Prospects on 'Open Source Software Development' Education to Technical Education Students of India

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ABSTRACT

With the success story of various open source software, open source software development during the last decade has got phenomenal momentum and attracted software developers around the world to join this revolution. Open Source Project hosting Websites like SourceForge, Google Code, GitHub, Codeplex, Launchpad etc. not only providing open source packages to the users but also providing development platform to the developers and still thousands of open source projects are in developing stage at these sites. Despite the success of OSS worldwide the adoption rate of OSS in India is very poor. Not only the usage of OSS but the participation in OSS development of Indian developer is also very less. Despite the fact that Indian universities are producing huge IT force and Indian developers are in the driving seats in software development, they are not among the list of top ten countries of OSS developer community. This paper study and analyzes the reasons behind the less involvement of Indian developers / students in OSS movement. We will conduct survey among the students of technical education to know their current status of knowledge towards the OSS, study the current learning pattern and software development practices of IT students, highlights the benefits of involving students in OSS development and proposes the changes in the syllabus for the adoption of study of OSS and OSS development in technical education of India.

General Terms

OSS, Development, Education, Awareness.

Keywords

Open source software, OSS development, Teaching open source, project, curriculum development.

1. INTRODUCTION

Open source software during the last decade has got phenomenal technological success and produces the alternate form of software development methodology. Open Source Software developers have produced systems with a functionality that is competitive with similar proprietary software developed by commercial software organizations. Software development is undergoing a major change from being a fully closed software development process towards a more community driven open source software development process [01]. Software like GNU Linux, MYSQL, Apache web server, Mozilla web browser, Open office, Perl programming language etc. getting the phenomenal success among the software users. Open Source Project Hosting Websites like SourceForge, Google Code, GitHub, Codeplex, Launchpad etc. not only providing open source packages to the users but also providing development platform to the developers and still thousands of open source projects are in developing stages at these sites. People everywhere are adopting various open source distributions or participating in the general movement by contributing their own modifications. Popular open source development web site sourceforge.net alone has more than 2 million registered users, [02] who not only using OSS software but also contributing in the OSS development in variety of ways like by code development, bug reporting, fixing of bugs, providing feedback, testing software, requesting new features etc. depending upon their skills, technical expertise and level of involvement. Open source applications are getting a stronger grip on almost every software vertical and in some place OSS have begun replacing prevailing software applications. Open Source is becoming a dominant development model in the software industry and there is a need that the next generation of software developers, computer scientists, system administrators, analysts, and build engineers need to understand Open Source and must be able to work efficiently within Open Source communities. Despite the success of OSS worldwide the adoption rate of OSS in India among corporate and individual is very low. This is because of several reasons like low internet penetration, lack of official interest, lack of awareness, and poor education system. India produces approximately 500,000 graduates from its engineering colleges every year and according to Nasscom estimate[03], only 25% of the engineers graduating are employable, rests are not absorbs due to their inadequate skill sets. The majority of universities fail to adequately prepare students for the professional world. However to prepare the students for real life experience and professional world in the final semester students has to undertake a project preferably in software industry. But majority of the students fails to carry out this work at software industry and take it as routine work results fails to prepare themselves for the future. Therefore there is a need that the current curriculum in technical courses is to be altered for producing better students. Participation in OSS development project is a fantastic way for the students to learn professional software development skills, get real world experience, and learn to work in collaborative environment. This paper study and analyzes the present learning methods and software development practices of technical/IT students of India, their current status of knowledge towards the OSS through survey, highlights the benefits of involving students in OSS development, highlights the importance of the inclusion of OSS learning and suggest the possible syllabus to develop interest and understating on OSS development.

2. OSS DEVELOPMENT AND OSS COMMUNITY

As per open source initiative [04] "open source is a collaborative development method for software that harnesses the power of distributed peer review and transparency of process to develop code that is freely accessible". Von Hippel [05] clarified that "Open source software development is a

unique form of innovation. The developers—especially users—engage in innovation, development and consumption of a product without the direct involvement of manufacturers". OSS is developed by loosely organized communities of participants located around the world and working over the Internet and remarkably, most participants contribute without being employed, paid, or recruited by the organization [06]. The main benefit of open source software is the availability of source code free-of-charge so that the user can make changes to this software to meet their requirements and release changed code back to the community, passing the benefits on to the others. Communities are simply groups of individuals sharing common interests. The "open source community" refers to a large group of individuals committed to the collaborative development and maintenance of Open Source Software. The members in the OSS community are the worldwide distributed pool of developers, programmers, users that collaborate in tens of thousands of projects by using internet-based tools for coordination. The user with enough knowledge and skill can join the OSS projects as these projects are usually open to participation by anyone, from any corner of the globe. Thus Open source development is oriented towards the joint development of a community of developers and users concomitant with the software system of interest. OSS development is often less structured but the users of the systems are encouraged to directly participate as part of the development community. One common way of doing this is to encourage new users to assist with parts of the development process, such as creating project documentation, user testing, requirements analysis and use case design. Since open source is developed by a group of individuals with a shared interest in the project this community of users and programmers is key to the advancement of any open source project. They participate in the community in different roles like code contributor, code repository administrator, module owner or code reviewer. It is not necessary that every user be developer, they can participate in OSS development by various roles depending upon their skills, technical expertise and level of involvement. Users can be involved by providing feedback, helping new users, recommending the project to others, testing and reporting or fixing bugs, requesting new features, writing and updating software, creating artwork, writing or updating documentation, translating etc. All of these contributions help to keep a project active and strengthen the community. The project team and the broader community will therefore welcome and encourage

participation, and attempt to make it as easy as possible for people to get involved. Depending upon the responsibilities OSS development community is classified as [07] Core developers - writing most of the code and generally responsible for software architecture, co-developers contributing code infrequently or only on some part of the project, active users providing feedback and bug reports as well as participating in discussions and helping each other in using the software, passive users who just use the program. The success of the open source project is attributed to the large spheres of co-developers and active users who find and solve various issues in the software.

