FLOSSCom - Using the Principles of Informal Learning Environments of FLOSS Communities to Improve ICT Supported Formal Education

Phase 2: Report on the effectiveness of a FLOSS-like learning community in formal educational settings

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Table of contents

List of Figures and Tables

1 Introduction

The objectives of this 2nd report of the FLOSSCom project are as follows:

- To analyze and evaluate the differences between Free / Libre Open Source Software (FLOSS) communities as informal learning environments and on the other side formal educational settings
- Point out ways on transferring those FLOSS principles to formal educational settings
- Look at existing examples of eLearning delivery and examine why these do not provide the types of constructivist learning environments observed in FLOSS communities.
- Provide examples of formal educational environments similar to FLOSS communities that would be further addressed at the FLOSSCom Phase 3 “FLOSS-like education transfer report”.

Table 1.1 provides an overview of the mapping between learning processes, and how these are manifested in FLOSS communities, and also the technologies used to support them. These three strands will recur throughout this report, namely learning (or pedagogy), FLOSS community characteristics and technology.

Displays and manifestations of knowledge	**Technological tools**	**Initiated processes of learning and knowledge-building**
Code	CVS repository	Full cycle of re-experiencing: Concrete experience Reflective observation Abstract conceptualization Active experimentation
Transactive Group Memory	Website content and hyperlinks (e.g. FAQs, content)	Productive inquiry Reflective observation
Instructive Content	Online tutorials and screenshots Bug reporting system, CVS change log and diff application	Active experimentation Reflective observation Participative practice
Instructive Discourse	IRC (Internet relay chat)	Reflective observation Collective reflection
Reflective Discourse	Asynchronous communication (e.g. mailing lists, newsgroups)	Collective reflection Collective conceptualization Virtual experimentation*
Note: * Here virtual experimentation is used as synonym for experimentation with things the programmers have in mind, but that do not exist as yet.		

Table 1-1: Learning Processes Initiated and Displayed Through Technological Tools

This report examines some of the pedagogic principles embodied in FLOSS communities and then looks at case studies of FLOSS-like approaches in education. One way of thinking about the adoption of FLOSS principles is to consider them as FLOSS-inside, ie bringing FLOSS principles in to a traditional higher education establishment, or FLOSS-outside, ie exposing students to a real FLOSS-like community, or ultimately by blending them into a mixed inside-outside approach as explored in section 6 and outlined in Figure 1.1

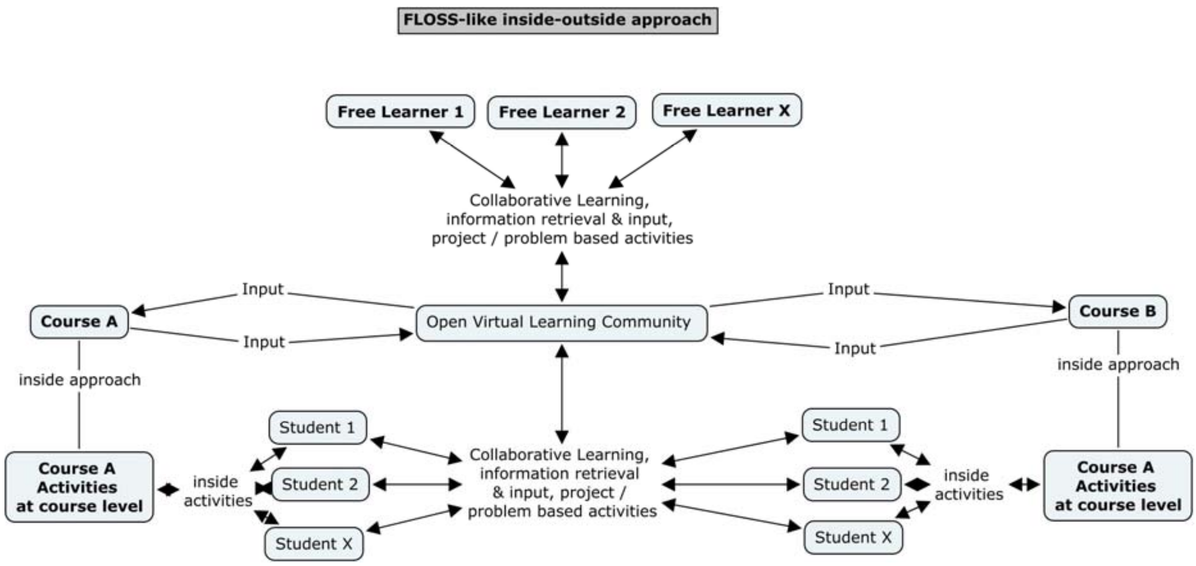

Figure 1-1: Mixed inside-outside approach of FLOSS-like education

2 How learning takes place in FLOSS

2.1 Introduction

In this section we will look at how individuals learn in FLOSS communities. There are a number of different ways in which learning occurs, and often it will be a mixture of more than one. These approaches are often in marked contrast with those found in traditional formal higher education, for example the interaction with learning materials is not with materials selected by an educator but rather those selected, and more importantly, generated by the community itself. This includes access to code, and also the dialogue between contributors. Unlike in traditional education where every cohort of students acts in isolation from previous ones, in FLOSS communities the history of other learners and contributors forms a vital element of the learning materials.

As well as the interaction with materials this section will also address the following:

Project-based learning - each FLOSS community can be seen as working on a project, i.e. the development of the software in question, and thus many of the skills required in project management are developed.

Collaborative learning in a networked environment – although FLOSS communities can vary considerably in size from two developers to several thousand, at the heart of them is the cooperative nature of development and thus necessitates cooperative learning from peers.

Reflective practice – the collaborative nature of FLOSS communities causes many practitioners to develop reflective practice, since they will have their contributions and assumptions challenged, and may need to reflect upon the best solution to a problem, their own communications, and when moving to another project lessons learnt from previous ones.

2.2 Interaction with learning materials, including self-study

The term “learning material” could be defined as any entity containing a chunk of information useful for somebody to develop knowledge in a certain context. It could be a book, a URL, an instructor, an observation, a peer, etc.

This definition is suitable for formal education and FLOSS, as it is broadly expressed. However, interaction with learning materials is very different in the two contexts.

<u>Learning materials are loosely coupled in FLOSS, but strictly defined in formal education.</u>

In FLOSS almost all resources are generated by the community: documentation, discussion, FAQs, and even the software code itself are continuously developed and enhanced. In formal education settings, the “content” is defined at the beginning of the course usually by the educator, and will remain the same to the end.

<u>Learning materials are fragmented in FLOSS, but coherent in formal education.</u>

In formal education settings, a great deal of effort is given in order to “engrave” knowledge as an inheritance for further generations. In FLOSS it is the responsibility of the individual FLOSS participant to search through a variety of learning resources and discover the information one is seeking for, while the provision of “relevant” information to the learner is in formal education settings an obligation.

Learning materials are often external and every time open in FLOSS, while in formal education they are developed in-house and context-based.

The trend in formal education is to open the learning resources to external influences; however, they are always assessed by the organization or the instructor in order to ensure their "soundness" and "adherence" to the stated educational objectives and scopes. In FLOSS the formal procedure that guarantees the "soundness" of the provided information is determined by the community and as far as it concerns the software's core code and features the final say is with the core development team. In general the usefulness of a resource is determined by the community, and even the software's core features are based upon the community's feedback to derive the future product requirement specifications and development roadmap.

There is selection of the learning materials in FLOSS, but obligation in formal education.

As a direct result of the characteristics discussed above there is freedom for the FLOSS participant to seek their own knowledge by developing their own knowledge paths, while in formal education the typical student is obliged to study the provided material. Active learning is an umbrella term that refers to several models of instruction that focus the responsibility of learning on learners. Bonwell and Eison (1991) popularized this approach to instruction. This "buzz word" of the 1980s became their 1990s report to the Association for the Study of Higher Education (ASHE). In this report they discuss a variety of methodologies for promoting "active learning." However, according to Mayer (2004) strategies like "active learning" developed out of the work of an earlier group of theorists, those promoting discovery learning. It has been suggested that students who actively engage with the material, are more likely to recall information later (Bruner, 1961), but this claim is not well supported by the literature (Mayer, 2004; Kirschner et al, 2006). Rather than being behaviourally active during learning, Mayer (2004) suggests learners should be cognitively active.

Progress is mainly self-assessed and sometimes peer-assessed in FLOSS, while in formal education it is evaluated through established procedures.

In other words, the FLOSS participant can not be always sure if they possess the necessary knowledge and skills to efficiently contribute to a project over the projects lifetime. Additionally new technologies, unforeseen problems or new feature requests might require the FLOSS participant to re-evaluate his learning needs and consequently set him back in his progress. In formal education, there is a continuous evaluation, performed by the teachers and the organisation against agreed criteria.

Validity of learning resources is debatable in FLOSS, but granted in formal education.

This is also an obvious consequence of the above discussed, and is also a side effect of the richness and variety of the FLOSS learning resources. However, if somebody wants to award a degree for the participation in a FLOSS-like course, one must guarantee *a priori* the validity, accuracy, completeness and actuality of the learning resources. This is difficult to realize in an open environment, although peer-assessment could be one possible solution (Glott et al, 2007) in any FLOSS project (see also a flashmeeting at http://flashmeeting.open.ac.uk/fm/fmm.php?pwd=f93803-9743 for a discussion on this topic). On the other hand, in times where knowledge becomes obsolete faster and faster with a great part of it being out of date once students graduate[1] this validity comes at a high price.

2.3 Project-based and case-based learning

Advantages

Perhaps the most convincing argument in favour of case-based learning (CBL), at least in constructivist implementations, is its potential to bridge the gap and forge connections between theory and professional practice (Kinzie et al., 1998; Shulman, 1996). Shulman (1996) asserts that content framed in cases is more memorable, and Richardson (2000) agrees that case content provides mental anchors for remembering facts, concepts and principles.

However, in strong practice-centred environments, such as FLOSS projects, it is often difficult for novice participants to elicit and conceptualize the underlying theoretical principles, so as to bridge this theory-application gap. In other words, formal education is interested in a sound theoretical basis, whereas in FLOSS settings the emphasis is on the project and/or product.

On the other hand, internalization of methods for case analysis learned in academic settings may provide heuristics for dealing with professional problems and dilemmas in future practice (Jonassen, 1996; Williams, 1996), and the wide variety and number of available cases affords greater breadth of case experience than a short practicum (Jonassen, 1996; Kinzie et al., 1998; Sykes & Bird, 1992).

Finally, CBL appears to foster communities of learning and to develop collaborative skills needed for professional practice. Students typically come to value open conversation and develop mutual respect as they develop their ability to articulate and defend their positions and to cede ground gracefully (Barnett & Ramirez, 1996; Benham, 1996; Hazard, 1999; Kinzie et al., 1998), as it is usually the case in FLOSS interaction and communication schemata.

Disadvantages

Despite its many advantages, CBL does come with a number of caveats as well. First, even text-based case creation is challenging and time-consuming, especially in an academic or school context. Desberg and Fisher (1996) note that decisions regarding content can be difficult. While a case needs to be complete enough to represent the situation authentically, the developer must avoid overwhelming the student with excessive description, and the resulting case can be limited in scope. Furthermore, the highly structured format of most text-based cases robs students of the opportunity for collection and structuring of information that is critical to most complex endeavors (Jarz et al., 1997). Cases sometimes focus narrowly on a dilemma facing a single person or group, while the viewpoints, beliefs, and actions of secondary "players" may be ignored or glossed over (Grupe & Jay, 2000). Williams (1996) also cautions against the use of "pedantic, simplified, or moralizing" (p. 194) cases that can stifle higher level thinking. Authors may unwittingly embed their own biases, either through the chosen language or through choices of what to omit or include.

