AN APPROACH TO MEASURE STUDENT ACTIVITY IN LEARNING MANAGEMENT SYSTEMS

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Abstract: Nowadays most universities and educational centres use LCMSs to support the learning and teaching process. In the new framework of the European Higher Education Space, in which the student learns to learn and where the assessment must consider the whole activity carried out by the learner, it is necessary to have some indicator which measures the attendance and participation of each student in virtual courses. This work proposes several student activity indicators which are flexible, extendible and independent from the LMCS. They are based on a parameter which gathers the instructor's criteria in order to measure the activity of his course (time spent, hits or a combination of both). These indicators are obtained for each learner in each resource (content pages, forums, etc.) with relation to the activity carried out by his or her classmates. These indicators will be shown periodically both to the learners and to the instructors so that each student can observe the effort/dedication levels he or she has made compared with the rest of the group and the instructor can assess the grade of activity and participation of each student in the course and furthermore, detect students at risk of drop-out, gaining insights about the learning style of each student and also check if the effort level carried out by students is adequate or higher than the instructor estimated for the course.

1 INTRODUCTION

In recent years, more and more, universities offer the possibility of enrolling in their degrees and masters in a semi presential or completely virtual (online) way in order to facilitate the learning along the life and to make compatible this with other activities.

In general, these organizations use Learning Content Management Systems (LCMS) –such as Moodle, Sakai or WebCT/Blackboard– to give technical support needed to develop the virtual teaching and learning process, since these systems support most of the activities that occur in the classroom and allow the use of different multimedia resources, generally, interactive ones. Furthermore, they facilitate the interaction among students and tutors and make the participation and collaboration among them possible in order to build their own knowledge.

Despite the advantages they provide, these systems present some shortcomings for both students and instructors. There is a list of problems encountered by students studying on-line courses, including the students' feeling of isolation due to lack of contact with the instructor, disorientation in the course hyperspace, and so on (Conrad, 2002; Mazza et al., 2007). On the other hand, instructors lack the appropriate tools in order to supervise the students' work in the current LCMSs (Hijon et al., 2006). As a consequence of this, getting a clear vision of each student or group academic progression during the course is difficult and time consuming for instructors. Furthermore, they generally face a higher number of drop-outs (Xenos et a., 2002; Jusung, 2005; Levy, 2007) and a panorama where student performance is lower (Zinn et al., 2006).

In our opinion, this mainly happens for two reasons: LCMSs do not suitably report to instructors the activity that each learner develops, in such a way

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that they can know how he or she is progressing in the course and take actions as soon as a lack of activity or under performance is detected; and LCMSs only report to instructors when giving learners some indication of their relative effort compared with their peers may motivate them to higher participation rates and success.

Most of the LCMSs have simple modules of reporting with which instructors can extract a limited knowledge about how often their students access the virtual course and what resources they use (Zorrilla et al., 2009), but they do not provide indicators that show a clear idea of the activity of each learner with regard to the rest of the group.

For this reason, the aim of this paper is to propose some student activity indicators which gathers the dedication of every learner in the different resources that the virtual course provides (forums, contents, wiki…). These indicators will be shown periodically both to the learners and to the instructors so that each student can observe the effort/dedication levels he or she has made compared with the rest of the group and the instructor can detect students at risk of drop-out, discover the learning style of each student, and also check if the effort level carried out by students is adequate or higher than he or she estimated for the course.

It must be said that these activity indicators does not try to measure performance, but to evaluate the assistance and participation in the course. The same way as traditional education instructors do when they write down who is in the classroom, who answers his/her questions, who takes part in debates, who suggests topics of discussion, etc. The definition of indicators of this style is justified even more inside the European Higher Education Space where the whole activity carried out by the learner must be assessed, attendance and participation being simply other aspects of the evaluation.

The paper is organized as follows. In Section 2 we review the existing research work related to monitoring and measuring students' learning activity in e-learning environments. Section 3 defines the proposed student activity indicators and explains and justifies the selection of each parameter. Section 4 discusses the utility of these indicators using as a case study a virtual course offered in the University of Cantabria. Finally, section 5 summarizes and draws the most important conclusions of our proposal.