Often big open source projects have their own websites from where users not only download the software but also participate in the project development, enhancement or by adding additional functionality to the project. Various open source project hosting Websites like SourceForge, Google Code, GitHub, Codeplex, Launchpad etc. are also providing development platform to the developers. Each project in these sites have their own community of developer where they contribute software content like programs, artifacts, execution scripts, code reviews, comments, etc. and communicate information about their content updates, patch reviews, design decision, project planning, future plan etc. via online discussion forums, threaded email messages, and newsgroup postings. These websites also provide the screenshots related to the project, how-to guides and list of frequently asked questions that serve to help convey system use scenarios. Administrators of the project sites serve as gatekeepers and make choices for what information to post, when and where within the site to post it [08] and whether to create a site map that constitutes taxonomic information architecture for types of site and project-specific content. Bug tracking and reporting is an important task which describes what doesn't work during use. These sites also provide bug reporting web pages, bug data base and mechanism to the user through like instant messaging, IRC channels or emails by which user can report the bug. Today open source projects use more sophisticated bug tracking system or web-based applications bug repositories that keep track of the change request and bugs found in a system. These bug repositories are used to report and track the problems of the software system, keep track of the change request, bugs found in a system and the potential enhancements.
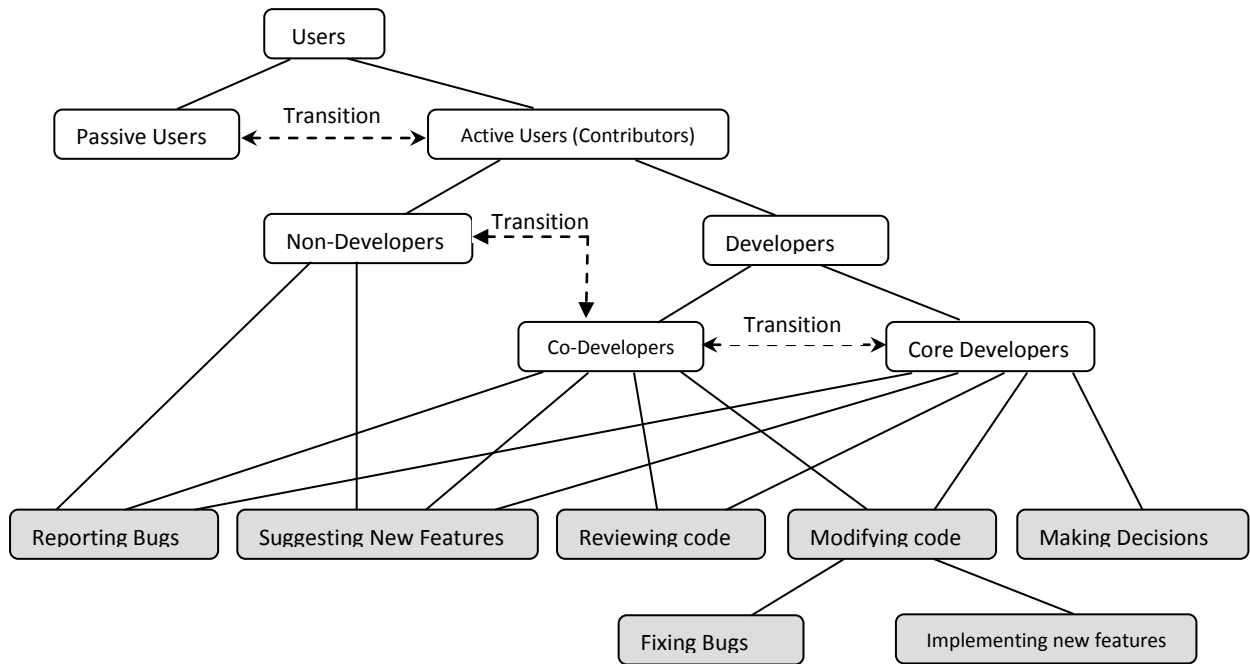
Figure: The classification of open source users and developers source [09]

