A Web-based Degree Program in Open Source Education – A Case Study

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ABSTRACT
In this paper, we describe the details of an interactive online web-based degree program in the area of Computer Science with specialization in Free/Open Source Software (FOSS) that has been successfully running for two years in a leading technological university in India. The subjects taught as well as the tools and platforms used in delivering the course are exclusively FOSS and put together by the university team, as described here. We also describe the details of the program, its goals and purpose, the manner of its implementation, the learnings we have had and the challenges being faced in going forward.

Categories and Subject Descriptors
K.3.1 [**Computers and Education**]: Computer Uses in Education - *Collaborative learning, Distance learning*

General Terms
Management, Human Factors.

Keywords
Education, FOSS, Online Education, Moodle, BigBlueButton.

1. INTRODUCTION

Gross Enrollment Ratio (GER) in Higher Education globally is around 25%, with large parts of the world, including India, being much below even this figure. Distance Education (DE) in one form or the other is believed to be the most effective and affordable mechanism to raise the GER value in most parts of the world. Conventional DE systems have been around for about a century, and there are universities specifically committed to DE that have enrollment figures running into many hundreds of thousands, such as the Indira Gandhi National Open University in India.

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It is however well known that the effectiveness of learning in the conventional DE environment is severely limited by the lack of two key elements of the conventional face-to-face class room system - real time interaction between the learner and the teacher, as well as amongst the learners themselves.

These drawbacks of the conventional DE system are overcome to a large extend in the Online Web based systems of the type described in this paper.

Web based learning is now a matured field, and many institutions and universities have begun to offer this as an option to their students. Real time interactivity is what Online brings to the DE world. Typically, the class logs on to the Internet and 'meets' in the virtual class room at appointed times as per a weekly time table, and the teacher 'takes class' as normally done. The student can 'raise hands' and, if permitted by the teacher, can ask questions – the exchange between the student and the teacher being heard by the entire class. Similarly, the students can discuss among themselves through 'chat' sessions either in real time or at their leisure, thereby enhancing their learning through the peer process. The complexity and sophistication of such programs are limited only by factors of cost, convenience, scalability etc.

Recent studies [1] have shown that the Online Interactive mode is at least as effective in imparting learning as the conventional class-room based method. Entry of global leaders in higher education like Stanford, Harvard and MIT into this field through systems like MOOCS is also fast removing the stigma of DE being a poor man's choice.

Along with suitable blending with off-line processes, Web-based education is poised to dominate the world of education of the future, and hopefully enable countries like India to reach their goal of a GER of at least 30% by 2020.

The present paper reports a significant contribution that could help move towards this goal.

2. ONLINE DEGREE PROGRAM

Schemes like MOOCS focus on enabling students to learn a subject from the best teachers in the world without any constraints of space, time and even money. Some Online Programs such as those offered by the Free Technology Academy in Europe [2] are much closer to conventional university schemes by enabling granting of academic credits to their modules. However in most parts of the world, the value of learning is vastly enhanced if it

leads to a formal degree of a recognized and reputed university. This is especially so in countries like India where education is still viewed primarily as a means towards acquiring a job that helps lift up one's family economically and socially. A degree from a reputed institution is the corner-stone of this plan, and Online Education must necessarily address this fact to acquire social reach and impact.

Fortunately many reputed universities have begun awarding their regular degrees based on Online learning in most fields such as Sciences, Engineering, Management, Humanities etc. University of Florida [3], Arizona State University [4] etc. are some of them who offer their entire range of UG, PG and Doctoral level programs Online. In fact there even exist commercial services that release annual rankings of hundreds of online university degree programs based on comprehensive evaluation methods [5].

Given the relative rigidity of university regulations and curricula in most parts of the world, a degree is tied closely to examinations, and all teaching-learning processes, online or otherwise, have got to be examination-oriented, and delivered in a cost-effective manner to a highly diverse student population whose earlier education would not have had mush stress on analytical and problem solving skills.

We describe here the 4-semester online M.Sc. (Computer Science-FOSS) Program offered by the Centre for Distance Education (CDE), Anna University, Chennai, India that attempts to address this need from ground up.

2.1 The Regulatory Aspects

The Online M.Sc.(CS-FOSS) Program has to presently work within the framework of CDE of the University for the various conventional DE programs it presently runs [6]. Regulations governing it specify the eligibility for admission into the program as being graduates in any field, who have to do a total of 17 papers and a Project spread over the four semesters for the degree. They have the freedom to pace their course work to suite their requirements, and can take up to 12 semesters to complete the program. A minimum attendance in the online classes is mandatory. While the internal (sessional) marks are awarded on the basis of online quizzes and assignments, the end-semester examinations have to be taken within the university Campus in Chennai. The AU-KBC Research Centre having specialized expertise in the FOSS domain is designated as the 'virtual study centre' and takes full responsibility for the design and implementation of the teaching-learning processes.