One could argue that in FLOSS context to "write down" the case/problem is needless, since the problem is usually well known. This could apply when one programmer is involved in the project, however, in case of a bigger project such as Apache or php, every contributor perceives the problem in a different way and what the "optimal" solution should be. So, strict guidelines and detailed

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[1] See for example the information as provided at Karl Fisch's presentation "Did you know" and the underlying data (http://thefischbowl.blogspot.com/2006/08/did-you-know.html)

descriptions must be prepared in FLOSS as well, so as to ensure a common view and the cooperation of participants. One part of those detailed descriptions is that the code in FLOSS is usually commented (see figure 2.1) in order for others to understand the rational and functioning for each and every section of the software.

```
/**
 * Load the parameters
 *
 *
 * @access public
 * @param boolean $install Install process indicator, default to
FALSE
 * @return mixed
 * @static boolean $is_loaded Cache object load indicator
 * @global object $database Joomla database
 * @global object $jsmfCache Joomla-SMF cache
 */
function loadParams($install = FALSE)
{
    global $database;
    global $jsmfCache;
    static $is_loaded;

    /**
     * Include the Cache Lite
     */
    if (!$install && empty($is_loaded)) {
```

Figure 2-1 – Example of commented Code, case SMF-Joomla bridge

From the user side FLOSS also provides users with a large number of use cases and case studies that are compiled by users or developers. The osCommerce project for example, an e-shop solution, provides not only detailed information and modification cases, but also hosts more than 12.000 live demonstrations of online e-shops that were provided by the community members.

Implementation of cases can also be a challenge for instructors of formal education, particularly those who are new to active learning principles. Learning effective case-teaching strategies can dramatically increase teacher workload at the outset (Hazard, 1999). Depending upon students' prior knowledge and experience in the domain, some theoretical background may be needed before beginning case analysis. Unfortunately, any use of a lecture format can be dangerous because it tends to establish the instructor as the purveyor of knowledge instead of facilitator of student involvement (Silverman & Wetly, 1996). Morine-Deshimer (1996) attempted to determine what aspects of CBL might influence what is learned. She determined that "the degree of teacher direction of discussion [and interaction] significantly impacted students' processing of information from the case" (p.120). In addition, instructor selection of case elements for emphasis affected what students considered key or salient and thus the type of analysis practiced. Less instructor direction clearly resulted in more complex thinking by students, but Barnett and Ramirez (1996) noted that letting go requires a teacher to be quite comfortable with his/her own conceptual understanding of both content and students' thinking. It therefore might be of use to have a closer look on CBL within the FLOSS domain to identify principles and practices that could be applied in formal educational settings.

Problem: Documentation

In FLOSS there is no "teaching" or "instruction" in the strict meaning of the term. There is a kind of mentorship and tutoring, where more experienced "gurus" give advice and guide inexperienced members. In addition to this, there is a huge collection of "educational" materials to be studied. Every novice participant in a project has to read and study documentations, FAQs, manuals, discussion threads and any other source of information relative to the project. A sensitive point here is that all this material has to be prepared by someone, a task which is considered as "trivial" by FLOSS developers, as reported by many authors (e.g. Lakhani & von Hippel, 2003; Crowston & Howison, 2004), and so finding volunteers to do this can be problematic. This material could also be suboptimal from an educational perspective, mainly because this documentation is fragmented and distributed, whereas the educator performs the filtering and collation task in traditional education.

FLOSS software development is increasingly dependent on expertise not confined within the limits of a given institution or firm, but takes place in a world wide community of practitioners who aid each other through mailing lists, chatrooms, blogs and discussion forums. Becoming a skilled practitioner is impossible without access to online resources, especially to written documentation. However, the majority of this documentation is fragmented, in the form of manuals, textbooks, reports, FAQs, lists, ICQ discussions, e-mail messages and so on.

The advantage of FLOSS documentation is therefore that, unlike the documentation of traditional software, it benefits from the fact that it can be updated by the community (Scacchi 2002). From an educational perspective this might be translated as user / learner generated learning and instructional materials or educational content.

Furthermore, often new developers have to not only to understand the code, but also the community, practices, and culture of that particular open source software project, which can vary considerably from project to project. Making the social networks of the community apparent would help new developers understand the culture and community they want to contribute to and ease their initiation. (Ankolekar et al. 2003)

Problem: Interpretation

In the FLOSS context, all pre-described models apply simultaneously. In other words, working in a FLOSS context can be problem, project, or case based, or alternating between them, providing well-structured or ill-structured working environments, long-term or short-term projects using strong or weak communication mechanisms. The variability of the projects is both a strength and weakness for developers (and researchers).

2.4 Cooperative learning in a networked environment

As explained in the Phase 1 Report, FLOSS production is a highly collaborative construction process targeted at solving complex problems (Scharff 2002) and is characterised by commons-based peer production (Benkler 2002).

One characteristic of FLOSS, and a sharp contrast to collaboration in the physical world, is the global access to a large pool of interested peers. (Hemetsberger 2006)

Typical collaboration spaces in FLOSS are chats (IRC), mailing lists, forums and more recently wikis, though the network itself might consist of a diverse range of collaboration spaces as shown in figure 2.2.

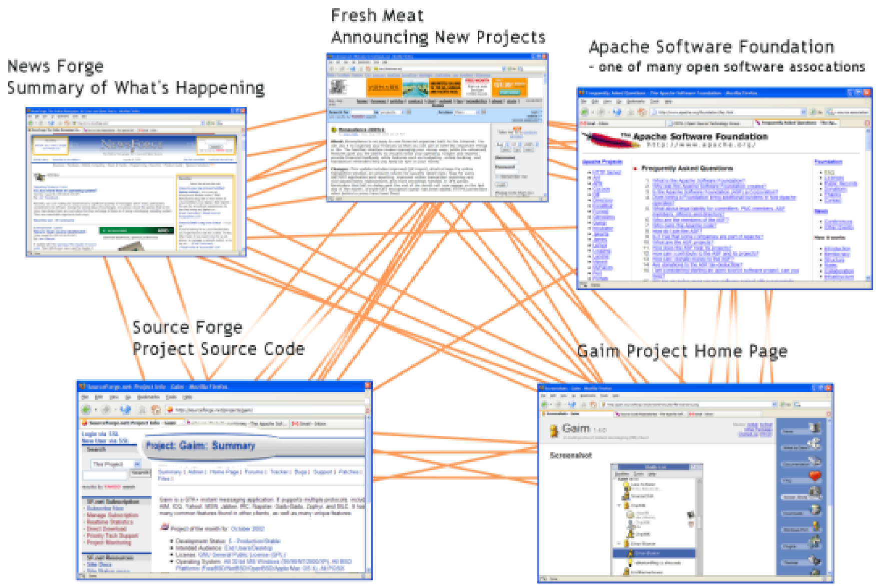

Figure 2-2: FLOSS Community Places (source http://innovationcreators.com/wp/?p=70)

Chat (IRC) seems to be usually used for (add-hoc) meetings (Hemetsberger 2006) and wikis for documentation purposes, meanwhile mailing lists and forums are used for knowledge building and as the community's group memory (Hemetsberger 2006). The advantage of asynchronous communication through mailing lists and forums is not only that conversations are recorded and become a learning resource itself, but also that they make members 'think' before they post (Hemetsberger 2006).

By contrasting the FLOSS case studies from Krogh (Krogh 2003) and Hippel (Hippel 2002) Meiszner (Meiszner 2007) suggests that mailing lists might be more frequently used by developers as a collaboration environment, while the larger community prefers the use of forums.

Learning in FLOSS is problem based as shown in table 2.1 and often is about people coming together to collaboratively 'scratch an itch' (Bolstad 2006).

Joomla - Section General Questions - last 10 Subjects (15.11.07 - 15.51GMT)		
Subject	**Replies**	**Views**
Multiple Content areas on one page New	6	47
Want to add new pages to my website (Newbie needs some help) New	8	75
how to change background color for content??? New	2	5
Can anyone please help me kill this bug!!! New	4	40
Cant create a new category in web links "Category Manager" New	0	5
SWf file in css file New	7	39
Joomla in two directories? New	1	9
Drop Down Menu New	1	18
How could I finish a site just similar to extensions.joomla.org by using joomla? New	2	20
Unable to install components in 1.0.13 New	1	8

Table 2-1: General questions – taken from Joomla forum directory

As highlighted by the FLOSSPOLS Developer Survey (Ghosh & Glott 2005b) self-studying is a common form of learning (58% of the community members), and the most common approaches to learning are those that provide the opportunity to either read or work on the code and that depend on Internet-based technologies. Collaborative learning, as shown in Figure 2.3, therefore takes place once the individual is stuck on a problem and requests help from the community, or as a result of reflecting on or discussing issues related to problems, projects or improvements.

Quote from: north on March 24, 2006, 11:13:11 PM

> After try my best to follow the instructions to move Joomla to a new server, I get this error on the new site:
>
> ####################
> Warning: main(): open_basedir restriction in effect. File(/public_html/includes/version.php) is not within the allowed path(s): (/home/north23:/usr/lib/php:/usr/local/lib/php:/tmp) in /home/north23/public_html/includes/joomla.php on line 71
>
> Warning: main(/public_html/includes/version.php): failed to open stream: Operation not permitted in /home/north23/public_html/includes/joomla.php on line 71
>
> Fatal error: main(): Failed opening required '/public_html/includes/version.php' (include_path='.:/usr/lib/php:/usr/local/lib/php') in /home/north23/public_html/includes/joomla.php on line 71
> ####################
>
> Any pointers on what my problem is here?
>
> Cheers,
> NORTH

i have the same problem (except mine is on line 75)... i have switched the file properly before and have not seen this error. i have changed my configuration files properly. any thoughts? thank you,
tom dorsey

Figure 2-3: Peer collaboration – taken from Joomla forum directory

Once they are more familiar with the project, the different programming languages and approaches, and the environment itself then learners might also take on a more pro-active role such as starting their own sub-projects or joining existing ones where they would engage in the collaborative construction processes.

> "… During this learning process constant interaction with others also strengthens social ties and leads to close friendships. Giving back and contributing to the community then becomes "the natural thing to do". Individual contributions are rewarded by reactions of community members who appreciate the contributions…Central to this concept is not to regard learning as being taught or instructed, that is, learning about practice, but rather as becoming a practitioner (Brown and Duguid, 1991). Learning takes place through observing practice, how other members of the community achieve their tasks. Newcomers first have to assimilate the norms and values of the community and analyze the activity of the experts before they are able and capable of contributing to the group." (Hemetsberger 2006)

But even within a vibrant FLOSS project, which has an existing community of thousands of members, new participants that have not yet established their own network within a community might find it difficult to get in contact with peers, as shown in Figure 2.4.

Use the modules homepage to report usage trouble by **pittmike**, March 26, 2006
5 of 5 people find this review helpful:

Very unfortunate that posters here do not want to share their usage problems. The projects homepages is
http://forge.joomla.org/sf/projects/mod_header_image
and there usage reports can be posted to the discussion forum.

The modules debug mode is intended as information to be posted along with the problem seen, so that we developers can improve the modules code.

Open Source lives from the feedback of its users that allow us to improve the software and redistribute it to all users in open form with no fees attached.

