The Impact of Competitiveness in Open Source on Education Quality: The Romanian Open Source Education Community

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Abstract: Open Source is a development model and pragmatic methodology applied extensively in the field of Computer Science. When applied to education, the Open Source brings educational benefits by encouraging competition and competitiveness within Open Source communities. In this paper, four examples of application of the Open Source paradigm in education have been spoken of, the structure of two of ROSEdu's main projects has been described and the impact of these projects on increasing student performance has been discussed.

1. INTRODUCTION

The Romanian Open Source Education Community (ROSEdu) is a non-profit organization with a mission to initiate, support and develop education based on the values of the Open Source culture[0]. ROSEdu is based in the Computer Science and Engineernig Department of the Faculty of Automatic Control and Computers of the University POLITEHNICA of Bucharest, where it was legally founded in 2009 as a formal entity supporting the interests of the pre-existing active Open Source student community there.

Nowadays, ROSEdu is highly engaged in teaching to young students with a strong passion for computer programming and the desire for technical excellence the skills necessary for making high profile contributions to both emerging Romanian software products and world renowned open source projects.

This paper discusses the importance of achieving competitiveness within the community-based Open Source world and how this supplements the quality of education in the field of Computer Science by studying two of ROSEdu's projects and their results.

1.1 Projects

Over the years, a number of technical and educational projects have been successfully initiated and developed within the community.

The Community and Development Lab is one of the oldest and best known of ROSEdu's projects. Currently at its fifth edition, the course aims to help undergraduate students make their first contributions within an open source project and get a feeling of real world software development.

ROSEdu Summer of Code is the community's vision of a summer internship programme that allows students to pursue their commitment for a given Open Source technology or project. It is conceptually modelled after a similar program sponsored by Google[1] and it involves the active participation of stakeholder software companies which warrant the quality of tuition involved.

The Linux Install Fest is ROSEdu's annual event that introduces the general public to the world of Open Source and the knowledge sharing environment by offering the technical support and experience of community members.

World of USO is a pioneering educational quiz-based game developed entirely by ROSEdu for enhancing acquisition and retention of the information contained in the freshman Operating Systems Usage class. Boasting an even longer tradition than the CDL, WoUSO is among the oldest and most praised education software the community has put forth and which earned strongly positive feedback from its target students along the years.

Hack Day is a hands-on day-long event during which participants have the opportunity to try out programming on a project of their interest under live supervision from a knowledgeable volunteer mentor who is often a distinguished engineer from the industry.

1.2 Motivation

The Open Source is a movement in the world of software development that promotes free source code distribution and promises better quality, more technically advanced source code development by means of distributed peer review and transparency of the engineering decisions.

Open Source communities across the world implicitly offer broader accessibility for contribution purposes, a greater visibility of personal achievements and better peer recognition, all summing up in an optimal environment for students of Computer Science to professionally thrive in.

2. STATE OF THE ART

Community based educational incentives in general and Open Source Education in particular have proven to be very successful in the past in training the next generation of Computer Science specialists.

Among the communities that are most acknowledged in the field, some have gained the recognition of the national education system and have been extensively praised for the results of their projects.

2.1 Infoarena

Infoarena[2] is an open source community focused on training high school and undergraduate students in the fields of computer programming and algorithm design and which uses computer programming competitions to drive their activities.

Infoarena has been active since 2003 and the main venue of interaction of the community with their target students is the Infoarena website.

Much of Infoarena's success in asserting itself as the *de facto* trainer and certifier for Romanian students of algorithm design owes to the dedication of former Olympiad winners who joined the community to share the benefits of their experience.

In recent years, Infoarena has gained special recognition from the national education system for their contributions to the National Olympiad in Informatics, as the training portal is recommended on the National Olympiad portal[3] and numerous web pages for teachers.

As the source code for the Infoarena web site is open, a number of valuable contributions have come from its users, and most importantly, its success could be replicated for teaching starter courses of computer programming[4].

There is currently an ongoing collaboration between Infoarena and ROSEdu with both communities contributing to each other's events. Development on the Infoarena website has been carried out within ROSEdu's Hack Day, and Linux Crash Courses have been integrated in one of Infoarena's training camps[5].

