

# LMS Monitor: An application for academic and performance monitoring of students in LMS

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## ABSTRACT

Applications developed specifically for supporting Learning Management Systems (LMS) have been deemed effective when used in distance and hybrid teaching models. They are especially attractive and powerful aids in geographical areas where access is difficult, as in small communities and towns within the Brazilian Amazon forest. As the use of these systems brought changes in the teaching-learning process, monitoring and tracking of student performance also had to be rethought. This paper presents the development of a plugin LMS Monitor tool to aid educators in academic performance analysis of students in LMS Moodle. The tool is intended to collect indicative data of student access to, and participation in virtual classrooms environment and activities. In an initial case study at the Federal University of Amazonas (UFAM/Brazil), the LMS Monitor was made available to educators in two hybrid learning model courses. The usability and practicality of the tool were evaluated using TAM (Technology Acceptance Model) with Likert scale. Evaluation results indicated that LMS Monitor is an effective support aid to educators in the pedagogical monitoring and performance analysis of students, significantly contributing to improve student retention and promotion rates.

## Categories and Subject Descriptors

K.3.1 [Computers and Education]: *Computer Uses in Education*  
– *Distance Learning*.

## General Terms

Design, Human Factors.

## Keywords

Monitoring of Students; Learning Management System; Moodle.

## 1. INTRODUCTION

Currently, distance education (DE) is being presented as a solution to meet the new educational demands arising from changes due to globalization, which is not only an economic phenomenon, but also a transformation of space and time [1]. In Brazil, universities and higher education institutions, public and private, are using technological resources in order to improve the process of teaching and learning and thus encourage collaboration and interaction between students and teachers, enriching the content and form of teaching in distance education [2]. The available technological resources lessen the difficulties inherent to physical distance between students and teachers, because it allows the creation of a virtual environment that contributes to collaborative learning [3].

Thus, learning management systems (LMS) emerge as tools to support distance learning. Among the features presented by these environments, data management, administrative and pedagogical resources management, access control, and the creation of means of interaction between users can be cited [4].

Distance learning teaching models benefited particularly from the methods of teaching that combine various technological and traditional resources. This is mostly due to the flexibility of the proposed blended learning, eLearning, online learning and mobile learning. Consequently, the teaching-learning process has undergone continuous changes and the methods of monitoring and tracking performance and student learning also had to be rethought.

The greatest difficulties of mediators of virtual courses, managed by an LMS, is precisely monitoring the academic performance of students in courses offered in these virtual environments. Failure rates, dropout and attrition are relatively high [2]. This reality has increasingly led many researchers in the field of education to conduct works to identify and reduce the causes of these issues. If in one hand technologies have enabled the offering of on-demand courses, on the other, there is the need to create ways to track their

progress, detect in advance students with technological or learning difficulties, and therefore devise and implement intervention practices to ensure the highest utilization of the available resources in the LMS [5].

In the Amazon, these problems are compounded by the great distances between cities and the difficult logistics of navigating through the river basin, since roads are scarce. This makes an effective in-person educational support to students practically unfeasible [6]. This reality has required planning by the government agencies. In order to compensate for the geographical isolation of the region, the Center of Distance Education (CDE) [7] of the Federal University of Amazonas (UFAM) has been offering free higher education access to seventeen municipalities of Amazonas state (called hubs). Undergraduate and graduate programs are currently being attended by around 2,000 students in distance learning model.

In this context, the LMS Monitor is presented as a tool for monitoring the academic performance of students in LMS Moodle. The goal is to assist professors, faculty and advisors in the task of monitoring the performance of distance learning students. For validation testing of the LMS Monitor application, data of student access to LMS and to other specific resources was used, along with activities specific to the pedagogical content of these classes. Evaluation questionnaires for the application were based on TAM [8] and the Likert scale [9] was utilized for its analysis. The LMS monitor falls into the category of tools to support learning analytics [10] based on its capabilities for monitoring, and learning performance analysis.

This paper is organized as follows: Section 2 presents some works related to learning with the use of technological resources (Blended Learning) and student performance evaluation in LMS. Section 3 presents the LMS Monitor app architecture and the description of the development of the plugin. Section 4 describes validation tests and application use cases. Finally, Section 5 provides final consideration and proposes discussions about the conclusions reached by this work.

