

CLOUD BASE e-LEARNING APPROACH: A COMPARATIVE STUDY

Dr. Vineeta Arora*

ABSTRACT

With the significant development in information and communication technologies, most of the areas, specifically in developing countries, are greatly been influenced and transformed. Teaching and learning section is also the part of this change. Now, institutions are thinking over some new technologies to incorporate the teaching and the learning process through electronic ways. Cloud Computing can be one of them. It has emerged as a modern and efficient way to share IT resources at a reasonable price. Application of Cloud Computing in education not only mitigate the educational Institutions from the burden of handling the complex IT Infrastructure management as well as maintenance activities but also lead to huge cost savings. Thus, this paper tries to figure out the cost effectiveness of cloud based e-learning services as compare to on premise approach. The study adopted the Total Cost of Ownership (TCO) method to compute the cost of implementing e-learning through cloud based architecture and on-premise based architecture, taking a government educational institute as sample for case study. The findings of this study serve as a base for educational institutions seeking cost effective alternatives to implement e-learning in higher education. In this paper a basic research has been carried out to show that cloud computing could be a viable alternative solution for adopting and implementing e-learning in higher education.

KEYWORDS: *Cloud Computing, On-premise Based architecture, E-learning, Higher Education.*

Introduction

Higher Education, in today's era, becomes the most important pillar of social development. It plays an important role too to uphold the economic growth of a country. Now a day, the track of higher education has been altered towards quality education. In the whole world, quality education has become an issue of importance as the landscape of higher education has been facing continuous challenges like increased international competition, growing demand of value for money, social and geographical diversity of the student body and also introduction of information technology. The classroom teaching is also transforming into e-learning as the students are becoming more technology oriented. So, in the growing need of quality education, both public as well as private institutions are under increasing pressure to deliver more from the less. Now, institutions are thinking over some new technologies to incorporate the teaching and the learning process. Cloud Computing can be one of them. It has emerged as a modern and efficient way to share IT resources at a reasonable price.

Cloud computing (CC) is an Internet-based computing method that provides shared processing resources and data to computers and other devices on demand and enables ubiquitous, access to a shared pool of configurable computing resources (Peter & Timothy, 2011). It is an extension of the concept of distributed computing – which is the process of running a program or application over many computers connected by a network. Application of Cloud Computing in education not only mitigate the educational Institutions from the burden of handling the complex IT Infrastructure management as well as maintenance activities but also lead to huge cost savings. The Indian Government is also having the ambitious plan to raise the present 34 million enrolments in higher education to 62 million by 2020 as well as interconnect electronically India's 799 universities, 39,071 colleges and at least 2,000 polytechnics for enabling e-learning and content sharing across country. But the cost of acquiring, managing and

* Assistant Professor, Department of ABST, Government Bangur P. G. College, Pali, Rajasthan, India.

maintaining the technical infrastructure in e-learning services is very intricate. Although there are many factors that may affect the higher educational institutions to adopt cloud computing, cost effectiveness is one of them. So this paper tries to compare the cost of hosting e-learning services between on premise and cloud approach in higher education.

The main research objective addressed by this paper is to figure out the cost effectiveness of cloud based e-learning services as compare to on premise approach. The findings of this study serve as a base for educational institutions seeking cost effective alternatives to implement e-learning in higher education. In this paper a basic research has been carried out to show that cloud computing could be a viable alternative solution for adopting and implementing e-learning in higher education.

Literature Review

A brief review of work already done on the subject reveals the following findings:

