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Monitoring an Online Course with the GISMO Tool: A Case Study

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This article presents GISMO, a novel, open source, graphic student-tracking tool integrated into Moodle. GISMO represents a further step in information visualization applied to education, and also a novelty in the field of learning management systems applications. The visualizations of the tool, its uses and the benefits it can bring are illustrated through a detailed case study of an online course. GISMO provides visualizations of behavioral, cognitive and social data from the course, allowing constant monitoring of students' activities, engagement and learning outcomes.

Introduction

Learning Management Systems (LMS), often called "Virtual Learning Environments," are a new class of software applications that have been developed during the last ten years, following the growing adoption of e-learning in universities, schools, and companies. LMS provide a convenient web-based environment where instructors can deliver multimedia content materials to the students, prepare assignments and tests, engage in discussions, and manage classes at distance (McCormack & Jones, 1997). Thanks to computer-based communication, the students may access the course, study, and perform the interactive learning activities with fewer time and space restrictions.

One of the problems that the students may face when learning online is the lack of support by the instructors and by other peers in the course. Because of the nature of computer-mediated communication, students tend to study

alone at home with few (or even no) interactions with others. In such a situation, the role of the course tutor is critical. He/she has to monitor the students' activities, provide support to the learners who may need it, and facilitate the learning process. Activities such as answering questions, promoting discussions, monitoring the learners' progress, and testing the acquired knowledge and skills on a regular basis are very important for successful online tutoring practice (Helic, Maurer, & Scherbakov, 2000; Cotton, 1988; Ragan, 1998). One of the best tutoring approaches is based on understanding the needs of individual learners in order to provide adapted help. Regularly monitoring the students' activities and being aware of what the students are doing in the course are essential conditions to provide adaptive and effective tutoring. Typical questions that the tutor has to address: "Are students participating in discussions?", "Have they read the course materials?", and, "How well do they perform on quizzes?" However, these sorts of monitoring activities are not easy to accomplish with common LMS. Although generic LMS are very effective in facilitating the delivery of distance courses, they provide very little help to instructors to gain understanding of cognitive and social processes in distance classes. For example, questions like "Did a student access the whole course materials? When did s/he do it?" or "Has a student participated in discussions regularly?" are difficult to answer appropriately using conventional LMS student activities tracking systems.

In this article, we describe the adoption of a graphical tool to the monitoring of a course given at distance. GISMO is a tool that visually represents tracking data collected by the learning management system which can be used by an instructor to gain an understanding of his/her students and become aware of what is happening in distance classes. Tracking data provided by the LMS is a valuable source of data that can be used by the instructor of the course for the usage analysis of contents, resources, and activities. However, tracking data is complex and usually is organized in some tabular format, which in most cases is difficult to follow and inappropriate for the instructors' needs (Mazza, 2004). GISMO instead adopts the Information Visualization paradigm (Spence, 2001; Card, Mackinlay, & Shneiderman, 1999), which consists of presenting data in a visual form and relying on the perceptual abilities of human vision for their interpretation. A well-constructed graphical representation of data may allow the instructor to develop a deeper understanding of data and immediately discover individuals who may need particular attention. In this article, we will show how GISMO has proven to be useful in several teaching activities performed at distance.

The article is organized as follows: The next section presents a generic description of the tool. We will then illustrate how GISMO was used in a real course to support the tutoring activities. A subsequent section will describe some related works that use visualizations to represent students' data. Finally, we will draw some conclusions and outline some directions of future work.

GISMO – a Graphical Interactive Student Monitoring System

GISMO is a tool that was implemented as follow-up of a previous research on using Information Visualization approaches to facilitate instructors in Web-based distance learning (Mazza, 2004; Mazza & Dimitrova, 2004). GISMO implements some of the visualizations found useful by teachers, based on our experience with the CourseVis research, within a new context, namely the Edukalibre project (Botturi et al., 2005) funded by the European Union. It is integrated into the Moodle LMS (Moodle, 2002) and is visible only to the instructors and tutors of courses as an additional block. We considered the Moodle learning platform in this work primarily because it is the learning platform used in our university. Its Free and Open Source nature allowed the easy integration of GISMO. However, GISMO can be adapted to support other learning platforms, thanks to a software Application Programming Interface (API) that is committed to retrieve some data that is usually present in a wide range of LMS.