Figure 2-4: The value of feedback – taken from Joomla extension directory

On the other hand, even if they are requesting help for issues that have already been discussed, participants might be lucky and be provided with guidance as figure 2.5 shows.

Figure 2-5: Individual guidance – taken from Joomla forum directory

In summary it might be said that collaborative learning, individual learning and learning through the observation of others are closely connected within FLOSS communities. Individuals are first asked to learn themselves with the provided broad range of learning materials, than to see what and how others have solved problems, and ultimately to collaborate with peers.

2.5 Reflective Practice

The FLOSS environment presents an interesting scenario where both learners and experts are co-present. The vibrant FLOSS development process only succeeds because many people volunteer their time and effort to share their knowledge and develop the software. FLOSS projects represent "Distributed Collective Practices" (Turner, et al., 2006) where users are not isolated from direct involvement in the development process as it unfolds. Every member has access to another member and the project's resources; increasing the chance for participants to easily interact and share their knowledge. FLOSS participants are engaged in a continuous design and collaboratively work in a complex software development and learning environment. The process of reflective practice and collaborative learning has been used as the key approach to understand how individuals interact, manage their tasks, and collaborated in complex FLOSS projects. According to Schon (1983) most professionals work as reflective practitioners.

What is reflective practice and who is a reflective practitioner has received a lot of attention in the organizational learning literature, and the following characteristics have been identified:

- Reflection is an active process of witnessing one’s own experience in order to take a closer look at it, sometimes to direct attention to it briefly, but often to explore it in greater depth (Amulya*)*
- Reflective practice involves thoughtfully considering one's own experiences in applying knowledge to practice while being coached by professionals in the discipline (Schon, 1983).
- Reflective practitioners (teachers) are relentless about striving for improvement in their practice, they challenge and question themselves; they look for new and improved ways of working so that all of their learners are enabled to make the best possible progress.

If we consider behaviour in FLOSS communities, then many of these characteristics are in evidence. Developer's will reflect on their previous efforts and inputs in order to improve. This may be a result of feedback they received from the community, or by observing other contributions, but the result is often reflection on their own performance. The coaching by professionals that Schon highlights is less formalized in FLOSS communities, but is widely in evidence with gurus and experienced community members offering support either directly (for example responding to a query) or indirectly (for example through reading forum exchanges between them).

3 Associated pedagogies

3.1 Introduction

In the last section we looked at how learning takes place in FLOSS communities. In this section we will take the same four approaches and examine them from a pedagogical perspective. For example, project based learning can be seen as being a good example of the communities of practice work set out by Wenger. Within a community of practice participants move from peripheral involvement to central involvement by performing legitimate tasks within that community. This is again in contrast to how much of higher education works, where students are often given theory and artificial tasks, but relatively little engagement with a real community (this is not always true, for example in medicine a community of practice approach is more identifiable).

3.2 Interaction with learning materials, including self-studies

Learning and memorizing

Learning materials are intended to aid and scaffold the student in learning. It is probably worth defining our interpretation of learning. Conceptions of learning were first described in 1979 by Säljö (Säljö, 1979), who interviewed 90 people in Sweden ranging in age from 18 to 70, asking them the basic question "What do you mean by learning?" The analysis of their responses led to five categories of description of learning, as follows:

A. increasing one's knowledge

B. memorising and reproducing

C. applying

D. understanding

E. seeing something in a different way

In 1982, Säljö claimed that there was a relationship between conceptions of learning and the approach to learning adopted by the students, and this was confirmed in Holland by Van Rossum and Schenk (1984). Then, using a different methodology, Giorgi (1986) also verified the existence of these conceptions of learning. In 1993, a longitudinal study of Open University students in the United Kingdom by Marton, Dall'Alba and Beaty (Marton et al., 1993) again confirmed Säljö's five conceptions and added a sixth,

F. learning as "changing as a person"

Traditionally, the contrast between deep versus surface approaches to learning is based on the learner's intention to understand or lack of such an intention. These two different approaches are expressed through a focus on the text itself, which the learner intends merely to reproduce (in the surface approach) contrasting with a focus on the underlying meaning of the text, which the learner intends to comprehend (in the deep approach). This contrast implies that memorisation, which the learner uses in order to reproduce, is by definition incompatible with understanding. But Kember (1996) cites a number of studies of Asian learners which contain evidence to the contrary. Kember and Gow (1990) identified a "narrow orientation" in students who systematically go through sections of the material to be learned, seeking to understand first, and then memorise. Hess and Azuma (1991) found that understanding in Japanese schools is achieved through repetition and memorisation, memorisation being used as a technique to understand. Marton et al. (1993) similarly found memorisation used as a strategy to reach or enhance understanding. In terms of chronological relationship between the two processes, this means that two patterns are found: understanding, then memorisation (Kember & Gow, 1990, 1991), memorisation, then understanding (Hess & Azuma, 1991) and both (Marton et al., 1993).

<u>Learning and understanding</u>

What is the relation between understanding and learning? Landbeck & Mugler (1994) argue that students learn with two quite distinct meanings, one to describe the acquisition and storage of information (which they call Learning1 (L1)), a process which does not necessarily imply understanding, and a second which referred to coming to an understanding of the material that had been acquired (which they call Learning2 (L2)). The knowledge of level L1 normally has to be thought about before it can be understood. Once it is understood, then what students themselves call "real" learning has taken place. The progression from L1 to L2 is illustrated by one student's words: "Well, learning is something that you get into your mind that's something new to you in the first place, and you keep it there, you get to understand it and then later you come to use it. I mean it's always there, it doesn't go away". (Landbeck & Mugler, 1994)

<u>Usability and learnability</u>

The variable of learnability as regards learning materials is considered in the literature as of paramount importance. There has been much discussion recently about the relationship between the usability of the enriched contemporary learning materials and their learnability, namely the ability of the materials to foster knowledge creation. This is a more complicated issue than it seems, since some cognitive aspects must be considered as well, for example the learning styles of the participants (Felder, 1996), individual student characteristics, such as age and cognitive abilities (Georgiadou & Economides, 2000), or content and nature of the instructional material (Poncelet & Proctor, 1993). Some studies (eg. Squires & Preece, 1999) argue that there is a very close relationship between the aforementioned notions, while others (eg. Mayes, 1996; Jones et al., 1999) state that the augmented usability of an environment does not affect its learnability or vice versa. Duchastel (2001) prefers to completely separate the two notions, claiming that the usability of online learning materials can be broken down into two distinct issues: the usability of the supporting infrastructure and the learnability of the course content.

<u>Constructivist learning materials</u>

As theories of learning have developed and educationalists have gained more experience in using computer-based technology, there has been a shift of emphasis from the behaviourist paradigm, through the weak artificial intelligence approach, as described by Atkins (1993), to a constructivist view.

Learning is a process (Duchastel, 2001) and so is instruction in the sense of manipulating the situation so as to facilitate learning. So a usable learning material adds to this direction, not only by becoming *transparent* to the user allowing him to concentrate on his goal (Preece et al., 1994; Shneiderman, 1998; Karoulis, 2001), but also by becoming *intuitive* supporting exploration and experimentation, two important features for every instructional resource (Jonassen, 1992; Ross & Morrison, 1989; Laurillard, 1987). When the synergy between usability and learnability occurs, the use of the resource can be thought of as "integrated", in that a seamless union develops between the use of the learning material and the learning process (Squires & Preece, 1996).

For most educationalists, constructivism offers far more scope for realising possible learning benefits of using information and communication technology. In fact Reeves (1994) refers to the claim by Gagné & Glaser (1987) that virtually all self-respecting instructional design theorists now claim to be cognitivists (Squires & Preece, 1999).

Many writers have expressed their hope that constructivism will lead to better educational learning resources and better learning (e.g. Brown et al., 1989; Papert 1993; Jonassen, 1994). They stress the need for open-ended exploratory authentic learning environments in which learners can develop personally meaningful and transferable knowledge and understanding. The lead provided by these writers has resulted in the proposition of guidelines and criteria for the development of constructivist learning resources (e.g. Rieber, 1992; Cunningham et al.,1993; Honebein et al., 1993; Driscoll, 1994; Grabinger & Dunlap, 1995; Savery & Duffy, 1995) and the identification of new pedagogies as regards their application (e.g. Guest, 1990; Hill, 1990; Edwards, 1990; Davis, 1990; Laurillard, 1992; Watson, 1992).

A recurrent theme of these guidelines, software developments and suggestions for use is that learning should be authentic, on a cognitive and contextual level. A tenet of constructivism is that learning is a personal, idiosyncratic process, characterised by individuals developing knowledge and understanding by forming and refining concepts (Piaget, 1952), which finally leads to the five main socio-constructive learning criteria (Squires & Preece, 1999) that must be met in order to characterize an educational learning resource as socio-constructive credibility, complexity, ownership, collaboration and curriculum.

Evaluation of learning resources

Georgiadou & Economides (2000) argue that the information contained within a piece of educational resource is the first parameter that should be evaluated. This evaluation usually occurs according to the criteria of Netskills (2000) and NCDPI (2000):

- Validity and authority: reliable content, reputable authors, publishers and origin of information
- Accuracy: current end error-free information, bias-free viewpoints and images, correct use of grammar.
- Appropriateness: concepts and vocabulary relevant to learners' abilities, information relevant to age group curriculum, interaction compatible with the physical and intellectual maturity of intended audience
- Scope and coverage: information of sufficient scope and depth, logical progression on topics, variety of activities, with options for increasing complexity.

In the field of the applied evaluation approaches for learning resources, Bates (1981) describes some *experimental* evaluation methods, however, the environment of these approaches is artificial, so it does not provide enough information on its real use with users (Gunn, 1995), while Tergan (1998) provides some checklists to evaluate educational resources, an approach that is broadly used. Yet, the ability of checklists to predict educational issues in all but a naive and superficial way has been questioned by several researchers, e.g. McDougall & Squires (1995). They argue the checklists to be seriously flawed in principle because they do not encompass a consideration of learning issues, and more particularly they fail to take account of the widely accepted view of learning as a socio-constructivist activity, as already stated. They cite a number of authors who identify problems which evaluators have found with the use of checklists as predictive evaluation tools to select educational software:

- it is difficult to indicate relative weightings for questions (Winship, 1988)

- selection amongst educational software of the same type emphasises similarities rather than differences (Squires & McDougall, 1994)
- the focus is on technical rather than educational issues (Office of Technology Assessment, 1988)
- it is not possible to cope with the evaluation of innovative software (Heller, 1991)
- it is not possible to allow for different teaching strategies (Winship, 1988)
- off-computer, teacher generated uses are not considered (Squires & McDougall, 1994)
- evaluation in different subject areas requires different sets of selection criteria (Komoski, 1987)

3.3 Project-based and case-based learning

By its very nature, work in a FLOSS context is problem-based, case-based or project-based. So, one could argue that the principles of Problem-based Learning (PBL), Case-based learning (CBL) or Project-based learning would be applicable here as well.

Definitions

According to Savery (2006), *PBL* is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem. Critical to the success of the approach is the selection of ill-structured problems (often interdisciplinary) and a tutor who guides the learning process and conducts a thorough debriefing at the conclusion of the learning experience.

A *case* is essentially a story with a point, a written narrative of a real-world event, situation, or experience that connects particular situations, faced by a single individual or many, to more general principals, theories, methods, or standards (Hachen, 1996; Shulman, 2000). A *case study* then becomes a "partial simulation of reality that presents real world problems in controlled environments" (Ward, 1998, p.103). Professionals in diverse fields use the language of cases to make sense of their practice, and, indeed, *case-based learning* (*CBL*) ultimately takes advantage of this human tendency to make sense of the world through sharing, comparing, blending, or denying stories. New stories provide alternative ways for the mind to organize and store information, elaborate existing understandings, and potentially transform one's professional view (Morison, 2001).

