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Development and Evaluation of a Learning Analytics Application to Support Online Teaching and Learning at the University of Alberta

Keywords: learning analytics, learning management systems, online teaching and learning, software development

Abstract: The objective of this project is to investigate, develop, evaluate and implement a learning analytics software application for the eClass learning management system. This application will support instructors in monitoring their students' online learning activities, interaction and performance and will facilitate the provision of personalized and enhanced advice to students. It will also provide students with new visual and analytical tools and opportunities to regularly manage their learning activities and interactions in order to be able to compare their performance with their peers in an ongoing and real time manner. The project will have direct impact on and implications for all instructors and students on campus. This project will take an innovative approach by making effective use of learners' data and their context held in eClass to provide new insight into teaching and learning in online learning management systems.

Introduction

The widespread development of online teaching and learning and the introduction of numerous online courses and programs have presented new challenges and opportunities for the institutes of higher learning to develop and apply new ways and tools for monitoring and evaluating online teaching and learning. Terms such as educational data mining, academic analytics and more commonly adopted term 'learning analytics' have been used in the literature to refer to the methods, tools and techniques for gathering very large online data about learners and their activities and contexts. The first International Conference on Learning Analytics and Knowledge (LAK 2011) defines learning analytics as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs". Clow (2012) provides a learning analytics life cycle to conceptualize successful learning analytics work, including four key components, namely learners, data, metrics, interventions. Learner means a student who may take an online course or courses that make use of a learning management system. The second step in the cycle is the generation and capture of data about or by the learners, including login and clickstream data. The metrics stage refers to the processing of data using various metrics, examples of which may include visualization, dashboards, list of at-risk students, comparison with previous cohorts etc. The final stage of the cycle refers to, for instance, dashboards for learners in order for them to be able to compare their activities with their peers or previous cohorts.

The advantages of learning analytics have been enumerated by Siemens et al. (2011) and Siemens and Long (2011), some of the important ones include:

- Early detection of at-risk students and generating alerts for learners and educators
- Personalize and adapt learning process and content
- Extend and enhance learner achievement, motivation, and confidence by providing learners with timely information about their performance and that of their peers
- Higher quality learning design and improved curriculum development
- Interactive visualizations of complex information will give learners and educators the ability to "zoom in" or "zoom out" on data sets,
- More rapid achievement of learning goals by giving learners access to tools that help them to evaluate their progress

A recent report on the state of learning analytics concludes that there is widespread interest, both within the academic community and beyond, in learning analytics and the possibilities they offer for tailoring educational opportunities to each learner's level of need and ability (Ferguson, 2012).

Objectives

Course and learning management systems such as Moodle hold very large data sets related to student interactions and activities. However, student tracking capabilities in these systems are usually limited and as a result the depth of extraction and aggregation, reporting and visualization functionality of these built-in analytics has often been basic or non-existent (Dawson, 2010). The University of Alberta eClass environment does not currently have learning analytics tools to provide support for analyzing, visualizing and making sense of very large student and instructor activities datasets. The eClass reporting features and logs provide only limited and basic level data, such as Time, IP address, course view, forum view, resource view, and actions such as ‘Add’, ‘delete’, ‘view’ for forum or blog posts. These data points are presented separately from one another, with no analytical, comparative or visual functionality to allow for a real time understanding of the individual and class performance. Therefore, instructors are not able to use these data points in a multidimensional way to make detailed and comparative inferences about student activities and interactions within one particular course activity or across the entire course content. For instance, it is not possible for an instructor to a) comparatively and visually identify the most frequently used resources within a course, b) detect the kinds of resources used by high performing students in class, or c) identify the nature of course materials not used by low and average performing students.

The overarching aim of this project is to develop, evaluate and implement a learning analytics software application for the University of Alberta eClass learning management system. The specific objectives of this study include:

- An environmental scan of existing open source and proprietary learning analytics applications for Moodle and other learning management systems
- A critical analysis and comparison of various software applications and plugins developed to gather, manage, visualize and present learner’s data within popular learning management systems such as Moodle, Desire2Learn, Blackboard, Canvas.
- Design and development of a learning analytics tool compliant with the eClass learning management system to support an integrated approach to the collection, real time visualization and management of large learners data sets
- Testing of the application using data available within completed and ongoing eClass online courses
- User-centred evaluation of the application using a sample of instructors and students
- Experimental implementation and integration of the application into the eClass platform to provide instructors and students access to data analytics and visualization functionalities

This project will be conducted in close collaboration with the Centre for Teaching and Learning (CTL), University Digital Strategy (UDS) and Information Services and Technology (IST). The principal researcher has already consulted with the above units to ensure that the development, code testing, compatibility analysis and quality assurance of the software are conducted in close coordination with them. This kind of collaboration and coordination will also ensure the sustainability of this project and its outcome. In order to contextualize this project within the previous research and development in learning analytics, a brief overview and critique of a number of learning analytics applications is presented to emphasize the significance and the anticipated contribution of the proposed project.

Context and Prior Research and Development

There have been a number of learning analytics tools developed for various learning management systems, such as Moodle, Desire2Learn, Canvas and Blackboard. There are two general categories of learning analytics tools. The first category is exclusively designed to be used by instructors and course designers with features and functionalities for analyzing and visualizing data related to student activities. The second category provides additional features and functionalities for students as well as instructors with access to learners’ interaction and activity data. A significant number of these learning analytics tools are open source applications, some of which are still being developed and others have not been kept up to date. In the following a review of ongoing and useful projects is presented.

