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## MONITORING STUDENTS IN COURSE MANAGEMENT SYSTEMS: FROM TRACKING DATA TO INSIGHTFUL VISUALIZATIONS

Monitoring students in a distance learning setting is a difficult task. Students tend to study alone with little, or even no, interaction with peers and instructors. As a consequence of this, instructors often have no a clue of what is happening to their students: have they accessed the course materials? Are they doing exercises? Are they contributing in discussions? This paper reports two research projects carried out at the Faculty of Communication Sciences of Lugano that used Information Visualization to graphically represent students' tracking data collected in Course Management Systems. The implemented system and the empirical evaluation with users have proved that such approaches can be effective to the instructors to gain some insights on the students of the course.

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## 1. Introduction

Distance learning is becoming the new challenge for 21<sup>st</sup> century universities and schools around the world. Almost each university already has done (or has planned to do) some experimental teaching activities at a distance through the World Wide Web. National and international research programs, such as the federal program Swiss Virtual Campus (SVC), are trying to boost e-Learning in places where learning always has been given in the form of lectures: the universities. The basic idea of these research activities is to exploit the latest research findings, using relevant pedagogic, didactic and instructional design methods and state-of-the art interactive and multimedia-based implementations in order to improve the quality of teaching and address the latest demand of mobility and 24-hour access to instruction.

Many software environments have been produced in the latest years to facilitate the adoption of distance learning through the Web. Thanks to the diffusion and the popularity of the Web, many software environments take advantage of the client-server communication on the Internet to support distance learning. Environments called Course Management Systems (CMSs) have been developed for this purpose. Using CMSs, instructors can distribute information to students, produce content material, prepare assignments and tests, engage in discussions, and manage distance classes. However, although they offer many interesting features that benefit the learning process (e.g., asynchronicity, interactivity, time and space independence), they have introduced some problems, such as students' feeling of isolation or the lack of effective support from the instructor and by other peers in the course (Helic et al. 2000; Ragan 1998).

Because of the nature of computer-mediated communication, students tend to study alone at home with little (or even no) interaction with others. The side effect of this is usually a high number of drop-outs that is common in several courses taught at distance.

Educational research suggests that in the distance learning context, the students should be assisted by a tutor who, among other things, has to monitor the students' learning, understand their needs, and provide adapted tutoring. While the instructor focuses on content production and grading, the tutor (usually a teaching assistant) is in charge of monitoring the course, moderating on-line discussions, mentoring individuals and groups, and providing systematic feedback to the instructor. To

this end, the tutor has to monitor regularly the student activities and be aware of what students are doing with the course: which concepts are known, whether students are participating in discussions, whether they read the course materials, who performs best on quizzes, etc.

CMSs accumulate large tracking data of the students' activities in a distance course and usually have built-in student-monitoring features that enable the tutor and the instructor to view some statistical data. However, usually, this information commonly is presented in the format of a textual log file, which is inappropriate for the instructor's needs (Mazza 2004).

We experimented with an approach to graphically represent the tracking data generated by a CMS. We argue that the tutors and the instructors can use the tracking data collected by the CMS more effectively when this data is represented graphically using appropriate visualization techniques. Information Visualization (Spence 2001; Card et al. 1999) is a field in Computer Science that examines techniques for processing and pictorially representing a vast amount of abstract data so that the data can be comprehended and interpreted by people. There are several situations in the real world where we try to understand some phenomena, data, and events using graphics. Graphics are powerful, as they instantly convey a huge quantity of information in our mind, allow us to recognize essential features, and enable us to make important inferential processes. This paper illustrates two research projects carried out at the Faculty of Communication Sciences in Lugano during the years 2000–2005 that used Information Visualization to graphically represent students' tracking data in CMSs. CourseVis is the name of the first application that was developed as the Ph.D. work of the author; GISMO is the name of the follow-up that we implemented in the context of a project funded by the European Union.

## 2. CourseVis

The first attempt to tackle the issue of monitoring students with visualizations was the CourseVis application. We started with a systematic investigation to find out what information about distance students the instructors may need when they run courses with a CMS. As well, we desired to identify possible ways to help instructors acquire this information. We conducted a survey with instructors involved in distance learning (Mazza & Dimitrova 2003). The survey considered social aspects

(interaction between students), cognitive aspects (performance of students on the course), and behavioral aspects (specific features of the students' behaviors, such as attendance, reading of material, etc.). The results of the survey were used to draw the requirements and to inform the design of CourseVis. In particular, we found that instructors of online courses are interested in:

- the participation of students in discussion and group works (for social aspects),
- the overall and specific performance for the concepts of the course (for the cognitive aspects),
- and the accesses of the students to the course and its specific resources and how their learning is progressing according to the schedule of the course (for the behavioral aspects).

