MONITORING AND VISUALIZING STUDENTS TRACKING DATA 
ONLINE LEARNING ACTIVITIES (TRACKING IN E-LEARNING 
PLATFORMS) MVSA

YAHYA AL-ASHMOERY*, ROCCHDI MESSOUSSI*, YOUNESS CHAABI *, RAJA TOUAHNI *

* Laboratory of Systems of Telecommunications and Engineering of the Decision (LSTED)
University IbnTofail, Faculty of Sciences, Kenitra, Morocco.

ABSTRACT

Most commercial or open source Course Management Systems CMS software does not include comprehensive access tracking and log analysis capabilities and lack the support for many aspects specific to evaluating participation level and analyzing interactions. CMS does not provide any tools for visually representing ongoing interactions. It is difficult and time consuming for the teachers and the educationalists to ascertain the number of participants, non-participants and lurkers in an ongoing discussion. This paper presents MVSA to Tracking student activity in online course management systems a system that takes a novel approach of using Web log data generated by course management systems (CMS) to help instructors become aware of what is happening in distance learning classes. Specifically, techniques from information visualization are employed to graphically render complex multidimensional student tracking data provided by the Course Management System. MVSA system provides accurate tracking information with an easy-to-use interface, and offers a wide range of activity information to instructors and educational researchers.

Keywords: Web log; log analysis, Collaborative learning, Asynchronous discussions, CSCL.

INTRODUCTION

CMSs accumulate large logs of data of student activities in on-line courses and usually have built-in monitoring features that enable the instructors to view some statistical data, such as a student’s first and last login, the history of pages visited, the number of messages the student has read and posted in discussions, marks achieved in quizzes, etc.
Instructors may use this information to monitor the students’ progress and to identify potential problems. However, tracking data is usually provided in a tabular format, is often incomprehensible, with a poor logical organization, and is difficult to follow. As a result, only few skilled and technically advanced distance-learning instructors use Web log data. Moreover, CMSs do not provide information about the actual learning that is taking place (e.g., the level of understanding achieved by a student on a particular concept and the concepts from the course material the students face difficulties with), albeit such information is very important for instructors in distance learning (Mazza, 2002), and is required to be tracked by recognized accreditors for college and university programs, such as ABET in the United States. Many university instructors have started to use Course Management Systems (CMSes) to manage or distribute course-related materials and conduct online learning activities. Students access course materials via the CMS, as well as participate in other learning activities, such as submitting homework assignments and posting discussion messages in online forums. Preliminary studies indicate that CMSes have the potential to both increase interaction beyond the classroom (Knight, Almeroth & Bimber, 2006) and positively affect student engagement with the course materials (Harley, Henke & Maher, 2004). However, most CMSes lack the comprehensive function to track, analyze, and report students’ online learning activities within the CMS. As reported in a previous study (Hijon & Carlos, 2006), the built-in student tracking functionality is far from satisfactory. The common problem is that a CMS only provides low-level activity records, and lacks higher level aggregation capabilities. Without students’ learning activity reports, an instructor has difficulty in effectively tailoring instruction plans to dynamically fit students’ needs.

Our research focuses on exploiting available CMS logs to provide learning activity tracking. One possible way in which CMS log data can be used is to visualize learning activity data via a more human-friendly graphical interface. This interface is updated in real-time to reflect all activities, and is integrated into the original CMS. Using this graphical interface, instructors can gain an understanding about the activities of the whole class or can focus on a particular student. Students can use the interface to understand how their progress compares to the whole class. Our hypothesis is that the availability of this graphical interface can provide important insight into how students are accessing online course materials, and this insight will be useful to both the instructor and to students.

