Continuous Proactivity in Learning Management Systems

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Abstract— **Three studies, conducted on graduate level, show findings that students with highly proactive behavior are more likely to succeed in a Learning Management System (LMS) environment. Statistical analysis techniques were used in the studies. In the second study the concept of continuous proactivity was introduced to observe if a study-group was more likely to succeed in the lesson compared to a control-group, and in the third study, proactivity was applied to the entire class. This paper reports the results of the second and third studies and introduces the concept of "continuous proactive learning strategies" to frame the future development of proactive rules in LMS.**

Keywords: Proactive Learning, Learning Management System, Learning Techniques, Learning Methods

I. INTRODUCTION

E-Learning environments, or Learning Management Systems (LMS) are a set of methods, tools and techniques to deliver learning content through the Internet or similar networks. LMS are suitable systems to support distance learning and blended learning – used in conjunction with face-to-face teaching. Over the past ten years LMS has been adopted by educational institutions, becoming almost omnipresent in many parts of the world. These systems have been designed adapting existing interactive web based technologies – relating to a program that responds to user activity – to deliver educational content.

Although there are already a large number of functions, covering a large number of users' needs for a variety of different users acting specific roles in these LMS environments, current LMS are fundamentally limited tools. They are only reactive software, content management based, and developed like classical user-action oriented software. These tools wait for an instruction, most commonly given through a graphical user interface, and then react to the user's request, limiting the value of the LMS to the user's own action and not to the needs of the learning process.

Learning is a continuous, step-by-step effort that requires conscious undertakes in order to achieve predefined learning goals. This continuous effort is orchestrated by pedagogic approaches where step-by-step strategies for instruction are defined. Different pedagogical theories exist: constructivism, resource based learning, collaborative learning, problem based learning, narrative based teaching, situated learning, etc. One of the common denominators of these pedagogical theories is the need of a continuous effort.

Proactive systems, as defined by Tennenhouse [3] adhere to two premises: working on behalf of, or pro, the user, and acting on their own initiative, without the user's explicit command. Proactive behaviors are intended to cause changes, rather than just react to changes. This is a major change from interactive computing, in which we lock a system into operating at exactly the same frequency as humans do. Proactivity is a means of continuous effort and student's continuous LMS interaction (engagement) is an approach to proactivity. Proactive Learning Management Systems (PLMS) is a new kind of LMS, designed to improve the users' online interactions by providing programmable, automatic and continuous analyses of users (inter-) actions, augmented with appropriate actions initiated by the LMS itself.

This paper reports statistical analysis observations on three studies in Proactive LMS. The first study develops a simple proactivity test-case study to answer the research question: "Are students with high proactive behavior more likely to succeed in a LMS environment?". This study was developed in a blended learning environment for a second year bachelor class during the winter semester of 2006-2007. The second study, developed during the winter semester of 2007-2008, was designed in order to observe: "Are students with continuous

LMS proactivity more likely to succeed in a lesson?". This study utilizes a study-group and a control-group to statistically evaluate if the study-group is more likely to succeed in the lesson. Proactivity was continuously triggered to provoke students' participation and interaction via LMS. The third study, conducted during the winter semester of 2008-2009, generalized the application of the **continuous proactivity** to an entire class in order to observe: "does continuous proactive rule have a direct positive impact in student's results?". Thus, **continuous proactivity** will increase the probability of student's success in a lesson. Furthermore, this paper introduces the concept of "continuous proactive learning strategies" to frame the future development of proactive rule in LMS.

II. OBSERVATIONS ON THE FIRST STUDY: SIMPLE PROACTIVE STUDY

A Simple Proactive Study [2] was implemented in a blended learning environment for a second year bachelor class during the winter semester of 2006-2007. The class itself follows the normal academic program, with the LMS as a supporting tool of the learning process.