2 RELATED WORK

In this section we provide an overview of the related literature, focusing our attention on monitoring and measuring students' learning activity in e-learning environments.

As has been mentioned previously, the LCMSs offer reports with which instructors can extract certain information about the behaviour of their students in the virtual course, although according to Douglas (2008), few teachers use them due to the difficulty of interpreting the information that they give. In general, these reports show, in table format, quantitative information relative to the different actions that students carry out in the virtual course such as the number of accesses, the number of visited pages, the number of read and sent messages or the total spent time browsing the course. But these numbers do not say very much if they are not elaborated measurements that allow instructors to compare the activity of a student with regard to the rest of the group.

For this reason, some research groups are developing software tools that allow this information to be shown in a more elaborated, graphical and intuitive way, such as CourseVis (Mazza et al., 2007), Gismo (Milani et al., 2007), Moodog (Zhang et al., 2007) and Matep (Zorrilla et al., 2008), at the same time answering questions that the instructors are more interested in knowing such as the participation of students in the forums, the frequency of use of each resource, the time spent per student and group in each resource, what resources they prefer or when and how often they access the virtual course, etc. But none of them provides an activity indicator in a strict sense.

We have found few papers directly related to measuring student activity in LCMS, among these are:

Pendergast (2006) describes a tool independent from the LCMS that allows instructors to assess the activity of the students exclusively in the use of forums. The formula is quantitative with weight assigned to the number of sent messages, the number of received and the length of the messages though it also includes a qualitative part that the instructor establishes once he or she has read the messages.

Chan (2004) defines a student participation index using 5 parameters corresponding to 5 student actions: number of pages viewed, number of forum questions read, number of forum questions posted, number of chat sessions participated in and number of chat message submitted. The computation of the index is based on the weight of each pre-defined student action and the median of the students' index

scores. Weights are assigned by the instructor.

In our opinion this indicator presents two shortcomings. On the one hand, it is focused on assessing and not measuring the participation in the course since instructors determine, by means of weights, what actions are more important for them. And on the other hand, the indicator is based on the number of events instead of time spent or in a combination of both, actions and time. What measures better the activity in the mail use: reading or writing two messages or the time spent in doing it? In our opinion, it depends on how the instructor wants to assess the activity, considering the time spent in each resource, the number of clicks carried out or using a combination of both. Even more it could happen that the instructor would choose a different criterion to evaluate the activity in each resource, since this depends on how the course is designed and organized.

Finally, Juan et al. (2008) propose a system to monitor online students' academic activity and performance. This, as in the rest of the papers, is independent from the LCMS and it is based on sending periodical reports by e-mail to online instructors and students. It offers three activity indicators which are calculated based on the number of events (post or read notes in forums, send or read e-mails, complete online tests, upload or download documents, etc).

- Students classification indicator defined as number of events per student during this week vs. number of events per student during an average week.
- Individual student monitoring which monitors activity levels of each student throughout the course (weekly)
- Monitoring participation level which monitors the percentage of students that complete each test.

The authors show some interesting graphical reports although, as with the previous reference, they only use the number of events. Furthermore, as the index is computed globally, it is not possible to compare the activity carried out by each learner in each resource in relation to the group. This would allow instructors to discover the student learning style.

3 STUDENT ACTIVITY INDICATORS

Class attendance and contribution may be considered as student actions which can be used to evaluate student participation in the traditional classroom. However, in online courses, instructors lack face-to-face contact, so that they only can carry out this assessment using data about the students' actions registered in LCMS: accessing course materials, posting and reading discussion forums, taking online quizzes, writing in wiki, etc.

The student activity indicators (SAI) which we propose are generated independently of LCMS but use the information which e-learning platforms register in their tracking tables. LCMSs, in general, write down the initial and final time of each action carried out by a user (instructor, student, and administrator) in each resource. The action is considered finished when other action happens in the same or in another resource. We initially consider the following resources: content page, forums, mail, test and quizzes, wiki and chat because they are offered by the most known and used LCMSs (Álvarez, 2008).

3.1 Mathematical Function Selection

A measurement of activity could be modelled by means of a function v=v(t), where t is the value of the parameter about which the valuation is to be done, for example, time, and v is the activity indicator of a student that has dedicated a value t in the range of dates under study. The function v will return a value between 0 and 1.