- **Yaghmaei O. and Binesh F. (2015)** reveal that cloud computing is a new technology which can enhance the quality and speed of transferring data with cost-effective price. This paper argues that cloud computing brings countless benefits to current higher education system which intend to make the access of information easier, increase the speed of data transfer and at the same time decrease their costs.
- **Adeoye (2015)** reviews the extent to which cloud computing applications and services can be used in education. It also highlights the level of adoption and classroom utilization, and some aspects of the distinctiveness of cloud computing. Finally, this paper discusses alternative solutions to solve the IT limitations in higher education institutions.
- **Munjal (2015)** points out the opportunities, challenges and counter measures of cloud computing in higher education. Cloud computing has become an adoptable technology in many organizations. In this paper the author reviews what the cloud computing and its infrastructure is and what will it provide to the higher education.
- **Mtebe J. S. and Raisamo R. (2014)** have made an analysis of on-premise versus cloud hosted implementation in Sub-Saharan countries regarding e-learning. This paper compares the cost of hosting eLearning services between on-premise and cloud-hosted approaches in higher education, taking Tanzania as a case study. The study found that institutions can significantly trim down the cost of e-learning implementation by adopting a cloud-hosted approach.
- **Yadav K. (2014)** focuses on the impact of cloud computing on the education system and gives an idea to provide the quality education by using the cloud computing technology. The cloud allows the user to access his work anywhere, anytime and share it with anyone without the need of accessing any file or application like word processor or spreadsheet program. This paper introduces cloud education system for students, faculty and the educational institutes for providing quality education.
- **Mathew S. (2012)** carries out a basic research to show how cloud computing can be introduced in the education to improve teaching, agility and have a cost-effective infrastructure which can bring a revolution in the field of education. This paper investigates the essentials of cloud computing which can be considered as a new dawn to the higher education. Finally, this paper tries to bring out the benefits and limitations of cloud computing.
- **Sultan (2010)** explains that cloud computing is an emerging new computing paradigm for delivering computing services. This approach relies on some existing technologies like internet, virtualization, grid computing, web services etc. These technologies give cloud computing a new distinctiveness. This article also sheds the light on the current concerns that might be preventing some organizations from adopting cloud computing.
- **Katz et al. (2009)** explain in their article about the need of cloud computing in higher education. Cloud computing is driving down the capital and total costs of IT in higher education. Also it facilitates the transparent matching of IT demand, costs and funding. Further, the authors indicate challenges and risks that will constrain higher education's adoption of cloud computing relate to trust, confidence and surety.

The above literature review indicates that cloud computing is a rapidly growing field of technology. It offers a significant cost effective IT solution. But there is a considerable need to analyze whether or not cloud computing provides an appropriate platform in higher education especially for e-learning with the comparison for on-premise software and data sharing technologies.

Methodology

In order to compare the cost required to host e-learning in the cloud versus on premise, primary as well as secondary data have been used. The primary information regarding e-learning is collected directly from the informant institution through questionnaires, survey and interviews. The researcher selects Government Bangur P. G. College, Pali (Rajasthan) as sample for the case study purpose. The researcher is employed in the above institution so this sample is selected on convenient basis. The secondary information is obtained through the actual forms and operating documents currently being used by the department of e-learning of case study institution. Also online as well as journal articles are become helpful to understand the research problem. Moreover, the study adopted the Total Cost of Ownership (TCO) method to compute the cost of implementing e-learning through cloud based architecture and on-premise based architecture. This method is widely used to compute the real costs (capital cost and operating cost) associated with owning and managing an IT infrastructure. The total cost of both cloud based architecture and on-premise based architecture of investigated institute, is being compared and results are analyzed.

Cloud Computing in Higher Education

Cloud Computing technology can provide solution of any ICT requirement in higher education system. Cloud Computing enables users to control and access the data via Internet. The main users of a typical higher education cloud include students, Faculty, administrative staff, Examination Branch and Admission Branch as shown in Figure 1. All the main users of the institution are connected to the cloud. Teachers can upload their class Tutorials, assignments, and tests on the cloud server which students will be able to access all the teaching material provided by the teachers via Internet using computers and other electronic devices both at home and college and 24X7. It will reduce the cost of operation because servers and learning materials are shared with other colleges. The following are three types of cloud services that can be used in higher education (Mathew S., 2012):

- **Infrastructure as a Service (IaaS):** can be used to satisfy the infrastructure needs of the students, faculties or researcher globally or locally with some specific hardware configuration for a specific task.
- **Platform as a Service (PaaS):** certain providers are opening up application platforms to permit customers to build their own application without the cost and complexity of buying and managing the underlying hardware and software layers.
- **Software as a Service (SaaS):** the application service provider is hosting the application which runs and interacts through web browser, hosted desktop or remote client. It eliminates the need to install and run the application on customer own computer and simplifying maintenance and support.