Our log analysis tool has been developed for the Moodle CMS (Moodle, 2013). MVST is superior to the original Moodle log facility in several aspects:

1. Contact Online with E-learning Platforms LMS (Learning management system) like Moodle, (Integrated into LMS as a Plugin)
2. Mapping Asynchronous Discussions System
3. Materialization of an intelligent agent to assist teachers in a collaborative work environment
4. Building a smart student profile
5. Advising teachers to help them manage distance classes is required to reason about the students’ knowledge status, including both individual and group bases
6. Interaction Visualization in Web-based Learning using Complex Graphs
7. It provides aggregated and meaningful statistical reports
8. It visualizes the results, which makes comparisons between multiple students much easier
9. Display the activities that a student has performed also identifies the materials a student has not yet viewed
10. It has the capability to remind students to view those materials that they have not yet downloaded
11. Implement a visualization tool that will enhance the means by which asynchronous online communications in discussion forums can be analyzed
12. Choose evaluation procedures that can be integrated with the visualization tool that will allow comparisons between groups participating in the online discussion environments
13. Observe any sort of user, including lurkers, and track finely any of their activities of communications on forum on both server side and client side.

An important aspect of online teaching and learning is the monitoring of student progress and tools utilization in online courses. Educational research shows that monitoring the students’ learning is an essential component of high quality education. Using log files of learning management systems can help to determine who has been active in the course, what they did, and when they did it. (Romero, Ventura & Garcia, 2007). Feedback about the status and the history of the activities in online-courses can be useful to teachers, students, study program managers and administrators. For example it can help in better understanding whether the courses provide a sound learning environment (availability and use of discussion forums, etc.) or show to which extent best practices in online learning are implemented (students provide timely responses, teachers are visible and active, etc.). Learning Management Systems provide some reporting tools that aim to monitor students' and tools' usage, but these are seldom used mainly because it is difficult to interpret and exploit them; the obstacles to interpretation and exploitation are the following:

- Data are not aggregated following a didactical perspective;
- Certain types of usage data are not logged;
- The data that are logged may seem incomplete;
- Users are afraid that they could draw unsound inferences from some of the data.

In the attempt of overcoming these difficulties, new reporting functions of LMS have been added, for instance Moodle now provides reporting tools which enable teachers to evaluate the activity patterns of individual students. Moreover in the last few years researchers have begun to investigate various data mining methods which allow exploring, visualising, interpreting and analysing eLearning data thus helping teachers in better understanding and improving their eLearning practice (Romero et al. 2010) (Mazza&Botturi, 2007).

USE CASE

Recently, research is focusing towards finding methods for the evolvement and support of critical thinking through interactions, taking place within asynchronous discussions, in order to achieve high quality learning. Such a goal requires tools, frameworks and methods for the facilitation of monitoring, and/or self-reflection and therefore Self regulation that could be supported by the automated analysis of the complex interactions that occur:
Monitor Collaboration Among Students.
Objective: to monitor how much the student collaborates with other students.
Two different indicators: observations and contributions.
- Observations: reading of messages (in forum) or content (in wiki and chat).
- Contributions: creation of new messages (in forum) or content (in wiki and chat).
- Contributions: sum of contributions on forum, wiki and chats over the time.

Monitor Interaction Teacher-Student.
Objective: to monitor the interactions between teacher and individual students.
Teacher view of forum
Teacher posting to forum
Teacher posting feedback to assignments
Teacher grading assignments.

Monitor Knowledge testing.
Objective: to monitor the student’s use of their available knowledge in tests.
Quiz view
Quiz submission
Assignment view
Assignment submitted

Monitor Information access.
Objective: to monitor the student’s access to resources (file, HTML page, IMS package), assignments and quizzes.
View of resource, also over the time
Submission of assignment, also over the time
Submission of quizzes, also over the time

Monitor organization of learning.
Objective: to monitor how the student organizes her own learning process by planning, preparing for f2f meetings, preparing exams, reviewing learning goals, looking at and comparing performances and reflecting about the learning statistics and outcomes as well as about the process itself.
- Pending resources: resources not viewed out of existing resources.
- Pending assignments: assignments not viewed (or not submitted) out of existing assignments.
- Pending quizzes: quizzes not submitted out of existing quizzes.

Monitor course activity level. The focus is on the course. The administrator wants to see the level of usage of courses.
- For Administrators only
Course observations: activities of users aimed at observing course content (view of resources, reading discussions, etc.)
- Course contributions: activities of users aimed at creating new course contents (adding or updating new materials, creation of quizzes, creating a new message in discussions, etc.).

