EVALUATING THE QUALITY OF STUDENTS ACTIONS IN A DISTANCE LEARNING PROGRAMMING LANGUAGE ACADEMIC DISCIPLINE

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Introduction

Online learning (OL) has grown in importance as a direct consequence of the rapid development taking place in information and communication technology (ICT). This development has pushed OL agents into finding new methods of teaching and learning that could explore the technological media to the limits that ICT could actually offer. Due to the evolution of OL, it is difficult to find a precise and current definition. Nichols (2003) describes OL as "education that occurs only through the Web, that is, it does not consist of any physical learning materials issued to students or actual face to face contact. Purely online learning is essentially the use of eLearning tools in a distance education mode using the Web as the sole medium for all student learning and contact." Though this statement is still valid, the notion of OL has evolved to include aspects such as collaborative learning (Garrison, 2009), connectivist learning (Anderson, 2003; Anderson & Dron, 2011) and online participation (Hrastinski, 2009).

This form of teaching and learning is very often based on the principles of student-centred learning; learning flexibility (spatial, temporal); and online interaction, in particular, asynchronous interaction, which blurs the temporal barriers imposed by communicational synchronism, and is consistent with the flexibility principle. Interaction is absolutely fundamental for the teaching-learning process so that students can effectively acquire the corresponding knowledge and skills. It occurs when students are actively participating in learning activities involving peer-to-peer and teacher communication, be it contributing in a discussion, solving an exercise, analyzing a result, simply exchanging views with their colleagues, or clarifying questions with the teacher (Graham, 2005; Pereira et al., 2007a; Pereira et al., 2007b; Tinoca et al., 2010).

One of the main research goals in online learning environments, according to (Oncu & Cakir, 2011) is enhancing learner engagement and collaboration. In distance education, online interaction is one of the most important practices that influence engagement and collaboration in the learner community. Anderson (2003) classifies interaction in 6 categories: learner-learner, learner-teacher, learner-content, teacher-teacher, teacher-content, content-content. Of these, the learner-learner and learner-teacher as well as the learner-content

categories are essential in modern learner-centred educational environments, and it is crucial to promote them in distance education, where the agents tend to become more isolated and these types of interaction are not commonplace or natural.

When teaching computer science in an online learning environment, we usually face increasing problems promoting student participation, when compared with other teaching fields (e.g. humanities). Students face natural inhibition in presenting publicly questions or issues that they consider to be of lower value or that expose their ignorance on more technical subject matters. Student's participation is often more than communicating a verbal opinion but to demonstrate a very specific technical issue. In fact, experience has shown that discussions are usually dominated by a small core of students with a greater mastery of the subject areas or who are less inhibited, which results in a reduced level of student participation.

Furthermore, online interaction of the learner-content type is more sophisticated in computer science, as it requires students to use specific computing resources or perform experimental work at virtual laboratories, using their own personal computers. This implies the design and implementation of improved forms of sharing computing resources and processes, as well as their individual and collaborative manipulation within a virtual class.

The adoption of e-learning tools and learning management systems has been, not surprisingly, prominent in the computer science field (Georgouli, Skalkidis & Guerreiro, 2008; Murphy, Phung & Kaiser, 2008; Renaud, Barrow & le Roux, 2001). However, most approaches tend to use these tools as an extension to traditional face-to-face courses, or as a way to simulate real classes, e.g. by providing students with recorded lectures and digital versions of slides (Huan, Shehane & Ali, 2011; Matthíasdottír & Harðarson, 2005). The potential for collaboration and interaction over the Web is rarely used, as instructors tend to think in terms of enhancing or replacing their usual way of teaching. Rosbottom (2001) pointed out some of the problems with teaching computer science at a distance (such as drop-out rates), and how Open Universities have been finding new ways to overcome these problems by fully exploring the communication speed and genuine collaborative work provided by the Web.

When learning online, many students have a passive attitude towards their classmates and teachers, as they think that everything they need to succeed will be provided via the learning management system. Thus, an important research question that we address in this paper is what tools and strategies could be used to reduce or eliminate passive engagement of students and promote their collaborative involvement in online learning.

To teach how to program with an object-oriented language (like C++) is normally not a simple task. It is especially true when the students do not have any programming background or previous experience with any other programming language. Even those students that are used to program in a procedural approach find some difficulty to change the way they reason to solve a problem under the object-oriented paradigm. This reality is quite recurrent in any

programming language teaching class anywhere around the world where the students are on-campus studying. Things can become a little bit more complicated when you have to teach object-oriented programming in a totally e-learning environment.