Project-based learning on the other hand focuses on a relatively long-term, integrated units of instruction where learners focus on complex projects consisting of multiple cases. They debate ideas, plan and conduct experiments, and communicate their findings (Krajcik et al., 1994).

Characteristics

Several authors have described the characteristics and features required for a successful PBL approach to instruction. Boud and Feletti (1997) provide a list of the practices considered characteristic of the philosophy, strategies, and tactics of problem-based learning. Duch, Groh, and Allen (2001) described the methods used in PBL and the specific skills developed, including the ability to think critically, analyze and solve complex, real-world problems, to find, evaluate, and use appropriate learning resources; to work cooperatively, to demonstrate effective communication skills, and to use content knowledge and intellectual skills to become continual learners. Torp and

Sage (2002) describe PBL as focused, experiential learning organized around the investigation and resolution of messy, real-world problems. They describe students as engaged problem solvers, seeking to identify the root problem and the conditions needed for a good solution and in the process becoming self-directed learners. Historically, the case method of instruction in higher education was first implemented at Harvard University – in law during the 1870's, medicine during the 1900's, and business during the 1930's (Sykes & Bird, 1992). PBL was thereafter intensively used in medical education, where a group of student doctors saw a patient and had to come up with a diagnosis. Certainly in many of these cases, there was a single correct answer. However, Hmelo-Silver (2004) argues that PBL is an instructional method in which students learn through facilitated problem solving that centres on a complex problem that does not always have a single correct answer. She noted that students work in collaborative groups to identify what they need to learn in order to solve a problem, engage in self-directed learning, apply their new knowledge to the problem, and reflect on what they learned and the effectiveness of the strategies employed.

In the case-based approach, case effectiveness depends upon the subject matter and context of its intended use. Sykes & Bird (1992) pointed out that each profession has its own challenges, central ideas, and environment that may require rethinking and restructuring of typical case-based instruction. Is the case intended to anchor an entire course of study, or will it be one of a series of "mini-cases" presented to "build a pattern of understanding across multiple instances" (p.464)? Bliss and Mazur (1996) further categorize cases according to two primary foci: *Controversy* cases explore a controversial or problematic issue within a field, while *aspiration* cases include rich and extensive descriptions of best practice for study and emulation.

Generally, however, proponents of CBL agree on many common characteristics of a strong case. First, an effective case is realistic and relevant; it contains a "hook" to engage participants' imaginations and engender identification with the dilemma facing the decision maker. Embedding an emerging issue from the domain gives students the opportunity to explore and apply current professional knowledge and research. A case should be ambiguous and messy, requiring students to identify, analyze, and consider multiple contributing factors and possible solutions. Ideally, a case will contain ambiguities that require students to "fill in the blanks." The human element – alternate agendas of the key players and organizational politics – should be embedded in the narrative and supporting ancillaries. Current wisdom recommends that cases require student groups to deal with conflicting values and multiple perspectives through collaboration, broadening their own knowledge bases and developing the teamwork skills essential to many professions. Finally, cases should frame the necessity for students to support all assumption and design solutions with evidence and to predict and consider the consequences of various courses of action (Abell, 1997; Bliss & Mazur, 1996; Hachen, 1996; Hazard, 2000; Julian et al., 1999; Morison, 2001; Shulman, 1996).

Project-based learning is similar to problem-based learning in that the learning activities are organized around achieving a shared goal (project). This instructional approach was described by Kilpatrick (1921), as the Project Method and elaborated upon by several researchers, including Blumenfeld, Soloway, Marx, Krajcik, Guzdial, and Palinscar (1991). Within a project-based approach learners are usually provided with specifications for a desired end product (build a rocket, design a website, etc.) and the learning process is more oriented to following correct procedures. While working on a project, learners are likely to encounter several "problems" that generate "teachable moments" (Lehman, et. al, 2006). These researchers argue that teachers are more likely to be instructors and coaches (rather than tutors) who provide expert guidance, feedback and suggestions for "better" ways to achieve the final product.

Esch (1998) offers two helpful continua for distinguishing between problem-based and project-based learning:

The extent to which the end product is the organizing centre of the project. At one end of this continuum, end products are elaborate and shape the production process and, at the other end, end products are simpler and more summative, such as a group's report on their research findings. The former case typifies project-based learning, where the end product drives the planning, production, and evaluation process and the latter, where the inquiry and research is the primary focus of the learning process, typifies problem-based learning.

The extent to which a problem is the organizing center of the project. In this case, at one end are projects in which it is implicitly assumed that any number of problems will arise and students will require problem-solving skills to overcome them and, at the other end, are projects that begin with a clearly articulated problem and require a set of conclusions and/or solution. Again, the former example typifies project-based learning and the latter typifies problem-based learning.

In both problem-based and project-based learning, the teacher (facilitator) is available for consultation and plays a significant role in modelling the metacognitive thinking associated with the problem-solving processes. While cases and projects are excellent learner-centred instructional strategies, they tend to diminish the learner's role in setting the goals and outcomes for the "problem." When the expected outcomes are clearly defined, then there is less need or incentive for the learner to set his/her own parameters. In the real world it is recognized that the ability to both define the problem and develop a solution (or range of possible solutions) is important.

<u>What makes PBL/CBL effective?</u>

On the website for the PBL Initiative (http://www.pbli.org/pbl/generic_pbl.htm) a set of *Generic PBL Essentials* is described in detail, summarized to the bullet points below.

Students must have the responsibility for their own learning. PBL is a learner-centered approach—students engage with the problem whatever their current knowledge/experience affords.

The problem simulations used in problem-based learning must be **ill-structured** and allow for free inquiry. Jonassen (1999) emphasizes that the problem should not be overly prescribed. Rather, it should be ill-defined or ill-structured, so that some aspects of the problem are emergent and definable by the learners. Ill-structured problems have unstated goals and constraints and have multiple solutions, solution paths, or no solutions at all. One needs to decide if the students possess prerequisite knowledge or capabilities for working on the problem that one identifies.

- Learning should be integrated from a wide range of disciplines or subjects, related to understanding and resolving a particular problem.
- Collaboration is essential. PBL provides a format for the development of essential collaboration skills.
- What students learn during their self-directed learning must be applied back to the problem with reanalysis and resolution. It is essential that each individual share coherently what he or she has learned and how that information might impact on developing a solution to the problem.
- A closing analysis of what has been learned from work with the problem and a discussion of what concepts and principles have been learned are essential. Barrows (1988) advises that learners examine all facets of the PBL process to better understand what they know, what they learned, and how they performed.
- Self and peer assessment should be carried out at the completion of each problem and at the end of every curricular unit. The significance of this activity is to reinforce the self-reflective nature of learning and sharpen a range of meta-cognitive processing skills.

- The activities carried out in problem-based learning must be those valued in the real world. A rationale and guidelines for the selection of authentic problems in PBL is discussed extensively in Savery and Duffy (1995), Stinson and Milter (1996), Wilkerson and Gijselaers (1996), and MacDonald (1997).
- Student examinations must measure student progress towards the goals of problem-based learning, both knowledge-based and process-based.
- Problem-based learning must be the pedagogical base in the curriculum and not part of a didactic curriculum.

Implementation of PBL/CBL

Despite the variety of application possibilities, Benham (1996), and others agree on a common model of the case-based method that can be summarized in the following steps:

- Clarify the facts of the case and identify the issues involved.
- Explore the case from multiple perspectives and learn how to "frame" the situation within its particular context.
- Use professional knowledge (from research and/or personal experience) to discuss the case.
- Propose possible decisions and action plans to solve the dilemma or identify and explain examples of best practice in the domain.
- Determine the consequences of alternative courses of action.
- Choose and justify a solution, and create a plan to evaluate its effectiveness.

This is not an unusual approach, as it bases on the *eight steps of programming*, a well-known procedure in management science. Laudon & Laudon (2000) summarise these steps as follows:

- Definition of the problem and the objectives to be achieved
- Environment analysis
- Proposal of alternative treatments
- Requirements analysis for these treatments
- Choosing the "ideal" treatment
- Preparation and design of the application
- Implementation of the chosen treatment
- Evaluation of the perceived results as regards the initial stated objectives

As reported in the literature (e.g. Bacon & Dillon, 2006; Crowston & Howison, 2005) FLOSS projects are not anarchic but merely managed by the core programmers. However, this management is not rigorous, so the first, more general list is generally followed in designing the project structure under consideration. This list provides a guidance in either cases, typical education and FLOSS.

An undeniable strength of CBL is its potential for supporting a range of epistemologies. Morison (2001) points out that instructors who view human learning from an objectivist viewpoint can design their cases to flow in a logical and rational sequence, with built-in decision points and choices. These instructors can guide learning activities and navigation, posing carefully-crafted problems and critical thinking exercises that can be evaluated in an objective manner, with particular attention to rational decision-making and student ability to evince that thinking in their approach to the case.

This is the case in FLOSS projects as well, as the participants have to rely on their prior knowledge on various domains and build upon different perspectives in order to proceed to an “optimal” solution.

3.4 Cooperative learning in a networked environment

Cooperative or collaborative learning approaches that rely on a cognitive and constructive assumption gained more and more on popularity within the educational landscape in recent years (Karagiorgy, 2005). This development might also correspond with the opportunity that ICT provides for cooperative / collaborative learning in networked environments. A majority of literature that covers ICT and technology enhanced learning (TEL) approaches learning as a social experience, using constructivist learning strategies, and agrees that the use of technology helps to support the needs of diverse learners.(Gulati, 2004).

The constructivist theory argues that knowledge is being actively constructed by the individual, with the individual being left to make their own discoveries, inferences that are based on their current and past knowledge, and to draw their own conclusion as a results of their actions (‘hands-on approach’) (Mayer, 1992; Hendry, 1996).

From the cooperative / collaborative learning theory learners are supposed to work together in groups towards a common goal, being responsible for one another's learning as well as their own. One benefit is seen within the active exchange of ideas within these groups that not only increases the interest among the participants but also promotes critical thinking (Gokhale, 1995). One of the underlying ideas is that students learn more once being engaged in activities instead of just watching and listening; and also that cooperative / collaborative learning is of mutual benefit for both weak and strong students. Weak students that are working individually are likely to give up when they get stuck, but if working cooperatively do not so, meanwhile strong students learn more by supporting weak students and likely also find gaps in their own understanding that they won’t not have done else. (Felder & Brent 2007)

Research further indicates that students, who are engaged in a collaborative learning project, frequently gain an increased level of tolerance and acceptance of other people's viewpoints, a skill which can be beneficial in real-life situations where compromises are often required (Andres, 2002). Challenges of cooperative / collaborative learning might be the requirement for coordinated scheduling, availability of common communication tools, no mutually accepted goals and objectives, lack of basic skills and for formal education the individual assessment of student’s achievement (Andres, 2002). Gulati (2004) argues that constructivist learning strategies often do not work out in educational settings due to the lack of informal learning spaces and opportunities that provide freedom to “try things out”, to adopt multiple roles, to make use of prior knowledge, or to take risks and make mistakes.