We consider suitable a crescent function (more time implies more activity) which fulfils the following conditions:

1. For t=0, v must be 0.
2. In order to measure the activity in relation to the average and maximum activity of the group, we establish that
   - For a value t=α, v is considered the average activity, that is 0.5
   - For a value t=β, v is considered the maximum activity, that is 1.

The simplest function with three free parameters which gathers these characteristics is $t=av^2+bv+c$, isolating v, we will have

$$v(t) = \frac{-b + \sqrt{b^2 - 4a(c-t)}}{2a}$$

where

1. For t=0, v must be 0, so that c must be 0.
2. For $v(\alpha)=0.5$ and $v(\beta)=1$, then $b=4\alpha-\beta$ and $a=2\beta-4\alpha$.

Next, we explain how to calculate the SAI for each resource.

3.2 SAI in Content Pages

$A_1,\ldots,A_n$ are the students enrolled in the virtual course whose activity must be calculated for a range of dates divided into 1, …, k periods (for example, weeks). This value is denoted $v_k(A_j)$.

For each period k, a set with the time spent for each student A_j in each page viewed is defined. Next, t_{kj} is calculated as the sum of the time spent for the student j in the period k. Then, an interval $[m_k, M_k]$ with the values comprised between 10 and 90 percentile of the t_{kj} is defined with the aim that the average is not affected by extreme values.

Next, α_k and β_k are defined as:

$$\alpha_k = avg(t_{kj}) \quad where \quad t_{kj} \in [m_k, M_k] \tag{1}$$

$$\beta_k = \max(t_{kj}) \quad where \quad t_{kj} \in [m_k, M_k] \tag{2}$$

In order to calculate the activity of the student A_j in the period k, denoted $v_k(A_j)$, the number $y_k(t_{kj})$ is considered, where $y_k(t)$ is the following crescent function which returns a value between 0 and 1.

$$y_k(t) = \begin{cases} 0 & m_k \geq t \\ \dfrac{-b_k + \sqrt{b_k^2 + 4a_k t}}{2a_k} & m_k \leq t \leq M_k \\ 1 & t \geq M_k \end{cases} \tag{3}$$

This function fulfils that $y_k(0)=0$, $y_k(\alpha_k)=0.5$, $y_k(\beta_k)=1$ so that it can be considered as a measurement that assesses the activity of a student compared to the rest of the group. A value higher 0.5 is obtained when the student spends more time than the average. Alpha and beta parameters can be modified in order to adjust the measurement to other criteria. For example, α_k could be the average time that students spend in browsing a content page in the period k multiplied by the number of pages that students browse on average in this period; and β_k, the average of the maximum time that students spend in browsing a content page in the period k multiplied by the average of the maximum number of pages that students browse in this period.

3.3 SAI in other Resources

We use the same formula and method of calculation in the different resources. For each resource, we choose those actions which better allow us to value the activity carried out in it. For example, for mail and forum, the messages read and sent; for wiki, the web pages edited, etc. Next, we choose the parameters we are going to use to measure. For example, the number of accesses, the time, a combination of both, etc. And finally, we calculate the indicator following the same steps described in section 3.2. It is possible to define different criteria according to how alpha and beta are chosen (see Table 1).

Table 1: Possible alpha and beta parameters for the different resources, t_{kj} being the time spent by student j in the period k in the resource and n_{kj} is the number of times that student j carried out the action.

Alpha	Beta
$\alpha_k = avg(t_{kj})$	$\beta_k = \max(t_{kj})$
$\alpha_k = avg(n_{kj})$	$\beta_k = \max(n_{kj})$
$\alpha_k = avg\left(\frac{t_{kj}}{n_{kj}}\right) x\, avg\left(n_{kj}\right)$	$\beta_k = avg\left(\frac{t_{kj}}{n_{kj}}\right) x \max\left(n_{kj}\right)$
$\alpha_k = avg\left(\frac{t_{kj}}{n_{kj}}\right) x\, avg\left(n_{kj}\right)$	$\beta_k = \max\left(\frac{t_{kj}}{n_{kj}}\right) x\, avg\left(n_{kj}\right)$

3.4 Global SAI for Resource and for Period

The student activity indicators defined until now are for a resource and a period. But the possibility of joining them in order to obtain a global indicator for resource and another for period also exists.

