

An Empirical Study on Implementing Free/Libre Open Source Software (FLOSS) in Schools

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Abstract. This empirical paper shows how free/libre open source software (FLOSS) contributes to mutual and collaborative learning in an educational environment. However, unlike proprietary software, FLOSS allows extensive customisation of software and supports the needs of local users better. In this paper, we observe how implementing FLOSS in an Italian high school challenges the conventional relationship between end users themselves (e.g. teachers and students) and that between users and developers. The findings will shed some light on the social aspects of FLOSS-based computerization -- including the roles of FLOSS in social and organizational change in educational environments and the ways that the social organization of FLOSS are influenced by social forces and social practices.

Keywords: free/libre open source software (FLOSS); FLOSS implementation in schools; collaborative learning; mutual learning; OpenOffice.org; blog

1 Introduction

Many recent studies have pointed out that the relationships between lay and expert, users and developers, knowledge consumers and producers can be greatly challenged in a computer-supported knowledge-based society (e.g. Millen and Muller 2001; Hine 2001, 2002). In such a complicated knowledge system, mutual learning is a prominent phenomenon observed in various sectors. Educational sector is one of them that has been experiencing digital transformation.

In this paper, we observe such digital transformation in schools fostered by the implementation of free/libre open source software (FLOSS). We argue that FLOSS, unlike many other educational institutes that use proprietary software such as WebCT to facilitate the teaching and learning in schools (e.g. Pearson & Koppi

2002), has greater potentials of stimulating cross-boundary learning, and of shaping the technologies into the desires of users.

Istituto Statale di Istruzione Superiore J.M.Keynes (hereafter ‘the Keynes High School’), located in the outskirt of the city Bologna in north Italy, initiated the implementation of FLOSS-based ICT to facilitate e-learning. Given the transparency of the technologies itself with openly available source code (Perens 1999; DiBona *et al.* 1999), the schools not only reduce management costs of existing IT systems (e.g. licensing fees of proprietary software, the cost for periodical update to fix vulnerability, and the fare for improvement of capability), but also allow them to customize the software to their specific reality. Working closely with the technicians and the system designer, the teachers and students at Keynes also contribute to the construction of the system and the software they consume.

These experiences are valuable for the development of effective environments for learning, and more importantly, they shed light on how FLOSS can be implemented in schools, and benefit both the users and developers. These examples also denotes a celebrated chapter about how social actors can participate in the technological development and configure the technologies to meet their demands (Fleck 1993, 1994). While earlier work on e-learning and computer supported cooperative work (CSCW) has attempted to use ICTs as effective medium for interactive teaching and learning, few of them have discussed the possibility of including learners and teachers in the design process of the learning technologies. Thus, this paper will be one of the most novel papers about how to design learning technologies with the participation of users in the design process.

2 Research Methods

We employ a qualitative methodology for this study in order to understand the social-technical dynamics in the implementation process. The research methods employed include ethnographic observation, informal face-to-face interview, and document analysis. One of the authors, Enrico Zini, was a student at the Keynes high school and is now both the designer of the system and a teacher of communication courses. As a student, a teacher, researcher and supporter of the system, he has had the opportunity to see the use of new technologies in education from a variety of perspectives. Being involved in the development process makes it easier for the researcher to observe and investigate the learner/user perspectives on e-learning, rather than just follow the promising functions envisaged by the system builders/providers. Apart from his participatory observation, we also collect other second-hand documents (e.g. students' and teachers' on-line discussions and off-line presentations) and informal conversations and interview with the students, teachers and technicians. These multiple sources of data provide rich information for an in-depth case study (Yin 2002).

3 The Keynes High School and their Information System

3.1 The Keynes High School

The Keynes High School is an aggregation of different former high schools located in the same area. It offers a range of didactic paths: a scientific lyceum, a technical business high school, a geometer technical high school and a tourism-oriented professional high school. It is also responsible for High School education inside the penitentiary of Bologna.