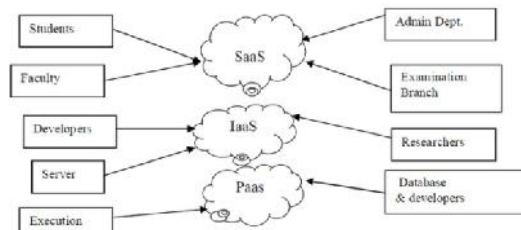


Figure 1: Users of an Educational Cloud Computing System
(Source: Mathew S., 2012)

All in all, cloud computing creates a friendly and organizational data environment for the higher education, which improves educational operations. Students and other users can communicate, collaborate and work effectively together in this cloud environment from various locations and at different time.

E-Learning Platform based on Cloud Computing

Now days, most of the traditional education forms has become unsuitable for the requirements of social progress and educational development. Recently e-learning has grown as a widely accepted way of learning. Introduction of cloud computing brings a new value to an e-learning system as educational services can be delivered in a reliable and efficient way. It also provides a suitable environment for ubiquitous learning activities. As a result, e-learning environment have been initiated over the last couple of years and are ongoing across the world. However, shifting from a traditional IT infrastructure to a cloud based infrastructure is a complex task for an educational institution (Masud and Huang, 2012).

The e-learning platform based on cloud computing includes all the necessary hardware and software as virtualized. The e-learning cloud architecture can be divided as five following layers. The infrastructure layer is a dynamic and scalable physical host pool which is composed of internet, intranet, system software, information management system and some common teaching resources. The software resource layer is composed by operating software that offers a unified interface for e-learning developers. The resource management layer works as loose coupling of hardware and software resources. The service layer contains all three levels of cloud computing i.e. software as a service, platform as a service and infrastructure as a service. The application layer provides content production, its delivery, virtual laboratory, collaborative learning, assessment and management features. The e-learning solutions based on cloud computing related with the risk of data protection, security and accounts management. Even if, it has reasonability, improved improbability, virtualization, centralized data storage and easy monitoring.

Computing Resources and Architecture

- **Computing Resources:** To implement e-learning for a typical institution the computing resources like Learning Management System (LMS), multimedia software, student’s laboratories, course content, digital library, and other ICT infrastructure must required. Some other services of email accounts, operating systems, productivity applications, malware detectors, cleaners, PCs, servers etc. are also essentials to set up e-learning program.
- **On-premise Architecture:** The architecture regarding on-premise e-learning implementation is not so much complex as well. On-premise software is installed and run on computers on the premises of the organization. The e-learning and IT Services Support Unit provides support to students and facilitator during e-learning implementation. All computing resources are centralized and managed by Services Support Unit. Figure 2 shows the on-premise based architecture for the users of e-learning.

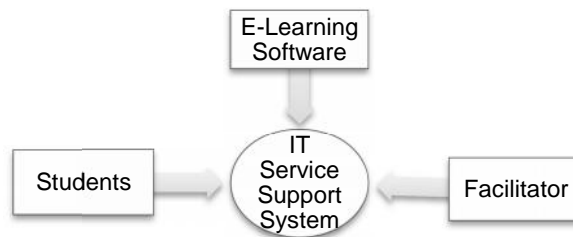


Figure 2: On-Premise based Architecture for E-Learning

- **Cloud Based Architecture:** In the cloud based applications, most of the computing resources are hosted in the cloud that are owned and operated by a provider as a service to customers. The e-learning software used by the institution can directly access from the cloud. Students and facilitators will access learning resources and other e-learning services hosted in the cloud-based servers via SaaS. Any other software required by students and instructors will be hosted in IaaS and made available online. Figure 3 depicts the cloud based architecture for e-learning.