Applied within virtual networked environments cooperative / collaborative learning has been often referred to as Computer Supported Collaborative Learning (CSCL). The opportunities CSCL offers are seen in enabling collaboration, interactive learning, and new pedagogical approaches that can lead to changes in the way students and faculty interact (Kim, 2000). CSCL practices are more and more implemented at K-12 educational level throughout Europe being described as a promising pedagogical paradigm (Dean, 2004). The ITCOLE project analyzed the impact of CSCL on students’ learning, involving 80 schools at K-12 level in 4 different countries. Teachers involved at this project agreed that the use of the electronic learning environments supported collaboration among students, but also concluded that knowledge building with students is a complex process, (especially when not explicitly guided by teachers) and that in addition to virtual meetings, face-to-face meetings were necessary to support students within their learning process. (Dean, 2004)

Chapter 2.4 has provided an overview of how cooperative / collaborative learning takes place within FLOSS communities. The learning activities in FLOSS as described at chapter 2.4 provide some similarities with the learning theories described above and illustrated at Figure 3-1.

Learning Theories					
	Behaviorism	**Cognitivism**		**Constructivism**	
proponents	B.F. Skinner	Jerome Bruner	Lev Vygotsky	John Dewey	Knowles
applications	training, e.g. flight simulators	any deep processing: exploring, organizing, synthesizing content		Collaborative learning	
instructional design focus	Instructor designs the learning environmment.	Instructor manages problem solving and structured search activities, especially with group learning strategies.		Instructor mentors peer interaction and continuity of building on known concepts.	
view of learner	basically passive, just responding to stimuli	Learners process, store, and retrieve information for use. (Bruner's Discovery Learning)		Learners create their own unique education because learning is based on prior knowledge.	
assets	integrating complex muscular and cognitive activities	Vygotsky's Zone of Proximal Development focuses on interactive problem solving.		Learning is interactive, dialogic.	
implications	**Climate for Learning**: Does the environment have the right stimuli to promote learning?	**Readiness**: Students will learn concepts that are maturing. **Opportunity**: ZPD = area between what a learner can do individually vs. assist by peer interaction, research and teaching. **Learners Customize Their Learning**: Provide a range of learning activities and concepts for core course objectives.		**Prior Knowledge**: Design learning to assist students to build on what they know. **Inquirey Learning**: Adult learners have a mutual vested interest in their learning and want to involve real experience; teachers are not the sole possessors of knowledge and perspective but co-learners and guides. (Knowles' andragogy)	

Figure 3-1 Learning Theories (source: VCCS Litonline)

As shown at chapter 2.4, and the FLOSSCom phase 1 report (Glott et al, 2007), learning in FLOSS can be seen as collaborative learning, that builds on prior knowledge, with individual learners having different degrees of knowledge and expertise, involving real experience, a peer component and the aspects of inquiry (see also 3.3). Learner in FLOSS create their own education due to the absence of curricula, with the learning being based on own prior knowledge or the one of others. From the learning theory side this prior knowledge of others might correspond with the knowledge the educator possesses and shares with the learner. Analogue to the notion of Felder & Brent (2007), that strong students benefit once supporting weak students, which has been identified as a strong motivational aspect within FLOSS (Ghosh et al., 2002; Lakhani and von Hippel, 2003).

Some of the aspects that might deserve further analysis are e.g.:

- the observation of Gulati (2004) that constructivist learning strategies often do not work out due to the lack of informal learning spaces and the importance of informality for learning in FLOSS
- the observation of (2004) Dean that in addition to virtual meetings, face-to-face meetings were necessary to support students within their learning process, which can be found in FLOSS projects too (e.g. Ubuntu, Joomla, osCommerce)

3.5 Reflective Practice

Schon (1983) noted that professionals often work on ill-defined problems which present opportunities for reflection, negotiation, collaboration, and eventually improvement in practice (Redmiles and Nakakoji, 2004). Schon drew a distinction between *technical rational* and *professional artistry*.

The technical-rational paradigm adopts a nomothetic approach, believing that systems are what matter and that these, being essentially logical, can therefore be made efficient by the application of logic and strategy. This approach relies upon laws, rules, prescriptions, schedules and routines to control and standardize the system.

The professional-artistry approach by contrast views organizational learning and development as a practical art rather than a scientific process. It stresses contextualized understanding of learning and development rather than adherence to a set of national standards. This approach takes a holistic approach to organizational development and believes that quality has to be measured from a multi-stakeholder perspective. Within this paradigm a key emphasis is placed on creativity, innovation and exploration of alternative and sometimes contradictory perspectives on practice. It thus sees organizational knowledge as more than a technical exercise. More than a set of defined regulations and procedures and above all, more than the sum of its definable parts.

Bond and Kirkham (1999) interpretation of the work of Argyris and Schon (1978) is much relevant to how learning takes place in FLOSS and is embodied in the concept of *constructivist epistemology of reflective practice* in which the "means and ends are interdependent and interact in problem-solving and setting, research and practice are interwoven, and knowledge arises from doing and informs further action which in turn generates new knowledge" (page 247). A comparison of the two dimensions of reflective practice as they apply to FLOSS is shown in Table 3.1 below.

Organizational Learning	
Technical rational	Professional artistry
Govern by rules, laws and tight work schedules	Flexible, diffuse rules, volunteering
Work to produce efficient systems	Creativity and room for errors and corrections
Knowledge is permanent	Knowledge is temporary
Visible performance, technical skills	Professional expertise
High quality and standards	Quality comes from within community
Pre-defined goals	Not all can be defined
Required theory to be learnt and applied to practice	Theory comes out of practice
Appraisal inspection control	Reflection and investigation of practice
Training	Education and development
Instrumentalist view	Constructivists view
Focus on product	Focus on process
Individual efficiency	Group efficiency

Table 3-1: The Two Dimensions of Reflective Practice in FLOSS

4 The ‘Commons’ component

4.1 Introduction

“Given enough eyeballs, all bugs are shallow” (Raymond, 2000) is today a well known description and one of the core characteristics of FLOSS communities. The FLOSS system is based upon the commons' component starting with the aspect of commons based peer production, the release of the final product to the commons and ending with commons support system.

The FLOSS commons’ approach might also be of interest for education helping to improve current educational systems and develop them towards educational commons (Hepburn 2004).

> “As schools begin to use open source products they will move closer to the ideal of a commons, while solving many problems that have confronted them in the past. As more schools move in this direction, the value and quality of the resources are likely to increase rather than be depleted. There are, however, several challenges that must be considered in order to begin taking advantage of open source products in a productive way.”(Hepburn 2004)

4.2 Content in FLOSS vs. Education

As highlighted in the FLOSSCom Phase 1 Report content in “FLOSS communities provides users with various types of learning resources, the ‘common’ ones like manuals, tutorials, or wikis, but also resources that might not be recognized at first as learning resources or content, for example mailing lists, forums or blogs. One common aspect of the different types of content is that they are jointly generated by user and developer and after generation continuously updated and improved”.

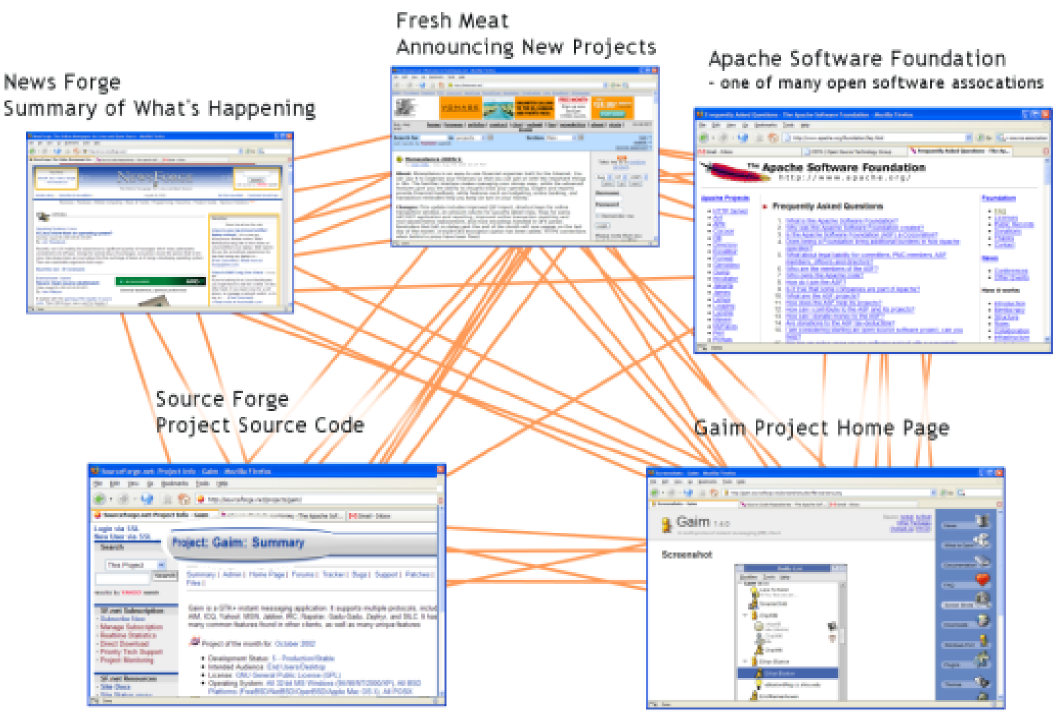

Figure 4-1: FLOSS Community Places (source http://innovationcreators.com/wp/?p=70

In sharp contrast content in educational settings is usually the product of few authors with few contributions from people other than authors. This content is infrequently released and feedback to it is only seldom considered, resulting in a low degree of updates with no continuous development cycle. The content usually does not include the prior learning outcomes and processes of learners, which are consequently not systematically available and searchable as one can see in FLOSS (e.g. at mailing lists/forums and commented code). (González-Barahona et al 2005a.; González-Barahona et al. 2005b)

Though content in educational settings today makes use of different available information, communication and multimedia technologies, the way content is produced and the underlying complexity of its production is still very different to what one can see in FLOSS, or the web at large. This does not refer to the FLOSS development process, which is likely to be as complex, but the production of learning resources in FLOSS. Figure 4.2 provides an overview of today's content production approaches in educational settings. This content production model follows the traditional expert model with complex and well defined development structures. Students' learning processes and outcomes are not a part of this system and students' involvement might be limited to providing some feedback on the final product.