GISMO provides graphical representations for the information regarded as useful for instructors that we detected with a survey submitted to instructors involved in distance learning in a previous research (Mazza & Dimitrova, 2003). In particular, graphical representations can be produced on social aspects (discussions), cognitive aspects (results on quizzes and assignments), and behavioral aspects (accesses to the course). In the next section, we will illustrate some graphical representations of GISMO's abilities on data collected from a real course, and we will describe some insights that can be derived from representations.

Case Study

The use of GISMO might vary in different settings. This section analyzes the case of a completely online course in a master program.

Course Setting

The Master of Science in Communication major in Education and Training (MET – www.met.unisi.ch) at the University of Lugano, Switzerland, is a 2-year program focusing on adult learning, human resources, educational technologies and intercultural communication. Some of its courses are shared with a twin program run by the Università Cattolica in Milano, Italy. Each year, a class of about 15 students in Lugano collaborates online – both asynchronously and in videoconference sessions – with another 15 students in Milano. One of the courses in which collaboration is more evident is *Instructional Design*, a completely online course delivered by the University of Lugano and held by Prof. R. Kenny of Athabasca University in Canada. The setting is highly distributed: about 30 students are located in Lugano (15, plus the course teaching assistant) and Milano (15), and the instructor is in Canada.

The course, which spans over 16 weeks (14 working weeks plus two holiday weeks over Christmas), aims at introducing students to Instructional Design techniques and to have them try some of them on a real project. The course is largely project-based: students are divided into groups of three to four and are assigned to a real instructional design and development project. Each group will carry on the design through a set of phases or steps according to the rhythm proposed by the course. Every second week, the class is engaged in an online discussion forum stimulating reflections on the work done thus far. The evaluation is composed of four parts: three group assignments on the project work (90%) and a personal forum participation score.

The course is supported by Moodle (a screenshot is depicted in Figure 1), and the installation includes the GISMO module, which has proved of extreme value for a number of critical issues of online learning.

The Benefits of GISMO

While the course instructor focuses on content production, moderating online discussions, and grading, the teaching assistant is in charge of monitoring the course, mentoring individuals and groups, and providing system-

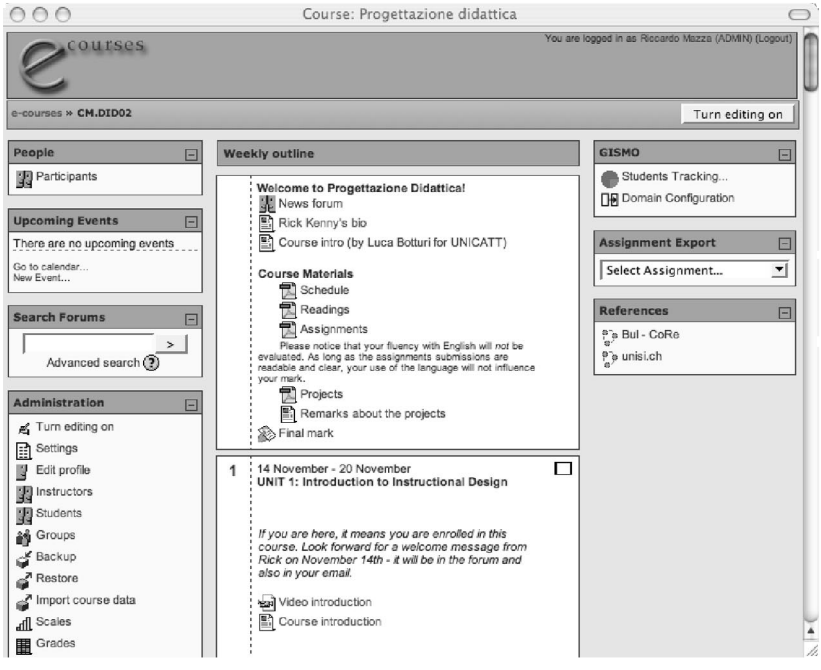

Figure 1. A screenshot of the main Moodle page of the online course on Instructional Design

atic feedback to the course instructor. To these ends, GISMO has proven to be a powerful tool for at least three activities: (a) monitoring class and individual behavior, (b) assessing participation in discussion forums, and (c) redesigning the course according to students' needs.

