

# **RESTRUCTURING THE INDIAN EDUCATION SECTOR WITH OPEN SOURCE CLOUD COMPUTING SYSTEMS**

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## **ABSTRACT**

*The education sector is experiencing a major innovation and the instrument in this development is new age Information and Communication Technologies (ICT) for teaching and learning. This growth has been fueled by the emergence of cloud based learning technologies. It is difficult for a developing country like India to benefit from these digital learning technologies as it is plagued by the challenges of inadequate technology access coupled with economic considerations of provisioning and maintaining IT infrastructure. In today's economy, educational institutions struggle to provide sufficient hardware and software that can offer students a complete learning experience. This paper suggests the use of Open Source Cloud Computing systems as a form of possible remedy. Free Open Source Software (FOSS) gives user the freedom to use, study, and modify the software based on their needs and preferences. The key benefit of cloud based learning is anytime, anywhere access to digital resources at a low cost. This new paradigm called Open Source Cloud Computing can provide a cost effective solution for the amplified use of digital technologies in education. This paper provides insights into cloud computing and FOSS paradigms. It further examines the benefits offered by the adoption of Open Source Cloud Computing Systems in educational institutions. Finally, features of popular cloud based open source software for academic use are presented.*

**Keywords:** *Cloud Computing, digital learning technologies, education, Free Open Source Software (FOSS), Information and Communication Technology (ICT)*

## **I. INTRODUCTION**

Information and Communication Technologies (ICTs) have proven as potentially powerful tools for educational change and reform. When used appropriately, digital technologies can help expand access to education, strengthen the relevance of education to the increasingly digital workplace, and raise educational quality by helping make teaching and learning into an active process connected to real life.

The higher education system in India is on the verge of experiencing a major revolution facilitated by the use of digital technologies. There is a tremendous potential for technology to improve the quality of higher education and student learning levels. The adoption of digital technologies in education sector requires huge investments

in the form of IT infrastructure and supporting software. Most educational institutions in India are dependent on the use of proprietary digital content. The cost of proprietary software is too high to be accommodated in the tight budgets of Indian educational institutions, whether government managed or privately owned. In these circumstances, equipping institutions of higher education with digital learning technologies seems like a challenge, despite the fact that the Union Budget 2016 indicated 4.9 per cent increase in the education budget. The solution to this problem calls for the creation of open educational resources that can be made available for free or at a low cost.

Free Open Source Software (FOSS) is stipulated by a liberal licensing policy that makes it possible to be obtained free of charge along with the source code, which can be modified by the user as per requirements. Advantages like increasing interoperability, developing local capacity/ industry, reducing costs, achieving vendor independence, enabling localization, reducing piracy/copyright infringements and increasing growth of knowledge-based society are among the compelling reasons for adopting FOSS[1].

Under its Digital India initiative, the Government of India is promoting the policies supporting development, procurement and sharing of open source software for government applications and services, including the education sector.

The advantages of FOSS can be further leveraged by deploying open source software on cloud platforms. A major advantage of cloud-based technology for the education is the reduction in operating costs. Cloud technology offers a solution by allowing educational institutions to hire required processing capacity from data centers rather than buying their own IT infrastructure. Hence, this new paradigm called Open Source Cloud Computing can provide a cost effective solution for the amplified use of digital technologies in education. The rest of the paper is structured as follows. *Section II* examines the FOSS philosophy and the motivation behind FOSS movement. *Section III* identifies how cloud technology can benefit and revolutionize teaching learning processes. *Section IV* highlights the advantages of Open Source Cloud Computing Systems for education. *Section V* further examines the key features of popular cloud based open source software for academic use.

## II. FREE OPEN SOURCE SOFTWARE

Free Open Source Software (FOSS) has the potential to become the foundation of a learning society. FOSS are programs whose source code can be freely downloaded, used, modified and redistributed by anyone, without having to pay royalties[2].

The growing popularity of FOSS is credited to the enormous efforts made by the Free Software Foundation, which is the principal organizational sponsor of the GNU Operating System (Unix Compatible FOSS). This Foundation has planted the seeds of computer user freedom for more than three decades. It identifies four essential freedoms for software to qualify as FOSS for its users- [3]

<b>Freedom 0</b>	The freedom to run the program for any purpose.
<b>Freedom 1</b>	The freedom to study how the program works, and change it.

<i>Freedom 2</i>	The freedom to redistribute copies so that you can help other users.
<i>Freedom 3</i>	The freedom to distribute copies of your modified versions to other users. By doing this, you can give the whole community a chance to benefit from your changes.

*Table 1- Four User Freedoms*

The FOSS movement dates back to the late 1970s and early 1980s when the sharing of software began to come in conflict with proprietary software. It is quite interesting to note that computer scientists working in higher education were the first to develop and freely share software in the 1950s. Even as modern computing developed, there were no open source licenses because by default almost all code was openly shared and freely redistributed. This was possible because software tools required a relatively simple development effort. But as computing systems became more complex and capable, the costs of software development increased. Moreover, most software development companies started thinking about software as an intellectual property. There was a shift towards releasing code only in closed-source form and computer hardware companies started charging for software that was bundled with their products. IBM became the first large organization to do this, starting in February 1983.