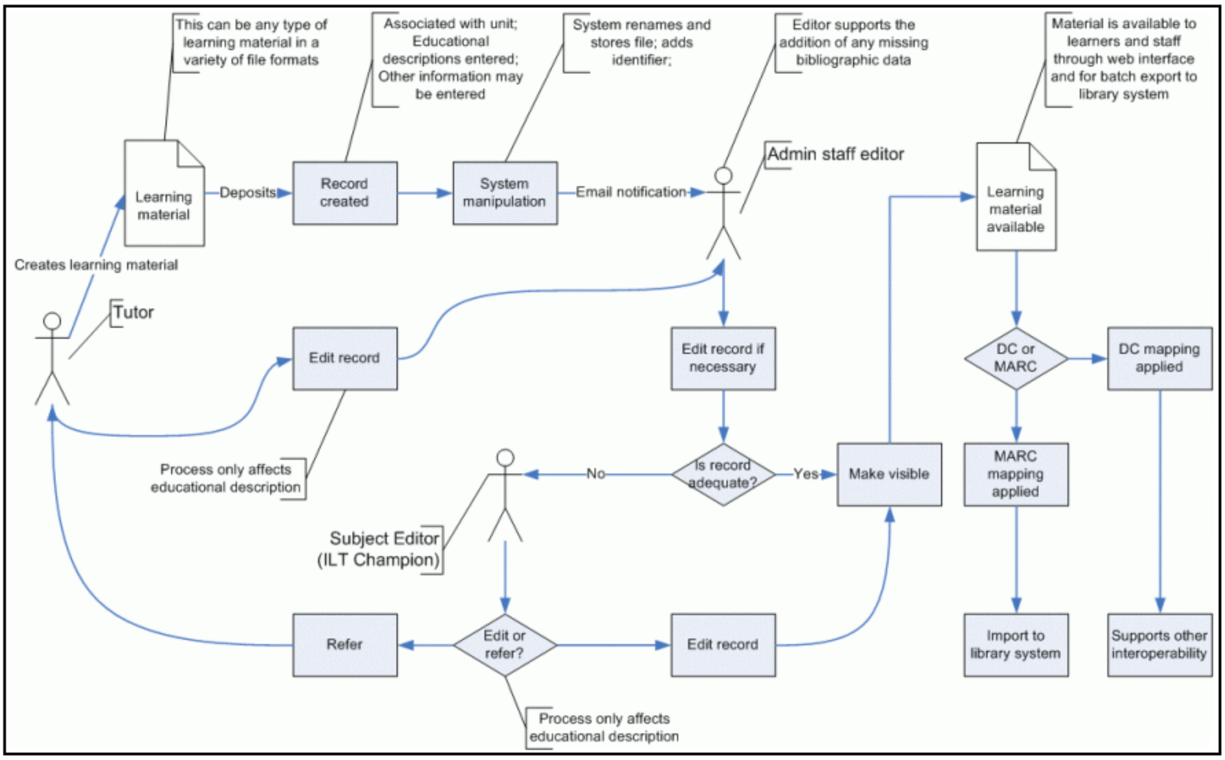

Diagram: Workflow for metadata creation for Learning materials at John Wheatley College.

Figure 4-2: Learning Resources in Traditional Education – Expert Production Model

The FLOSS model on the other hand combines expert production with users input, plus further user generated content. The production of the software itself, or at least the core code of it, might be comparable with the above expert production model within educational settings. FLOSS community members on the other hand, as shown in figure 4.3, are valuable contributors that create content 'on the fly' due to their interactions and activities, but also in a more organized way by compiling manuals, instructions or live demos, or by establishing their own sub-projects to extend the core functionalities of a piece of software.

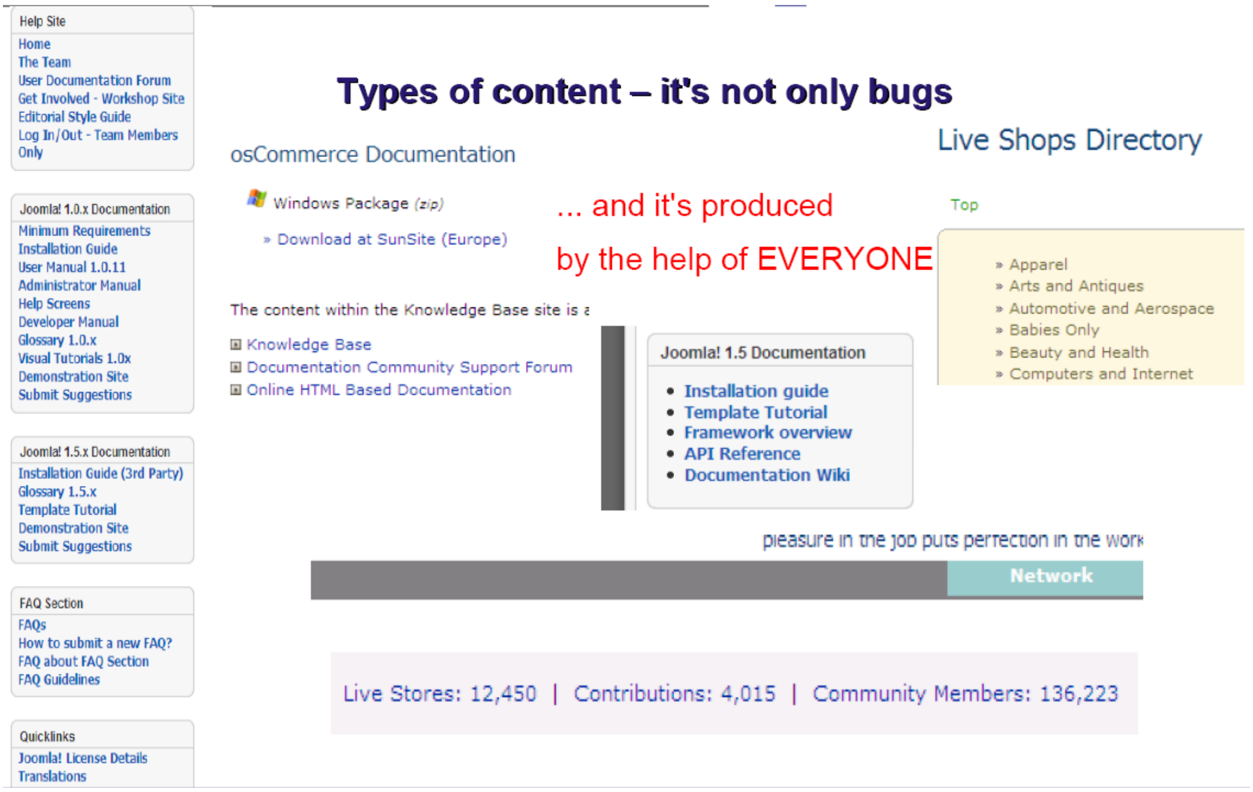

Figure 4-3: Learning Resources in FLOSS – Community Production Model

Early FLOSS-like educational pilots (dePaula 2001; Groom & Brockhaus 2007; Wilkoff 2007) have indicated however that FLOSS principles can be successfully applied to education and to provide students with similar learning resources, allowing them to become content creators. Such a FLOSS-like educational approach has also been suggested by the EU funded Edukalibre project, stating that FLOSS-like principles for educational settings might add a value for the creation and maintenance of educational materials, with those educational materials being located mainly on the Internet and are produced by groups of educators that come from different institutions and that are geographically dispersed. Those materials would also be used, commented on and modified by students, with educators and students using tools that enable them to collaborate in the way FLOSS developers do, making their produced materials publicly available to enable further collaboration on them with third parties. (González-Barahona et al. 2005)

4.3 Community based support in Floss and possible educational counterparts

The FLOSS community support system is today largely recognized for its user to user support approach and companies like e.g. DELL already started to market their products with Linux preinstalled installations as their customers' indicated that those community support systems would meet their support needs.

In the FLOSSCom Phase 1 report the functioning of the FLOSS support system has been briefly described; including the different stakeholders involved. The FLOSS support model relies on experts and advanced members that provide user to user support, plus demanding support seekers to first check that their problem or question has not been answered beforehand, or in the case it was answered to learn from those answers. It was further shown that the largest group of FLOSS community members resides in the newbie periphery and therefore it could be assumed that this group also represents the largest group of support seekers. In the case of the Apache support system however the most active support providers, but also the most active support seekers, were experienced community members with recognizable skills (Lakhani & von Hippel, 2002). Approximately 50% of the answers of the observed Apache support system were provided by the 100 most prolific providers (2% of all providers) and 50% of the questions were provided by the 2152 most prolific posters of questions (24% of all information seekers). A large degree of newbies' support is provided by learning from what others have done, with questions being raised mainly once the individual becomes stuck.

As of today there seem to be few cases within the educational landscape that try to provide similar extra-institutional (FLOSS-like) community based support systems. The maybe most prominent ones appear to arise together with the current Open Educational Resource movement. One of those initiatives is the Utah State University's Open Learning Support (OLS). OLS is a free and open resource for faculty, students, and self-learners around the world that currently provides discussion services for over 2200 modules in the Connexions (http://cnx.rice.edu/) collection at Rice University. OLS also provides discussion services for MIT's OpenCourseWare initiative (http://ocw.mit.edu/). The project is supported by the The William and Flora Hewlett Foundation (around $1.5 million). But despite all funding and the strong institutions behind the project has only attracted, as by November 2007, 2077 registered users that generated 565 posts between 2005 and 2007.

Besides those, apparently less successful, initiatives from educational institutions the web provides myriads of informal support communities such as PhysicsForums (http://www.physicsforums.com/). PhysicsForums is an informal collaboration space where people can chat about maths, physics and science. The forum went online in 2003 and had 77.203 members that started 154.509 threads and received 1.341.084 answers by November 2007. PhysicsForums features an extra educational section and as shown in table 4.1, and similar to the Apache case study, 50% of the total postings take place at the more advanced forum sections, with 40% in the educational section.

WWW.PHYSICSFORUM.COM (DATE 06.12.2007)	Posts		Current viewers	
	Number	%	Number	%
Science Education	61.514	39,69%	283	27,61%
Physics	31.222	20,15%	169	16,49%
Astronomy & Cosmology	4.472	2,89%	43	4,20%
Mathematics	14.529	9,37%	114	11,12%
Engineering	7.243	4,67%	97	9,46%
Other Sciences	15.009	9,68%	72	7,02%
PF Lounge (social / off topic)	20.993	13,55%	247	24,10%
Total	154.982	100,00%	1.025	100,00%

Table 4-1: PhysicsForums Community Discussions

Contrasting the OLS case with the PhysicsForum case and putting it into perspective with FLOSS cases; it appears that community based support systems can work out in educational settings as long as the community is heterogeneous enough consisting of experts, more advanced members and newbies and therefore provides different types of motivations to participate and contribute.

A further analogy between such informal support communities and the FLOSS support model seems to be the fact that a majority of information and support (app. 40%) is provided by a minority of members (<2%) as illustrated at table 4.2 that provides a brief comparison of two well established FLOSS communities and two informal support communities

phpBB Forum Community (14.02.07)					osCommerce e-Shop Community (12.12.06)				
	Number	%	Posts	%		Number	%	Posts	%
Most active 50 member	**50**	**0,02%**	515.743	**21,26%**	Most active 50 member	**50**	**0,06%**	134.071	**19,03%**
Other member	299.677	99,98%	1.910.409	78,74%	Other member	83.773	99,94%	570.413	80,97%
Total	299.727	100,00%	2.426.152	100,00%	Total	83.823	100,00%	704.484	100,00%
	Number	%	Posts	%		Number	%	Posts	%
Most active 500 member	**500**	**0,17%**	1.001.812	**41,29%**	Most active 500 member	**500**	**0,60%**	282.310	**40,07%**
Other member	299.227	99,83%	1.424.340	58,71%	Other member	83.323	99,40%	422.174	59,93%
Total	299.727	100,00%	2.426.152	100,00%	Total	83.823	100,00%	704.484	100,00%
Forum-hilfe.de (12.09.07)					http://www.uni-protokolle.de (12.09.07)				
	Number	%	Posts	%		Number	%	Posts	%
Most active 50 member	**50**	**0,59%**	110.310	**48,43%**	Most active 50 member	**50**	**0,05%**	148.976	**15,68%**
Other member	8.455	99,41%	117.452	51,57%	Other member	104.772	99,95%	800.910	84,32%
Total	8.505	100,00%	227.762	100,00%	Total	104.822	100,00%	949.886	100,00%
	Number	%	Posts	%		Number	%	Posts	%
Most active 500 member	**500**	**5,88%**	159.681	**70,11%**	Most active 500 member	**500**	**0,48%**	378.510	**39,85%**
Other member	8.005	94,12%	68.081	29,89%	Other member	104.322	99,52%	571.376	60,15%
Total	8.505	100,00%	227.762	100,00%	Total	104.822	100,00%	949.886	100,00%

Table 4-2: Most active 50 / 500 poster

Concluding it might be stated that the commons component is obviously a pre-requisite for community based support systems, but as important seems to be the right consistence of community members that include experts, advanced members and newbies providing the right mix of motivations to participate at such a community and to provide support.