3. OPEN SOURCE IN INDIA AND INDIAN DEVELOPERS INVOLVEMENT

Ex-President of India, Dr. APJ Abdul Kalam [10] once said, "The most unfortunate thing is that India still seems to believe in proprietary solutions. In India, open source code software will have to come and stay in a big way for the benefit of our billion people." Unfortunately Open Source software is not much in use in India as compared to other countries. As per springboard [11] research large enterprise in India has only 8.1% Linux server installations as compared to 91.8% Windows server. In the personal use front it is estimated that India has 8-9% Linux installations as compared to almost 90%+ installations of windows OS, out of which almost 70% installation are pirated one. The main reason behind is the lack of awareness among the users, developers and policy makers. In the educational syllabus right from beginning to college level education, students are taught only proprietary OS and office packages at beginning level instead of Linux OS or Open office. Even the policies towards the use of OSS at beginning level is vague and instead of purchasing the system with OSS installations, institutions are purchasing system with proprietary installation where merely operating system and office package are having cost almost equal to the cost of the system. India has abundant talent: it turns out 200,000 engineers, 300,000 technicians and over 3 million university graduates each year [12]. Indian IT industry have won accolades all over the world and the Indian software developers are at par with the global developer community but still Indian developers participation in the OSS movement is vary less and they are not in the list of top ten countries of OSS developer community at sourceforge [13]. Throughout the past decade, SourceForge was widely seen as the place for hosting open source software projects and was thus assumed to be more representative of the total universe of OSS developers than other. Primary reason for less participation is due to the lack of awareness about open source technologies

Table: Active developers at source forge with and without second level domain source [13]

Without SLD			With SLD		
Rank	Country	Active	Rank	Country	Active
1	United States	85,485	1	United States	112,981
2	Germany	23,267	2	Germany	24,197
3	United Kingdom	13,031	3	United Kingdom	14,051
4	Canada	11,238	4	Canada	11,524
5	France	10,525	5	France	10,987
6	Australia	7,897	6	Australia	7,945
7	Netherlands	6,666	7	Netherlands	6,687
8	Italy	6,185	8	Italy	6,200
9	Spain	4,563	9	Spain	4,760
10	Sweden	4,546	10	Sweden	4,642
11	Brazil	4,028	11	India	4,163
12	India	3,824	12	Brazil	4,038

among the developer communities in the country and also there aren't much good development tools and support for them.

In India's the governments has liberal approach towards OSS adoption and promotion because the advantages that OSS promotion has for its economy, and its dependence on the foreign multinational software corporations established in the country, for whom the important Indian software sector so-called software factories works. India holds first place in software and IT service exports worldwide, an industry that will represent 11% of the country's GDP in 2010 [12]. India accounts for 70% of outsourced IT services worldwide. There is no unanimous opinion about the effort made by the government to promote OSS. Now the advantages provided by the OSS to the developing countries are slowly getting recognition by the government. Various organizations and individuals also start realizing that open source platforms open up to new technologies, encourage collaboration and drive innovation which in turn play a major role in developing markets and economies. Government proactively starts promotion for OSS development in the country.

To promote OSS movement, in 2005 Indian government setup a National Resource Centre for Free and Open Source Software (NRCFOSS) [14] with joint venture between an university-based research lab (AU-KBC Centre) and the Centre for Development of Advanced Computing (C-DAC) to contribute to the growth of Free/ Open Source Software and serve as the nodal point for all FOSS related activities in India. The notable initiatives toward offering a low cost computing, flexibility and choice to the end users is the development of BOSS (Bharat Operating System Solutions) which is a GNU/Linux based localized Operating System for both desktop and server and EduBOSS for schools that supports 18 Indian languages. Another example of government initiative in 2007 is the formation of the Institute for Open Technologies and Applications (IOTA) as a joint venture between the state of West Bengal, Jadavpur University and open source industry players (Sun Microsystems and Red Hat). IOTA's mandate is to promote open source software in government and academia. "The policy on Open Standards for e-governance"' notified by the Government of India in November 2010 mandates adoption of royalty-free open standards for all e-governance projects. For the involvement of developers in OSS project in India AUKBC Research Centre, has made giant strides in HR development. A pool of FOSS trained teacher and student community has been generated across India through awareness campaigns, training programs and workshops. But all these efforts are inadequate and still Indian developers are at finger count as compared to developers of other countries on big collaborative development websites like Sourceforge. or Sarovar forge. Sarovar.org is India's first portal to host projects under Free/Open source licenses, located in Trivandrum and hosted at Asianet data center. This site has 518 hosted project and 77,530 registered users and unfortunately highest rank users in this site belong to the other countries [15]. Indian contributions to OSS come almost exclusively from students of the bigger IT or engineering colleges and universities and there is a need of change at the beginning level IT education to train students by free OSS software and at higher level the involvement of OSS technology at software development

4. SURVEY ON "CURRENT STATUS OF KNOWLEDGE ON OSS" OF TECHNICAL EDUCATION STUDENTS

We have investigated the technical education students about their current status of knowledge, their awareness and attitude towards open source through a survey research method. This survey assessed the students that how informed and aware they are, about the open source concept.   To test the awareness we have questioned students of various UG/PG technical courses of computer stream through multiple choice close ended questions and some open ended questions to explore their familiarity with open source software and the relationship between their text book and OSS development. We have chosen the students of last semester of their respective courses as they are in the stage of just before their working life and their attitude toward the OSS development may reflect the OSS adoption and development as they are going to become new employee of the software industry. The only limitation of survey was that, the vast majority of the respondents are the students of universities of MP, technical university of MP and IGNOU study centers situated in MP region. But we believe that the awareness indicator toward OSS in the other parts is more or less same. We have conducted this Survey through questionnaires sent via mail and through direct interaction with students by visiting various colleges and taken responses on paper. We framed about 20 questions and got responses from more than 700 students in the period from January first week to the First week of March 2012 as this period is their last semester of studies. The survey result is given in appendix 'A'.