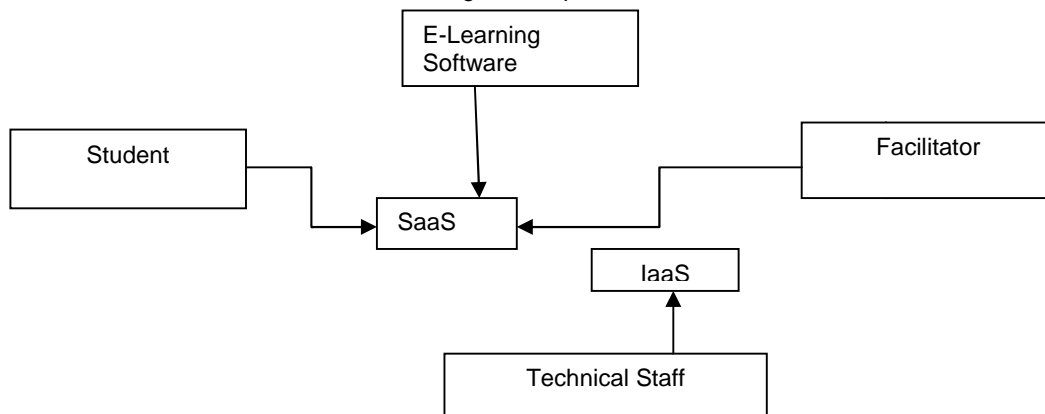


Figure 3: Cloud based Architecture for E-Learning

The Cost Analysis

To act in accordance with the objective of present paper, Total Cost of Ownership (TCO) approach has been used for cost analysis of on-premise vs. cloud, especially in e-learning area of higher education. TCO is a measuring tool meant to uncover all the lifetime costs that involved with implementing a specific project. Here, TCO has been observed into two main categories i. e. one time costs and annual recurring costs(operational costs). Therefore,

Total Cost of Ownership = One Time Costs + Annual Recurring Costs

One Time Costs

- **Server Hardware:** Cost of the computer server that hosts LMS and other learning services. These costs will include the backup server.
- **Software Cost:** Cost caused by licenses institutions need to pay for using various software. These software include: Operating System, LMS, Anti-virus, Content development software, and multimedia integration software.
- **Auxiliary configuration implementation cost:** Cost related to Uninterrupted Power supply (UPS), Network Interface Card (NIC), and switches and cables which are used to attach physical servers to the network.

Annual Recurring Costs

- **Support and Maintenance Cost:** The costs related to maintenance of hardware and software used to run the e-learning systems. Some important activities under this category include software upgrading, virus protection, disk management, and performance maintenance.
- **Hosting Costs:** It includes cost for hosting software and other applications via Internet or in the cloud.
- **Ongoing Internal Support Cost:** The cost related to cooling systems and electricity consumption by ACs, computer hardware, and related devices.

The Cost Analysis of On-premise based Architecture

To fulfill the objective of present paper, the researcher has chosen the institute, Govt. Banger P. G. College (Pali), as case study unit. This institute has set up its e-learning project with on-premise architecture. To calculate the TCO, onetime cost as well as annual recurring cost have been observed and tabulated. Table 1 & 2 show the scrutinized facts regarding e-learning on-premise based hosting over a period of last three years.

Table 1: One Time On-Premise Cost

Particular	Initial	Year 1	Year 2	Year 3
Server Hardware (Dell Inspiron 3268, 8GB RAM, 1TB HDD, Windows 10, 18.5" Desktop PC)	Rs. 0	Rs. 56,990	Rs. 0	Rs. 0
Backup Server Hardware	Rs. 0	Rs. 56,990	Rs. 0	Rs. 0
Content Development Software (Lectora Inspire \$5502 @ 63.89)	Rs. 0	Rs. 3,51,523	Rs. 0	Rs. 0
UPS (Microtek Sinewave, 1100 VA) (Qty. of 2)	Rs. 0	Rs. 10,520	Rs. 0	Rs. 0
Network Interface Card (Intel) (Qty. of 2)	Rs. 0	Rs. 10,520	Rs. 0	Rs. 0
Other Auxiliary Equipments (switches and cables)	Rs. 0	Rs. 3000	Rs. 0	Rs. 0
Total	Rs. 0	Rs. 4,89,543	Rs. 0	Rs. 0

Table 2: Annual Recurring On-Premise Cost

Particular	Initial	Year 1	Year 2	Year 3
Salary of 2 operators (Rs. 8,000 pm each)	Rs. 0	Rs. 1,92,000	Rs. 1,92,000	Rs. 1,92,000
Maintenance and Hosting Cost (approx.)	Rs. 0	Rs. 48,000	Rs. 50,000	Rs. 52,000
Electricity Cost (For 2 ACs and Running the equipments)	Rs. 0	Rs. 36,000	Rs. 36,000	Rs. 36,000
Total	Rs. 0	Rs. 2,76,000	Rs. 2,78,000	Rs. 2,80,000

In table 1, no cost has been included for operating system and Learning Management System because OS is pre-installed and LMS is open source software which is available for free. In table 2, the approximate figures are included as observed in bills and documents regarding e-learning project in the investigated unit. The electricity charges are assumed fixed during the period but it will gradually increase in future. Table 3 provides a summary of TCO for on-premise architecture.