5 Examples of the educational landscape including general and FLOSS-like approaches

5.1 Introduction

In this section a number of different case studies are provided which demonstrate how FLOSS-like approaches have been used in education. These provide examples of the different ways in which these approaches can be implemented, and also illustrate that they can be done so across a range of subject areas. A summary of each case study is provided in this section, with the full and further case studies being available at the FLOSSCom repository

5.2 Case study 1 - University of Washington Bothell, US

(based on Martha Groom's and Andreas Brockhaus' Educause presentation (http://educause.edu/upload/presentations/E07/SESS089/Using%20WikipediaFINAL.ppt)

Course area: Environmental: History and Globalization; Conservation and Sustainable Development

Type of community: Higher education

Principle type of user: Student, general audience

Activities: Group work and assessment. As part of the courses students were given an assignment and supposed to research Wikipedia and write articles for submission. The students' assignment published their assessment in Wikipedia.

Similarity or not to FLOSS: Students work was subject to community acceptance, and peer review. Their contributions were often deleted or modified. Comments were often frank and occasionally harsh, as is seen in FLOSS communities. The activity was legitimate and contributing towards an overall goal or project. Dissimilar in the nature of the community, the use of tools and the nature of the task.

5.3 Case study 2 - Utopia Discovery / ADM - Douglas County School District, US

Based on Ben Wilkoff's work: blog: http://yongesonne.edublogs.org, podcasts: http://bhwilkoff.podomatic.com, wiki: "Starting From Scratch: Framing Change for All Stakeholders": http://takemyhand07.wikispaces.com

Course area: Citizenship, social studies, futurology (students create a vision of a future society)

Type of community: K12

Principle type of user: K12 student, general audience

Activities: Students create in a wiki a vision for a future society that addresses the major issues, such as the role of government, responsibility of the individual. Students are asked to use different media, link to other projects and engage in collaboration and discussion.

Similarity or not to FLOSS: Adopts the general principles of FLOSS, such as openness, collaboration, use of distributed tools.

Dissimilarity: The community is limited and the output is specific to the project, it is not part of a broader project and thus some of the interaction is bounded.

5.4 Case study 3 Dept. of Informatics, Aristotle University, Greece

Course area: Software engineering

Type of community: Higher education, FLOSS

Principle type of user: Student, FLOSS communities

Activities: Students choose a FLOSS project and learn bug reporting and other procedures. They then test the software using various techniques. They report any bugs and monitor the progress of these.

Similarity or not to FLOSS: As this involves participation in real FLOSS communities, using the tools and procedures adopted in those communities, it is obviously very closely aligned with FLOSS principles including active participation, observation, use of technologies, software testing and community monitoring.

Dissimilarity: The course is also part of a lecture series, so students are taught some FLOSS principles which others may have to self-learn. There is a formal assessment element also which is not part of FLOSS usually.

5.5 Case study 4 Openlearn, The Open University, United Kingdom

Course area: All subject areas

Type of community: Higher education, open educational resource.

Principle type of user: Educators, independent studiers.

Activities: The OU has released over 5000 hours of study material under a creative commons license. There are two sites: LearningSpace which releases pre-formatted material in a Moodle environment and Labspace which releases this material plus other content for remixing and reuse. Research and content communities have established around some of the subject areas.

Similarity or not to FLOSS: There is a definite product, ie the course content, and it is available for modification by the wider community. Learning is informal, and non-accredited. The provided tools are similar, ie forums, instant messaging, virtual meetings.

Dissimilarity: The product (in this case the course material) is released in a largely finished state, so not produced by peer commons. There is no guru leading the project.

5.5 Case study 5 OpenEd syllabus, Utah State University, United States

Course area: Education (open education)

Type of community: Higher education, open educational resource.

Principle type of user: Educators, students

Activities: The course is structured in a formal and traditional way with well defined activities that consist of weekly assignments, namely readings and bloggings, and also with well defined roles and structures.

Students are supposed to read the weekly assigned materials and to blog answers to pre-formulated questions, or simply complete assignments for weeks when there are no readings or questions. Bloggings are supposed to demonstrate students' understanding of the assigned reading material and to include original thoughts and synthesis.

Following the initial course design the course also includes grading with each weekly assignment being worth 10 points, for a total of 150 possible points for the course. Weekly assignments are supposed to be graded according to (1) the degree to which they completely answer the questions asked, (2) the degree to which they demonstrate understanding of the assigned reading material, and (3) the degree to which original thinking is evident in the writing.

Similarity or not to FLOSS: The course is freely available and open to anyone to join. It uses a lot of the same technologies such as blogs and wikis.

Dissimilarity: Most of the content is pre-selected by educators and there is little opportunity for the students to modify it. The student generated content is through the student blogs. There is a formal assessment method, and the course structure is tightly defined, unlike in many FLOSS communities which are more 'organic'.

5.6 Conclusion

What these case studies demonstrate is that there are a number of different perspectives with which a FLOSS-like approach can be implemented in education. The main perspectives are:

- Openness – most educational courses are 'closed' in that students have to attend, pay or sign up for a course. One way of adopting a FLOSS-like approach is to make the content of a course open, and free to access. This is seen in case studies 4 and 5 in particular.
- User generated content – another means of embracing FLOSS principles is to allow students to contribute to the creation of the content itself, as in software projects. This is seen in case studies 1 and 2.
- Contribution to the process – one important aspect of FLOSS communities are the different roles that individuals undertake, such as maintaining forums, testing software, peer review the work of others or to provide support to their peers. Case studies 1 and 3 are examples of this.
- Use of technologies – using the type of technologies that are adopted in FLOSS communities and in the same way, e.g. using forums as a means of discussion but also as a learning resource. All of the case do this to an extent, but case study 3 particularly so.
- Informal learning – learning in FLOSS communities is through access to peers and a community, rather than formal structured support systems. In this respect most of the case studies are not similar because they tend to relate to formal courses. Case study 4 is the closest in that it is not supported formally.

6 Possible adoption of FLOSS approaches in educational settings

6.1 Introduction

In this section we will look at how FLOSS approaches can be implemented in higher education. These discussions are based on the preceding sections combining the practical examples set out in the case studies and the pedagogic theory in section 3.

Our suggestion here is that you can view the case studies in section 5 as falling broadly in to one of two categories: FLOSS-inside or FLOSS-outside. FLOSS-inside refers to the practice of taking the principles of the FLOSS community and applying them within an educational context. Conversely, FLOSS-outside refers to the practice of working with students in higher education and giving them experience of a real FLOSS-like community external to the university. We also consider whether a hybrid approach that adopts both elements is possible and desirable.

6.2 FLOSS vs. traditional educational settings

There are clearly many desirable attributes in the learning process that occurs in FLOSS communities, for example that it is based around legitimate activity, it is collaborative and often the learning is deep in nature with learners valuing it and being able to apply it. As has been highlighted a number of times in this report, many of these findings are in contrast to the way in which learning occurs in higher education. In this section we will consider how these approaches to learning in FLOSS communities could be implemented in higher education.

The first point is that although many of these characteristics are desirable, that may not necessitate a wholesale abandonment of traditional higher education practices. There are a number of higher education practices that are valuable in ensuring *all* students have a good chance of success. For example, while the FLOSS approach is very learner, or community – centred, it has been found that the more traditional teacher-centred approaches are often better for less able students (Giles et al 2006). But even within a more traditional teacher-centred approach less able students could benefit from FLOSS-like environments as they would e.g. provide them with a broader range of learning materials, or they might benefit from support provided by global or local peers.

However, true FLOSS-like approaches have rarely been implemented, and although the teacher centred approaches may be useful for students, that may be because they are the approaches that are suited to the system, particularly the assessment methods that are established. Put simply, they are a good means of getting students to pass exams because that is what the educational system has been created to do. I does not necessarily mean they are the best method for getting people to *learn,* and to retain that knowledge over time. It could be argued that within a FLOSS-like approach the less able students benefit through the content richness, the fact that they can easily follow the process that others used to solve a problem / fulfill a task, and through asking unanswered questions. If one looks at the largest FLOSS user group, ie. lurkers, these can be compared with less able students that consume resources, but don't give back. In FLOSS however, resources are not consumed (browsing a forum does not consume, demanding teacher's time does), or if consumed (by asking for individual help) the output (answer) is again 'in the commons' and here the cycle starts again.

There are thus a number of practices from higher education we would wish to retain. These include:

- Educator input – although the educator may no longer be the main source of information, they still have an important role to play in offering guidance.

- Structure – learners approaching a new subject area value the structure and focus offered by a course, and so a means of providing this reassurance within the looser community based model would need to be found.
- Learning objectives – it would still be important to set out for students what they should be able to learn through the experience.
- Assessment – some form of formal assessment would probably still be required, although the nature of this is likely to change significantly from traditional forms such as the exam.

However, from the FLOSS approaches the following would also be desirable:

- A greater range of inputs – not just from the educator, but from all contributors so the collective is the source of knowledge, not one individual
- A more personalized learning experience – instead of learning objectives that apply to a whole cohort, a FLOSS approach allows learners to gather the elements of knowledge they require.
- Greater sharing of knowledge – in higher education much of the previous input is lost, whereas in FLOSS the dialogue, resources, and outputs remain as learning resources.
- Peer production – active engagement in producing something with a set of peers is a powerful motivational and educational driving force.
- Real activities – engaging in legitimate activities that are not restricted to an artificial university setting also provides valuable experience.
- Peer support – a large support network provided voluntarily by peers in a collaborative manner nearly 24/7.
- Open learning environment – The sum is bigger than its parts, thus there is the need of providing new educational models and scenarios that are not limited to students formally enrolled at a course.
- Underlying business models to assure sustainability – open educational scenarios demand new business models to assure sustainability beyond the one currently existing

6.3 FLOSS-like inside approaches

FLOSS-like inside approaches refers to the practice of taking the principles found in FLOSS communities and applying them within the higher education context. For example Fischer (2007) talks of ‘meta-design’ which is aimed at supporting self-directed learners within virtual learning communities by creating socio-technical environments that support new forms of collaborative design. It thus takes the sort of approaches and tools found in FLOSS as its inspiration. Fischer talks of users creating socio-technical environments and has a continuum of participation ranging from passive consumer to meta-designer. These mirror some of the roles of engagement in FLOSS communities which range from passive users to core developers.

Fischer is therefore taking the principles observed in FLOSS communities and *mapping* these onto higher education.

6.4 FLOSS-like outside approaches

An alternative approach is to work from education outwards. This is seen in the work of the Aristotle University in Greece, where they send undergraduate students out in to real FLOSS communities as part of their degree in software engineering. They provide an initial academic background in principles of software engineering, testing software and the tools and approach in FLOSS communities and then require the students to choose and engage with a real project. This clearly has benefits in computer science as it gives students real experience of collaborating with other developers and also of the different types of role and work required in software development (see Case Study 3 for further details).

The outside approach is not restricted to computer programming however. It can be realized whenever there is an external, 'real' community that is operating on FLOSS like principles. Wikipedia is an obvious example, and in case study 1, students from Washington were required to contribute to actual Wikipedia articles as part of their assignment work, thus gaining much of the practical experience of collaboration and authenticity experienced by the software programmers at Thessaloniki.