The global SAI for resource could be calculated as the average of the SAI for resource obtained in each period. This would allow instructors to compare each student with respect to the average activity and gain insights about his or her learning style.

The global SAI for period could be calculated as the sum of weighted SAI obtained by the student in each resource (m) available in the course (see eq. 4). These weights, with the aim at being independent of instructor's criteria, could be calculated, for example, as a percentage of time invested by all students in each resource. That means, the time spent by all students in the course would be summed up and the weight for each resource would be proportional to its contribution with respect to the total. This indicator would offer the instructors a global valuation of attendance and participation of each student in a period.

$$SAI = \sum_{i=1}^{m} \varpi_i SAI_i \tag{4}$$

4 CASE STUDY

The virtual course entitled "Introduction to multimedia methods" is a subject of 6 ECTS which was taught in the first semester of 2009 at the largest virtual campus in Spain, called G9 (this group is composed by 9 Spanish universities; one of them is the University of Cantabria). It is a practical subject in which a multimedia tool is taught. The course is designed by means of web pages conformed to SCORM and include some video tutorials, flash animations and interactive elements. It is registered in Blackboard LMS.

Although the number of students enrolled in the course was 80, only 45 made the first assignment, whose submission was 15 days after the beginning of the course, and finally, 37 students followed the course until the end.

For this case study, we calculated the indicators considering only the time variable. The alpha and beta parameters were obtained at the end of the course using a weekly period.

In order to analyze the validity of the proposed indicators, the instructor selected three students (mlm90, euh10, rce56), that she suspected had a very different behaviour in their involvement in the course. Their way of working, their participation in the forum and their communication with the teacher by e-mail was making her suspect an uneven utilization of the different tools available in the course. Another additional reason for their selection was their final mark: mlm90 had a high qualification, euh10 average and rce56 low.

Next, the instructor discusses the results obtained in content pages, forum and mail due to the fact that the course had neither quizzes nor wiki.

As can be observed in Figure 1, the alpha and beta parameters associated with the content pages reveal two important facts: the time spent in content pages is regular enough throughout the course with a decrease in periods after a submission of an assignment. The average time spent per week in content pages is 5000 seconds (approximately 1 hour 20 minutes per week). It is important to highlight that, because of the practical nature of the course, most of the proposed tasks do not require students to be connected. This dedication is considered suitable by the instructor.

In Figure 2, it can be observed that the activity carried out by the three learners in content pages show that they behave differently. Euh10 scarcely visits the content pages (practically the first two weeks of course); nevertheless, mlm90 and rce56 have different degrees of activity. The first carries out an activity superior to the average practically every week whereas the activity of the second is lower than the average and concentrated in the dates before a submission was due (the weeks in which a submission had to be done are marked in rectangles in Figure 1).

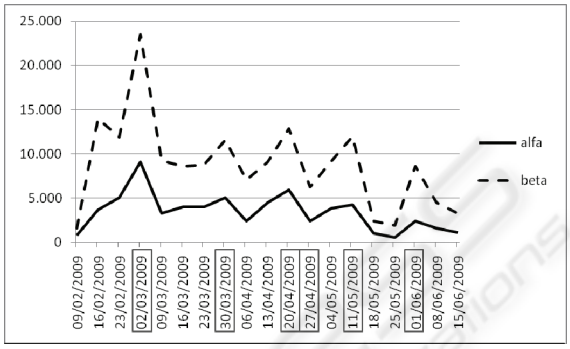

Figure 1: Alpha and beta for SAI in content pages.

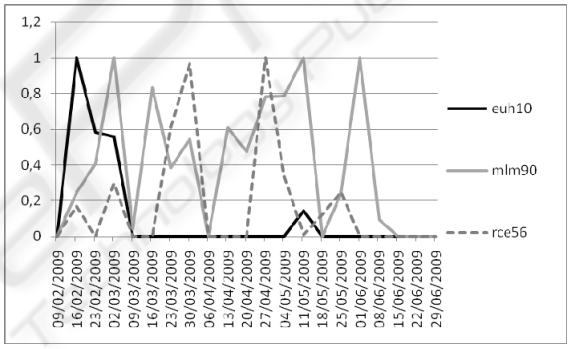

Figure 2: SAI in content pages for the three chosen students.