Different activities were programmed for the students to balance the learning, and more precisely, to provoke continuous step-by-step effort in order to answer the research question: "Are students with high proactive behavior more likely to succeed in a LMS environment?". Two types of reactive activities, forums and homework were available on the LMS for the students to participate and all the students' interactions were recorded. A proactivity rule was triggered two times during the semester, one early in the semester and one in the middle. The rule was based on the students' total participation in the class activities and the rule sent an email notification to those students who had not enough participation encouraging them to participate.

Statistical analysis on this study shows a 82% correlation level between the forum and homework activities and the exam results, and a 73% correlation level for online content access of the students for whom proactivity was triggered (see table I). These first results also show by 28% and 33% respectively, that proactively triggered students were more successful than those who were not.

TABLE I.   PROACTIVELY TRIGGERED STUDENT'S CORRELATION ANALYSIS

Correlation	Proactive	Entire Class
Activities vs. Final Grade	0.824	0.541
→Forum Participation vs. Final Grade	0.506	0.403
→Homework vs. Final Grade	0.742	0.665
# Online Connects vs. Final Grade	0.729	0.405

III. OBSERVATIONS ON THE SECOND STUDY: CONTINUOUS PROACTIVITY CONTROL STUDY

In the first study we observed a 82% correlation between students' LMS participation, and the final results for students were proactivity was applied compared to a 54% without proactivity. A second scenario – case study – was developed to answer the research question: "Are students with continuous LMS proactivity more likely to succeed in a lesson?".

This second study focuses on continuity as means of increasing LMS user engagement, enabling the continuous step-by-step effort required to achieve learning goals. A proactivity rule was triggered six times during the semester only to the study-group, and aimed to encourage the student's participation on online Forums. The rule was event-time based, and an email was sent to all the students in the study-group on a regular basis.