The school has 6 computer labs with 140 computers and 4 servers (based on the GNU Linux operating system) supported by 5 technical staff to serve 607 students, 96 teachers. Currently, the 4 Linux servers provide services such as routing the laboratories to the Internet, firewall with possibility of isolating different computer rooms in case the teacher does not need to use the Internet, LDAP centralized user management, file sharing including shared space and personal space and desktop accessible from every computer, DHCP services, local Debian mirror for faster upgrading of Linux machines, web server with school portal, school wiki and personal web space for teachers and students, webmail, mail server with virus scanning and spam filtering, mailing list services, IMAP server, print server, HTTP proxy cache to speed up the lessons where 20 to 30 computers connect to the same website at the same time. Some facilities, such as the webmail or internal communications, are also available remotely from home.

3.2 The Introduction of Free/Libre Open Source Software (FLOSS)

The computer laboratory has been established since 1985 to support computer lessons in the technical business courses, and the initial equipment of Olivetti M20 has been slowly upgraded and expanded.

FLOSS first came into the school in summer 1998, when the technicians decided to try and install Linux on a testing computer. At the beginning of 1999, a Linux server was deployed to share the dialup Internet connection and provide shared disk space over the network. The server has kept continuously evolving since then, partly due to the needs of the school (such as working as a print server) and partly due to the interest of the technicians to learn and experiment with new technology (such as installing a web server and CMS, or a VPN between the two campuses).

In 1999 the school faced an expense plan of about 35000000 lire (ca. 18075 euros) to buy proper Microsoft Office licenses for a new laboratory plus some of the existing seats. Since the school staff had already experience with FLOSS, facing that big cost, the school decided to try other office replacements. At that time, Sun had just acquired Star Division and released Star Office 5.1 under a free software license, and so the school installed Sun's Star Office (which later on became OpenOffice.org), instead of Microsoft Office, in one new laboratory.

Such a switch encountered a strong resistance from many teachers, who feared of having to be reeducated to acquire new skills. The students, instead, had little problems with the change. The switch experiment ended up in a trade-off, where only about 13000000 lire (ca. 6710 euros) were spent on Microsoft Office licenses. The rest of the budget was used to buy new hardware.

3.3 The Growth with Free Software

After the installation of Star Office, new FLOSS-related services were deployed in the servers and the school staffs started to have more contacts with the developers' community. With the increasing awareness about free software, the school started to learn how to utilize the FLOSS-based infrastructure they built – not only passively use the system but more positively participate in the design and development process. The concept of inclusion in participatory design is gradually grounded in Keynes high school. They started to have students moderate mailing lists where mutual help was provided. The mailing lists were also open for the public so that prospect students could subscribe to the mailing lists and ask about the future school environment. Through the communication on the mailing lists, not only could prospect students start making progress in the social network they were going to be a part of, but also could the moderators – the senior high school students - have more advanced computer experience of moderating and facilitating an on-line community.

Moreover, the students were also issued a CD with the free software used at school (e.g. OpenOffice.org, Mozilla Composer, Free Pascal) to install in their home computers. In so doing, the students experiment different operating systems and software. Therefore, as Daniela, the teacher in charge of the computer lab at the Keynes high school saysⁱⁱ,

In using free software, our students realize that working with computers does not mean working with a single software. [...] They understand that it is possible to switch easily from one software to another [to complete a task]. When sitting in front of computers, they don't search for 'Word', but they look at what software is installed and what can be useful to them.

Apart from starting implementing open source technologies, open contents, which share the same philosophy with the free/libre open source software movement, were also employed in the daily teaching and learning. The teachers and students started to use information on Wikipediaⁱⁱⁱ for extensive teaching/learning materials. Meanwhile, some of them also contributed to translating webpages on Wikipedia or adding new contents to the on-line encyclopedia shared openly by Internet users around the world. The implemented ICT fosters a greater learning environment for both students and teachers at the Keynes high school with more interactive activities locally and globally, and more importantly, with the FLOSS-based system, the school members are empowered to influence and contribute to the technological design and knowledge production potently. Their participation in the design and knowledge-making process changes not only the power relationship between users and developers but also that between students and teachers. In the following, we will present a couple of examples how their uses of FLOSS-based technologies transform local experiences, understandings and social formations. We will focus on particular digital practices – developing the OpenOffice.org Italian thesaurus and creating a school weblog - and analyze representations of these technologies in discourses.