Despite recent advances of electronic technologies in e-learning, a consolidated evaluation methodology for e-learning applications is not available. Maybe the main cause for this is the complexity that the evaluation of an e-learning environment demands. Many different perspectives (Ardito et al., 2006) and thus dimensions, in the analysis process can be considered, such as the quality of: learning, teaching, learning environment and interaction. Each of these dimensions can be evaluated according a group of pre-defined and chosen indicators. In the case of interaction, we may consider that the quality of students' interaction is one of the most relevant indicators.

This article presents the main results obtained through the analysis of the students' actions while interacting and using the object oriented programming discipline available on the Moodle platform of Open University (UAb) of Portugal to the students of the 1st cycle in Computer Science degree. All teaching and learning activities were developed online (emphasis on asynchronous communication) and this discipline is taught in the first year of the graduation (second semester).

Background

E-learning systems store large amount of data based on the history of users' interactions with the system. These pieces of information are usually used for further course optimization, finding e-tutors in collaboration learning, analysis of students' activities, or for other purposes. The interest in scrutinising this data better is gradually increasing inside academic community.

Slaninová et al. (2012) present the comparison of selected methods for the definition of students' behaviour with the focus to influence of dynamic time warping. Obtained patterns and relations between them are presented using complex networks; the visualization and pattern clusters extraction is optimized by spectral graph partitioning.

Hogo (2010) introduces an evaluation methodologies for the e-learners' behaviour that will be a feedback to the decision makers in e-learning system. His work presented the use of different fuzzy clustering techniques as fuzzy c-means and kernelled fuzzy c-means to find the learners' categories and predict their profiles.

Rovai and Barnum (2007) analysed nineteen on-line graduate courses in order to determine how perceived learning varies by course and its relationship to active and passive participation by students in on-line discussions. Study results provided evidence that significant differences existed by course, suggesting that quality assurance is an issue in Internet-based instruction. Moreover, female students felt that they learned more than their male counterparts. Only active interaction, operationalized by the number of messages posted by students per week,

was a significant predictor of perceived learning. Passive interaction, analogous to listening to but not participating in discussions and operationalized by the number of accesses to the discussion boards of the e-learning system each week, was not significant.

Sriwardiningsi and Siswono (2014) conducted a survey on 274 e-learning students from Online Binus University and Indonesia Open University (UT). Ten hypotheses were proposed but only some hypotheses were valid. Variables such as motivation, digital literacy and satisfaction would affect directly to the attitude of und understanding student learning, while the curriculum material product and interaction e-learning website did not influence the understanding student e-learning attitude.

Although these works focused on analysing e-learning student's behaviour, none of them actually looked at it in terms of Moodle usage, nor in the context of a typical programming discipline. This article focuses exactly on this and tries to perceive better how they explore the content that is made available to them.

Discipline content and organization

The object oriented programming discipline aims at providing students with fundamental knowledge and practices regarding the principles, main concepts, models and main techniques related with computer programming based on the object-oriented paradigm. The teaching of the discipline syllabus adopt the analysis of the object-oriented programming paradigm, algorithms and blocs of code as also several techniques, looking for correct way to solve problems throughout object-oriented programming, while students are also stimulated to design and implement new approaches or improvements of existing ones. The programming language and environment adopted are C++ and Eclipse IDE, respectively.

It assumes a total workload of 156 hours, being 26 contact hours. The students' assessment is done through 2 digital written documents (called e-folios) during the semester and a classroom assessment (called p-folio) in the end of the semester. The e-folios contribute 40% to the final grade, while the p-folio, 60%. They can also be assessed through a unique classroom exam. If they fail, they have a last chance of being approved with an appeal exam.

The Moodle environment of the discipline is composed of 7 topics, in which the student faces an increasing degree of complexity, and is asked to execute always a learning activity (that does not compute to the final grade and is not obligatory). Each topic lasts 2 weeks and didactic material (with vast examples of codes and relevant links, and even videos) specially developed for the students are made available, besides the solution of the learning activities and e-folios. All the topics have a forum where support to the topics content is guaranteed by the teacher asynchronously. The teacher always answer the questions within 48 hours (weekend) or in daily basis (from Monday to Friday), besides stimulating the students to participate. The discipline had a total of 124 students subscribed and two classes, each with 62 students. It took place in the 2014 academic year.

Analysed data

The data was extracted directly from the Moodle platform, through its reports facilities. The activity record report gives detailed information about each student actions along the year. It informs what, when (date and time) and from where (IP address) he has executed some interaction with the discipline.