Because of the mushrooming growth of engineering college, our most of the respondent were from the engineering colleges. We have not given much emphasis on diploma course students. Most of the students are using internet for email and chatting only approximate 21% of total respondents are using internet for improving their software development skills, and almost 72% have never visited some important open source community sites. Only 30% respondents were aware of the most popular OSS community site sourceforge. Approximate 98% students were aware of Linux operating system and only 57% students know that it is an open source software. Almost 2/3 of students are unable to define open source software, who develops it? and why developers participates in OSS development? Almost all respondent are using Microsoft products and approximate 90% using adobe products but only 18% installation having valid licenses for some of these products. More than 50% are aware of that the legally completely free software are available but the adoption rate of these softwares are very poor. VLC media player and Mozilla Firefox are some popular OSS software among users and rest are having less than 40% user base. Although more than 90% are aware of LINUX OS but still most of the students using widows OS without legal license.

From survey questionnaires it became clear that the awareness towards OSS and OSS adoption among students is very low and it may also be concluded that they hardly participate in OSS development. To validate this, and to know the reasons for less awareness we have asked some more questions to the respondents. Almost every student of computer course has to undertake project work (except some students from B.Sc. course) whether it a short term or long term duration. But only 14% were lucky enough to get the opportunity to work on a live project in software Development Company. Most of them completed their project work in the training institutes but no

one has ever tried to participate in open source project. But the situation is not disappointing almost 99% are interested to participate in OSS development because of any reason. The main reason for the less awareness toward OSS is that currently students are not studying OSS/OSS development phenomenon at any level. There is no separate course/paper on OSS/OSS development on any of the UG/PG/Engineering courses, even paper on software engineering mainly focuses on traditional software development process. There is no separate unit/discussion on open source development in any course. Most the software engineering book which students read during their studies are not having chapter on open source software development phenomenon or engineering.

5. REASONS FOR LESS PARTICIPATION IN OSS MOVEMENT

As our survey reveals that the main reason for the less involvement in OSS development of Indian students is because of poor awareness about open source concepts. This is not because students aren't interested in open source, but because of colleges and universities currently not offering open-source classes. Open source concepts are not adopted in curriculum in any of the course even there is no introductory level unit at any level in the entire course duration. And this is the situation not only in our survey responses but in the various other universities of India too. We have analyzes the syllabus of various computer courses of the many universities/technical universities across India, available at their websites and also some responses through mail by students of various universities. Almost 99% universities of India not having separate subject paper of OSS in any of their degree program or even a single unit on open source development is included in their software engineering course. We have also analyzes the course contents of most widely used software engineering books used to teach software engineering principles in Indian universities and found that not a single book having the complete chapter on open source development. This situation reflects student's future involvement in OSS development, as at no other time in their lives students will have as much time on their hands to get involved as they are in student life. Negative sentiment about open source software and negligence of OSS development in teaching causes less participation of students in OSS development and a great opportunity is lost here both for the students and for the open source movement.

6. CURRENT TEACHING MODEL OF SOFTWARE ENGINEERING EDUCATION AND PROJECT ANALYSIS

Every degree program in computer education teaches the student software engineering principles. Software engineering paper in the curriculum mainly focuses on traditional software development process and gives only theoretical knowledge to students through traditional lecture methods. Traditional lectures espousing software engineering principles hardly engage students' attention due to the fact that students often view software engineering principles as mere academic concepts without a clear understanding of how they can be used in practice [16]. Researchers have proposed that IT courses should include a significant "real-world" experience that is necessary to learn software engineering skills and concepts [17]. Thus the main challenge of current education is to prepare student for the real world since by simple gaining the theoretical knowledge students feel difficulty in coping with problems of the real world in future. To prepare the

students for the real world colleges / university themselves do not have any facilities or plan and students are expected to do a project in their final semester. Almost every professional computer degree program requires its students to undertake a system development project of 3 to 6 months duration. The purpose of this Project is to expose students to "real" software engineering practices and to take hands-on experience in analyzing, Designing, Implementing and evaluating information system of the real world. The students are encouraged to spend at least three man-months working on a project preferably in a software industry or any research organization. However, IT students still graduate without getting enough experiences in realistic and long-term software engineering projects [18]. This is partly because most of these projects are closed source proprietary software projects, which may not be available for the students to participate. Our survey also shows that only 13.95% students are being able to get the project in software development companies and experience the actual work culture, rest of the students complete their project work at training institute, at home or directly purchase from market. So the overall purposes of project training to the student gets collapsed, and because of the absence of seriousness student take this task as a routine work and fail to prepare themselves for future.

We have also analyzed the project work submitted by the last semester students of various computer courses, and it is found that project work submitted during last 4-5 years are :

- Most of the project works were carried out in the private training institutes providing no real life experience.
- Projects were repetitive in nature since these training institutes are not having live projects in their hand.
- Most of the submitted projects are web based and websites of same nature.
- Software Testing projects mostly on same software product and having the same nature
- In search of live projects students have moved to the cities like Pune, Hyderabad, Delhi/Noida, Bangalore etc. but still carried out their projects at training institutes by paying the fee. Perhaps this is because of the saturation in the software development companies and these companies hardly have places for the trainees.