Table 3: TCO for On-Premise Architecture

Particular	Initial	Year 1	Year 2	Year 3
Total One Time Cost	Rs. 0	Rs. 4,89,543	Rs. 0	Rs. 0
Total Annual Recurring Cost	Rs. 0	Rs. 2,76,000	Rs. 2,78,000	Rs. 2,80,000
Total Cost of Ownership	Rs. 0	Rs. 7,65,543	Rs. 2,78,000	Rs. 2,80,000

Thus, the initial cost of on-premise is nil but in the first year it requires high investment almost Rs. 8,00,000. In the subsequent years, total cost is less as no capital cost is there, but it will gradually increase by time passes.

The Cost Analysis of Cloud Based Architecture

Cloud computing has created a shift from the use of physical hardware and locally managed software-enabled platforms to that of virtualized cloud-hosted services. Cloud assembles large networks of virtual services including hardware and software resources. So in the investigated institution, if cloud service is applied for e-learning, no hardware, no software, and no auxiliary server equipment cost will require except of content development software. It is assumed that Institution will incur the same cost of procuring content development software. Table 4 puts some light on one time cost for cloud based architecture.

Table 4: One Time Cost for Cloud Architecture

Particular	Initial	Year 1	Year 2	Year 3
Server Hardware (Main & Backup)	Rs. 0	Rs. 0	Rs. 0	Rs. 0
Content Development Software (Lectora Inspire \$5502 @ 63.89)	Rs. 0	Rs. 3,51,523	Rs. 0	Rs. 0
UPS & NIC	Rs. 0	Rs. 0	Rs. 0	Rs. 0
Other Auxiliary Equipments	Rs. 0	Rs. 0	Rs. 0	Rs. 0
Total	Rs. 0	Rs. 3,51,523	Rs. 0	Rs. 0

The annual recurring costs like supporting and maintenance cost is included in the service agreements. Also, by hosting e-learning services in the cloud, institution will not incur any cost related to electricity consumption by ACs, computer hardware and related devices for the system. Only institute will pay the hosting cost for e-learning services in the cloud. To obtain this cost, this study adopted Google Cloud Service. Google offers several pricing option for hosting services in their cloud in three categories as compute, storage and network.

According to the requirements, LMS server with needed configuration is charged \$0.530 per hour. Therefore, the cost of running LMS for a year will be \$1,272 ($\$0.530 \times 8 \text{ hours a day} \times 25 \text{ days in a month} \times 12 \text{ months}$). Additionally, Google charges \$0.10 GB per month for storage space. In this case, with the requirement of 100 GB per month, the cost of storage for a year will be \$120 ($\$0.10 \times 100 \text{ GB per month requirement} \times 12 \text{ months}$). Similarly, Google charges network transfer at a rate of \$0.12 per GB. So the network transfer cost for a year will be \$144 ($\$0.12 \times 100 \text{ GB per month requirement} \times 12 \text{ months}$). In total, the cost of hosting e-learning services using the Google cloud service per year will be \$1,536 ($\$1,272 + \$120 + \144) or Rs. 98,304 ($\$1,536 \times \text{Rs. } 64$, taken as average). Table 5 reveals some more idea on annual recurring cost for cloud based architecture.

Table 5: Annual Recurring Cost for Cloud

Particular	Initial	Year 1	Year 2	Year 3
Salary and Maintenance cost	Rs. 0	Rs. 0	Rs. 0	Rs. 0
Hosting Cost (approx.)	Rs. 0	Rs. 98,304	Rs. 98,304	Rs. 98,304
Electricity Cost	Rs. 0	Rs. 0	Rs. 0	Rs. 0
Total	Rs. 0	Rs. 98,304	Rs. 98,304	Rs. 98,304

Now, table 6 provides a summary of TCO for cloud based architecture:

Table 6: TCO for Cloud Based Architecture

Particular	Initial	Year 1	Year 2	Year 3
Total One Time Cost	Rs. 0	Rs. 3,51,523	Rs. 0	Rs. 0
Total Annual Recurring Cost	Rs. 0	Rs. 98,304	Rs. 98,304	Rs. 98,304
Total Cost of Ownership	Rs. 0	Rs. 4,49,827	Rs. 98,304	Rs. 98,304