## 2. RELATED WORK

The concepts of using blended learning to create a more flexible, engaging and effective learning experience have been widely used in various researches of computer science applied to education. This technique is characterized by being a combination of technology with traditional educational resources [11]. According to Finn [12], blended learning is defined to the “*effective integration of various learning techniques, technologies, and delivery modalities to meet specific communication, knowledge sharing, and informational needs*”. Traditional learning models [13] benefit from the advantages of hybrid teaching, especially when there is the need to use multi-modal resources and virtual classrooms. [11].

In some works related to this research and mentioned below, it's been noted that the use of technological resources allied to traditional teaching-learning methods, the blended learning characteristics, have contributed in enriching experiments and to propose new ideas and solutions for educational guidance. In addition, the selected studies seek to identify contributions to the

analysis of learning that were based on tools implemented to e-learning, online learning or mobile learning, utilizing LMS or not.

Gómez-Aguilar, Hernández-García, García-Peñalvo and Théron [14] implemented a tool to evaluate the interaction between students and facilitators in an LMS system using visual analysis. They found that the visualization tool facilitated the understanding and interaction of students in identifying patterns and the discovery of new information that was not evident in virtual platforms. In the experiments it was observed, within certain parameters, a relationship between final grades and the period of highest activity of students in LMS. The study results showed that the behavior in the LMS and academic performance are related, and this feature was repeated in different courses.

The eTutor [15] is a system that enables monitoring the current state of students' learning state and, in case the student fails to interact with learning objects in a LMS for a certain period of time, notifies the professor that interventions are needed using hints and alerts. Through the use of this tool, the professor may verify the participation in a certain proposed activity and send private or group messages, should an intervention be required. After experiments, the eTutor was considered efficient by the authors for promoting the monitoring of students.

Some methodologies have been presented with the goal of evaluating students' performance on a LMS [16] [17], such as those that analyzed interactivity levels and those that applied similarity metrics to evaluate academic performance. The proposition of Cobo, Angel, Rocha, and Rodriguez-Hoyos [16] developed a methodology to evaluate and to classify the interactivity level of students in LMS. To promote the improvement of the tutoring process in e-learning, a model with several criteria was presented, which allows professors to calculate an indicator of students' interactivity in the virtual environment. That model allows mediators of virtual courses to identify how students use new technologies, and classify them based on behavior patterns. According to the authors, the calculation of interactivity index may provide advantages to professors when it comes to recognize students' needs, for example, selecting the students with lowest levels of activity in the environment, and therefore facilitating an individualized intervention.

The A4Learning framework [17] applies similarity metrics with activity available for students based on a historical record of data relating to the same virtual course taught previously, estimating performance and visually presenting the results obtained. In the reports made available by the application, similarities between students from previous and current semesters of the same course are presented. The paper proposal is to identify students that participated in previous semesters of same course, which presented similar behavior as students in the current course, to comparatively analyze the results obtained and to display them in a visual summary.

Following this same line of academic performance analysis of LMS through visual reports, the paper of Silva, Teles Lucena and de Oliveira [18] presents the WebMonitor, a framework for monitoring students' performance in LMS. It is in fact a plugin for LMS Moodle. According to the authors, this tool aims to facilitate the monitoring tasks of academic activities using graphic techniques of displaying information for analysis of interactions of students with learning elements in a virtual classroom. The data on

resources accesses and participation in activities are displayed in a Treemap chart [19], in which different colored boxes indicate the resource type accessed and the box size indicates the quantity of accesses to resource or activity. The tests performed allowed identifying signs of attrition or failing, and still offered mechanisms for a direct intervention of mediators of the virtual courses, in order to reduce the occurrence of these problems.

Our paper proposes to make use of the advantages of blended learning, combining technological and traditional learning resources, in order to facilitate monitoring student performance in a LMS. Monitoring is done through reports made available to courses mediators, in which data are displayed graphically for clarity of information.

### 3. LMS MONITOR ARCHITECTURE

The LMS Monitor tool has been developed as a plugin for Moodle LMS and visually consists of a block with options inserted in the virtual room, as can be seen in Figure 1. Students' monitoring is carried out based on school exercises grades, number of tasks executed and not executed, resources used and means of access to the LMS utilized (mobile or desktop), thus providing data for a performance analysis of the students.



Figure 1. LMS Monitor in virtual classroom of Moodle.

To collect student data, the plugin will have access to multiple tables of the Moodle database in order to verify the information about students' interaction and performance in the virtual environment. Figure 2 shows the architecture of LMS Monitor where the actions of teachers and students using the system are represented. The flow of information consists of: (1) the student accesses Moodle, which in turn records the data and, (2) the teacher requests information on student interaction and performance, and the plugin responds with the information in graphical format. The student has the option of using a desktop computer and a mobile device such as mobile phone or tablet.