The rule is defined as:

```
rule description: On dates D1, D2... D6 advise the study-
group about the status of the online forum by email to
increase their online engagement.

data acquisition:
cc = get_course(C)
sg = get_group(
tt [...]= get_dates(D1...D6)

activation guards:
date = tt[...]

conditions:
es.get_all_users(study_group(cc))

actions:
sendLMSeMail(to = es.name, subject = "Forum Info
Update", data = "Please be informed that the forum "WBS
Level Two" has been closed and graded. The forum "WBS
and Mindmaps" will be closed on 16/11. These activities
represent 30% of the course evaluation.")
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The LMS recorded 12,202 student interaction events for 22 students (12 in the study group and 10 in the control group). The Figure 1 shows the integration of the students' LMS daily access and the class activities over the time. In this figure it is visible that particular events drive students to access the LMS, notably the day before a class and the day of a class connections were doubled.
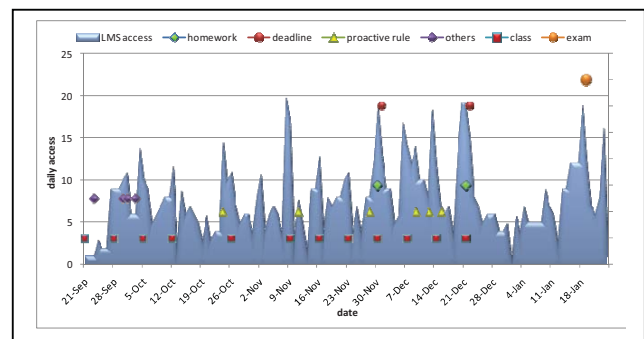

Figure 1.   Interactions on the LMS

This is a logical confirmation on how the students take advantage of the LMS as source of information and knowledge.

However this is also a confirmation that students were only driven by a particular event, stimulus, in this case update their knowledge just before the class. This shows the general class trend of using the LMS intermittently and the question is: are both, study and control groups, intermittently accessing it or is there a different trend?

The study-group received six proactive rules via email notifications to create awareness of the status and availability of forum activities. Figure 2 shows the access distribution between trigger day -1 and day +3. Total traffic increased between 25% and 30% on the triggered date and up to two days after the event. This result shows that the stimulus lasts a maximum 3 days, similar to the class event where the stimulus also lasts 3 days (day -1 to day +1). The combination of these events increased continuity or student engagement in the class lessons.
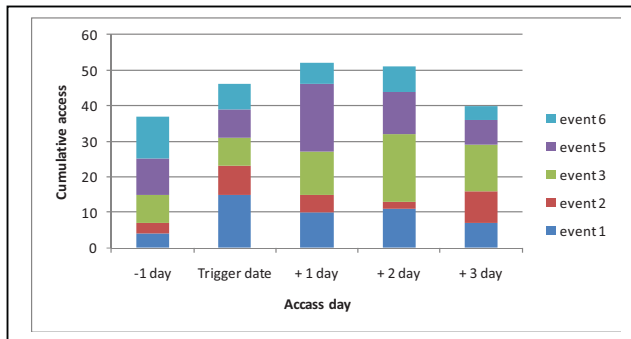

Figure 2.   Study-group and control-group interactions on the LMS

To answer the research question if "students with continuous LMS proactivity are more likely to succeed in a lesson", the class assessment results were analyzed and the comparative showed 20% more success in the study-group than in the control-group. In this particular scenario the strategy was LMS engagement in order to increase the success rate. The study-group's participation in the online forums was 12% greater than that of the control-group, and assessment results were also 5% higher on the study-group compared to the control-group. Figure 3 shows the daily LMS access and events for the study-group and control-group.

Further analysis was developed to study the relation between the online forums subjects and assessment on those subjects during a final exam. Seven questions in the final exam were drawn in relation to the 13 online forums, and correlation analysis show a 7.8% direct improvement on the study-group as a result of proactivity. In summary, observations on this case show that the study-group, on which proavtivity as a mean of continuous engagement was applied, is more likely to succeed in comparison to the control-group.
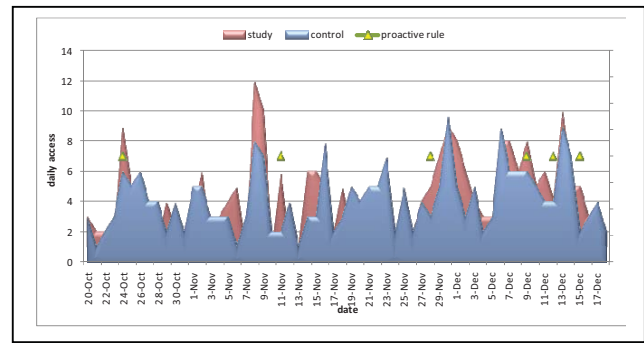

Figure 3.   Study-group and control-group interactions on the LMS

IV. OBSERVATIONS ON THE THIRD STUDY: GENERALIZED CONTINUOUS PROACTIVITY STUDY

A third study, conducted during the winter semester of 2008-2009, generalized the application of the continuous proactivity to an entire class in order to observe: "does continuous proactive rule have a direct positive impact in student's results?". Consequently, continuous proactivity will increase the probability of student's success in a lesson. This third study elaborates on the observations of the second study, where a combination of events increased continuity or student engagement in the class lessons.

In this study a proactive rule, based on events, was triggered 8 times during the semester to encourage all students participation in online Forums.

The rule is defined as:

rule description: On event *New Forum* F1, F2…F8 advised students about new online forum by email to increase their online engagement.

data acquisition:
cc = get_course(C)
ee […]= get_event(F1…F8)

activation guards:
event = *ee[…]*

conditions:
es.get_all_users(cc)

actions:
sendLMSeMail(to = es.name, subject = "*New Forum*", data = "*A new topic "XYZ.." has been added to your Project Management class Forum*")

The LMS recorded 5,466 student interaction events for 13 students. Figure 4 shows the access distribution between trigger day -1 and day +3 of the proactive rule. Total traffic increased 11% on trigger day and up to three days after the event, this could be seen as a decrease compared to the previous study. However, this is not the case because these events where triggered approximately +2 days after the class session to increase engagement (continuous effort) and traffic

during class window increased 13%. This shows an overall 12% increase during the combined events, proactive plus scheduled class session, with a stimulation effect lasting more than 4 days in some cases.
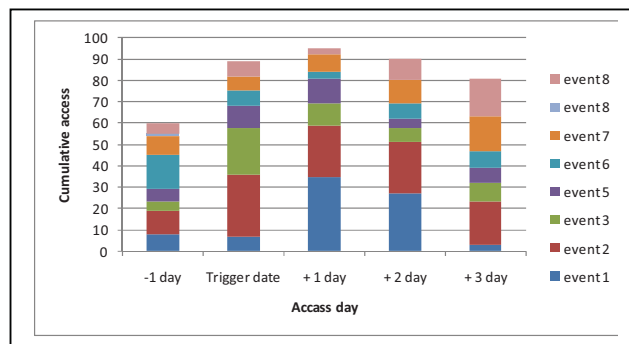

Figure 4.   Third study interactions on the LMS

The Figure 5 shows the integration of the students' LMS daily access and the class activities over the time, showing a similar trend to previous studies where LMS access around an event increased.
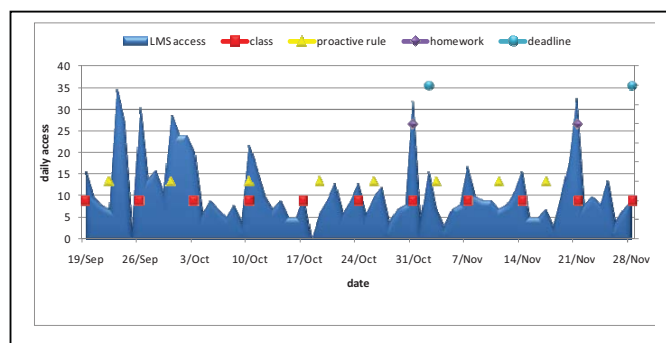

Figure 5.   Third study interactions on the LMS

In this study, statistical analysis was carried out on the relation between grade results and the student's activity in the online Forums as a result of the proactive rule. Analysis on the Forums participation was done based on type of action performed by them. Three types of actions where registered; (a) create a new entry in a forum, (b) read an entry and (c) respond to an entry.

TABLE II.   Correlation analysis between forum online actions and activies, exam and final grade

	Forum Online Actions		
	new	responses	read
Activities	0.50	0.32	0.60
Exam	0.54	0.41	0.56
Grade	0.61	0.42	0.68

Table II summarizes the correlation analysis. Analysis shows a 68% correlation level between students's reading the online forums and final grade, compared to 61% by new entries and 42% for responding to other students entries. This results shows that there is a direct relation between continuous

proactive triggering and students success, 68% for this population. Notably reading forum entries has a 28% higher relation in the final results compared to responding to a forum entry.

V.   FUTURE WORK: CONTINUOUS PROACTIVE LEARNING STRATEGIES

The results of these studies cannot be considered as general conclusions, even if all three studies show a positive relation between proactivity actions and student's success. In order to further research the benefits of these observations, the creation and validation of proactive rules will be required which implies the definition of learning strategies oriented to stimulate the "continuous step-by-step effort" required in the learning process. These strategies are called Continuous Proactive Learning Strategies (CPLS).

The creation of proactive learning strategies requires the understanding of the factors involved in the learning process. Bransford [1] indentified 4 main factors in the learning process: attention, motivation, emotions, and experiences of the learner (progression).

- Focus of attention determines if a student mentally follows a class and, therefore, the degree of behavioral change. LMS requires a strategy for getting and keeping the student's attention on the learning content and activities presented.

  Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring other things

- Motivational states of students are of importance for stimuli given by the teacher or LMS to trigger the learning process. The willingness to learn results from different motives beginning with the intention to achieve something, competing against colleagues, helping other people, or emotional factors like anxiety. Motivational aspects for LMS may also depend on learning content, pointing out the relevance of an instruction or including interactive media elements such as online discussions, debates, games and simulations.

  Motivation is the internal condition that activates behavior and gives it direction; and energizes and directs goal-oriented behavior.

- The emotion is an unconscious system to alert us on potential opportunities or risk, it triggers positive or negative motivation and attention responses. Triggering the student's emotional channel could improve the learning process and could be achieved in a LMS through storytelling, empathy, provocations, animations, and group works, enabling participation in the learning context.