4 The Open ‘Office.org’ Italian Thesaurus

Hitherto, we have described the current computer-supported learning environment at the Keynes high school and the motivation for them to switch to a FLOSS-based infrastructure. Additionally, open contents are also employed in the daily teaching and learning. Both open technologies and contents on the one hand enable the teachers and students to take more active part in the technological design process and on the other hand also shape their learning behaviors and activities. Technological design and pedagogy thus indeed have the potential to co-evolve in the new medium (Bruckman 2003). The following case on OpenOffice.org is illuminated.

OpenOffice.org is open source office software suite for processing text documents, spreadsheets, presentations and drawings. The language customization of this software usually is developed and maintained by a local community of volunteers, though sometimes funded by Sun Microsystems Inc. The Progetto Linguistico Italiano Openoffice.org (PLIO), the Italian OpenOffice.org project, develops, maintains and distributes the localized Italian version of OpenOffice.org. And the source code is freely available for interested people to download, modify, study and redistribute.

In year 2004, students of the class III H were asked by their Italian teacher, Daniela Volta, who was also responsible for the computer infrastructure at the Keynes high school, to write up synonyms as a reflection of their linguistic and lexical skills. Because the Open Office they were using did not have an Italian thesaurus, the teacher thought it would be a good idea to collect students' work on synonyms and submit it to the Italian Open Office development team PLIO as an enhancement.

However, bringing students into the development of free software requires some basic training. To prepare the students to work on a Free Software project, the second author was invited to give a background lesson about the concepts and mundane practices of free software. The lesson also included a short history of OpenOffice.org as a background on the free software project the students were about to get involved with. Later on, through the coordination of Mrs. Daniela Volta, the work on the list of synonyms, began with the synonyms letters A & B drawn up by the class III H at the Keynes high school, is continued by the students at different high school and others from the wider FLOSS community.

The creation and development of Italian Open Office thesaurus shows active cross-boundary learning and developing activities based on social networking and mutual support. Because of the teacher's link with other high schools, she can call more people to participate in this project. Students, crossing the school boundary, contribute their learning results to one of the biggest free software project in the world that can be used by many others coming from different social worlds (Strauss 1987). Drawing on heterogeneous knowledge from diverse actors, the thesaurus for the Italian Open Office resembles a boundary object (Star 1989) that has been and will be constantly shaped by people who share the software. The construction of the technological artifact (i.e. the Italian Open Office thesaurus) thus embeds and embodies students' learning experiences and results. Technological innovation is no longer just within the strong expert-led industrial-supported research environment; learning is no longer just within schools. Instead, this case shows how innovation is

fostered by a 'community' (Lave and Wenger 1991) including diverse actors traveling across multiple boundaries.

Moreover, as written in the Debian package documentation 'openoffice.org-thesaurus-it', the students reflected what they've learned "This experience shows that in the school it is possible to achieve an active and experimental approach to the computer technologies, with the aid of competences concerning different subjects, in this specific case the Italian language." Such interactive, community-based and cross-boundary learning thus proves to be more effective than other one-way passive Internet-based learning with websites providing course resources (text, graphics, maybe audio, video). However, it also entails that such a learning community based on FLOSS technologies is more dynamic and it requires further studies in order to understand why some tools are chosen over others, and how are they implemented in a context determined by the teachers, the subject matters, and the social, cultural and political environment of the institution.

4 Blog: A Collaborative Instrument

The blog is another facility that fosters a collaborative learning environment at the Keynes high school. Moreover, it also shows how students build both the learning community and their collective identity based on the shared learning experiences.