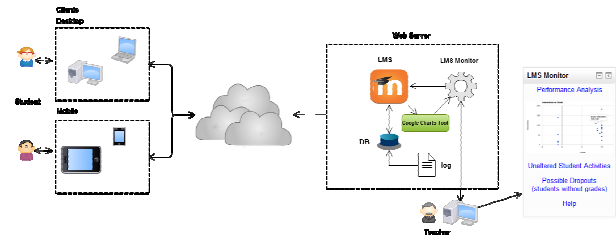


Figure 2. General architecture of LMS Monitor.

Once the data is analyzed by the plugin, it provides the following information in its reports:

- Evaluations over time;
- The relationship between interaction and grade achieved;
- The resources and activities accessed by students in a timeline;
- The median of grades in relation to class, outliers values and students' grades by access device.

The LMS Monitor consists of four modules:

- 1) *Performance Analysis*: This module that allows users to analyze the performance of students in a course or group based on evaluations done.
- 2) *Unaltered Student Activities*: This module presents all the activities turned in by the students, prior to any evaluation.
- 3) *Possible dropouts*: This module shows the potential dropout students based on the amount of ungraded activities.
- 4) *Help*: Provides help and instructions for the use of the plugin.

These modules are accessed according to the option chosen by the course mediator. Figure 3 shows the LMS display with the menu options.

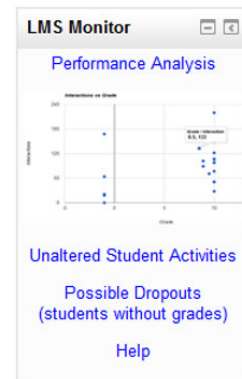


Figure 3. LMS Monitor options.

## 4. EXPERIMENTS

### 4.1 Test Scenarios

Validation tests of the LMS Monitor plugin were performed in three classes of three undergraduate courses of the Federal University of Amazonas, offered in blended mode in the 2015/2 semester, according to Table 1.

All classes utilized the Virtual Learning Environment Moodle in the 2.5.9 version, which is compatible with the version used by the Distance Education Center (CED) of the Federal University of Amazonas. A mobile application has also been made available to students. With this app, students can perform basic activities, participate in forums, messages, chats, and download and view files.

**Table 1. Classes Under Evaluation**

#	Undergraduate classes		
	Class	Course	Students
01	Introduction to Computer Science	Bachelor of Physics	28
02	Introduction to Computer Science	Electrical Engineering	42
03	Discrete Mathematics	Computer Science	43

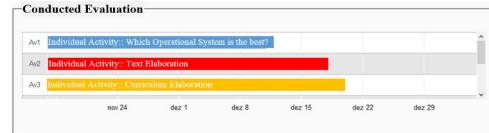
The methodology consisted of lectures, practical classes in laboratory and periodic evaluations. The practical classes were composed of programming laboratories and exercises that could be carried out in the actual class or remotely. This way students had weekly in-person interactions with the teacher in the laboratory, and on other scheduled days when there were no regular classes with the teacher, tutors were available to assist students, both in the classroom as well as remotely.

The courses were structured in the form of topics, with content distributed in modules. In these modules, activities presented in the courses generally corresponded to a Quiz, a Task and a Forum, with resources being the URL, and files download and upload. Also available were blocks of information such as Upcoming Events, Recent Activities, Latest News, among others.

### 4.2 Analysis of a class

To exemplify the LMS Monitor actions, data from class #2 were selected. When the Performance Analysis option is selected, a screen with evaluations conducted is shown (Figure 4). The

evaluations are shown in a timeline where the start of each bar refers to the date when the activity was available. The final bar refers to the final date to post the activity.

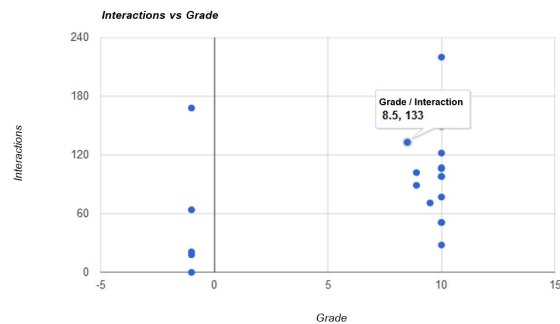


**Figure 4. Evaluations conducted**

To start the performance analysis, a students group, the type of evaluation and the graphics option group must be chosen. The graphic options are: (1) Interaction and Grade, (2) Interaction through access and (3) Approved, disapproved and gradeless students.