2.2 Belgian ACM Student Chapter

Another example of success based on community effort is the Belgian UCLouvain ACM Student Chapter[6]. The student chapter has been praised in Belgium for organizing the Belgian National Olympiad in Informatics. They have expressed belief that this will increase national awareness among students regarding a career in Computer Science and, in the long term, increase the quality of technical education in Belgium.

The chapter is also known for carrying out educational initiatives intended to bring the field of Computer Science closer to the elementary school curriculum and for undertaking projects that promote the Open Source culture.

Similarly to ROSEdu's agenda, the chapter also places high emphasis on Linux Install Fests as a means to introduce the technologically naïve general public to the values and opportunities of Open Source.

2.3 The Google Summer of Code

Google Inc. is a strong supporter and contributor to the world of Open Source, as it has released either the algorithms or the implementation of many of its products and the company also has a special department[7] that handles aspects pertaining to the world of Open Source software.

Google, one of the most technically appraised companies in IT, publicly recognizes the role of the open source software in the world and is running student outreach programs such as the Google Summer of Code and Google Code-in to stimulate the competitiveness in the field.

The Google Summer of Code is a worldwide program that gives undergraduate students the opportunity to contribute to a software project of their choice and earn experience and technical skills under the guidance of a mentor for the duration of the summer.

Now at its eigth edition, the Google Summer of Code project has trained a large number of current Google Interns and employees and participation in the project is correlated with strong skills on the part of the students.

In 2011, the University POLITEHNICA of Bucharest was ranked second in the world in terms of number of students participating in the Google Summer of Code programme[8], an increase correlated with the highest number of software engineering summer interns present at Google in California the same year who study at the university.

2.4 The University POLITEHNICA of Bucharest

The University POLITEHNICA of Bucharest is a perfect example regarding the use of Open Source technologies in the academia.

Among the solutions chosen by the university to be the most technically advanced and the most suitable for use in teaching, Moodle and LDAP are perhaps the ones with the highest profile, being implemented at university level.

At the same time, the Computer Science and Engineering Department strongly encourages use of Open Source solutions from the very first semester in the freshman year by giving a mandatory course on Linux utilisation and then in subsequent semesters by selecting the most advanced solutions in open source for study at various courses.

By respecting and promoting competitiveness in open source, the Computer Science and Engineering Department recognizes the technical merits of the communities that developed the products and expresses belief in their potential.

3. OVERVIEW

Open Source as a general concept and philosophy works on the bases of volunteering and individual contribution. Perhaps the most common example to illustrate the principle is Wikipedia, the entirely open sourced online encyclopedia.

Wikipedia is not only the sum of small individual contributions done by millions of users worldwide, but it is also the product of their effort to check, review, organize and improve the content on the web site.

Is is because of this cross validation effort and public availability towards contributions that the project could grow to have close to 4,000,000 articles in English alone, with 40 languages supported in total, and with content that is almost universally trusted for correctness.

Meritocracy is the fundamental value of Open Source communities. People are driven to volunteer within such communities not for personal gain but for the psychological reward of putting their knowledge to a useful end with impact on millions of people around the world.

3.1 What Makes a Successful Contribution

The viability of contributions in Open Source is tightly connected to the web of trust which interconnects individual contributors.

If we go back to using Wikipedia as an example, an article starts out as a stub created by an initial user. It is in the best interest of the user for the information he has written to be accurate, trusted and properly documented for the article to endure. However, without later involvement from other users in content expansion and restructuring, the initial effort will die out and the article will end up being removed.

This holds true for all Open Source projects. Enduring contributions create a basis for trust and peer recognition which ensures that the project will eventually reach out to the general public and be useful to them – the principal success criterion for all Open Source projects.

3.2 The Importance of Competitiveness in Open Source

Contributions to Open Source projects, unlike efforts that go into proprietary activities, have the advantage that they are highly visible and directly attest to the abilities and technical standing of the contributor.

Being competitive in an Open Source environment is different from being competitive within a company because there is a far greater number of peers who must believe in the significance of your actions. This automatically trains the contributor to consider the context of his efforts, to conduct proper research beforehand and to put forth a product designed with far greater care for details.