Monitoring class and individual behavior

The first – and probably most straightforward – benefit of GISMO is offering a synthetic view of the class behavior in terms of logins, access to resources, and participation in activities. While this might be trivial in a face-to-face or blended learning setting, it is critical in completely online learning: Is the class reacting well to the instructor's stimuli? Are they actually engaging with the course content?

Figure 2 reports a graph on the accesses to the course. A simple matrix formed by students' names (on Y-axis) and dates of the course (on X-axis) is used to represent the course accesses. Each blue square represents at least one access to the course made by the student on the selected date. The histogram at the bottom shows the global number of hits to the course made by all students on each date. Figure 3 represents the global number of accesses made by students (in X-axis) to all of the resources of the course. If the user clicks with the right-button mouse on one of the bars of the histogram and select the item "Details," he/she can see the details of the accesses for a specific student. Figure 4 shows such details, that is to say, on which days the student visited a specific resource (with the graph on top) and how many

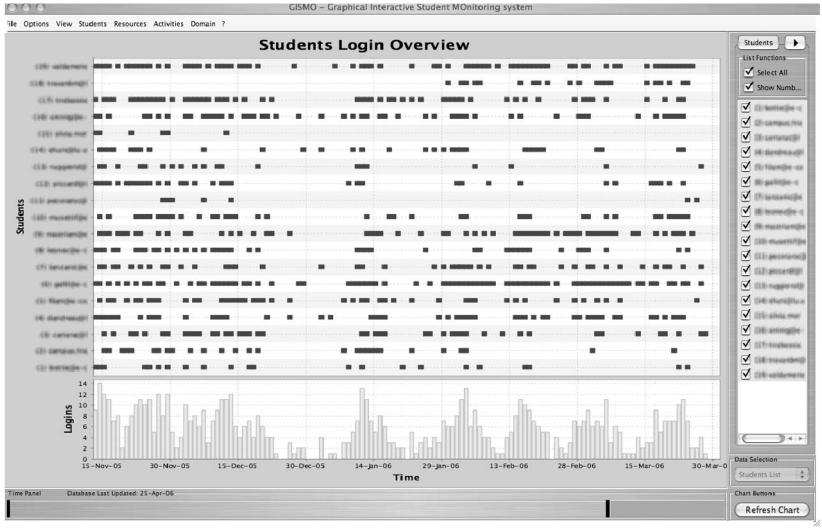

Figure 2. A graph reporting the students' accesses to the course

global accesses he/she made to all the resources for each day of the course (with the bar chart on the bottom).

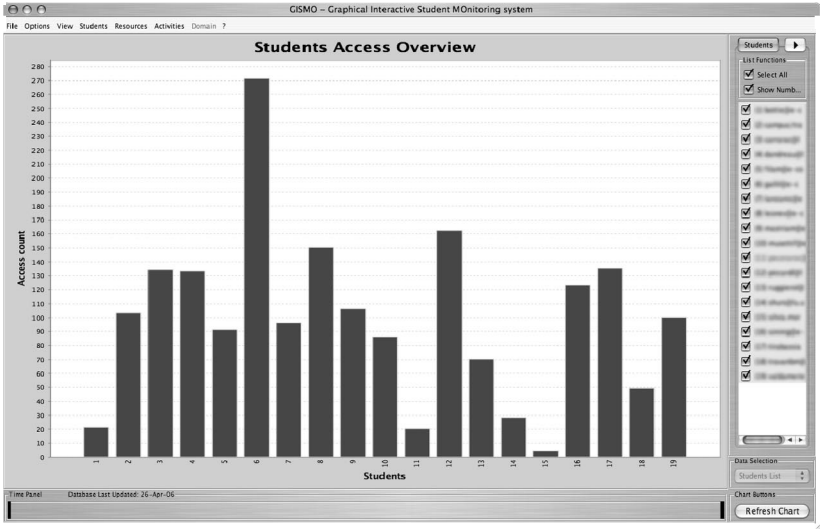

Figure 3. A graph reporting the number of accesses made by the students to the resources of the course