Students come from various backgrounds and therefore have various learning styles. Their knowledge is heterogeneous, dynamic and situated (Lave and Wenger 1991; Gomez *et al.* 2003). It would be effective if their different knowing and learning experiences can be shared through the rapidly developed information technologies, part.

One of the objectives of the new media education at Keynes is to help students to step back and ask critical questions about what they're seeing- rather than just absorbing media messages passively and unconsciously. To develop Internet literacy in schools, the Keynes high school initiated a new module on communication technologies covering issues such as how to provide and present information on the Internet. Trying to be neither passive information receivers nor disinterested knowledge consumers, the students were invited to play a more active role in the Internet-based society. On the class, examples such as Internet news websites Slashdot.org or Indymedia.org were presented to the students. Moreover, as a practical ground for experiencing independent information providers, a FLOSS-based weblog infrastructure using technologies such as pyblosxomiv, apachev, planetvi, weblog-addvii was set up in early 2005.

This weblog system can also aggregate all individual blogs of students and staffs automatically and turn them into a community blog (e.g. a class blog collecting all teachers and students' blogs from the class II H; a school blog collecting all blogs of staffs and students). In so doing, information collected from different sources and contexts can be rearranged and presented for different purposes and shared amongst wider interested audiences. Compared with other Internet technologies, this blog system contains the following advantages:

1. With a simplified interface, the blog is comparatively easier to use than web pages or wiki pages because the weblog only allows posts in plain text, and then the content will be automatically edited, display and archived. In this

regard, the school did not just blindly accept any 'cool' new technologies. A careful evaluation of the educational needs in a specific situation has been made before applying technologies (Fox 1998; Huysman and de Wit 2002). The technologies thus were less likely to discourage participation of teachers and students (Dougiamas 1999; Dougiamas and Taylor 2003; Shirky 2004).

2. Unlike on-line forums, no topic needs to be pre-given on a blog for discussion. Thus, users are offered great freedom (except for the rule that the blog is not used to insult people) to express themselves in whatever content, and whatever style they want.
3. Unlike a mailing list, a weblog is universally accessible by any user on the Internet. The information can be disseminated further and network more actors (both information providers, mediums and receivers).

It is worth noting that this concept of linking different blogs together is a common practice amongst free software developers to create an aggregation of the blogs of all the developers working on the same project (e.g. Planet Debianviii for Debian GNU/Linux; Planet Ubuntuix for Ubuntu GNU/Linux). This technology implemented in the school thus was technically trivial, yet socially very effective. The creation of *Planet Keynesx* with the blogs of everyone in the Keynes high school fosters a greater learning community where mutual learning takes place not only between students themselves but also between students, teachers and technicians.

For example, when learning about a Greek epic poem, one student had been posting the lyrics of a popular song that was inspired by this ancient Greek poem onto the class weblog. Shared with everyone on-line, the teacher indicated in her follow-up message that this lyric would be discussed at the next lesson for drawing parallels between ancient narrative artwork and modern pop music. In this case, the teacher learned from the students about the current teen culture. In sharing the lyrics, it shortened the gap between the teacher and the students. Being applied in the teaching on the class, the spontaneous information shared on-line had become useful material to reflect something taught in the textbook. This instance illustrates how ICTs are used to integrate the physical off-line life and the digital on-line life, and more importantly, motivate the students to reflect and share what they've learnt with not only each other but also the rest of the world. In other words, such a community-based blog system not only enhances peer-support but also hinders the hierarchy in a traditionally educational environment where teachers own the power to deliver knowledge and students passively receive the information given. Moreover, it also helps provide information on-line and bridges learners around the world. Although not yet prominently observed, the technicians could also learn from the activities of their users and design better devices and services for them. A learning community with active exchanges between diverse actors thus is built and so is their collective identity based on the shared learning experiences.

