3. Malicious Insider: Sometimes employees of cloud service providers, such as system administrators and others, may have a private access to the sensitive data which is stored in their cloud. Any abuse of such system privileges can harm & risk the confidentiality, integrity and availability of universities data & information which is being maintained by cloud service provider.

4. Dependency to Service Provider: There is a lack of standardized tools, data formats, procedures or services interfaces. This makes data, application and service portability unfeasible. This acts like a constraint as it makes switching from one service provider to another by educational institutions almost impossible. They thus become dependent on a particular cloud service provider.

5. Loss of IT Governance: Academic institutions have to give away the control over their resources to CSP. Universities and cloud service providers sign a Service Level Agreement in the beginning. These SLA mostly do not offer a very comprehensive measures and commitment od desired level of security by Cloud service providers. This leave s a huge gap in security of universities' data and applications stored on the cloud's platform or software

*6. Cloud Service Termination or Failure***:** Cloud Computing is a very new and upcoming technology; therefore Cloud service providers face lot of struggles of a new business. Often many of those go out of business or they change or restructure some of their

originally offered services. This often leads to poor quality & deterioration of service delivery performance, as well as a loss of investment,. Such a situation hence becomes risky for the educational institutions attached with such Cloud services provider.

VII.   CONCLUSION

Overall, Cloud computing has an important place in higher education. Day by day for educational institutions, costs of various resources are increasing. They are under intense pressure of institutional performance and competition,. In such an environment, Cloud computing has become a vital prerequisite for many educational institutions. Cloud computing resources and e-learning tools can augment the engagement and interaction of the faculty, students and researchers in a very cost efficiently. Various educational institutions can collaborate with each other. They can develop a common virtual platform using centralized data storage facilities, virtualization, and other facilities, overall reducing the expenditure and manpower requirement.

Cloud computing is slowly bringing in a paradigm shift in education sector and the way the teaching is done. It does involves some of the associated risks and challenges but the cases of these various Universities and educational institutes shows the capabilities and prospective advantages of cloud solutions that can not only greatly enhance pedagogy and experience of teaching but also advances their IT infrastructure and leading to quicker and more effective and efficient learning and research. These advantages do outweigh the challenges and risks associated with it. The cloud is at present being utilized by numerous educational institutions on a global scale. They all are experiencing the benefits of providing delivering relevant info via innovative technologies. Not only has it lessened the IT Staff requirement but have immensely fulfilled the students' expectations and their ever growing demand for the newest technology on the campus.

VIII.   REFERENCES

[1] Azure in education. (n.d.). Retrieved from https://azure.microsoft.com/en-in/community/education/.

[2] Bristow, R., Dodds, T., Northam, R. & Plugge, L. (2010). Cloud Computing and the Power to Choose, educause. Retrieved from http://www.educause.edu/ educause+review /educause Review Magazine Volume 45/ CloudComputingandthePowertoCho/205498.

[3] Chinyao Low, Yahsueh Chen, Mingchang Wu, (2011) "Understanding the determinants of cloud computing adoption", Industrial Management & Data Systems, Vol. 111 Iss: 7, pp.1006 – 1023

[4] Choosing your Cloud Computing Deployment method. (2016). Retreived from: http://www.edureka.co/blog/what-is-cloud-computing

[5] Ercan T. (2010). Effective use of cloud computing in educational institutions. Procedia: Social and Behavioral Sciences, **2**, 938-942.

[6] Flinders, K. (2011). University of Salford makes £5.7m cloud computing investment. Retrieved from http:// www.ComputerWeekly.com.

[7] Goel, M., Kiran, D., & Garg, D. (2011). Impact of cloud computing on ERP implementations in higher education. International Journal of Advanced Computer Science & Applications, 2(6), 146

[8] Golden, B. (2012). "What Cloud Computing Can Do for Higher Education," CXO Media Inc.

[9] Google for Education. Retreived Sep 15,2016. from: https://www.google.co.in/intl/en_in/edu/products/productivity-tools/)

[10] How cloud computing services benefit cornell university. (2013, June 13).Retrieved from: http://pawprint.cornell.edu/?q=articles/columns/tech-talk/how-cloud-computing-services-benefit-cornell-university

[11] H. Kruizinga. (2014). Cloud Computing in Education: Deakin University Case Study.Retrieved from https://www.crucial.com.au/blog/2014/12/17/cloud-computing-in-education-deakin-university-case-study

[12] http://www.edureka.co/blog/what-is-cloud-computing/

[13] http://wikisites.cityu.edu.hk/sites/netcomp/articles/Pages/RiskofCloudComputinginUniversities.aspx

[14] Jain A., Pandey U, S. (2013). Role of Cloud computing in higher education. International Journal of Advanced Research in Computer Science and Software Engineering, **3**, 966-972.