7. BENEFITS TO STUDENTS WITH INVOLVING IN OSS DEVELOPMENT

As discussed in the previous section the main challenge of current education is to prepare students to take the challenges in the field real world. Students have very rare chance to get the real world experience before the start of their professional career in information technology. The educators constantly seek new channels, methods and technologies to reach and intrigue the students; teach them skills that they can apply in the real world. [19]. Participation in open source project is a fantastic way for the students to get some hands on experience in a live project and get real world experience. We believe that software engineering education should also include the training of future software developers in understanding and use of the OSS at early stage. Knowledge of pure Software engineering is not enough. The theory taught in class room is of limited interest to the students because of the lack of visibility into the application areas. Participation in open source projects gives an opportunity to students to understand and participate in solving the real world problems, experience in large scale software collaboration and development and

world-size laboratory and supporting staff. Student's involvement in OSS also gives the possibility of analyzing the student's ability to cope with the real world problems. Open source software development as claimed by OHara and Kay [19] can serve as a channel, method, and technology to teach and learn computer science. "As a channel, OSS can expand teamwork past the classroom to include much larger projects and more distributed teams. As a method, OSS can be used to introduce our students to the larger computer science community and to the practice of peer- review. Finally, acting as a technology, OSS can provide us with free or lower-cost technology in the classroom that we might otherwise be unable to afford."

Working within an open source project brings many benefits to the students. Some of the opportunities which students get while joining the OSS project are:

- Opportunity to get real world experience
- Opportunity to work with experienced people
- Opportunity to write lots of code and get work reviewed by experts
- Opportunity to review and analyze large code base
- Opportunity for finding and fixing bug of real problem
- Opportunity to work on project of their interest
- Opportunity to learn Software development Skills
- Opportunity to get global recognition
- Resume enhancement
- Greater Job Opportunity

As there are very few places for trainee-students in the software companies the open source participation giving great opportunity to the student to feel real-world experience from their own workplace. Working with highly connected developer communities around the globe is a great experience to the students because it gives students the opportunity to interact and collaborate with the best people in the field and learn from their experiences. Joining an open source project is an easy way to interact with and learn from highly respected professionals. As the student begins to contribute code to the project, these colleagues send feedback [20]. Such a peer-review process facilitates effective learning and sharing of knowledge. The ability to work with people they never met, redefines communication for an individual and makes student more responsive, accurate, polished and effective at communication. Open source projects provide a wealth of materials for students to study. Not all are exemplars but it is valuable to expose students to a variety of programming styles and encourage their critical abilities [21]. While joining the open source projects students have opportunity to write lots of code because they have choice to choose from different projects, different modules and development languages of their interest in which they feel comfortable. Code submitted in the OSS community is reviewed by the experts involved in the project. By fixing the problems reported by the reviewer students can learn lessons from their mistakes and improve their skills. Code reviews is another great way to learn. OSS makes large sets of generally well-written programs, along with their source code available freely. Study of a well written program is a good way to improve programming skills. Students have the opportunity to work with many more code bases in open source than are found in traditional student projects. Good open source projects in dynamic communities provide a wealth of examples for students to read, understand, and work on. After analyzing and testing the OSS project students can also improve their skills on finding and fixing

bugs. This will help the students to understand the differences between the small programs that they write for themselves and the large scale software products that they will deal with when they are working. Teaching open source development in information technology education sets the stage right for individuals to be able to pursue their own dreams and take their ideas ahead. While joining the software industry students can not pursue their technical interests in which they are comfortable and give shapes to their own ideas rather than having to do what they have been told. Students who learn open source development during their studies are more likely to have greater fulfillment in life because they are able to convert their ideas into solutions. Students also have an opportunity to improve their development skills. This is achieved through constructive feedback and the experience of working within a mature, well-run open source project team. This experience provides version control, configuration management tools, regular automated builds, and testing and packaging issues. These are essential professional software development skills that are seldom well-taught in formal teaching. Lakhani and Wolf [22] show that a majority of OSS developers rated their participation in OSS projects as the most creative experience in their lives; reasons for participation included (a) user need for the developed software, (b) intellectual stimulation of coding while having fun, (c) improved programming skills, and (d) an ideological belief that software should be open.

By participating in a global open source project students can show their skill and ability in developing code, learning existing code base, enhance the code base by adding new features and modify the code to fix bugs. This will give them valuable credentials, reference-able experience, public portfolio of their practical work and a global recognition. Another benefit to the students is that during interviews with potential employer after passing out from the course they can showcase their previous work to them. They have a proof on the web for the whole world to see. If they have coded for other companies, the work may be locked behind proprietary protections. But open source projects are free and easy for anyone to view that could serve to rapidly develop their career. Software companies that hire the fresher will first train them eventually in areas like how to work in a collaborative environment. If the candidate worked on and contributed in open source projects means they are already familiar with working in such an environment. It essentially means that the students worked with OSS project an edge over other candidates because recruiter knows training expenses and employers want candidate to be productive as soon as possible. The exposure to collaborative development practices due to involvement with Open Source gives them the confidence to recruit these people. So participation in OSS projects not only gives students a leg up in their education but also by adding these experiences in their resume yields greater job opportunity.