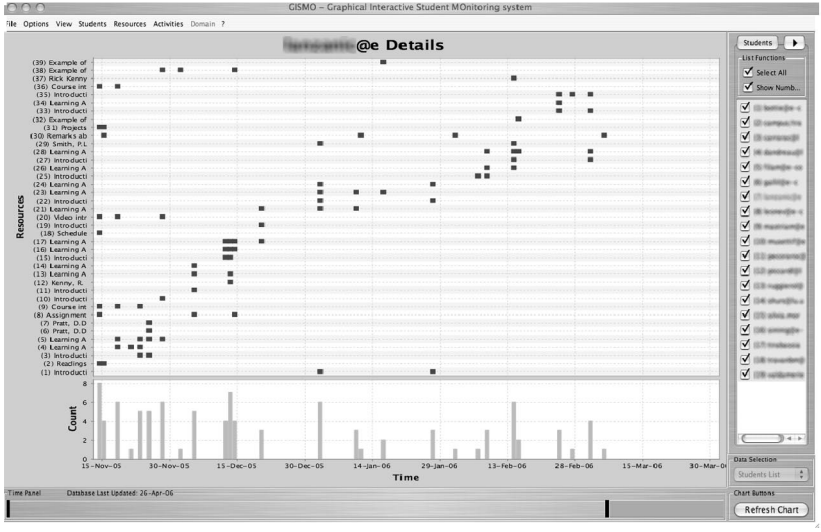

Figure 4. A detail of the accesses performed by a student to the course's resources

The advantages of GISMO in this respect are twofold: on the one hand, it offers a simple visualization of specific parameters (login, access to resources), which are much more legible and readable than the long lists of log records available as standard feature in Moodle and in most LMS; on the other, it allows the instructor to compare different aspects of a class' behavior and to refine what would be otherwise a generic assessment. In fact, it is different to ascertain that there is a high number of logins per week and to be able to see which students actually log in and what they do after logging in: Do they browse course resources? Do they post to or read forums? A quick comparison to the different visualizations in GISMO allows forming a structured assessment of a class' behavior.

Notice that the largest part of these activities is not impossible with standard tracking systems (cf. Figure 5) – only they take more time and require harder cognitive work in interpreting long lists of figures: they hardly can be scheduled as weekly activities, and they are rather confined to post-course assessment.

During the Instructional Design course, the teaching assistant used the GISMO overview tool every third week in order to monitor the class' progress in the activities. After a while, it was possible to identify two