By the end of 1980s, the importance of software became clear and many technology leaders began speaking out against the ever-increasing costs associated with it. Hence, FOSS surfaced as a result of a need for free, collaborative effort in complicated and expensive software development process. The concept of Free Open Source Software (FOSS) was envisioned and promoted by Richard Stallman through the establishment of GNU Project and Free Software Foundation in 1980s.

The term “open source software” was coined in 1998 when Netscape released the source code for its cutting-edge web browser, in hopes of improving it by allowing more people to find and fix bugs. The attention surrounding the Netscape release created the opportunity to educate and advocate for the superiority of an open development process [4].

### III. USING CLOUD TECHNOLOGY FOR TEACHING AND LEARNING

Cloud based learning can act as a change agent in current education setup in India. Currently, Cloud Computing is the most popular innovation in the information technology sector. Cloud technology allows students, teachers, and parents have access to critical information using any device, from anywhere. This is possible because in cloud computing, the data or the software applications are not stored on the user’s computer, but are stored in the data centers of cloud provider and can be accessed through the web from any device at any location and at anytime. The hardware and software resources are provided as a service to the user[5]. The end users don't have to worry about purchasing new hardware, obtaining software licenses, data storage, updating or upgrading existing software, taking backups etc. because all of these are included in the cloud services provided by the vendor.

Cloud technology is a scalable solution for resource crunch educational institutions as it has the potential to revolutionize the education arena. Both public and private educational institutions can use the cloud to deliver better services, even when working with fewer resources. Following are the benefits of using cloud technology in education-

## A. Anywhere, anytime access

Lesson plans, notes, assignments can be easily uploaded in the cloud and are available 24x7. The data stored in the cloud can be accessed anywhere from almost any device like mobile phone, tablet, PDA, laptop and PC.

## B. Low cost option for using high end systems

Cloud services can be a low cost option for the educational institutes that are facing funding cuts, yet still have to invest in technology to improve learning standards. There is no need to purchase the hardware and software[6]. Also, due to pay per use model, the institutions are charged based on the number of students using the resources and the amount of resources used.

## C. Increase in engagement and productivity

The gap between the student and the teacher can be shortened as the students are able to access the lessons at home or on-the-go. This leads to increased engagement and productivity.

## D. Outsourced IT management

Tasks like software updates, licensing issues, IT security management etc. can be taken care of by the cloud provider. Thus, administrative burden can be reduced.

## E. Collaboration and sharing

The open and collaborative nature of cloud opens up opportunity for more contributions from other people within the learning environment that enables effortless sharing [7]. Group projects, lesson plans, notes can be optimized for both teachers and students.

## F. Access to latest technology

The cloud service providers regularly update the systems with latest technology. This may include up-to-date version of the software as well as upgrades to the servers and computer's processing power.

## IV. OPEN SOURCE CLOUD COMPUTING SYSTEMS

The rise of Cloud Computing is rapidly changing the landscape of information technology. Cloud based e-learning can play a key role in the education transformation in India. It can open an entire new world of knowledge for teachers and students that can be accessed anytime, anywhere and from any device. At the same time, by combining the characteristics of Free Open Source Software with benefits offered by Cloud Computing, a high quality educational environment can be created which is reliable, flexible and cost-efficient. If Free Open Source Software (FOSS) is used on cloud platforms instead of expensive proprietary software, the benefits offered by cloud technology will increase manifold. This new paradigm called Open Source Cloud Computing can provide a cost effective solution for the amplified use of digital technologies in education in India. The open source cloud platform can be completely designed and developed according to the specific requirements of the educational institution. As a result, these systems are more flexible and lower overall cost as they are free from licensing issues.

Free and open source software (FOSS) is being used extensively in the provision of cloud services. FOSS can be deployed at all three levels of Cloud Computing Stack. The following table identifies the varying levels of cloud service provision and the popular examples of free and open source software that facilitates each.

Cloud Service	Purpose of Service	Examples of FOSS
Infrastructure as a Service (IaaS)	Delivery of resources such as storage, processing power, server, networking capabilities as a service by cloud vendor	<ul style="list-style-type: none"><li>• OpenStack</li><li>• CloudStack</li></ul>
Platform as a Service (PaaS)	Delivery of the tools that are used for software development and run time environment	<ul style="list-style-type: none"><li>• RedHat's OpenShift</li><li>• Pivotal's CloudFoundry</li></ul>
Software as a Service (SaaS)	Delivery of applications and user interface as a service where the user needs only a web browser to access different applications	<ul style="list-style-type: none"><li>• OpenSaaS</li><li>• MIT AppInventor</li></ul>

Table 2- FOSS at different levels of Cloud computing hierarchy

The use of FOSS on cloud platforms has many benefits compared to proprietary software, and it encourages the development of a free digital society. The adoption of Open source cloud computing systems in education has resulted in reduction in IT cost. In addition, it brings to educational institutions other benefits like:

- A. The licenses are almost free, so there is no increase in license fee. Moreover, almost all proprietary software in developing countries is imported. Their purchase consumes precious foreign reserves. These reserves could be better spent on other development goals.
- B. Free software licenses do not expire, which means that once Free Software is adopted, institutions remain independent from the vendor.
- C. Software piracy is a problem in almost every country around the world. In developing countries, software piracy rates as high as 90%. The major reason for this is high cost of software. FOSS discourages the unhealthy act of software piracy as a result educators and students are not forced to use illegal software copies.
- D. The software can be completely customized to the local needs. Localization is one of the areas where FOSS shines because of its open nature. FOSS can be modified easily to suit the unique cultural and linguistic requirements.
- E. Stable, secure and easily installed Free Software solutions are readily available for education.

Despite the numerous advantages of using free software on cloud platform, there are certain issues that must be considered before making a shift from proprietary software.

- A. Lack of support and skills in dealing with errors, or in fixing/modifying the systems in cases where there is a change in requirements.
- B. Many teachers/instructors are reluctant in shifting to new software that will require putting in considerable time and effort to learn using it.
- C. Moreover, there is a lack of documentation supporting particular free software.

Regardless of the above mentioned issues, the potential benefits of Open Source Cloud Systems outweigh the problems that it may cause. Moreover, these concerns can be addressed by collaborative effort of open source

community. This new age technology certainly has the potential to act a catalyst for the growth of education sector.

## V. POPULAR CLOUD BASED FOSS FOR EDUCATION

The impact of Open Source movement on education is the rapid proliferation of FOSS that can be deployed on cloud platforms. This section examines the features and capabilities of a variety of cloud based FOSS initiatives for education.

- A. *Apache OpenOffice*- OpenOffice is the leading open-source office software suite for word processing, spreadsheets, presentations, graphics, databases and more. It is available in many languages and works on all common computers and in several operative systems. It stores all the data in an international open standard format and it can also read and write files from other common office software packages. It is a viable open source answer to Microsoft Office suite. It can be downloaded and used completely free of charge for any purpose[8].
- B. *BOSS Linux*- BOSS (Bharat Operating System Solutions) is a GNU/Linux distribution developed by the National Resource Centre for Free/Open Source Software (NRCFOSS) of India at C-DAC, Chennai in order to benefit the usage of Free/Open Source Software in India. It is customized to suit Indian's digital environment and supports most of the Indian languages. [9]
- C. *MoodleCloud*- Moodle is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments. In 2015, Moodle launched its MoodleCloud free hosting service. MoodleCloud is an open source cloud based tool to create, customize and control a learning environment. It gives users the opportunity to create their own online courses and use collaborative learning tools through the platform. This tool comes with free hosting, unlimited database space for a number of courses. Intended for individual classes of up to 50 users and other small learning environments, MoodleCloud provides the latest version of Moodle software, including integrated Web conferencing feature. [10]
- D. *FOSSEE (Free and Open Software in Education) project*- FOSSEE is an initiative of Government of India and Indian Institute of Technology, Bombay to promote the use of FOSS tools to improve the quality of education in India. The FOSSEE project is part of the National Mission on Education through Information and Communication Technology (ICT), Ministry of Human Resources and Development, Government of India. FOSSEE team develops new FOSS tools and upgrades existing ones to meet requirements in academia and research. Some of the popular tools developed by FOSSEE team are: *Python*, a general-purpose, high-level, and a powerful dynamic programming language that can be used in a wide variety of application domains and *Osdag*, a cross-platform free and open-source software for the design of steel structures using a graphical user interface [11].
- E. *MIT App Inventor for Android*- AppInventor is an open-source cloud based web application originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT) to build mobile apps right in your web browser. App Inventor is a way for people to develop Android applications without prior knowledge of programming. It provides a web-based interface for designing Android apps

without the need to get into Java programming with the Android software development kit. It uses a graphical interface which allows users to drag-and-drop visual objects to create an application that can run on Android devices. As AppInventor is open source software, it is being used by educational institutions as a base to build similar applications, helping students get interested in Android application development. The simple graphical interface of AppInventor makes it suitable to teach computer programming in a non-technical way. Due to this reason, it has been incorporated into classes at Wellesley College and the University of San Francisco, among other places [12].

## VII. CONCLUSION

Open Source Cloud based learning can play a key role in the education transformation in India. It can open an entire new world of knowledge for teachers and students that can be accessed anytime, anywhere and from any device. This new paradigm has the potential to fix the dual dilemma of inadequate technology access coupled with economic considerations of provisioning and maintaining IT infrastructure faced by education industry in India. Free and open source software is used and available at all levels of the cloud computing hierarchy. A number of cloud infrastructure platforms are released and developed under permissive open source licenses, with contributions from across the technology sector. Hence, by combining the characteristics of cloud computing with benefits offered by FOSS, a high quality educational environment can be created which is reliable, flexible and cost-efficient. The various benefits offered by Open Source Cloud Systems can only be utilized if educational institutions take an initiative to make a shift from proprietary software and readily adopt this new age system.

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