The next step was the implementation of a prototype of CourseVis for our local CMS platform. We implemented a version specific for the WebCT<sup>1</sup> CMS. CourseVis acquires tracking data from the CMS (which usually is provided in the form of tabular textual data with a well-defined syntax), performs some minimal computations over this tracking data, and finally generates some graphical representations that can be explored and manipulated by instructors to examine specific aspects of distance students. The architecture of CourseVis, together with a detailed description of the visualization generated, is described in Mazza and Dimitrova (2005).

We conducted an empirical evaluation of CourseVis to evaluate whether the proposed visualizations comply with the instructors' requirements detected with the survey and whether instructors may take advantage of the proposed representations. The evaluation focused on its effectiveness (can it help instructors gain an understanding of what is happening in distance classes?), efficiency (can instructors infer required information quickly?), and usefulness (to what extent is the information provided useful to the instructors?). The evaluation involved instructors with experience in using CMSs in distance learning and took place in three stages:

- 1) A *focus group*, conducted with five instructors who were provided with CourseVis.

<sup>1</sup> <http://www.webct.com>

- 2) A *controlled experiment*, conducted with six instructors with experience in distance learning.
- 3) Finally, *semi-structured interviews* with participants involved in the controlled experiment.

The focus group and the semi-structured interview aimed to assess the usefulness of the graphical representations generated in CourseVis, while the experimental study aimed at verifying the effectiveness and the efficiency of the representations.

The evaluation of CourseVis has shown that graphical representations produced with it can help instructors to identify individuals who need particular attention, discover patterns and trends in accesses and discussions, and reflect on their teaching practice. The CourseVis evaluation is presented in detail in Mazza (2004).

### 3. GISMO

Following the encouraging results we obtained with CourseVis, we decided to implement the visualizations found useful by the instructors in the evaluation of CourseVis in a new context, namely the research project “EDUKALIBRE, Libre software methods for E-Education,” funded by the European Union in the years 2003–2005 (Botturi et al. 2005). For this project, we aimed to develop an additional module for the Moodle<sup>2</sup> CMS, which is usable by the instructor in realistic settings. We considered the Moodle learning platform primarily because it is the learning platform that we adopted after the previous experience with WebCT. We also selected it because of its Free and Open Source nature that allowed easy integration with the developed software.

We implemented a tool that we called GISMO. Like in the previous research, GISMO uses the CMS tracking data to generate graphical representations aiming to help instructors in their teaching and monitoring activities. Thanks to the feedback that we received by the instructors with the evaluation of CourseVis, GISMO exploits only the visualizations that instructors found useful for their activities, implementing an improved version of those. In addition, GISMO is developed as a plug-in module fully integrated with the CMS. In fact, it can be installed on any recent

<sup>2</sup> <http://www.moodle.org>

version of the Moodle learning platform and is visible to the instructors as an additional block. The graphical interface is delivered through the Web using a Java Applet. The software is distributed as Free Software under the GNU General Public License, and it can be downloaded from <http://gismo.sourceforge.net>. The software is downloaded at an average of 50 downloads per month, and we have been contacted by dozens of people from around the world who are using GISMO in their Moodle platform. The GISMO tool and the produced visualizations are described in detail in Mazza and Milani (2005).

#### 4. Conclusions

We have presented two research projects carried out at the Faculty of Communication Sciences of the University of Lugano that aimed at exploring a novel approach of using graphical representations of student-tracking data collected by learning tools to help instructors become aware of what is happening in distance learning classes. The research follows the approach of Information Visualization, which is receiving a large consensus among researchers in domains as diverse as bioinformatics, physics, social sciences, marketing, computer science, etc.

The systems we implemented, CourseVis and GISMO, have proved that Information Visualization can be effective in creating graphical representations that can be useful to the instructors to gain some insights on the students of the course. We want to continue with this approach, and we aim to design and explore new Information Visualization solutions to address teaching and learning needs in the future.

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