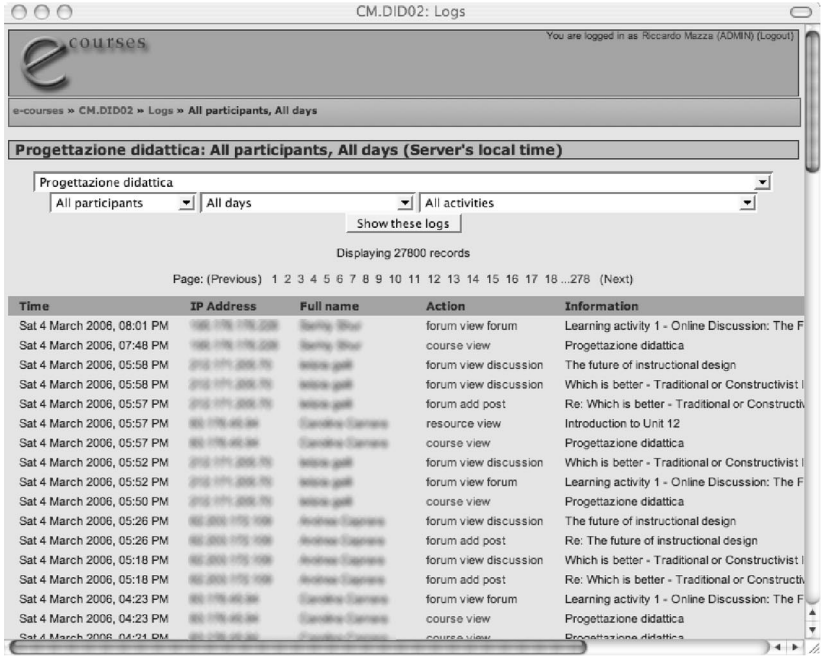

Figure 5. The standard Moodle log window that displays all users' activities

"slackers" who did a very low number of logins. This first observation was based on the raw access counting of Moodle, then it was developed into a more detailed analysis. For example, the two of them might have different problems, preventing them from fully participating in the course. A cross-check with detail visualizations (Figure 6) indicated that one student actually logged in thrice at the beginning of the course, accessed some resources and (presumably) printed them out; that student also took part in discussion forums, which she then abandoned. On the other hand, the second student logged in frequently during the first two weeks and then abandoned the course. Constant control over time indicated that the student probably suffered from work overload for other courses: he/she actually came back to the course after some weeks and took the time to revise all past forum messages, and to explain that he/she had to submit his final bachelor's thesis. Checking this out with GISMO only took a few minutes, while it would have been more difficult without graphs.

Assessing Participation in Discussion Forums

The evaluation of forum participation covers an important position in the Instructional Design course: it is the only personal mark that contributes to the final grade and is the result of a continuing and potentially hard work, reading other students' posts and writing one's own. The requirement for getting full credit for forum participation is posting at least two substantial messages (i.e., something more than "Great! I also agree with that") in four out of six discussion forums. Controlling this without a visual interface requires huge work, checking messages one by one.

GISMO does not provide a complete support to that, but in the case of the Instructional Design course, (a) it allowed identifying at a glance potential "slackers" who did not reach the minimum required number of messages, and (b) it made it easy to retrieve additional data on those cases. Of course, this does not eliminate the fact that actually reading messages is paramount in order to assess the quality of contributions. Figure 7 reports a chart where

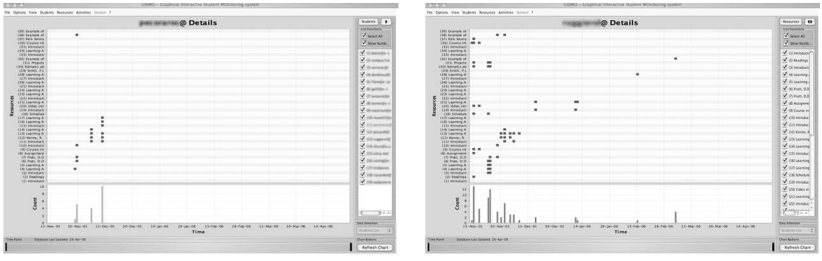

Figure 6. Details of the accesses for two students of the course

instructors may have an overview of all of the discussions in which students participated. For each student of the course, the chart indicates the number of messages posted (with a red square), number of messages read (with a blue circle), and the number of threads started by the student in the discussions (with the green triangle). The GISMO interface allows the teaching staff to identify at once people who post "because you need to" without actually being involved in the discussion and also reading others' postings. The information that GISMO visualizations provides on this point provided a good indication of the general trend of the class and supported the more fine-grained activity of grading, especially in borderline cases. For example, the course instructor learned by heart the names of those making the most relevant contributions to the discussion or those posting more often. The issues in grading concern people who did not demonstrate a particular behavior – and GISMO provided a sound support in assessing those cases.

Moreover (and quite differently from the usual LMS built-in tracking systems), GISMO allows filtering of a single student's data in order to reconstruct her/his personal behavior, thus allowing the teaching staff to identify critical cases of different types. For example, an online discussion can suffer and be brought off-track by super posters who did not take enough time to read course content or only occasionally participate in discussions, reading few messages and writing long ones. Also, some students might be more reflexive and contribute with few postings while actually reading forums regularly and browsing all available content.