[15] J. A. Méndez and E. J. González,.(2013).Implementing Motivational Features in Reactive Blended Learning: Application to an Introductory Control Engineering Course, IEEE Transactions on Education, Volume: PP, Issue: 99

[16] Katzan, H. (2010). The education value of cloud computing. Contemporary Issues in Education Research, 3(7), 37-42

[17] Laisheng, X., & Zhengxia, W. (2011). Cloud computing: A new paradigm for e-learning. Proceedings of the 2011 Third International Conference on Measuring Technology and Mechatronics Automation, IEEE Computing Society, Washington, DC, USA. http://dx.doi.org/10.1109/ICMTMA.2011.181

[18] Lazowska, E., Lee, P., Elliott, C. & Smarr, L. (2013). "Infrastructure for Escience and Elearning in Higher Education," Computing Community Consortium. [Online], [Retrieved March 6, 2016], http://www.cra.org/ccc/docs/init/Infrastructure.pdf

[19] Mell P., Grance T. (2014). The NIST definition of cloud computing. Communications of the ACM, **53**, 50-58

[20] Microsoft Classroom. (2013). Retrieved from https://www.microsoft.com/en-us/ education/ products /office/ default.aspx

[21] Mircea, M. & Andreescu, A. J. (2013). "Agile Systems Development for the Management of Service Oriented Organizations," 11th International Conference on Computer Systems and Technologies, CompSysTech'10, So9ia, Bulgaria, 17-18 June 2010, ISBN: 978- 1-4503-0243-2, 341-346;

[22] M. Mircea and A. I. Andreescu,(2015). "Using Cloud Computing in Higher Education: A Strategy to Improve Agility in Current Financial Crisis," IBIMA publishing, 2015

[23] N. Rajan. (2013). A Cloudburst in the classroom. Retrieved from: http://www.businesstoday.in/magazine /features/ cloud-could-fill-the-gaps-in-india-education-sector/story/197270.html

[24] Network Computing.(2011).Retrieved from: http://wikisites.cityu.edu.hk/sites/netcomp/articles/Pages/RiskofCloudComputinginUniversities.aspx

[25] Oracle Introduces Oracle Cloud Platform Services for Higher Education Institutes in India. (2015, September 18). Retrieved from: https://www.oracle.com/in/ corporate/ pressrelease/oracle-cloud-platform-services-for-higher-education-institutes-in-india-20150918.html.

[26] Oludele, A. , Ogu, E. C. , 'Shade, K. , & Chinecherem, U. (2014). On the Evolution of Virtualization and Cloud Computing: A Review. Journal of Computer Sciences and Applications, 2(3), 40-43. Retrieved from: http://pubs.sciepub.com/jcsa/2/3/1

[27] Digital Learning.(2015). Retrieved from: https://www.tcsion.com/dotcom/TCSSMB/LX_microsite/whyLX.html#ylxpage2

[28] Pocatilu, P., Alecu, F. & Vetrici, M., (2009). "Using Cloud Computing for E-Learning Systems," Recent Advances on Data Networks,

Communications, Computers, ISBN: 978-960-474-134-2, [Online],

[29] Praveena, K. & Betsy, T. (2013). Application of cloud computing in academia. The IUP Journal of Systems Management, 7(3), 50–54

[30] PWC Report. (2014). retrieved from: https://www.pwc.in/assets/pdfs/publications/2014/cloud-computing-discussion-paper-for-the-education-automotive-and-it-ites-sector.pdf

[31] R. Katz, P. Goldstein, and R. Yanosky. (2013). Cloud computing in higher education. Retrieved from http://net.educause.edu/section_params/conf/CCW10/highered.pdf

[32] Sasikala, S. & Prema, S. (2012). "Massive Centralized Cloud Computing (MCCC) Exploration in Higher Education," Advances in Computational Sciences and Technology, 3 (2), 111–118;

[33] Start Building on AWS Today.2016. Retreived 10th Dec 2016 from: https://aws.amazon.com/education/

[34] Sultan N. (2015). Cloud computing for education: A new dawn. International Journal of Information Management, **30**, 109-116.

[35] Thorsteinsson G., Page T., Niculescu A. (2011). Using virtual reality for developing design communication. Studies in Informatics and Control, 19 (2), 93-106,

[36] Tout, S., Sverdlik, W., & Lawver, G. (2013). "Cloud Computing and its Security in Higher Education," Proc ISECON, v26 (Washington DC): §2314, EDSIG, [Online], [Retrieved March 5, 2016] from: http://proc.isecon.org/2009/2314/ISECON.2009.Tout.pf

[37] University Of São Paulo Move To Open Source Apache CloudStack To Power Latin Americas Largest Educational Cloud.(2015 April, 21). Retrieved from: http://www.shapeblue.com/university-of-sao-paulo-move-to-open-source-apache-cloudstack-to-power-latin-americas-largest-educational-cloud/

[38] Using Cloud Computing in Higher Education: A Strategy to Improve Agility in the Current Financial Crisis. Mircea, M. & Andreescu, A. J. (2011).Retreived from: http://ibimapublishing.com/articles/CIBIMA/2011/875547/875547.pdf

[39] US NIS (2015). NIST Special Publication 800-145. Retrieved from: http://www.nist.gov/itl/cloud.

[40] "World's 3rd biggest open university ups learning innovation by moving their OSS LMS to the Microsoft cloud. (2015, Nov 17). Retrieved from: https://customers.microsoft.com/Pages/CustomerStory.aspx?recid=24719

[41] Wyld, D. C. (2012). "Cloud Computing 101: Universities are Migrating to The Cloud for Functionality and Savings," Computer Sight. [Online], [Retrieved March 3, 2016], http://computersight.com/ programming/cloud-computing-101-universities-are-migrating-to-the-cloud-for-functionality-and-savings/