Interactive Visualization Tools to Improve Learning and Teaching in Online Learning Environments

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ABSTRACT

This paper presents two interactive visualization tools for learning management systems (LMS) in order to improve learning and teaching in online courses. The first tool was developed at the Intelligent Information Systems Laboratory (IISLab) at the Tampere University of Technology (TUT). The tool is used to analyse students’ activity from automatically recorded user log data and to build interactive visualizations. They provide valuable insights into the learning process and participation of students in a course offered to teachers and students. The second tool was developed at the Unitelma Sapienza University. It extends navigation and search functionalities in the discussion forum of an LMS with a topic-driven paradigm. The tool analyses forum content and automatically identifies discussion topics. It then enhances the original forum with a topic-driven navigation structure and an interactive search graph. Both tools have been developed as plug-ins for the Moodle LMS, but their analysis processes and techniques can be adopted into any LMS.

KEYWORDS
Data Mining, E-Learning, Information Retrieval, Information Visualization, Learning Analytics, Visualization Tools

INTRODUCTION

As online learning spreads and becomes pervasive, the need for tools that monitor students’ participation in online courses and measure knowledge and skills development has greatly increased. Most learning management systems (LMS) and Web-based solutions that are adopted to offer online courses are able to record rich amounts of information about students’ activity, such as communication, collaboration, and participation in online courses. Many LMSs also offer reports and even simple graphs about each student’s (elementary) actions. However, these reports are poor indicators of students’ activity and participation if they are considered singly (Soller, 2001). Exploiting the log data of LMSs in order to understand the activity in an e-learning environment, how to improve student learning processes, and how to support the process of teaching requires tools and strategies that help
to select the right information in a timely fashion and present it at the right location in a correct, clear and effective way (Tufte, 2001; Tervakari et al., 2014).

To achieve this goal, at IISLab was developed a visual analytics instrument called the TUT LA tool. The implementation of the tool was for TUT Circle, an e-learning environment that is built using the Drupal content management system (Silius et al., 2011; Tervakari et al., 2013). In this paper, we present the basic principles of an extended version of this tool, which was re-implemented as a plug-in for the widely adopted Moodle LMS.

Discussion forums are one of the main means of asynchronous communication used in e-learning environments. They are available in all LMSs. Forums are used in online courses to facilitate the learning and teaching processes, such as supporting student-to-teacher interaction, student collaboration, group work and cooperative learning. Discussions held in a forum within a certain period are a potentially useful source of information for any student that subsequently accesses the forum online. However, the success of a forum as an information source and means of communication is determined by the richness of its content. Moreover, its content (discussions and messages) can be navigated and searched. While the first property depends on user participation and use of the medium, the second depends on the navigation structure and the search features provided by the forum.

To support the discovery and retrieval of relevant information in discussion forums in the e-learning environment of distance-learning through the Unitelma Sapienza University, we defined a data analysis process that exploits information retrieval techniques. It employs topic models (Blei, 2011) and formal concept analysis (Ganter and Wille, 1999) to identify the topics discussed in a given forum and to provide topic-driven searches and navigation (Cerulo and Distante, 2013)(Distante et al., 2014).

In this paper, we briefly describe these processes and describe the implementations of the plug-ins for the Moodle LMS. They provide interactive visualizations that help both students and teachers find the information they need and monitor students’ learning and actions in the learning environment.

RELATED WORK

Recently, on-line education systems have become widespread tools adopted by both historical and newly founded educational institutions. E-learning and e-teaching are new contexts for education through which large amounts of information are generated and available to users worldwide. A large portion of the available information takes the form of free text without the structure required for automated knowledge retrieval.

Learning analytics provides valuable support for teachers and students to understand learning habits and to obtain rich information about learning and teaching processes. Learning analytics is commonly used to measure, collect, analyse and report user data about learners in order to understand and optimize learning, learning environments and teaching (Siemens and Long, 2011). For example, Carr (2012) reported that a great number of open online courses monitor every user’s action, such as pausing a video, increasing feedback speed, responding to quiz questions, revising assignments and participating in forums. The data are then used to analyse student behaviour and test how people learn. Hence, the teacher can tailor the learning environment to fit each student’s learning style and needs.

The lack of quality in collected tracking data represents a major challenge to ensure its effective utilization. Moreover, large amounts of data can be difficult to analyze, interpret and understand because processing data requires complex cognitive processes. However, if the data are packed and presented in a correct, clear and effective manner, users can process an incredible amount. When the data presented are complex to perceive and process, adequate visual presentations are mandatory (Berg, 2012). Appropriate visualizations can help to process information, such as by increasing memory and the number of available processing resources, reducing the number of searches for information, enhancing the recognition of patterns, enabling perceptual inference operations and using perceptual attention mechanisms for monitoring (Ware, 2012). A good visualization helps the users understand
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