8. HOW TO INVOLVE STUDENTS IN OSS MOVEMENTS

Involving students in OSS movement is a three step process, awareness-motivation-participation. Raising open source awareness among students at early stage of their studies is very important and sometimes difficult task too. To create the awareness, students should be encouraged to use open source software in the beginning of their course. Using open source software also has the beneficial effect of ensuring that students are aware of the open source software movement, and opens up opportunities to discuss topics such as software

piracy and ethics [21]. This can be done by removing the proprietary bias from the syllabus. Sometimes in the syllabus proprietary software are mentioned by brand names which prevent the students from choosing the software that best suits their need and budget. By using open source software at early stage students gets well aware about the open source software. Introduction of open source software development, during their learning on software engineering principles, is another important activity; this will introduce the students to some aspects relevant to working in open source environment. Live events/workshops in the teaching institute on OSS are another method to create awareness. These events introduce the students various aspects of open source software apart from using them and motivate them in participation of OSS development. Initially students can participate in OSS project by providing feedback, recommending projects to others, exploring and requesting new features, testing and reporting bugs, writing or updating/translation of documentation etc. These activities help students to get acquaintance with OSS development environment and build confidence in OSS development. When students become successful working with a large code body, by running builds and making small modifications, they lose fear and their confidence level increases tremendously [23]. In later stage students can get involved in code analysis and code contributions and patch submissions.

To facilitate the student's participation in OSS development, teaching institute/university can help them in two ways, either by helping them to find out the projects according to their interests and capabilities on various OSS development sites by creating their own database or by establishing OSS lab in the institute/university. After finding the project of students interest institute simply provides the code to student. Codes are downloadable from the respective project web site. The availability of the source code for OSS provides a unique opportunity for the educators to experiment [24]. Students then ask to analyze the code, create documentation provide feedback, request for new features and report bugs. After familiarization with code they may ask for code contribution and patch releases. Students can also start new project by using this code or may start new project of their interest from scratch. Institutes may then advise students to join project mailing list. Mailing lists are generally the main communication channel, but some projects may also use forums or other tools. Generally clear guidelines on how to get started and which channels to use are available on the projects website. Potential students may also be motivated to participate in OSS movement through the Google's "Summer of Code" program [25]. This program sponsored by Google for students to write code for open source organizations. As the name suggests, when it's summer time, students do the development, get paid. In the month of March/April students can choose between different open source projects and see which project is the most interesting to them and apply for these projects. Establishment of OSS lab in the institute and creation of open learning space for students to provide a central meeting point helps to promote OSS activities in the institute. Faculty members which work as advisor and mentor in this lab helps to facilitate the students work, review project proposals, maintain the center website, and facilitate students peer group meetings and discussions. Patterson [26] suggests that it is inspiring for computer science students to work on real production projects—an opportunity that civil engineering or history students do not have. Finally there is also a need in the change in the curriculum of computer science courses and inclusion of one full subject on open

source software development. This subject/paper will introduce the students the concepts of OSS development and motivating the students to participate in OSS development.

9. PROPOSED SYLLABUS

Software engineers are increasingly expected to be able to evaluate open source solutions, integrate with open source products or libraries, and contribute fixes and enhancements to open source projects. However, the traditional university curriculum offers little guidance for these activities. [24]. The understanding towards the OSS of IT and CS students of various technical courses is of concern and there is a need to expose and make aware students about open source software and develop interest among them on participation in OSS development. Research proposes that OSS is both an alternative teaching methodology and an educational model [27].We believe that at the starting point to develop interest in open source movement and to create awareness, one full paper on open source software technology must be introduced in their syllabus as an elective or preferably core subject. This paper shall be introduced after the students get acquaintance with computer programming and this course must involve lecturs, practical, demos and hand on practices. This course covers the key topics of open source development today, develop understanding toward the basic principal of free/open source softwares, the Open source movements and the open source development process. After the study of the course students get understanding towards OSS and skills needed to join open source community and projects.

The Syllabus:

Open Source Software Philosophy: Introduction to OSS and free software, The Four Freedoms and their meaning, OSS definition, characteristics of OSS, benefits of OSS, shortcomings of OSS, Examples of OSS, binary code vs source code difference between proprietary software vs OSS, free software vs freeware., Open standards, Adoption and deployment of open source.

History and emergence of Open Source Software: Richard Stallman, The Cathedral and the Bazaar (CatB), Open source movement and rise of Linux, Describe several GNU/Linux distributions and their tradeoffs GNU Project, Free Software Foundation.

Legal aspects, licensing: What is a License; Copyright & Copyleft, Open Source Licenses: GNU, General Public License (GPL), Intellectual Property, GNU Lesser General Public License (LGPL), GNU Affero General Public License (AGPL), Apache License, Artistic License, MIT, BSD etc

OSS developers and Communities: Who Participates in the Open Source Process?, Motivation of participants, How OSS Developers Collaborate?, Open source communities, Organization of the Open Source Community, Importance of Communities in Open Source Movement, Alliance formation and Community Building, Developing blog, group, forum, social network, Design, discussion roadmap mailing lists, Cooperation, coordination and control in OSS, Managing People, Roles and responsibilities, group size and communication, group problem solving, The Collaborative Medium.