Although we had 124 students subscribed (7 female and 117 male, 9 from outside Portugal), only a small part of them actually attended (32%) and were approved in the discipline (26%). The period of time considered is from March to November of 2014. Figure 1 shows the total number of students that interacted per month on Moodle. In March, a total of 72 students executed some action, although only mostly half of them actually tried to be approved and by July (end of the semester) only 32 remained active. The Table 1 illustrates de scenario we had and the respective figures:
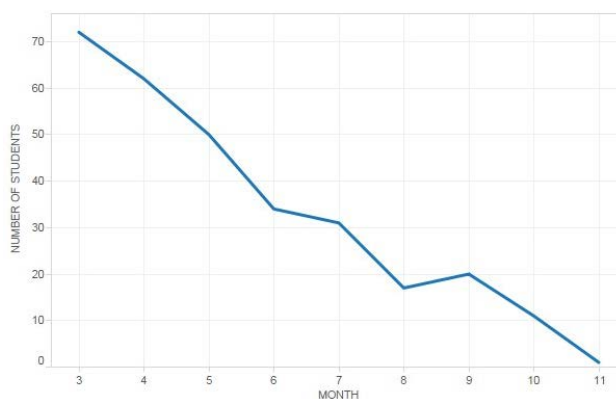

Figure 1. Total of students interacting per month

Table 1: Totals of students in the discipline along time

Scenario	Totals
Subscribed students	124
Interacting at least once with the discipline	115
Did e-folio A	35
Did e-folio B	30
Did p-folio	27
Did only final exam	5
Did appeal exam	2
Approved	31
Highest number of accesses per student	529
Average number of accesses per student	153
Minimum number of access per student	1

Actions in the Moodle can be one of those (total of 31, and in the context of this discipline, it is supposed that they have some interaction especially at those actions marked with an asterisk:

- assign submit (*);
- assign view (*);
- assign view all;
- assign view submission grading table;
- assign view submit assignment form;
- book print;
- book print chapter;
- book view (*);
- book view all;
- book view chapter (*);
- choice choose;
- choice choose again;
- choice view;
- choice view all;
- course view (*);
- folder view (*);
- folder view all (*);
- forum search (*);
- forum subscribe all;
- forum unsubscribe all;
- forum user report;
- forum view forum (*);
- forum view forums;
- IMSCP view all;
- label view all;
- page view all;
- resource view (*);
- resource view all;
- URL view all;
- user view and user view all.

After the extraction, the data was treated to find out totals, average values and detect potentials tendencies. Based on the numerical analysis, some graphs were produced to more easily evaluate the results that were being obtained.
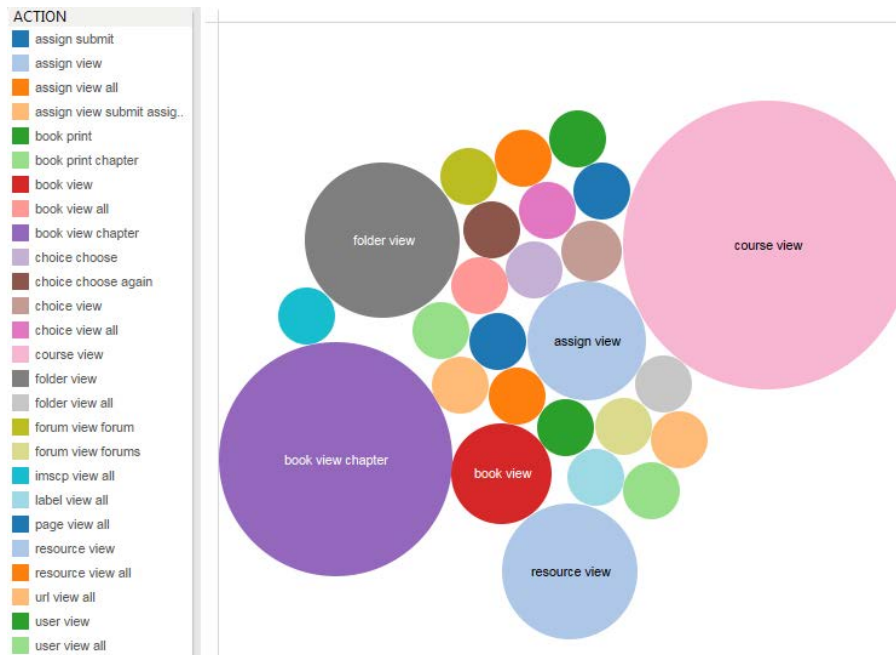
Figure 2. Totals per actions

The Figure 2 illustrates the totals per actions. Course view (38.5%) is the most recurrent action performed by the students followed (in this order) by the book view chapter (17.5%), folder view (12.5%), resource view (10.5%), assign view (7.8%) and book view (3.4%). All the other actions are less significant and have approximated the same total values. The course view is an entry each time the student simply accesses the discipline space in Moodle, but the book view chapter, means that they are constantly consulting the planning (time table) of the course and its overall schedule and content description. The folder view action indicates that they repeatedly open folders to download didactic materials and solutions of learning activities and e-folios, while the assign and resource views points out their interest in viewing the learning activities proposed (although, most of them do not solve it).