*An **emotion** is a mental and physiological state associated with a wide variety of feelings, thoughts, and behavior*

- Knowledge transfer can be improved if students relate prior knowledge, either in the same domain or in a similar context. LMS learning strategies need to detect lack of knowledge at an early stage and more importantly, lack of progression during a learning cycle.

__Progression,__ a learning principle which states that the benefits accrued from learning will continue only if knowledge is gradually learned.

The proactive strategies need to create an adequate environment to activate these 4 main learning factors and enhance the continuous step-by-step effort. Strategies can be divided into two types: pattern recognition and event based.

- Event based strategies monitor the currents of events such as time and status of an action, and focus on increasing student LMS engagement. These strategies main objective is to enable attention, motivation and emotion.
- Pattern recognition strategies are continuous assessment of the student's LMS performance to determine the student's learning trend. These strategies main objective is to enable progression

The proactive strategies are to be activated via rules to evaluate the time/status events and patterns. The activation of a rule will generate a synchronous or asynchronous interaction back to the students. The asynchronous interaction could be achieved by the use of standard email or SMS based notification, however this mode of communication does not guarantee the reception and processing of the notification. Asynchronous interaction is still a valid mode of proactivity and the three studies have shown positive results when used in combination with a reward system. Synchronous communication modes achieve greater levels of engagement. This category groups technologies such as instant messaging, chat rooms, microblogging, traditional class and tutoring sessions, which could be used as a result of a proactive rule.

Future work will define and experiment event and pattern strategies to validate their impact in the learning outcome. The proactive strategies need to be combined with the mode of communication to cover the 4 learning factors. Different modes of communication have different levels of impact in the learning factors, e.g. emotion could be achieved in a tutor one-to-one session, but it would be very difficult to achieve it via email notification, nor to measure it automatically. Another example is the use of instant messages or microblogging to engage students in learning based reward activity, such as solving a particular problem and receiving points for it. The table III summarizes the expected impact, to be studied, for different mode of communication and the learning factors, "+++" meaning higher positive impact to "+" for lower level of positive impact.

TABLE III.   Impact of communication modes

	Attention	Motivation	Emotion	Progression
email		++		+++
SMS		+	+	++
instant messaging	+	+++	++	++
chat	+		++	+
micro-blogging	+	+++		+
class session	+++	++	++	
tutoring	+++	+++	+++	

VI.   CONCLUSIONS

This paper reports the statistical findings of two new studies on proactive LMS, oriented to stimulate the continuous step-by-step effort required in learning. On one study (second study) the question: "Are students with continuous LMS proactivity more likely to succeed in a lesson?" was answered with the observation that the study-group performs 20% better than the control-group. The third study answered the question: "does continuous proactive rule have a direct positive impact in student's results?", Showing that active online participation in class forums is linked (68%) with the student's grade results. The result of these studies cannot be considered as general conclusions, even if all three studies show a positive relation between proactivity actions and student's success, because the subject matter and populations were limited, a total of 75 students in three different calendar semesters have been observed.

The paper also describes the future work required to exploit the observation of this studies with the creation and validation of Continuous Proactive Learning Strategies.

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