Monitor teacher facilitation level. The focus is on the teacher. The study program manager wants to identify the level of activity of teachers in facilitating learning with the LMS.
- Study program managers only
- Teacher’s facilitation of collaboration: observations and contributions by a teacher
- Teacher’s facilitation of interaction: usage of assignments and quizzes by a teacher
- Teacher’s facilitation of information: usage of assignments and resources by a teacher

Monitor Student learning level. The focus is on students (similar to the previous one).
- Study program managers only
- Students learning by collaboration: observations and contributions by a student
- Students learning by interaction: usage of assignments and quizzes by a student
- Students learning by information: usage of assignments and resources by a student

Monitor Course learning level. In this use case the focus is on course and on identifying the level of facilitation by teachers and the level of learning by students.
- Study program managers only
- Sum of Teacher’s facilitation of collaboration
- Sum of Teacher’s facilitation of interaction
- Sum of Teacher’s facilitation of information
- Students learning by collaboration
- Students learning by interaction
- Students learning by information
THE COLLABORATIVE ENVIRONMENT

Our system is based on some basic principles related to the CSCL (Computer Supported Collaborative Learning) paradigm (Koschmann, 1996). These principles are:

1. joint construction of a problem solution
2. coordination of group members for planning the tasks,
3. semi-structuration of the interaction mechanisms
4. focus on both the learning process and the learning result, and therefore, explicit representation of the production and interaction processes

Figure: The four levels of the architecture of MVSA

- **Configuration level**
  Once the teacher(s) have planned an experience of collaborative learning, on this level they can configure and install automatically the environment needed to support the activities of groups of students working together. The environment will provide the resources needed for carrying out joint tasks. In the configuration level teachers specify tasks, resources and groups, either by starting from the scratch or reusing generic components.

- **Performance level**
  This is the level where a group of students can carry out collaborative activities with the support of the system. Activities may involve a variety of tasks with associated shared workspaces. Collaboration is conversation-based. The system manages the users interventions, named contributions, supporting the co-construction of a solution in a collaborative argumentative discussion process. All the events related to each group and experience are recorded. They can be analyzed and reused for different purposes in the analysis and organization levels.
• Analysis Level

In this level we analyze the user's interaction and make interventions in order to improve them. We offer tools for quantitative and qualitative analysis for observing and analyzing the process of solving a task in the performance level. In the analysis level we propose a way of observing and value the users attitudes when they are working together. We offer the possibility of intervention by sending messages to the group or to individuals explaining how to improve different points of their work. Finally, we register the messages and the moment when we make this intervention and analyze the improvements.

• Organization level

Here we gather, select and store the results of collaborative learning experiences and the processes. The information is structured and valued for searching and reusing purposes. This information is stored as cases forming an Organizational Learning Memory. We offer functionalities for defining, searching, collecting different cases, and for defining links to work material in the configuration level for related tasks. For more information about this level.

MVSA ARCHITECTURE
User Activity

Provides a rich set of information about how often and how intensely students interacted with Moodle. Figure 3 shows the student activity statistics for the MS110A course. The statistics show six fields of data: total number of views, total number of sessions, total online time, number of viewed resources, number of initial threads posted by the user, and the number of follow-up messages posted. Normally student names are provided in the instructor view, however, to protect student privacy, student names have been removed from Figure 3. The first line of the table shows the average value for all students for each variable. The average view count is 357, and the maximum is 776. The average number of sessions is 60, and the maximum is 130. And the average online time is 7 hours 15 minutes, while the maximum online time is 16 hours 32 minutes. In terms of the number of visited resources, we note that only two students had viewed all 52 resources posted on the course page. The average number of viewed resources is 36. Our preliminary analysis shows that there is a positive correlation between a student’s forum activity and the overall course grade. Students who frequently viewed the forums performed better on course assignments and exams. In future work, we plan to identify which online activities predict academic performance.
Discussion in forum

Discussion plot example: visualization of discussion threads focusing on the students who have initiated the threads.