If the option (1) is chosen, the plugin will show a scatter plot (Figure 5), which will show the grade according to the students' interaction related to the chosen activity. Each point represents a student, the values in x-axis represent the grades and the values in y-axis represent the student interaction in the college period in which access to the activity was allowed. The students that have grades with value -1 are the ones that don't have grade and are possible dropouts.

If the chosen graphic is the type (2), the plugin will show the grade,



**Figure 5. Grades according to the interaction of students.**

the amount of students' accesses to the LMS Moodle by a device type (Figure 6).

### 4.3 LMS Evaluation

For a qualitative assessment of the LMS Monitor, online questionnaires were applied, answered after the end of classes of the second semester of 2015. Through these questionnaires, the participants (teachers and tutors) expressed their views on the use of the LMS Monitor tool for supporting classes in LMS Moodle.

To investigate the acceptance of the tool, TAM [8] was employed, which attempts to explain attitudes and behavior of people in the acceptance of technologies. The questionnaire consisted of questions of identification data, utilization of the Moodle, perceived usefulness and ease of use, intentions of utilizing the tool in the future, compatibility with faculty work, as well as essay questions seeking opinions about the advantages and disadvantages of the tool. Following are arranged the questions of the questionnaire:

1 – Identification data:

Age, sex, and job.

2 – Experience in the use of the LMS Moodle:

Have you ever utilized the LMS Moodle before?

3 – Ease of use of the LMS Moodle:

Was it easy for me to learn how to use the tool?

Did I get confused while utilizing the tool?

4 – Perceived usefulness of the LMS Monitor:

Will the use of the plugin enable me to complete my tasks any faster?

Would the use of the plugin enable me to improve my performance?

Would the use of the plugin enable me to improve my productivity?

Would the use of the plugin enable me to improve my efficacy?

Would the use of the plugin make my job easier?

Would I consider the plugin useful in my job?

5 – Perceived ease of use of the LMS Monitor:

Was it easy for me to use the plugin?

Would I consider the plugin easy to control in order to do what I want it to do?

Was my interaction with the plugin clear and understandable?

Was it easy for me to become proficient in the use of the plugin?

Is it easy to remember how to perform tasks using the plugin?

Did I find the plugin easy to use?

6 – Intentions of utilizing the LMS Monitor in the future:

Assuming the plugin is available; would I regularly take advantage of using it?

Would I rather use the plugin instead of other alternatives such as Moodle's standard reports?

Would I like to use the plugin in the future to facilitate my job?

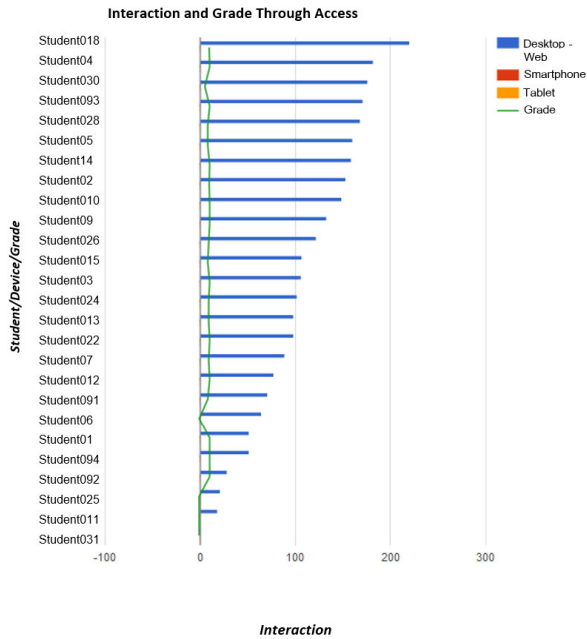


Figure 6. Interaction through access.

For the option (3), it will be shown the general situation of the class (Figure 7).

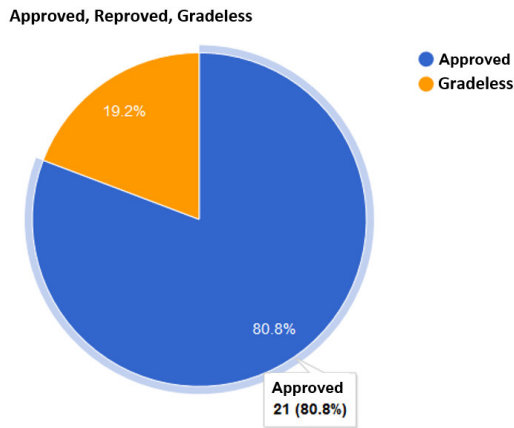


Figure 7. Approved, disapproved and gradeless students.