It is this sum of strict quality requirements that certify competitive contributors to be especially dedicated and knowledgeable professionals.
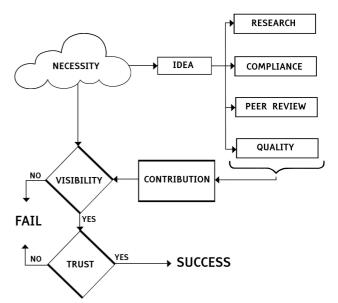

Illustration 1: The General Workflow for Contribution in Open Source.

4. IMPLEMENTATION

ROSEdu was founded with the goal of supporting Open Source as an extracurricular means of education that would increase the quality of learning in the University POLITEHNICA of Bucharest.

We will further discuss the way in which two of the oldest projects run by ROSEdu: CDL and WoUSO, stimulate and encourage education through competition in the Open Source environment.

4.1 The Community Development Lab (CDL)

The Community Development Lab[9] is a course organized in the Computer Science and Engineering Department of the Faculty of Automatic Control and Computers of the University POLITEHNICA of Bucharest that aims to teach undergraduate students the knowledge and soft skills (most importantly, team work) they need for making their first true upstream contribution to an Open Source project.

Each CDL student is assigned to a real Open Source project and throughout the span of the course he will strive to make a significant contribution - taking the form of a software patch - to that project. The student's efforts are supervised and guided by an assigned mentor who has extensive experience with the project in question and can make sure that the student strives in the right direction.

With the sole exception of the first edition, the project selected for participation within CDL are all mainstream projects which have very good visibility either in Romania or worldwide and which impact on a very large number of users. Table 1 illustrates the title of the projects that the students developed on during the first five editions of CDL.

Table 1: The CDL Projects by Edition.

Edition	1st (2009)	2nd (2010)	3rd (2011)	4th (2011)	5th (2012)
Project List	Starbugs Mail Notifier	WoUSO Grand Challenge	DEXOnline Harmondale	Kate	Pidgin
	Nethack	WoUSO FB	WoUSO Django	Unknown Horizons	Open SIPS
	FKP Player	Pidgin Sketch	Digikan	WoUSO Django	Digikam
		Osmo Synchronizer	Jeopy	IxCode	DEXOnline
		Ext3grep GUI	Anjuta Snippets	CUBRID	WoUSO on Android
		Joomla!	Synergy+	DEXOnline	
		MinVG Sound Mapping	DEXOnline Improvements		

Structurally, CDL was designed to balance three main components:

a) *Theoretical presentations* combined with *practical hands-on laboratories* which are designed to pass on to the students the technical expertise required to efficiently make use of various programming languages and software tools available to them. The presentations are held by experienced community members who have had extensive experience themselves with the technologies presented and special emphasis falls on the students acquiring best practices regarding the subject.

In order to make the course more accessible to the students who either did not apply to the course on time or were not accepted, entry to the presentations is free for everyone interested and the slides and specific materials are published on the CDL website immediately after the course.

b) *Development sessions*, during which the students work on features of their projects together with their mentors. After having analysed the feedback year after year, it was revealed that the development sessions were the most favoured by the students as they felt any progress made to be especially rewarding.

At the same time, the development sessions helped mentors pass on to their students certain aspects pertaining to work methodology and research strategy which are not normally taught during presentations or lectures.

Last but not least, students and mentors alike reported that development sessions helped them develop a strongly positive team spirit and a sense of attachment to the project they hadn't previously experienced while working on personal projects.

c) *Distinguished Guest Presentations* held by industry leaders of the Romanian IT community. The presentations are held on various topics, ranging from career directions in software engineering, start-ups, specific fields of technology, etc. It is through these presentations that the students are encouraged to reflect on their career options and consider fulfilling their professional potential from early on in their first years of university by being proactive and committing themselves to an Open Source project or incentive.

The current structure of the course is the product of close feedback analysis after each of the five editions. Care was also taken to track the future development of the students within the Open Source world and some joined ROSEdu out of the desire to contribute back to its success.

After graduating from the CDL course, many students felt that they had expanded professional horizons. For example, some of the students decided to apply to the Google Summer of Code programme and this has lead to a constant increase in the number of students from the University POLITEHNICA of Bucharest who successfully take part in this programme, as can be seen from Table 1. (data was taken from the official Google Summer of Code web site[8]).