Software Engineering and OSS: Open Source and Closed Source Software Development Methodologies, Difference between two styles of development, Cathedral and Bazaar, OSS development process, Stages in open source software development, Overview of various software development

models, Life cycles model of traditional software development, Life Cycle Model for Open Source, phases in OSS development, various OSS development models, OSS Pendulum model, development model of Woods et el, model of roets et el. Open source system development cycle, Jorgensen life cycle, Mockus model, comparisons of OSSD life cycle with SDLC, Agile vs OSS development, extreme programming, Open source software engineering (requirements, architecture, evolution, testing, reuse, documentation etc.)

Bug Tracking in OSS: What is Bug/defect?, Bug management in OSS, Bug tracking and removal, Issue making, tracking and patch, bug tracker tools (Launchpad, bugzilla, trac and others), Mail reporting, comparisons of defect density of OSS, software reliability and its measures, reliability issues in OSS, security. Version control, Overview of CVS, CVS Commands.

Starting / participating in OSS: Open Source Software Development Hosting Facilities and directories, Open source communities, Effective communication, various roles in OSS development, Starting your own open source project, Choosing a project – feature ideas, Providing the ecosystem for your open source project, Accepting contributions, Contributing in OSS, submitting a bugs.

OSS development tools/software: OSS development tools debuggers, Analysis tools, source code management, Languages Used to Develop Open Source Products C and C++, Perl, PHP, Python, Java and other languages, cross platform code.

Major Open source software and Distributions: Category of Open Source Software, Operating Systems, Middleware, Servers , Desktop Environment, Development Environments, Major Linux Distributions, Introduction to the LAMP (Linux, Apache, Mysql and PHP) software bundle.

Case Study some successful OSS projects: BIND (DNS Server), Apache (Web Server), Mozilla (Firefox), Sendmail (Email Server), OpenSSH (Secure Network Administration Tool), Open Office (Office Productivity Suite), Linux, Wikipedia, Joomla

After studying the proposed syllabus students will be able to define open source software, Identify and discuss various software licensing models, Understand the motivation, theory, strengths and weaknesses of open source software, OSS communities, OSS software engineering, Bug tracking and reporting in OSS, motivation towards participation in OSS and become familiar with major open source software and distributions. Additional and optional part of this course is to encouragement by the tutor to student for participating and contributing in Open source software development. In this way students know how OSS is developed and what challenges are met when working with actual project. In the beginning students may be practiced through the game and then they can move onto existing open source projects at various sites. They can freely choose the open source community and those students who concentrate on contributing to an actual open source project in addition to the course content will be rewarded

10. CONCLUSIONS

The Open Source movement has touched almost every sphere of software technology and development model of open source has now become an alternate and dominant development model in the software industry. Participation in

open source is now an important skill set for the future developers i.e. students which provides them unique opportunities to gain experience, solving real-world problems. Computer Science Students of Indian universities leg behind in OSS participation, not because that they are not interested but they hardly get exposure during their studies. As our survey shows lack of awareness and absence of OSS contents in the syllabi are the main reasons. Analysis of syllabus of most of the Indian universities also reveals that they teach computer science without any mention of this recent advance. There is a need for the change in the computer science curriculum by the inclusion of course in open source software development. We have proposed the syllabus for the possible inclusion in computer science curriculum. This syllabus not only creates awareness among students but also helps them to understand the OSS development process. A bit of guidance is just sufficient for the students to participate in OSS development and build their software skills in the open source world. To make the success of open source teaching responsibility of the professors is to motivate students to take part in a OSS movement in various ways depending upon their skills. It is also the responsibility of the teaching institute to discourage students to submit project work which is repetitive in nature and not carried out in software industry at their final semester. Students are encouraged to take on their final year project on open source community sites either by starting their own open source projects or by participating in existing ones and such students should be rewarded. This helps to create environment in favor of open source among the students. This will also reflect the future software development as these students are the software engineers and computer scientists of the next generation and usher these practices in their workplace. With the presence of huge IT force in India, it is expected that in near future India would become a net "Giver" to the Open Source community and may transform software into a cottage industry.

11. ACKNOWLEDGMENTS

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Appendix: Survey results

Awareness of open source concepts

Q.1   You are a student of final semester of the course (Tick any one of the following courses):

Total number of respondent: **738**

Diploma Course :	PGDCA / DCA	021	02.84%
Engineering Course:	BE (CS/IT) / B.Tech (CS/IT)	508	68.83%
Bachelor's Degree Course:	BCA / B.Sc. (CS/CA/IT)	097	13.14%
Master's Degree Course:	MCA / M.Tech / M.Sc.(Comp. Sc./IT)	112	15.17%

Q.2   You use internet resources for which of the following activities: (Multiple Answers)

(i)	For emailing / chatting	732	99.18%
(ii)	For searching games songs movies	630	85.36%
(iii)	For preparing assignments ,notes etc. related to study	681	92.27%
(iv)	For improving software development skills	156	21.13%

Q.3   Have you ever visited any of the following websites: (Multiple Answers)

(i)	SourceForge	168	22.76%
(ii)	Google Code	083	11.24%
(iii)	GitHub	017	02.30%
(iv)	Launchpad	013	01.76%
(v)	None from above	532	72.08%