Discussion on Findings and Further Scope

The present study intends to compare cost of hosting e-learning services on-premise vs. cloud based architecture, taking Govt. Bangur College (Pali- Rajasthan) as a case study. The whole investigation finds that the institute can reduce the significant cost of running e-learning courses by hosting this service with cloud. More specifically, the study also finds that the institute can save approximately Rs. 3,00,000 in the first year and about Rs. 1,80,000 in the next subsequent years. Thus, the overall saving is about Rs. 5,00,000 in 3 years by hosting e-learning services in the cloud. The cumulative cost graph of Total Cost of Ownership has presented in figure 4. This figure outlines a three year TCO of both cloud based and on-premise solution.

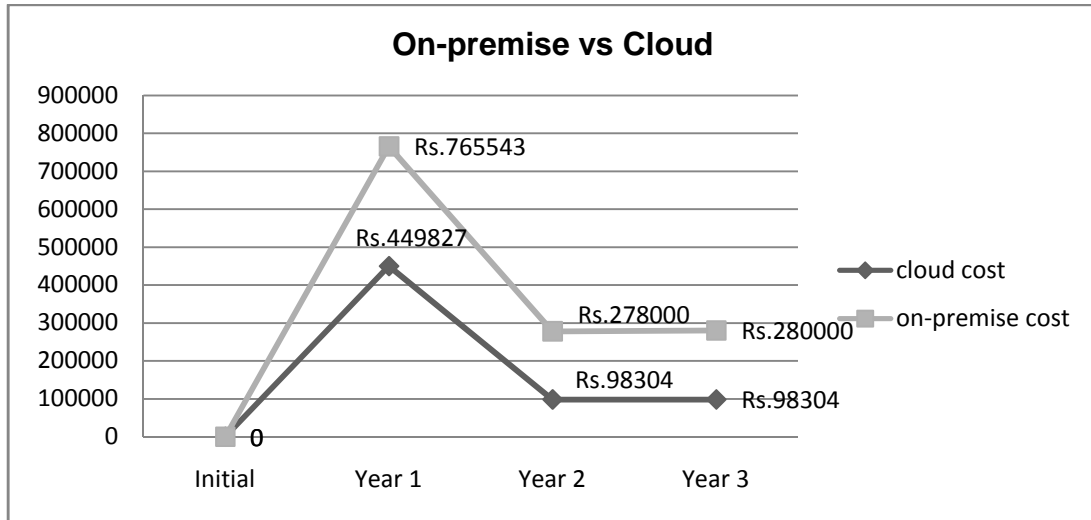


Figure 4: Cumulative Cost Graph of On-premise v/s Cloud

Moreover, this study works with some limitations that can be considered in further investigation. For calculation of TCO, it is assumed that 200 hours (for the whole month) require for e-classes. But in many institutions e-learning classes are required only for a short period even in the whole year also due to vacations. So the cost of hosting e-learning will go down according to the requirement of specific institute. In addition, this study is based on public cloud architecture, but due to security reason, institutions can go for private cloud. In such case, new cost analysis can be done for private cloud architecture. However, one more option for hybrid cloud computing is available which is mix up of public and private cloud computing. Finally, this study did not consider other charges such as the cost of migration from existing infrastructure into the cloud, the cost of using a public IP address, and the cost associated with learning how to use cloud computing. These charges were not considered significant and would not change the conclusion of this study.

Conclusion

Cloud computing is recently emerged technique for managing and delivering services over the internet. It rapidly changes the landscape of using the resources on cloud instead of using on-premise resources with heavy infrastructure. The main difference between these two systems is how they are deployed. Cloud based software is hosted on the vendor's servers and accessed through internet. On-premise software is installed locally with institution's own computers and servers. The current paper is focusing the cost analysis of on-premise solution and cloud solution for the area of e-learning. In the present circumstance, e-learning system is facing challenges of optimizing large scale resource management as accordance with the huge growth of users, services, education content and online resources. The features of cloud computing completely match to face the challenges of e-learning. The outcome of present study also supports this assumption that cloud computing can be the better option for e-learning system with the quality of required flexibility and scalability for the resources including storage, computational requirements and network access. Finally, the findings of this study are expected to serve as a base for educational institutions seeking cost effective alternatives to implement eLearning in the developing countries like India.

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