2.2 The Curricular Aspects

The curricula of M.Sc.(CS-FOSS) [7] has been drawn up to meet the general requirements of an entry level degree program in the CS area whose graduates will compete with the regular 4-year graduates of the BE(CSE) programs in the job market. The only restriction imposed is that all teaching-learning will use only FOSS principles, technologies and products, and all the tools and platforms used in the program would be exclusively FOSS. The following goals have been kept in mind while drawing up the curricula and the syllabi as well as delivering the course:

- Enable engineers with CS qualifications to acquire specialised knowledge and skills in Open Source technologies.
- Enable engineers with non-CS/IT degrees to acquire a CS Degree of Anna University.
- Enable graduates from all backgrounds to become Computer Scientists specialized in Open Source.
- By keeping the live classes on weekends, enable working people to do this program on a part-time basis.

Each of the 17 papers offered at any given time across all the enrolled batches has about 25-30 'live' contact sessions of 60-90 minutes duration each taken by a Course Instructor (CI) assisted by a Teaching Asst.(TA) , and delivered from 9AM to 5PM on Saturdays and Sundays throughout the 16-week long semester. All regulatory and curricular aspects of the M.Sc. (CS-FOSS) degree program including the detailed syllabi are approved by the same formal bodies of the University that supervise all the other programs.

3. ARCHITECTURE, PLATFORMS AND TECHNOLOGIES USED

For creation and delivery of the course, we have developed a robust, highly customizable and cost effective Online Interactive Portal using FOSS Products and Technologies exclusively. The current implementation uses 4 Servers – for the Portal, Live Classes, Media Server and the Support Tracking System. The overall architecture of the system is shown in Fig. 1.
Some of the key technologies and products used by us are listed below:

Gnu/Linux OS– Ubuntu and CentOS distributions were the operating system platforms used by us.

BigBlueButton – an open source web conferencing system that enables synchronous learning through real time multimedia class room with interactivity – video, audio, text, slides, animation, images, desktop sharing, integrated VoIP using FreeSWITCH, public and private chats etc.

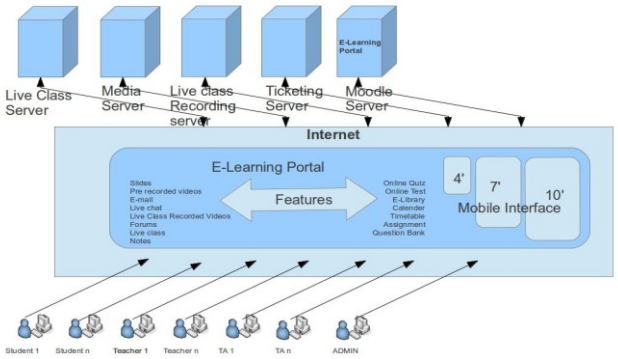

Fig.1 The online portal architecture

We have optimally combined and integrated these components to meet the requirements and contexts of our University. The software is released under the LGPL license.

Moodle – is an open source Learning Management System (LMS) for creating online courses with a focus on interaction and collaborative construction of content. It is written in PHP and is released under the GPLv3 license and has features such as assignment submission, discussion forums, file download, grading, Moodle instant messages, online calender, online news and announcement, online quiz etc. Moodle was extended by creating plugins for question types (multiple choice, true and

false, fill in the blanks etc.), data field types (for database connectivity), authentication methods (username and password accessibility), enrollment methods etc.

Apache/ngnix – The Apache HTTP Server is used as the webserver which is also considered as the best process-based server. Ngnix is used to make the site access faster and for fast and efficient reverse proxies. It is an event-based webserver and is acclaimed for lower memory usage.

Eidete,ffmpeg and Kaltura - The Online Platform also supports asynchronous learning where the student can view the missed classes. All the live classes are recorded using Eidete, a screen casting application. Eidete is also used for pre-recording lectures which the students can view before attending the classes. Videos recorded using Eidete are edited and converted using the open source tool ffmpeg. The Kaltura's online video platform is used as media server having all the recorded videos. It is released under the GPLv3 license.

Libre-office/Open-office – The presentations that are in .odp or .ppt form are converted into html format using Libre-office and Open-office suite. These presentations are then uploaded onto the Online Platform for students to view. They are cross platform and released under the LGPLv3 and GPLv3 license respectively.

Request Tracker - A FOSS based ticket tracking system, Request Tracker (RT) is integrated into the Online Platform that enables students to raise issues they face while using the portal or any other issues they want to bring to the notice of the support team. The support team looks into the tickets generated and solves the issues. RT is cross platform and is released under the GPL2 license.