Q.4   According to you sourceforge.net is a :

(i)	Domain name for Search Engine	022	02.98%
(ii)	Website hosting site	083	11.24%
(iii)	Open Source community website	236	31.97%
(iv)	No Idea	397	53.79%

Q.5   Have you ever used/heard about Linux operating system:

(i)	Yes used during my studies (it is in my syllabus)	689	93.36%
(ii)	Yes used just to know about Linux OS	031	04.20%
(iii)	Heard about it but never used	014	01.89%
(iv)	Neither heard nor used	04	0.54%

Q.6   According to you Linux is:

(i)	A Microsoft Product	011	01.49%
(ii)	A product of AT&T bell lab	114	15.44%
(iii)	A product of SUN Microsystem	031	04.20%
(iv)	It is an Open Source Software product	422	57.18%

Q.7   Where you have heard the term "Open Source" in relation to computer software:

(i)	During Study of Linux OS	631	85.50%
(ii)	During Internet surfing / reading magazine/book	078	10.56%
(iii)	During study it is in my syllabus	00	0 %
(iv)	Can't say	029	03.92%

Q.8   According to you open source softwares are:

(i)	Available free on the Internet only source code is chargeable	326	44.17%
(ii)	Available free along with their source code	246	33.33%
(iii)	Available on payment with/without source code	032	04.33%
(iv)	Can't say exactly	134	18.15%

Q.9   Open Source softwares are developed by:

(i)	Big Software Companies	147	19.91%
(ii)	Small software companies	173	23.44%
(iii)	Individual / Volunteers	271	36.72%
(iv)	Can't say exactly	147	19.91%

Q.10   Open Source software developers participate in OSS development because of:

(i)	They are hired by OSS web sites on contract basis	198	26.82%
(ii)	They get monthly/weekly perks for their contribution	137	18.56%
(iii)	Just for fun and to enhance their development skills	274	37.12%
(iv)	No Idea	129	17.47%

Q. 11   In your computer do you use following software: (Multiple Answers)

(i)	Windows OS	738	100%
(ii)	MS Office	736	99.72%
(iii)	Photoshop and other product of Adobe	667	90.37%
(iv)	Dot Net (like VB.net, ASP.net etc) for programming	548	74.25%
(v)	Oracle SQL etc.	556	75.33%

Q. 12   You have got above softwares from: (Multiple Answers)

(i)	While purchasing computer vendor has installed on my request	614	83.19%
(ii)	Some of them copied from my friends	452	61.24%
(iii)	Downloaded from Internet	046	06.23%
(iv)	Some purchased along with legal license	137	18.56%

Q.13   Do you know many **legally completely free**, software alternatives to commercial programs for word processing, image manipulation, 3D modeling, animation, web browser, media player etc. are available?

YES	385	52.16%
NO	353	47.83%

Q.14   Do you use following software in your Computer/ Computer Lab: (Multiple Answers)

(i)	Open Office (Office software)	022	2.98%
(ii)	GIMP (graphics editor tool)	014	1.89%
(iii)	Mozilla Firefox (Web browser)	534	72.35%
(iv)	VLC media player	662	89.70%
(v)	MySQL (Query Language)	302	40.92%
(vi)	PHP (Scripting Language)	298	40.37%
(vii)	Linux (OS)	681	92.27%
(ix)	Moodle (Course Management System)	011	1.49%
(x)	Apache(HTTP web server)	241	32.65%
(xi)	Perl / Python / Ruby Programming language	009	1.21%

Q.15   In your course work you are supposed to do live project work of

(i)	6-12 weeks duration (summer course)	079	10.70%
(ii)	6 Months (complete semester) duration	097	13.14%
(iii)	In parallel with last semester (with 3 months in industry)	528	71.54%
(iv)	Not having project work at all	034	04.60%

Q.16   Where you have completed project work (or planning to do project):

(i)	In a software development company	103	13.95%
(ii)	In a computer training Institute	515	69.78%
(iii)	At home (by obtaining problem from teacher/friends etc.)	079	10.70%
(iv)	Purchase from market or downloaded from Internet (Because wasted so much time on searching live project)	041	05.55%

Q.17   Are you interested to participate in OSS development project:

(i)	Yes if have a opportunity to show my skills	298	40.37%
(ii)	Yes if prize money is there	114	15.44%
(iii)	Yes on a live project to gain real life experience	315	42.68%
(iv)	Not interested	11	01.49%

Q. 18   During your studies have you studied the concept of open source software development:

(i)	Yes one introductory unit was there in my syllabus	00	0%
(ii)	Yes one full paper is there in my syllabus	00	0%
(iii)	Not in syllabus but some discussions were made by teacher	596	80.75%
(iv)	Not studied at all	142	19.25%

Q.19   Which Software Engineering text book(s) in your syllabus (please mention Title and Author's name)

Top 5 text books in our survey are:
1. Software Engineering: A practitioner's approach by R.S. Pressman
2. Software Engineering by Ian Sommerville
3. An Integrated approach to software engineering by Pankaj Jalote
4. Software Engineering: Theory and Practices by Pfleeger
5. Fundamental of software engineering by Carlo Ghezzi

Q. 20   In this book is there any chapter for OSS development practices? If yes give brief description.
…………None……………………………   ………………………………………………….