![Figure 2: User activity](image-url)
**Summary of a user activities**

Indicator that features the statistical data related to four different activities of a user on a discussion forum. The main objective of such indicator is to provide an overview of the following activities:

- Reading messages
- Viewing course materials or assignments that are posted in the forum
- Posting new messages (or starting new discussion threads)
- Replying to messages

**MAPPING ASYNCHRONOUS DISCUSSIONS SYSTEM**

- **Online Participation and Interaction**
- **Visualization Mapping**:

  which could help them understand the flow of conversation
- Visualization of Interaction, Learning or lurking?
ADVICE GENERATION

We have discussed the need for a computational framework for advising teachers to help them manage distance classes is required to reason about the students’ knowledge status, including both individual and group bases, and to decide appropriate advice

- Advice concerning individual students performance
- Advice concerning each group performance
- Advice concerning the whole class performance

1. Generating Type-1 advice

   Type 1-1 Advice is used to inform a facilitator about the problems related to the student’s knowledge status. As mentioned earlier measures the student’s knowledge status regarding each domain concept as “Completely Learned”, “Learned”, or “Unlearned”. Type 1-1 advice will be generated when the student knowledge model shows concepts with “Unlearned” or “Learned” understanding levels. In this case, should investigate the reason(s) that led to this problem, which may include:

   - The student has not completely read and worked on the learning objects and assessment quizzes related to the concept.
   - The student has not completely mastered the related prerequisite concepts.
   - The student has not participated in the communication activities related to the concept.

   To specifically investigate the possible reason(s), it is necessary to perform more detailed analysis using the information available in the student behavior model and the student knowledge model

   Type 1-2 Advice is used to inform a facilitator about the student’s progress with course material related to a certain concept. will use the course calendar and the student behaviour model (which is part of the student model) to determine if the student is delayed with (lagging behind) the course-studying plan. The AG(Advice Generator) will deliver advice to the facilitator with information such as the student name, the concepts with which student is delayed, and the delay time (time-lag) of each concept. The facilitator may send this information to the student or take the necessary actions depending on the delay times and student case. Besides assisting facilitators to be more knowledgeable about their distant students, this type of advice is useful in making students feel that they are being supervised from their distant teachers.

   Type 1-3 Advice offers more attention to the students who are at unsatisfactory learning levels. Type 1-3 advice is used to focus on the students evaluated as “Weak”. will classify those “Weak” students according to their communication levels (Weak and uncommunicative, Weak and normally communicative, Weak and highly communicative). The facilitator could take some action, e.g. talking directly to the students, creating special online chatting sessions to discuss the reasons for their lagging behind their peers and encouraging the students, or directing the students to contact their more knowledgeable peers.

   Type 1-4 Advice is used, in contrast to Type 1-3 advice, to inform the facilitator about the students with advanced learning levels. In this case, the AG looks for students evaluated as “Excellent”. As in Type 1-3 advice, will classify the “Excellent” students according to
their communication levels. The facilitator may use this information to encourage those students to maintain their general learning levels and/or to direct them to help other “Weak” peers by talking to them through mail or discussion forums.

Type 1-5 Advice is generated to inform facilitator about the students who had not started working with the course till the time of advice generation session. If this type of advice is generated for one of the students, then other Type-1 advice will be suppressed.

2. Generating Type-2 advice

Type-2 advice is concerned with a group of students. The learning level of each concept and the general learning level of a set of concepts will be monitored to identify problematic situations concerning the group’s learning. This type of advice enables the facilitators to know about common problems that face a group and correlate these problems to the group characteristics. In addition, the facilitator could try to solve the highlighted problems by providing the students with appropriate feedback and guiding information. The following subtypes are considered:

Type 2-1 Advice is used to inform a facilitator about problems related to the group’s knowledge status. This advice subtype will be generated when the group knowledge model shows concepts with “Unlearned” or “Learned” levels. Similar to the actions performed in Type 1-1 advice, AG searches for reason(s) that may lead to this situation and presents this information to the facilitator together with a recommendation of some actions that may be taken.

Type 2-2 Advice is used to inform the facilitators about problematic situations related to the groups’ learning levels. The facilitator’s attention is directed to groups, which have unsatisfactory learning levels. Type 2-2 advice that concerns groups is similar to Type 1-3 advice that concerns individual students. Advice Type 2-2 is used to highlight to the facilitator the “Weak” groups. will classify those “Weak” groups according to their communication levels (weak and uncommunicative, weak and normally communicative, and weak and highly communicative). The facilitator can take some actions, such as talking directly to the group members, creating a special discussion forum or chat sessions for the group, or guiding group members to “Excellent” peer students especially from the same group.