Forum and mail were the tools used to establish the communication among the students and the instructor mainly. The instructor confirmed by means of the comments written in the required assignments that students considered the forum very useful.

In Figure 3, it can be seen that the time spent on average per student in a week is nearly 2500 seconds (practically half of time dedicated to content pages). A higher activity in the period in which students had to carry out one of the more difficult and longer (April – March) practical exercises is also observed. Finally, a decrease in activity when the course is ending is also appreciated.

In relation to the students' behaviour it can be said that euh10, mlm90 and rce56 behave differently. Euh10 is one of the students who has been connected most to the forum (for several weeks his/her valuation is maximum). On the contrary,

mlm90 and rce56 have less activity and, once again, rce56 concentrates this in dates near a submission.

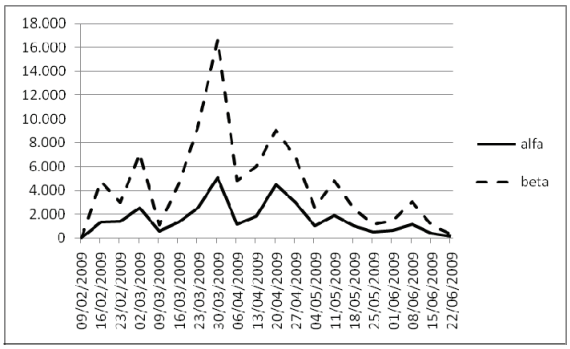

Figure 3: Alpha and beta for SAI in forum.

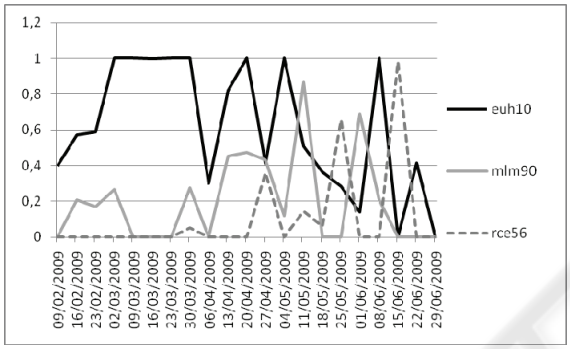

Figure 4: SAI in forum for the three chosen students.

The use of the mail was more specific, generally to answer doubts in an individualized way. The value of alpha associated with the indicator (see Figure 5) confirms the suspicion of the instructor that the forum was the tool most used for the communication (the instructor does not have knowledge of the messages sent among students).

The behaviour of mlm90 in the mail tool might be considered the most usual. The student hardly communicates with the instructor in an individualized way since he/she has other tools to consult and solve his/her doubts (content pages and forums). Nevertheless, rce56 and euh10 behave very differently. The instructor, after analyzing the three indicators together, confirms her impression with regard to how they had carried out the activity in the course. In case of rce56, his/her activity was centred on periods near the submissions and since he/she did not visit the forum regularly, he/she asked the instructor for help. However, euh10 is a student who tried to do the tasks without reading the content pages, looking for the solution in the forum. If the student did not find the answer, then he or she sent the instructor an email.

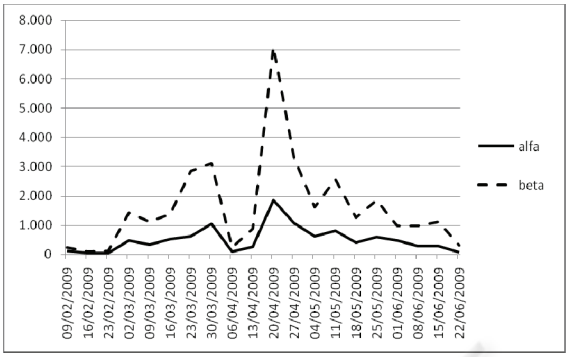

Figure 5: Alpha and beta for SAI in mail.