Dovecot - It is a FOSS based IMAP and POP3 server for Linux systems which is used for sending and receiving emails. Known for its secure design and implementation it is released mostly under the MIT and LGPLv2 licenses.

Publican – Publican is a single source publishing tool based on the DocBook XML. It is used for creating the *Portal Help* documentation.

PHP, MySQL and HTML are the other technologies that have been made use of in our realization.

3.1 Handling the Video

If slides with voice overs are given, the portal team uses the ffmpeg suite of software to convert the presentation to flash video format. The converted videos are then fed to the Kaltura streaming media software which resides in the media server. For maximum compatibility the video is streamed in flash video format by default. There is also a fallback HTML5 video stream which is used for devices capable of viewing HTML5 videos. In both cases the portal team adds links in the learning portal to the newly uploaded materials. The students can then access the newly added material for their use.

During the class, the entire session is recorded by the BigBlueButton software in the server. In addition, dedicated machines also record the sessions using eidete by being a participant in the class session. This is done since, the version of BigBlueButton used currently does not support the recording of the course instructor's desktop if the instructor shares it during the class. Once the classes are over for the day, all the recorded videos in the recording machine is converted into flash video format using ffmpeg tools. The converted videos are then uploaded into the Kaltura server and linked to the learning portal.

3.2 User-end equipment

The students registering for this program are required to have unlimited access to the following Desktop or Laptop environment:

- *Hardware specifications* - higher than Pentium 4 @ 1GHz, 300GB Hard Disk,1GB RAM, 64MB video memory, 16 bit Sound Card, Headset with Microphone, Web camera.
- *Software specifications* - GNU/Linux OS, Office Suite, PDF reader like Adobe, Browser (Firefox/Chrome), browser plugin for Adobe Flash and any other SW packages as required for the program.
- Internet connection speeds - 2Mbps for download and 1Mbps for upload.

4. LEARNINGS AND CHALLENGES

The Online M.Sc. (CS-FOSS) program started in April 2012 and the first batch would pass out in March 2014. There are over 100 students presently on the rolls in the program spread over the four semesters, about 70% of whom are working engineers from all over the country.

There is a team of about 20 CI s and TA s involved in the process offering 17 courses round the year, with 3-4 live class sessions being held simultaneously during working hours in the weekends.

Given the importance of clearing examination for the award of the degree, some data pertaining to the pass performance in the three comparable programs of the University are presented in Table.1. Data presented are a set of normalised performance measure (not pass percentage) averaged over the first three semesters of three distance learning programs-- M.C.A. and M.Sc.(IT) which are both done in the conventional DE mode, and M.Sc.(CS-FOSS) done in the Online Interactive learning mode. Column 3 is the average performance of both conventional mode programs.

Table 1. Performance in examinations

MCA	M.Sc. (IT)	MCA & MSc(IT) Average	M. Sc. (CS-FOSS)	Improvement of Online over Conventional
100	109.6	109.8	158.7	44.6 %

As can be seen from the last column, Online Interactive program gave a distinctly improved performance of nearly 45% compared to the conventional ones. This conclusion however is based only on 3 semesters and would need to be further validated as further semester data become available from the Online program. Levels of preparedness, motivation, commitment etc. could also vary across the two groups and would need to be accounted for before the results can be more firmly validated.

It should be noted that we had completely done away with studio based lectures being telecast live in order to cut costs as well as give freedom to the CI s and TA a to be located anywhere for their live sessions. Teaching was based only on bi-directional audio,

slides, desk-top sharing etc. The results seem to show that this has perhaps not affected the efficacy of learning much.

We also observed that, unlike in the conventional contact classes held in physical class rooms, there was more interactivity in the online live sessions, though this may be partly accounted for by the fact of the majority of the class being working engineers who communicate more freely.

One problem that was observed and probably limited the performance of the candidates was the rather high rate of absenteeism in the live classes, which again could be due to the classes being on weekends which for working people meant working round the week without rest for 16 weeks. Also, as the Online program is much costlier than the conventional DE courses of the University, the fees had to be doubled which in turn is perhaps affecting the enrollment figures.; the present figures are only about half of what is needed for financial break even. And finally, while the program could get launched and run because of the acceptance of the existing DE framework, especially its examination and grading systems, our experience has shown that such framework significantly inhibits from realizing the full potential of the online systems. Distinctly different and progressive regulatory frameworks need to be evolved to fully benefit from the power of the Online.

5. CONCLUSIONS

We have reported here the case study of an online education program leading to the degree of a leading mainstream engineering university in India in the area of computer science – something that we believe is quite unique and significant in contexts such as ours. While the system has been designed from ground up and fully implemented end to end using local resources and talents, some of the processes are still in the process of being stabilized and standardized, and made scalable and sustainable, in order to have the desired impact of helping boost the GER value in the near future.

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