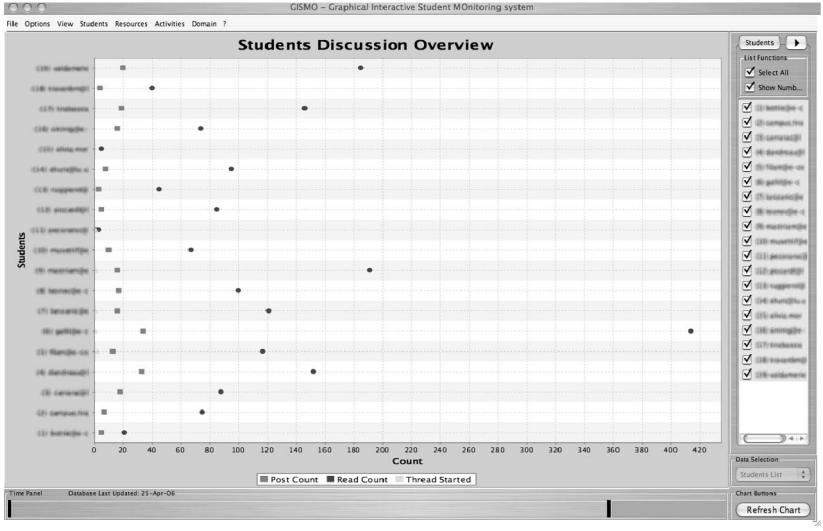

Figure 7. Graphical representation of discussions performed in a course

Redesigning the Course According to Students' Needs

A final critical point in online courses is redesign (Botturi, 2003): What was actually useful to students? What did they actually use? Given that the production of digital materials for online courses costs much, having clear information about this is paramount in order to make correct decisions.

GISMO's visualizations offer a set of synthetic and detailed views about resources (namely, the resource access count, the student/resource matrix, and the detailed view of each resource's use). Figure 8 represents a histogram of number of accesses made by students to each resource. Figure 9 reports an overview of students' accesses to resources of the course, student names on the Y-axis and resource names on the X-axis. A mark is depicted if the student accessed this resource, and the color of the mark ranges from light blue to dark blue, according to the number of times he/she accessed this resource. Figure 10 reports a detailed view of the usage of a specific resource.

The cross-reading of these data allowed the identification of

1. Poorly-used resources (those probably less-integrated in the course mainstream, or even pointless);
2. Resources only used during specific timeframes, which then could be hidden in order to simplify the course interface;
3. Resources accessed by all, but only a few times;
4. Resources accessed often by all.

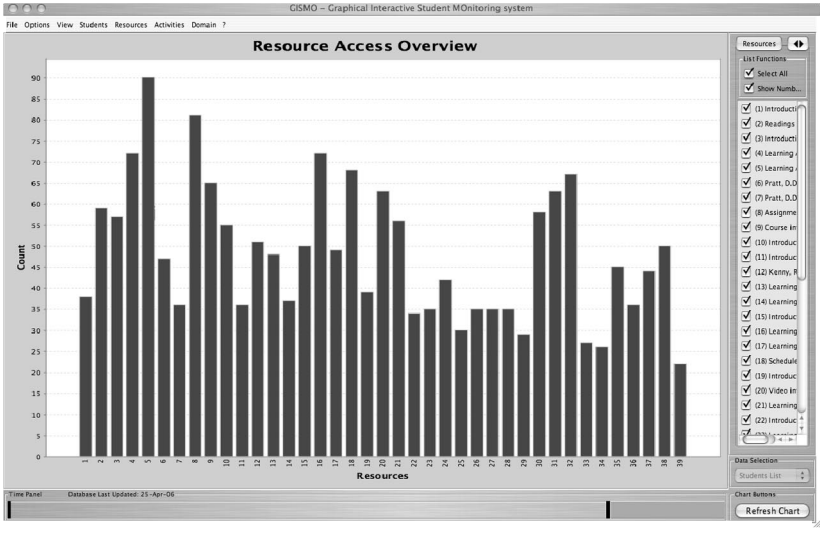

Figure 8. The resource accesses count overview, providing for each resource the number of accesses made