### 7 – Suitability to the user’s activities:

- Is the plugin suitable and compatible with work style?
- Is the use of the plugin suitable for all aspects of my work?
- Is the plugin compatible with the way I organize my work?

### 8 – Advantages and disadvantages of the tool:

Based on your experience using the plugin, what are the advantages and disadvantages you could point?

### 9 – Additional comments.

To correctly evaluate responses to questions 3 to 7, and order to properly assess the level of agreement of respondents, Likert scale [9] was employed. It is a 5-point of psychometric responses: Strongly Disagree, Disagree, Indifferent, I agree and Strongly Agree.

Identification data analysis revealed participants age varies between 23 and 35 years, 80% are male and 20% female. Four tutors and one professor participated in the evaluation. Following are the responses divided by topic:

- Experience with LMS Moodle

The previous experience that participants might have had in using the Moodle virtual learning environment has found that 40% of surveyed had already used this platform, while 60% had not used.

- Ease of use of LMS Moodle

In regards to the question “Was it easy for me to use the plugin”, 40% of respondents agreed it was easy, 20% strongly agreed, 20% disagreed and 20% considered it indifferent. Interestingly, 60% of participants have not had previous contact with LMS Moodle, nonetheless this same percentage agreed that learning to use this environment was easy.

- Perceived usefulness of the LMS Monitor

On the question “Will the use of the plugin enable me to complete my tasks any faster”, 60% of respondents agreed while 40% were indifferent. On the question “Would the use of the plugin enable me to improve my performance”, 40% agreed and 40% strongly agreed, while 20% were indifferent. Responding to questions about “Would the use of the plugin enable me to improve my productivity”, 60% are indifferent, 20% agreed and 20% strongly agreed.

On questions “Would the use of the plugin enable me to improve my efficacy” and “Would the use of the plugin make my job

easier”, 60% of respondents strongly agreed, while 40% were indifferent. On the question “Would I consider the plugin useful in my job”, 40% of respondents said they agree and 40% strongly agreed, while 20% were indifferent.

As for the perceived usefulness of the tool, it can be noted that a larger number of participants was indifferent on the question “Would the use of the plugin enable me to improve my productivity”. However, as can be seen in Figure 8, on all other questions the level of agreement (agree and strongly agree) is always higher considering the opinion of respondents in its entirety.

- Perceived ease of use of the LMS Monitor

The responses related to the ease of use of the LMS Monitor, referring to questions “Was it easy for me to learn how to use the tool”, “Would I consider the plugin easy to control in order to do what I want it to do”, “Was my interaction with the plugin clear and understandable” and “Did I find the plugin easy to use”, 80% of respondents agreed and 20% strongly agreed. Responding to the question “Was it easy for me to become proficient in the use of the plugin”, 100% of users said they agree. Regarding the question “Is it easy to remember how to perform tasks using the plugin”, 60% of respondents agreed, 20% strongly agreed, while 20% were indifferent.

As for the perceived ease of use, it resulted in 20% of respondents being indifferent only to the question “Is it easy to remember how to perform tasks using the plugin”, while for the remaining questions, 80% of respondents tend to agree that the LMS Monitor is easy to use.

- Future use of LMS Monitor

In relation to future use intentions of the plugin as the question “Assuming the plugin is available; would I regularly take advantage of using it,” 20% of respondents were indifferent, 40% agreed and 40% strongly agreed. Responding to questions about “Would I rather use the plugin instead of other alternatives such as Moodle’s standard reports”, 40% agreed and 40% strongly agreed, while 20% were indifferent. However, on the question “Would I like to use the plugin in the future to facilitate my job”, 60% agreed and 40% strongly agreed. About the intentions of future use of the plugin on two questions some participants responded indifferent when asked about “Assuming the plugin is available; would I regularly take advantage of using it,” and “Would I rather use the plugin instead of other alternatives such as Moodle’s standard reports” respectively 40% and 20% were indifferent. However, most of the questions resulted in a higher level of agreement.