Table 2: The number of Google Summer of Code participants from the University POLITEHNICA of Bucharest by Year.

Year	2005	2006	2007	2008	2009	2010	2011
Number of students	0	3	0	4	11	13	23

Table 1 shows a steep increase in the number of participants following the start of the first CDL edition in 2009, and in 2011, the University POLITEHNICA of Bucharest was ranked 2nd in the world in terms of the number of participants.

Concurrent with the success CDL had in training students for Google Summer of Code, many of the students who graduated from the first edition of CDL went on to complete internships at Google, FaceBook, Mozilla, Ixia, Adobe, Nokia, BitDefender and other companies that do cutting edge software development in Europe and the USA.

4.2 World of USO

World of USO[10] is an online educational game designed to help first year students better acquire and retain information. Currently, WoUSO is mainly being used to enhance the students' commitment to the Introduction to Operating Systems course, but plans exist to replicate its success with other classes in the future.

The main purpose is that students can interact over the course of the semester and compete using their knowledge of the Linux Operating System to gain points and earn a reputation among their colleagues. This drives students towards self evaluation and acquiring an independent learning style.

The game is designed to end with a final quest which is a technically demanding competition which touches on advanced subjects from Computer Science that require a deep understanding of the topic. With each edition, the difficulty of the challenges increased constantly, indicating that overall each generation of students is more engaged than the previous one.

WoUSO is designed to include five types of puzzles:

a) *Question of the Day* is a type of puzzle that gets published daily and takes the form of a multiple answer question aimed of verifying the rate at which students acquire the topics in the curriculum. Besides providing the students with a mechanism for daily self evaluation, the Question of the Day

also helps keep them engaged in the game and gives them feedback for guiding their study process.

b) *Challenges* are more complex competitions that involve two players answering five questions in a limited time frame of five minutes, with only one winner at the end. This type of competition has the effect that the students take initiative to challenge each other and earn a better standing among their colleagues, which can be demonstrated by the number of points they earn as a result.

c) *The Special Quests* are real world tasks (akin to Scavenger Hunts) which aim at encouraging students to build a team spirit and to collaborate. The special quest deals with forming the soft skills necessary to collaborate successfully in the field of Computer Science.

d) *The Weekly Quest* lasts for one day and helps the students train for the Final Quest. The puzzle comprises of ten tasks in increasing level of difficulty which are based on knowledge from the field in general. The weekly quest is particularly appealing and has the beneficial effect of encouraging students towards extracurricular independent study.

e) *The Final Quest* is the epitome of WoUSO's puzzles. The quest involves hacking into a virtual machine in a "capture the flag" style of game and involves technical knowledge which students do not typically acquire in their first year of study. By this quest, the WoUSO organisers intend to stimulate the truly passionate students demonstrate their abilities and reward them for their proficiency.

The structure and features currently present in WoUSO are the product of intense feedback analysis over the course of its first five years of existence. Besides the feedback received from the students themselves, usage statistics have also been taken into account.

For example, the number of challenges run in the 2011 edition was 2,606, a 56.23% increase from 2009, while the total number of points accumulated by players was 6,885.677, a 26.5985% increase from two editions before (data taken from the official WoUSO web site[7]). The statistics point to the success of using competitions to motivate students in informal learning initiatives.

5. CONCLUSIONS

In this paper I have discussed the importance of the Open Source development model in the field of Computer Science and the educational benefits deriving from encouraging competition and competitiveness within the framework of Open Source communities.

The Open Source model has already been successfully applied in various fields of Computer Science education and industry in both Romania (Infoarena, University POLITEHNICA of Bucharest) and abroad (Belgian ACM Student Chapter, Google Summer of Code) and it is ROSEdu's mission to support education based on the values of Open Source.

I have described two of ROSEdu's oldest projects and spoken about their structure and factual results in improving the quality of the students' extracurricular technical education. Both projects demonstrate good results and attest to the positive implication of using competitiveness in Open Source as a specific indicator of education quality in Computer Science.

Two useful directions for future work are a long-term investigation of the performance of students involved in the Open Source world, and a study on the efficiency of expanding the aforementioned projects to other sub-fields of Computer Science, respectively.

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