Figure 3 show the total number of actions only by weekdays and by weekdays per months. Most of the students in UAb are workers with average age towards the 30-40 years old. Surprisingly, the weekend isn't when the highest accesses happen, but instead on Monday (24%). Topics are usually made visible to the students on Mondays and e-folios, on Fridays. Along the time we can also notice that the activity decreases significantly and although Monday is always when more actions are registered, in April, Tuesday has slightly more actions, while Thursday, Friday, Saturday or even Sunday, have almost the same number of actions.
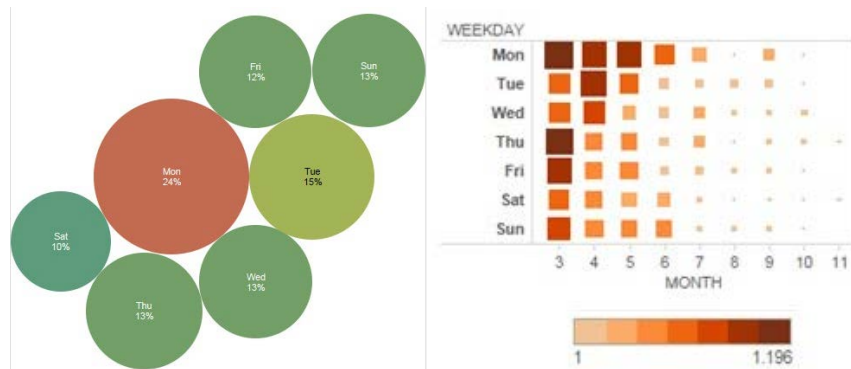
Figure 3. Totals actions per weekdays and per weekdays x months in the period

In terms of time, Figure 4 illustrates the total number of actions along each day in the period as stacked totals of each weekday. The students' actions indicate that they gradually increase their number of actions between 19-22 pm, decreasing their activity after that time. There is also some expressive increase in lunch time or between 7-10 am, being totally coincident with the general profile of our students (employed people) who are more active in less demanding working hours.
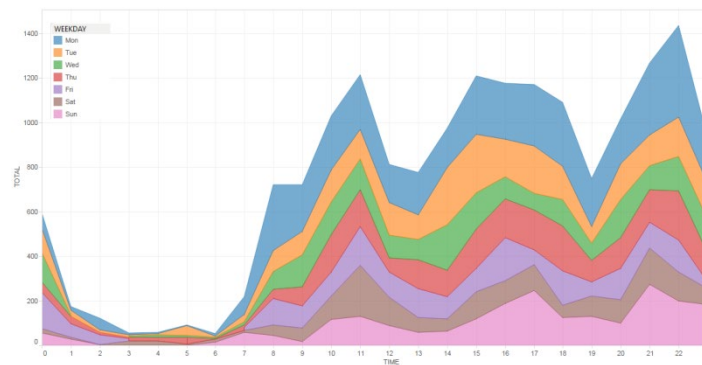

Figure 4. Totals actions per time in the period and per weekday

The decrease of participation and thus interaction of the students increased significantly along the time. Although some of the graphs before already give a hint of this, taking a close look at the most repeated action (Course view), it is more clear the decrease of the rate of participation of the students. In March, 61% of the students that at least has accessed the discipline once were active. In July, this figure drops to only 26%. Figure 5 gives a better view of this happening through tree-maps charts.
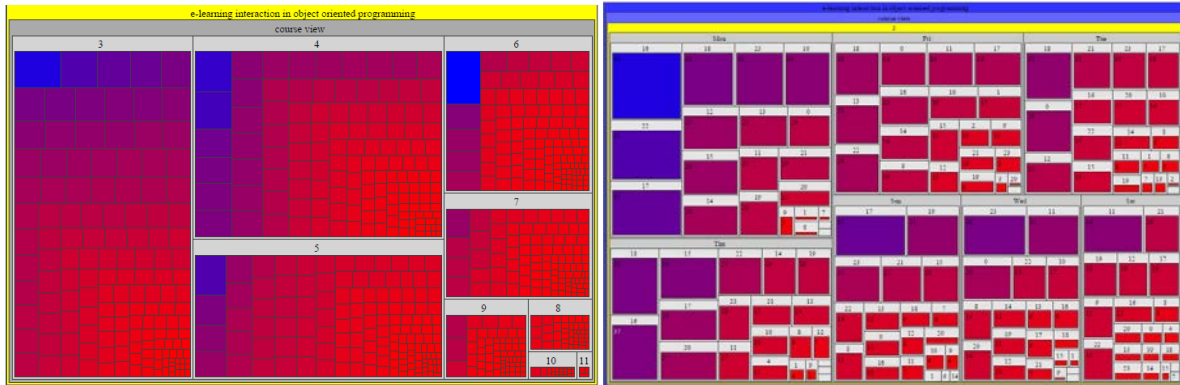
Figure 5. Course view action execution during the period and per weekday and time during the period