SNAPP (Social Networks Adapting Pedagogical Practice) is a browser plugin that has limited functionality and creates social network diagrams that can be used to identify isolated students, network patterns and interaction occurring between student participants. This tool allows instructors to evaluate student behavioral patterns against learning activity, design objectives and intervene as required a timely manner (Dawson, et al., 2010). It can be used within Moodle, Blackboard, and Desire2Learn.

The Moodle Analytics and Recommendations block is a small scale project that uses colour coded charts and tables to allow students to quickly view their participation. Teachers are able to view single, comparative analytics and global analytics. This block is not currently maintained up to date or supported.

LOCO-Analyst is an open source educational tool that provides teachers with feedback regarding student activities and usage. The application does not provide any features and functionalities for students to compare their learning data with their peers. This application is still being developed (Jovanovic, 2008).

GISMO (Graphical Interactive Student Monitoring Tool for Moodle) is a graphical interactive monitoring tool that provides useful visualization of students' activities in online courses to instructors. Using GISMO instructors can examine students' attendance, reading of materials, and submission of assignments. While GISMO is designed to work with Moodle, the version available is not compatible with University of Alberta eClass platform. Another major limitation of the application is that GISMO focuses mainly on instructors and there is very limited functionality for student use of and interaction with their own data.

The Academic Analytic Tool (AAT) is an open source ongoing project at the Athabasca University, which allows instructors to access and analyze student behaviour data in learning systems. It enables them to extract detailed information about how students interact with and learn from online courses, to analyze the extracted data, and to store the results in a database and/or CSV/HTML files. While AAT is compatible with Moodle, it has primarily been developed for learning designers (Graf et al., 2011).

In addition to the above applications there are other learning analytic tools developed for Blackboard, Desire2Learn and Canvas. The main point is that learning analytics are becoming an integral and expected component of learning management systems. This proposed project aims to design and develop a learning analytics application for eClass that provides learning analytics functionalities for both students and instructors. The application will be compatible with Moodle and will have the potential to be used by other universities and colleges that may use Moodle as their learning management system.

Examples of use case scenarios, where learners' data can be easily visualized and presented to instructors and students for decision making and curricular improvement are depicted in the appendix A.

Methodology

Design and development of application

This project will draw upon Clow (2012) learning analytics life cycle to design an application that will support the four stages of the learning analytics life cycle, namely learner, data, metrics and interventions. The learning analytics tool that will be designed in this project will support both instructors and students and will be compatible with the eClass environment. Moodle databases collects large multidimensional data files from student activities, clickthrough data, access to various digital objects, history of pages viewed, number of hits for each day of the course. However, this data is available in a tabular format and it is very difficult to understand the structure and organization of data or to be able to make sense of various types of data collected. The learning analytics tool that is proposed to be developed in this project will provide the following key components:

- Data repository: Data collection and amalgamation
- Data transformation mechanism to organize and cluster raw data
- Data processing to support large data analysis
- Data and information visualization functionalities to visualize and demonstrate individual and comparative views of the following data points:

- Logins
- Submissions
- Interaction with learning objects (resources accessed and frequency)
 - Frequently used content and media
- Interaction with discussion forums, lessons, quizzes etc.
- Student interaction and social networks
- Blog and discussion forum analysis and visualization
- Time spent (on individual pages, on average, across the course etc.)
- Detection of low, average and high performing students

The application will make use of a broad range of technologies, including PHP and MySQL, information visualization technologies, and text and data analysis tools.

Evaluation

Application for research ethics approval will be made once the funding is awarded. The user-centred evaluation of the application will involve 20 instructors and 30 to 50 students. The instructors will be selected from those teaching courses that make use of eClass in collaboration with CTL as well as a number of instructors from the School of Library and Information Studies in the Faculty of Education, where there is a fully online program. Students from various courses will be sampled to participate in this evaluation. Two data gathering methods will be adopted to conduct this evaluation. Individual interaction with the learning analytics tool will be used to gather data on both instructors and students impressions, thoughts and usefulness of the tool. Think aloud technique will be used to allow the participants to share their real time experience with the tool. This is to gain an insight into the usability, usefulness and intuitiveness of the application. Two separate focus group discussion sessions will be held for instructors and students to provide a venue for brainstorming and group thinking when evaluating the application. Both individual evaluation and focus group discussions will be conducted to identify potential issues and problems with application in order for the researchers to address them before the proper implementation of the application. The findings from these user evaluation studies will be used to modify and make changes to the software application to make it a usable and easy to use application for students and instructors.

Contribution

The main outcome of this research and development project will be a learning analytics software application that will operate as an integral part of the University of Alberta eClass environment and will be made available to all instructors and students. The outcomes of this project will make significant contribution to learning and teaching on the University of Alberta campus. This application will support instructors and students in monitoring learning and teaching activities and will support the provision of personalized and enhanced advice to students. The tool will have the potential to be expanded to include department level and campus-wide evaluation of learning and teaching to facilitate prediction, adaptation, personalization and intervention in the learning process.

Dissemination

The results of this project will be shared within and outside the University of Alberta. Due to the nature of this project and its evident impact on instructors and students, a number of dissemination venues will be adopted. In collaboration with the CTL, an introductory workshop will be held to introduce the tool to the U of A community in the second year of the project. One presentation will be delivered at one of the University of Alberta International Week events. Two video tutorials will be created for instructors and students in order to provide easy instruction on the use of the application within eClass. These cooperative activities with CTL will ensure the sustainability of the learning analytics application. Furthermore, the results of this project will be presented at the International Conference on Learning Analytics and Knowledge (LAK) Conference. An article will be submitted to the peer-reviewed Journal of Learning Analytics.

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