Another implication found in the implementation of weblog technology is related to the feature of free software. The system designer, Enrico Zini, had been paying extra attention on minimizing the divergence of the customized software from the upstream project for easier maintenance and better integration. He also created new features to automatically install (and mass-install) the pyblosxom weblog in any user's webspace. The bugs found and fixed in the customization and implementation process together with the new features added were reported back to the original developers. Since this is the first of such a FLOSS-based weblog

system implemented in a school, documentationxi was also produced to share this experience of customizing and implementing FLOSS-based weblogs at schools. This proves that the implementation of a FLOSS-based weblog system at the Keynes high school is indeed a socio-technical innovation.

5 Conclusion and Future Research

Hitherto, we have introduced the cost-saving and effective FLOSS-based technologies implemented in the Keynes high school. This system not only fosters a local learning community integrating the physical school and on-line learning environment, but also bridges the local knowledge-sharing and learning with the global Internet society. We have presented two eminent examples showing how FLOSS-based technologies improves the current e-learning technological development in encompassing both students and teachers in the development process. The first example is the usage of OpenOffice.org, the open source office software developed by volunteers, at the Keynes high school. Apart from being the software users, the students are also developers contributing their lists of Italian synonyms to the construction of the Italian thesaurus. In this process, the students not only learned Italian synonyms, but also actively participated in the free software development and made contact with the outside world. Their learning across the boundary between users and developers brings socio-technical dynamics into both the free software development and school education. Another example on using FLOSS-based weblog technologies also shows how on-line knowledge-sharing subverts the traditional power relationship between teachers and students and empowers all actors to learn from each other. Software bugs found and new features developed in the customization and implementation process were also reported back to the original free software developers. To sum up, the Keynes high school benefits from the FLOSS development for having cost-saving and customizable e-learning and knowledge-sharing software, and the FLOSS development benefits from the Keynes high school for having users feedback and contributions. Compared with similar proprietary software, the FLOSS technologies can be tailored to suit the users' specific requirements and therefore empower users to play a more participatory role in the design process.

In this paper, we have examined the highly dynamic and socially complex processes of collaborative learning at the Keynes high school bolstered by the FLOSS-based technologies. We have also investigated the changed role of teachers and students in such a community-oriented educational settings from an integrated socio-technical perspective, taking socio-cultural processes as well as technical infrastructures into account. However, we have also observed some phenomenon that requires further studies. For example, we found that not every student had dedicated the same amount of time to blogging, and that the teacher played an important role of adopting FLOSS-based technologies and motivating students' learning activities on-line. To get a better understanding of such a FLOSS-based learning community, consistent investigation is needed in order to understand how the experience earned with a long period of blogging can be leveraged, how shared interests can be built and enhanced amongst all participants, and how to motivate students to continue blogging. Additionally, in the future, we are also expecting to

study whether implementing FLOSS and using non-proprietary data formats indeed helps teaching pupils about exactly how computers operate, making them learn about the formats and the tools by letting them experiment with them (Marson, 2004). Finally, we would like to strengthen that such an implementation process should never be considered as smooth and straightforward as there were some socio-political factors (particularly human factors) involved in the implementation process (such as the disfavoring of some math and science teachers at the school in the beginning). These socio-political factors should always be taken into account when planning such implementation.

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- i At the same time, the expense plan to buy hardware for a completely new laboratory was a little more than 30000000 lire (ca. 15500euros)
- ii This paragraph is translated from her presentation at the seminar 'Software Libero - Un'opportunità per la pubblica amministrazione e il sistema economico regionale', June 16, 2003, Emilia Romagna Regional Administration.
- iii <http://wikipedia.org>
- iv <http://pyblosxom.sourceforge.net/>
- v <http://www.apache.org/>
- vi <http://planetplanet.org/>
- vii <http://pyblosxom.sourceforge.net/blog/registry/input/weblog-add>
- viii <http://planet.debian.org>
- ix <http://planet.ubuntu.com>
- x <http://keynes.scuole.bo.it/planet>
- xi The documentation is available at the Keynes wiki page <http://keynes.scuole.bo.it/phpwiki>.