Conclusions and further work

Based on the results, it is clear that the drop out of students is very high, although most of all of them accesses the discipline and do some minor interaction at least once. The quality of their interaction is very low in terms of using (posting or/and reading) the several forums available for asynchronous communication. For instance, only a set of 30 students actually accessed a forum. The highest times that action forum view forum was executed by a single student (from those set) was 16 and an average of 3 accesses was the average result to the set as a whole. This reveals a total failure of the main pillar on which the e-learning model relies.

Another interesting outcome is that only 38 students have accessed at least 182 times (in different dates) the discipline. If we assume that they spent 1 hour per day on the platform, this reveals that these students were more interested in navigating and participating actively them those with lower figures (the other 77). If we assume this rate of usage, this figure also indicates that these 38 students exceeded the expected 156 hour of workload only while interacting with the platform (the highest number of times was 529). In fact, most of this group of students was those that actually tried to be approved on this object-oriented discipline. Figure 6 illustrates the relation between final grades of the students that were approved and the total number of actions they did. The two students with highest grades (20) were those with the smallest number of actions, while in general, the approved group had a total number between 200-400 times.
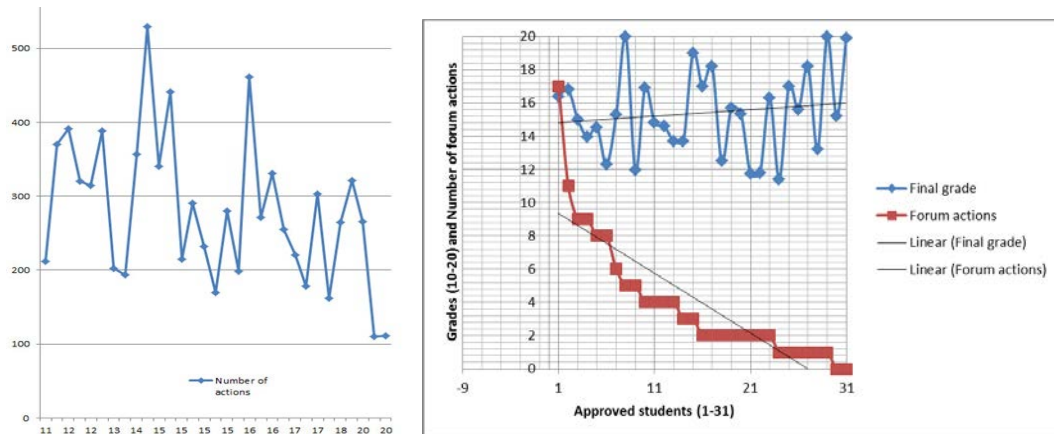
Figure 6. Number of total actions per final grades of approved students and final grades x total of forum actions per approved student

An additional significant outcome is that a divergence occurred between the grades and the number of total forums actions. The interaction through the asynchronous forums is another key premise behind the e-learning model. We can notice clearly in the chart below (Figure 6) that the highest grades were achieved by students with very low number of forum actions (post messages or open forums possibly to read messages).

In general, based on the results, we can assume that the quality level of the students' interaction is low than it was expected or supposed to be the ideal. This indicates that possibly the e-learning model is not well tailored to work with disciplines such as those were programming languages are taught and other didactic and pedagogic strategies, have to be added in this case. The introduction of regular synchronous meetings or the development of multimedia content to teach interactively how to program may be future ways to explore (using virtual and augmented reality, for instance). One very important conclusion is the significant underuse of the forums by all the students, and mostly, the lack of evidence that their underuse leads to fail in being approved.

Another vital thing to do is to run a survey to understand better what limitations and drawbacks cause so many students to drop out or to have such a low quality level of interaction in the distance learning environment in the case of object-oriented programming. Also a future work will be to compare these results against those achieved from other programming disciplines that the Computer Science degree offers in UAb.

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