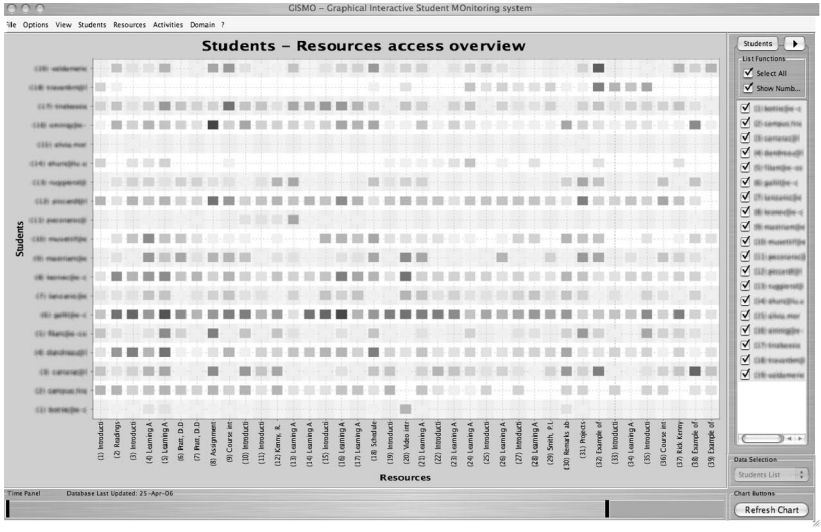

Figure 9. A graph reporting an overview of students' accesses to resources of the course

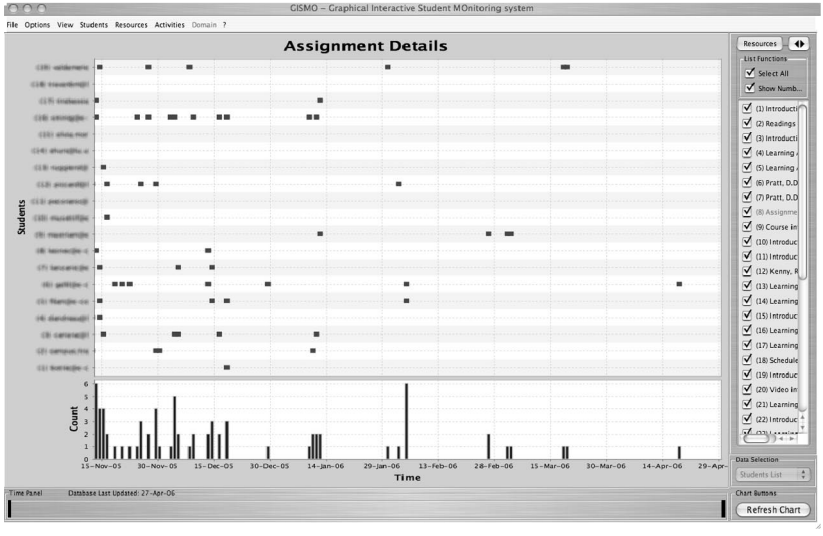

Figure 10. Details for the accesses to a specific resource of the course

For example, the instructors expected that the page explaining how the assignments work was accessed at the beginning of the course, printed out, and then used as reference (see Figure 10). Actually, this was the most-

accessed resource during the whole course. Also, before the deadline for assignment submission, some students asked for a sample submission to see what they were expected to do. The sample assignments were prepared and put online, and GISMO allowed controlling if they were used only by the few students who asked for them or by everybody (which was the case) and when they were accessed. It was therefore decided to include them in the course area right from the start. Also, technically-similar resources (e.g., two webpages, or two PDF files) were used differently according to their content: some were printed, while some were accessed multiple times.

The graph in Figure 11 is dedicated to visually indicate the date of submissions of the assignments. Vertical lines correspond to deadlines of each assignment provided to students (represented here on the Y-axis). Lines and marks have different colors for different assignments to help the reader locate the marks corresponding to each. In this example, it can be clearly seen that almost all submissions were late: the students, in fact, asked for an extension of the submission deadline, which was accepted, because they had other deadlines from other courses at the same time.

Some Issues

The experiment done so far has shown that GISMO is a powerful tool for course management and provided effective support in the Instructional Design course, allowing the tutor to get a more detailed picture of what was going on in the course. It also has indicated that the correct interpretation of some data and visualizations require some learning and attention.