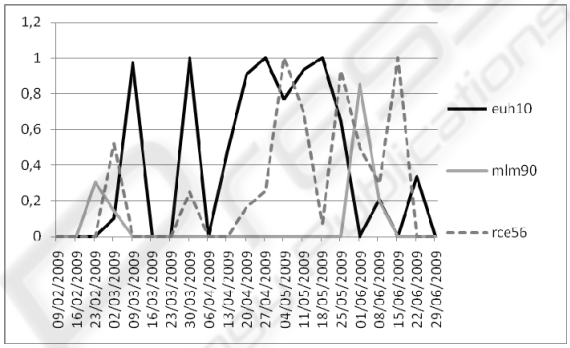

Figure 6: SAI in mail for the three chosen students.

Figure 7 shows the global indicator for each resource of the three students obtained as the average of their SAIs throughout the 15 weeks. In the instructor's opinion, this graph allows her to see if a student has carried out an activity above or below the average and get an idea of his or her learning style.

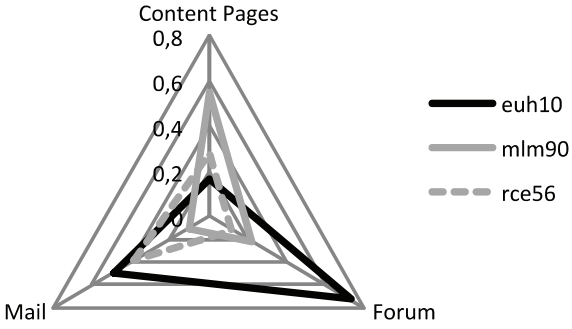

Figure 7: Global SAI for resource.

Lastly, Figure 8 shows the global SAI for each week. This graph illustrates the activity carried out by the students but hides their behaviour. Rce56 has a low activity, euh10 is a little more and mlm90 is the student with the highest activity. We consider

that the SAI in each resource is more useful for the instructors.

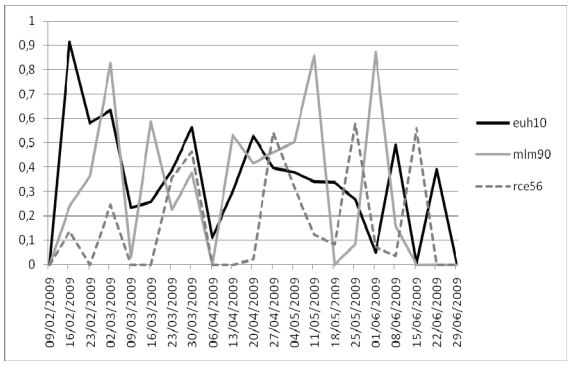

Figure 8: Global SAI for each week.

5 CONCLUSIONS

Monitoring activities in conventional teaching environments involves observing students' behaviour in the classroom and estimating the effectiveness of pedagogical strategies in a continual and visual feedback. However, in e-leaning context, this informal monitoring is not possible, and the teachers must look for other ways to obtain this information (Lera-López et al., 2009).

In this sense, our work seeks to offer instructors a student activity indicator that allows them to gain insights into the learning style of each student, detect students at risk of drop-out, and assess the grade of activity and participation of each student in the course. Furthermore, students will also be benefited since they will be able to know what their effort is with relation to their classmates.

The proposed method for assessing students' online activity is a) flexible, you can decide what parameter to use in order to measure the activity (time, hits, a combination of both) and the frequency with which the indicators are generated; b) extensible, you can decide which resources to measure; and c) independent from the LCMS, which means, you can use data registered in it or in any learner trace collector which is available.

The results obtained in our case study show that our indicators adequately reflect the activity carried out by the students, according to the instructor's criteria.

Our next work will be to obtain the indicators with other criteria (see Table 1) in order to analyse the behaviour and the information which they offer, and the advantages and disadvantages which each criterion presents. After that, we will automate the calculation of the student activity indicators and obtain them in other virtual courses to check their validity and generality. Next, we will develop a software module with which instructors can configure the parameters for their courses and request the reports which they want to analyse. Lastly, we will gather the opinion of students and instructors with respect to how useful these indicators are.

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