6.5 FLOSS-like mixed inside-outside approach

If we view FLOSS inside and FLOSS outside approaches as opposite ends of a spectrum, then there is clearly a range of blended, hybrid approaches in the middle, which take components of both elements. At this early stage in the adoption of FLOSS approaches in higher education, there are few examples that employ both an inside and outside model.

Perhaps one such model for this hybrid approach is that of an open participatory learning ecosystem, as outlined by John Seely Brown (2007). The concept here is that some of the principles of FLOSS communities are adopted in education (thus it is an inside approach), such as collaboration, use of technologies, peer production. People learn by doing, for example by remixing or remashing content that is viewed by others. However these activities occur in a broader ecosystem that is open for everyone combining students, informal learners, tutors, experts, organizations, etc, and in this manner it is FLOSS-outside approach since learners are engaged in a real community. This approach is effectively blurring the boundaries of the university and would give the name "Open University" a very different meaning.

6.6 Conclusion

By considering Floss-inside approaches educators can take some of the existing practices found in FLOSS communities and employ them within a conventional higher education setting. However, some of the constraints of higher education mean that this mapping across from FLOSS to higher education may not always be successful or complete.

By adopting Floss-outside approaches educators can give students experience of a real FLOSS like community, providing them with richer and more up to date learning materials and allowing them to gain soft and key skills on the fly through real interactions in the virtual world. This obviously has benefits in the field of software development, but also in other subject areas as it gives students experience of real collaboration and accepting feedback. However, the opportunities for this type of approach may be limited, since it relies on an existing FLOSS type community to be realised, and these may not be present in every subject area.

The hybrid approach may seem the best option, but probably requires the most drastic overhaul of higher educational practices to achieve. However, given the interest in social networks, web 2.0, user generated content, open educational resources, etc. it may be that such an approach has momentum behind it from several different drivers and thus we may see versions of this become accepted practice over the coming years.

7 Issues to be addressed

7.1 Introduction

In this section we will consider what issues need to be addressed in order for higher education to adopt the FLOSS like approaches set out in this report. These can be broadly summarized as:

- Content
- Assessment and accreditation
- Acceptance
- Quality control

7.2 Content

Much of what educators do is produce ‘content’ of one form or another, be it articles, books, lectures, exam questions, etc. In a FLOSS-like approach much of the need for this content is removed, partly because the participants produce it themselves, but also because the pedagogy moves from one being based on the transmission of information from educator to learner, to a more activity based approach. So what then is the role of content in a FLOSS-based approach?

Firstly there is likely to be a core set of educational content (this needn’t be produced by the educator themselves though). Although much of FLOSS-learning is based on learning by doing, it is still the case that in developer communities most participants enter with at least some formal knowledge of computers and software development.

Secondly, it is likely that the type of content educators produce in such an environment is altered. Instead of focusing on the standard ‘information transfer’ type content, the educator’s role is one of creating meaningful activities.

Lastly, this entails a shift in the overall function of the educator from delivering information, what we commonly think of as ‘teaching’ to guiding and mentoring learners in FLOSS like environments.

Another issue related to content is that of quality, namely how do educators ensure the quality of the content produced in a distributed, democratic community? We will consider this under the general heading of quality control later.

7.3 Assessment and Accreditation

Assessment and accreditation lie at the heart of the education process. They are the means by which a learner demonstrates their understanding of a subject area and then how that is recognized by others. Thus for any FLOSS-like approach to be acceptable in higher education it will need to satisfy the demands of a formal assessment and accreditation process. This presents some issues as the standard assessment models (e.g. exam, project) may not be suitable as they are often based around individual activity and have a clearly defined structure. FLOSS-like approaches tend to be more collaborative, distributed and unpredictable.

One suggestion is to use different metrics to measure performance in a FLOSS community, such as number of contributions, accepted bug-fixes (or its equivalent in another subject area), etc. The danger in this approach is that a version of Heisenberg’s uncertainty principle comes in to play, namely that as soon as you measure something you alter it. If educators start making these informal measures formal then they will influence behaviour, which may be to the detriment of the FLOSS approach. For example, if you measure successful bug fixes this prioritizes one type of behaviour in a FLOSS community, which will be to the detriment of others. A successful FLOSS community has many different roles, for example, moderating the forums which are not directly related to bug-fixes.

An alternative then is to use some secondary, or proxy, form of measurement which is assessable in the traditional mode. For example, students could be asked to write a reflective piece on their experience of participating in a FLOSS-like community, using contributions as a basis for this. This might be coupled with a form of peer-assessment and evaluation from within a given project group where one evaluates the other and from outside for a learning project as a whole, or for the support provided to peers. Considering the support aspect for students' assessment and evaluation might also provide the required motivations for establishing FLOSS-like support systems.

7.4 Acceptance

A FLOSS-like approach to education can be viewed as an adaptation of existing teaching methods, and thus part of a tradition of innovation in pedagogy that runs through higher education. However, it can also be viewed as a radical departure from much of the standard practice in higher education that has existed, at least in the West for many hundreds of year. Many of the practices that are embedded in universities have a reasonably standard model of learning as their basis. A radical change will challenge many of these systems, including assessment, finance, administration, and technical. There is a strong pre-conceived notion as to what higher education should 'be' like, and any departure from this runs the risk of not being deemed appropriate.

There is thus a question as to the degree to which a heavily FLOSS-based education would be accepted by educators, students and society in general. This is largely to do with the quality issue, which we shall address next, but also because how such an education would work is largely alien to many people, and thus they have no prior experience to draw upon. In the same way that many corporations struggled to see how open source development could work, because it was so different from anything they had learnt or experienced, so a FLOSS-like education would struggle to be accepted. There would be a legitimacy deficit in the eyes of the various stakeholders which would need to be overcome. This is similar to the legitimacy deficit distance education encountered when the Open University was first established in 1969, as many detractors said quality education could not be delivered at a distance. The success of the British Open University and other distance learning establishments have overcome this view, and the same could happen for FLOSS-like education.

7.5 Quality Control

Lastly, we come on to perhaps the biggest issue of all, namely quality control. This applies to both the quality of the content produced, and that of the learning experience in general.

Let us examine the issue of the content first of all. This debate is not restricted to education alone, and there has been a lot of criticism about user generated content in general. Perhaps most prominent amongst these has been Andrew Keen (2007), who argues against the quality of user generated content. The cult of the amateur he says

"worships the creative amateur: the self-taught filmmaker, the dorm-room musician, the unpublished writer. It suggests that everyone—even the most poorly educated and inarticulate amongst us—can and should use digital media to express and realize themselves."

On the Encyclopaedia Britannica web site, Michael Gorman (2007a) takes this argument further stating that the difference between traditional sources of information (such as encyclopaedias) and online information is "the authenticity and fixity of the former (that its creator is reputable and it is what it says it is), the expertise that has given it credibility, and the scholarly apparatus that makes the recorded knowledge accessible on the one hand and the lack of authenticity, expertise, and complex finding aids in the latter."

Authenticity and reliability lies at the heart of the problem for Gorman, who argues that only through top down processes can these be assured:

"The task before us is to extend into the digital world the virtues of authenticity, expertise, and scholarly apparatus that have evolved over the 500 years of print, virtues often absent in the manuscript age that preceded print."

This concern over the quality and reliability of content is one that is pertinent to education and frames many educators' response to web 2.0. For example, many will find themselves in agreement with Gorman (2007b) when he asks

"Do we entrust the education of children to self-selected "experts" without any known authority or credentials? Would any sane person pay fees to take university courses that are taught by people who may or may not be qualified to teach such a course?"

And on wikipedia, the best example of online user generated content Gorman (2007c) adds

"A few endorse Wikipedia heartily. This mystifies me. Education is not a matter of popularity or of convenience—it is a matter of learning, of knowledge gained the hard way, and of respect for the human record. A professor who encourages the use of Wikipedia is the intellectual equivalent of a dietician who recommends a steady diet of Big Macs with everything."

What the argument between the critics and the proponents seems to be about is *process*. For the critics the top-down, official metrics and measure approach to authenticity is the best way to produce high quality resources. For the proponents, the bottom up, distributed process is more powerful.

In terms of the power of distribution we have the example of the software produced through open source communities. Many of the most reliable, robust and popular pieces of software available are produced through this distributed process. So, even if there seems a logical argument that having predefined experts work together would produce better content, we have empirical evidence that this is not the case. And beyond software there is Wikipedia, the best example of user generated content, where the process of creating entries is performed through careful negotiation and dialogue between contributers.

In objective tests wikipedia has been found to be as reliable as Britannica (Giles 2005) (and it even contains a list of entries with errors in Britannica http://en.wikipedia.org/wiki/Wikipedia:Errors_in_the_Encyclop%C3%A6dia_Britannica_that_have_been_corrected_in_Wikipedia). After this study was completed the errors identified in wikipedia were fixed within a few days, whereas Britannica had to wait until the next round of publication to address theirs.

Clay Shirky (2007) recalls how he demonstrated support from an open source community to programmers from AT & T who were accustomed to buying support through a formal contract. Even though he demonstrated it to them they still went away unconvinced, because as Shirky memorably puts it "they didn't care that they had seen it working in practice, because they already knew it couldn't work in theory." Much the same might be said of those who doubt that quality content can be produced by a community.

This at least demonstrates that distribution as process can work in creating complex content other than software. However, it does not necessarily demonstrate that learning can be scaffolded in this manner. This brings us to the issue of the quality of the learner experience. A university has a duty of care towards its students and also needs to guarantee a level of provision. While we have seen that the distributed model inherent in FLOSS communities can be very successful, there are also many FLOSS projects that do not succeed, either because they do not attract enough contributors or the community does not work cohesively. While the standard lecture and exam model may be flawed in many respects, universities have established a structure around it which means they can help students through the process. Part of the FLOSS approach is to be more organic with regards to how a community forms and the tasks involved, which necessitates less of a top down approach to structuring the learning process. This may have positive benefits, but it is by no means proven that it would work for all students, or that overall the understanding achieved by students would be superior. Marrying the level of support, structure and guarantee of service found currently in higher education with the engagement, participation and quality found in FLOSS will be a major challenge for higher education over the next few years.

8 Conclusion

In this report we have seen how the type of learning that takes place in FLOSS communities is closely bound with several pedagogic theories, including cooperative learning, case based learning and reflection. We have also examined the attempts by various individuals to adopt FLOSS-like approaches in (higher) educational contexts. This led to the analysis of FLOSS-inside, FLOSS-outside and FLOSS-hybrid approaches. In the last section we looked at some of the issues remaining that need to be addressed, particularly those of content, accreditation, acceptance and quality control.

The conclusions we can draw from this are as follows:

There is a solid pedagogic framework for the type of learning that occurs in FLOSS communities. It is not the case that FLOSS communities deliberately set out to implement particularly pedagogies, but rather that through their structure, approach and governance certain pedagogies have emerged.

There are many advantages for the learner in FLOSS communities. These include access to a variety of resources, learning by doing, community support, mentorship and engagement.

The adoption of FLOSS principles in higher education have largely been successful. While the number of case studies is limited and no meta-analysis is available of performance across such approaches, the initial reports have been favourable regarding student performance and motivation.

Both FLOSS-inside and FLOSS-outside approaches are viable. At the moment it is not possible to say if one is preferable to another or if particular subject areas or activities suit one approach more than another. The Hybrid model potentially offers benefits but remains to be explored.

There are cultural and institutional issues that need to be addressed in the uptake of FLOSS approaches. These were covered in the previous section and are often concerned with assessment and quality issues.

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