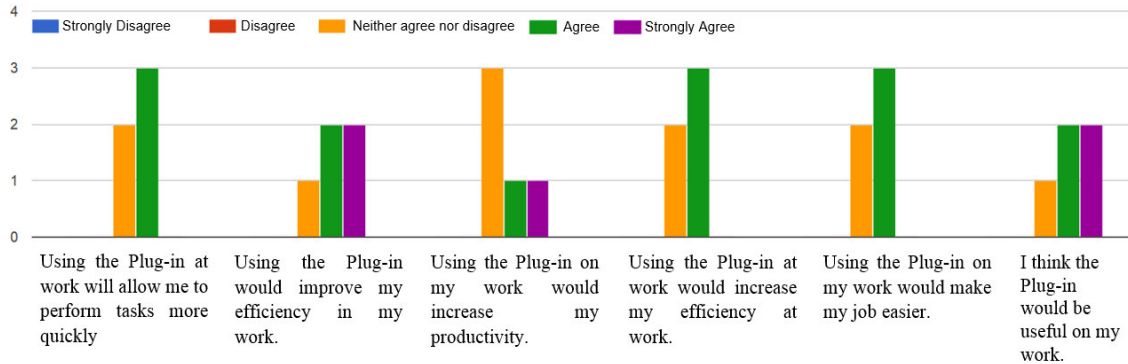


Figure 8. Perceived of the usefulness of LMS Monitor.

- Suitability

In respect to the suitability of the plugin for the work carried out by respondents, it's been verified on the questions "Is the plugin suitable and compatible with work style" and "is the use of the plugin suitable for all aspects of my work", 80% of respondents agreed and 20% were indifferent. However, on the questions "Is the use of the plugin suitable for all aspects of my work" and "Is the plugin compatible with the way I organize my work", 40% agreed, 40% strongly agreed (80% when grouped in terms of agreement) and 20% were indifferent. This means that most of the participants agree that the tool is appropriate for use in their teaching activities.

Some informal interviews were also conducted with tutors and teachers within the experiment (a total of six tutors and four teachers). Even from the informal perspective, it's been observed that the LMS Monitor plugin presented advantages for the respondents, especially regarding the capability of analyzing class data in a number of ways, enabling analysis of students' interaction within the environment, and to offer visual reports on the general state of the group under study. In addition, the various options for viewing the information in graphical format were considered very useful for mediators.

## 5. CONCLUSIONS

This article presents the LMS Monitor plugin, a tool to aid educators in academic performance analysis of students in LMS Moodle. The main goal of this study was to analyze the implication of using visual tools to monitor the performance of students, and provide resources to improve integration and information needs to assist professors or mediators of a virtual classroom: performance analysis and progress, possible dropouts, student's activities and resources tracking, among others.

The review of literature and some articles, included in this paper on Section 2, shows that there are many works that use blended learning as a technological tool to enrich educational experiences and promote students involvement in virtual courses managed by LMS. In the UFAM CDE, some difficulties experienced by mediators using Moodle are related to the interaction with and tracking of students performance [21]. A preliminary case study at CDE using LMS Monitor had been conducted. The usability and

practicality of the tool were evaluated using TAM with Likert scale for its analysis.

The description of the LMS Monitor architecture was described on the Section 3. The goal of the tool is to collect and monitor the performance of the students to provide visual analysis for the relationship between the interaction and the student's performance on the LMS, assisting professors or tutors in monitoring the performance of distance learning students.

The evaluation results presented on Section 4 showed that the LMS Monitor is an effective support aid to educators in the pedagogical monitoring and performance analysis of students, and that educators are comfortable with the use of this system. Preliminary results of the use of this tool indicate that it significantly contributes to improving student retention rates.

As future work, we think that it is necessary to investigate the application of new techniques to improve visual representation, with easier to use features and, thereby increasing the power of learning analytics to provide mediators of the educational process an enhanced understanding of their students. In the meantime, it is important to provide students awareness of their intellectual development, helping them in self-adjusting their learning processes.

## 6. ACKNOWLEDGEMENT

We are grateful to CDE staff that kindly provided all the necessary information, in special, to the director, Prof. Dr. Gabriel Arcaño Santos de Albuquerque. Part of the results presented in this paper were obtained through support by Amazon Research Foundation (FAPEAM – Fundação de Amparo à Pesquisa do Estado do Amazonas) and R&D activities of "Large Scale Qualification Program on Mobile Technologies - PROMOBILE" project sponsored by Samsung Eletrônica da Amazônia Ltda., under the terms of Brazilian federal law No. 8.248/91.

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