Type 2-3 Advice is used to inform the facilitator about groups with satisfactory learning levels. In this type of advice, AG should look for the “Excellent” groups. As in Type 2-2 advice, will classify “Excellent” groups according to their communication levels. This information will be highlighted to the facilitator who may decide to encourage students in these groups to maintain their general learning levels and/or to give help to their “Weak” peers via e-mail, chat, or by posting on the discussion forums.

3. Generating Type-3 advice

Type-3 advice is concerned with the status and behaviour of the whole class. Advice of this type does not automatically result in subsequent recommended advice or feedback to individual students instead it is primarily used to advice and guide course facilitators while they are managing their distance classes. The overall class learning level will be monitored according to each concept learning level. This type of advice is important to the facilitator because it gives an overview of the class, and highlights the common problems. The facilitator may try to solve these problems during the course period by taking appropriate educational actions. Furthermore, analyzing the generated information and the reasons behind
common class problems, the facilitator may consider how to avoid the occurrence of these problems in the following courses.

Type 3-1 Advice is used to inform the facilitator about problems related to the knowledge status of the whole class. This advice will be generated when the AG detects concepts with Unlearned or Learned levels in the class knowledge model. The AG will search for possible reason(s) that might have led to this situation and will notify the facilitator about it. The course facilitator may then make, according to the situation, appropriate decisions and pass them to all students in the class. For example, if the class knowledge model indicates that a concept c is “Unlearned” by the class because most students have not studied the learning objects related to c, will highlight this situation to the facilitator. In this case the facilitator may encourage the students to start studying learning objects related to c. Type 3-2 Advice is generated to inform the facilitator about excellent students (for example, the top three) and weak students (for example, the bottom three) relative to the whole class during each of the advice generating sessions.

Type 3-3 Advice is generated to the facilitator to inform him about the most and least communicative students relative to the whole class during each of the advice generating sessions.

Type 3-4 Advice is generated to the facilitator to inform about the most and least active students relative to the whole class during each of the advice generating sessions. Students’ activity is measured by the aggregate number of interactions (hits) made by the student in different sessions. Information from this advice can be compared to information from advice Type 3-2 to correlate between the students’ activity and their general learning levels.

MOODLE IN A LEARNING ENVIRONMENT

Moodle is an open source course management system (Moodle, 2013) designed for managing flexible communities of learners [Lengyel et.al, 2007] based on the principles of social pedagogy (Moodle, 2011). It is a software tool, which creates communication and collaboration channels. Two attractive aspects of Moodle are: It is extensible and so a developer / researcher / educationalist can contribute to its development and add the modules they require. Secondly, Moodle is customizable. There are many options that can be adjusted to suit the needs of the user.

Blocks in Moodle

Blocks are “boxes” that appear on both sides of a Moodle page when displayed on a browser (Alier et.al, 2007). Moodle is highly adaptable, driven by the use of these blocks, which can be chosen and structured in a desired way. The Moodle community has created many different add-on blocks to choose from. All courses in Moodle contain blocks where the center block displays course content. Blocks can be added or removed to customize the look and feel of the site.

CONCLUSION

This research to design and implement MVSA application to track students’ online learning activities based on CMS logs. We then visualize the results with a simple graphical interface. MVSA is also able to automatically send feedback and reminder emails based on students’ activity histories. We have integrated the MVSA module into the Moodle CMS and
made some small interface changes to Moodle. Intuitively, the presence of the popularity bars should encourage students to check the course materials more frequently and promptly if he or she sees most of their classmates have already done so. Our hypothesis is that the availability of MVSA statistics will positively affect both how an instructor adapts the course and how students learn. Monitoring student learning activity is an essential component of high quality education, and is one of the major predictors of effective teaching (Cotton, 1998). Research has shown that letting a learner know his or her ranking in the group results in more effective learning. MVSA provides a possible means for students and the instructor to receive this feedback. In future work, we plan to more comprehensively evaluate the impact of MVSA statistics on student academic performance.

REFERENCES