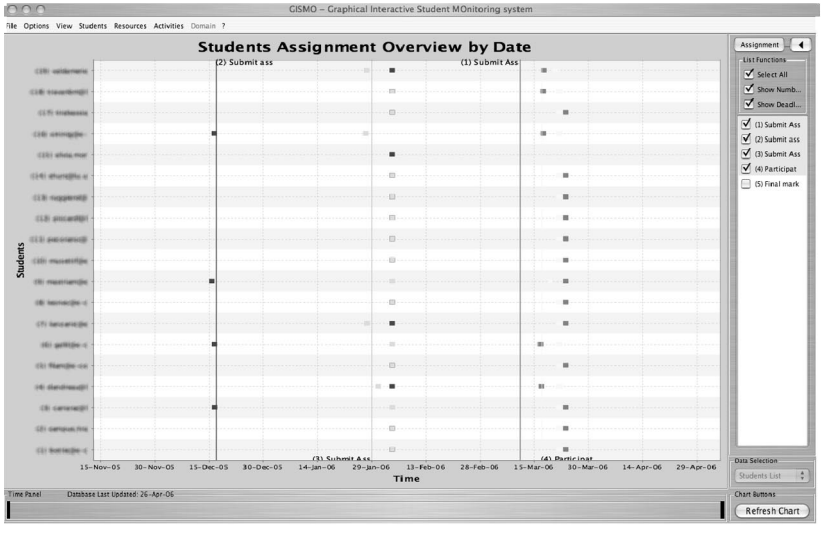

Figure 11. A graph reporting the submission time of assignments

First of all, it is important to distinguish resource types: PDF files can be accessed only once and printed, so that a single hit from a student might be all that you can expect. It is not the same for interactive Flash applications, which can be accessed only online.

Secondly, it is important to understand the actual meaning of data: For example, a single *read post* count in Moodle actually means accessing a whole thread – in Moodle, the standard view of a forum post is embedded into a nested thread.

Finally, different students have different needs, and the same behavior does not imply the same learning. For example, students with a less intense behavior cannot be supposed to learn less – and vice versa. GISMO visualizations are useful sources of data that must be interpreted carefully before being used for evaluation.

For this reason, the choice of the Instructional Design course was to use GISMO mainly for monitoring the course during its delivery and collecting data to support the students more effectively. GISMO was therefore not used directly for evaluation – which was project-based, and supported by other tools available in Moodle – except for the simple support provided in assessing the participation in discussion forums as discussed above.

RELATED WORK

Recently, there is a growing interest in the analysis of learner interaction with LMS. Among the different approaches, the idea of using information visualization is one of the newest. Some forms of visualizing cognitive aspects of the students model have been explored in the field of Intelligent Tutoring Systems (Zapata-Rivera & Greer, 2004; Kay, 1995; Hartley & Mitrovic, 2002). Also, some past works attempt to visualize the communication pattern of a course, identify recurring events and roles, and assess the degree of student engagement in social activities (Reffay & Chanier, 2002; Xiong & Donath, 1999). Simple visualization techniques have been used to build a tool to enable instructors to monitor distance students engaged in learning by doing activities based on a specific domain (Despres, 2003). CourseVis (Mazza & Dimitrova, 2004) was our first attempt to explore Information Visualization techniques to graphically render complex, multidimensional student-tracking data, and it was the precursor to this research. The effectiveness of using visualization techniques to explore student-tracking data already has been demonstrated in the CourseVis research (Mazza, 2004) by an empirical evaluation that involved instructors with experience in distance education. That study showed that the graphical representations can help the instructor to quickly and more accurately identify tendencies in their classes and discover individuals who might need special attention.

Among the different works that have been proposed on the usage analysis in learning systems, none of them have found practical exploitation on

widely-diffused learning management systems. GISMO goes a step further and aims to become a module widely-diffused in Moodle's community. With this spirit, GISMO follows the Open Source movement, and the prototype is released as Free Software under the GNU[1] General Public License.

CONCLUSION AND FUTURE WORK

Based on our experience with the CourseVis research, we have designed GISMO, a tool that graphically represents student-tracking data collected by learning tools to help instructors become aware of what is happening in distance or blended learning classes. GISMO is designed to be a practical tool, easily integrated into a popular LMS that can be used by the instructor in realistic settings. It proposes some graphical representations that can be useful to gain some insights on the students of the course. It is also a further step on the path traced by quite a large body of previous literature and research.

The case study included in the article was aimed at illustrating how GISMO works, how it can be useful, and how it can be integrated in the day-to-day activity of online course management and delivery.

GISMO is released as Free Software and can be freely downloaded from the project website (http://gismo.sourceforge.net). Several people around the world have contacted us and given some interesting feedback that allowed us to improve the tool. Our plan for the future is to continue receiving feedback from the users and improve the tool to address better usability and users' needs.

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Notes

[1]GNU is a recursive acronym for "GNU's Not UNIX"; http://www.gnu.org/