Using Learning Analytics in Moodle for assessing students' performance

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Abstract

The assessment of students' performance in online learning environments is a challenging and demanding task for the teachers. Moodle offers several assessment tools. This paper presents a new assessment tool, called Learning Analytics Enriched Rubric (LAe-R). LAe-R is based on the concept of assessment rubrics which is a very popular assessment technique in education. LAe-R contains "enriched" criteria and grading levels that are associated to data extracted from the analysis of learners' interaction and learning behavior in an e-learning environment. LAe-R has been developed as a plug-in for the Moodle learning management system. The findings of a case study showed that LAe-R is a very usable tool that is highly appreciated by teachers and students.

Keywords

learning analytics, interaction analysis indicators, learning indicators, rubrics, enriched rubrics, LAe-R, evaluation, assessment

Introduction

School education is being reformed. Modern pedagogical methods such as computer supported collaborative problem solving (CSCL) and inquiry learning are being adopted in order to promote the "21st Century Life Skills", i.e. creativity, critical thinking, collaboration, and problem solving skills. These skills are needed in order for individuals to function successfully as global citizens and workers in diverse ethnic and organizational cultures (Griffin et al., 2012).

As a result, teachers design learning scripts that require from students to engage into well-structured complex collaborative learning and problem solving scenarios which require individual and team learning activities over authentic problems, the undertaking of roles for the joint development of group deliverables, communication via chat/forum, co-sharing ideas and arguments using virtual workspaces as well as access of online learning resources, etc. Despite the proliferation of such teachers design initiatives, a key factor that is still missing relates to the design and application of modern assessment strategies tailored to probe the competencies and skills that these modern learning scripts try to enhance (Strijbos, 2011).

The assessment of students' performance in complex computer-supported collaborative learning or inquire based learning scripts is a tiresome and a time-consuming process for the teachers, who should take into consideration a huge amount of parameters. The process of assessment involves designing appropriate authentic assessment activities and gathering information from a variety of sources (e.g. project deliverables, discussions log files) to cultivate a rich and meaningful understanding of student learning and behavior in the learning environment. Students' assessment should be related to participation, support for group activities, quality of contributions to the group deliverables, helpfulness, creativity in product development, etc. New assessment approaches and tools such as learning analytics which help teachers to have a better understanding of students' online interactions have been proposed lately. Such learning analytics approaches and tools have also started being integrated into Moodle (Dyckhoff et al., 2012; Romero, 2010; Siemens et al., 2012).

The purpose of this paper is to present a new learning analytics tool, which has been developed as a Moodle plug-in (version 2.2+), which helps teachers to evaluate a number of key skills and competencies developed in a Moodle-based learning environment, when modern pedagogical methods such as computer supported collaborative problem solving and inquiry learning are adopted. This tool/plug-in is called Learning Analytics Enhanced Rubric (LAe-R). It was created as an advanced grading method. It is an enhanced version of the

existing rubric plug-in. At its current version, LAe-R allows a teacher to add types of criteria that are associated to Learning and Interaction Analysis Indicators (LIAI) such as collaboration, grades to assignments or study of learning resources.

The structure of this paper is as follows. Next section gives a brief overview of existing learning analytics tools that interoperate with Moodle. Then, the LAe-R tool will be presented followed by the results of an evaluation study of its usability to which teachers participated. The main results of that study will be showed and finally, concluding remarks will be made about the use of the tool so far, as well as future plans regarding the tool's usage and functionality.

Moodle related Learning Analytics tools

Long and Siemens (2011) define Learning Analytics (LA) as "the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning." LA mainly intends to help teachers and students to take action based on the evaluation of educational data (Retalis et al., 2006).

A number of LA tools which interoperate with Moodle have been proposed. These tools are the following:

- *GISMO* is a visualization tool for Moodle, which uses log data, edits them and finally produces graphical representations that can be used by teachers so as to examine social, cognitive and/or behavioral student interactions. The tool is incorporated in Moodle as a supplement block within the graphics environment, visible only by the teacher. It provides analytic statistical representations and shows a general picture of the students as a whole, analyzing the more general learning process of all the students on all subjects (Mazza and Botturi, 2007).

- *MOCLog* is a sum of tools that are used for the analysis and presentation of data within Moodle. The development of the tool was based on GISMO. Thus, some of GISMO's main components for the production of statistical reports for educators and students have been re-used. MOCLog attempts the analysis of interactions occurring in an online course so as to achieve better analysis of both the products and the educational process itself. It distinguishes among users according to their role within the system and presents different statistical reports tailored to these roles. So, the system's users have access to summative reports of interactions related to actions on educational resources and educational tools within specific subjects, such as quizzes, assignments, wikis, etc. (Mazza et al., 2012)

- *Excel Pivot Tables* is a tool that can be used for the production of learning statistics coming from Moodle. Moodle itself exports its data from the log files in spreadsheet form (Excel), through which the user can feed in data and create Pivot Tables. The graphic result is called 'summative table report'. With the aid of this tool the user can relatively easily and quickly organize in groups a great volume of data, sum up important information emerging from the data and execute immediately complex calculations on these data (Jelen & Alexander, 2010).

- *Analytics and Recommendations* is installed within Moodle as a supplement block and can be used both by teachers and students. It is a tool for the visualization of students' involvement in each activity of an online course as well as a consultation tool which can recommend activities to students so that they can improve their attainment. The tool uses tables and graphs, enriched with special coloring, so as to render the provided information easier to comprehend (Sampayo, 2013).

All the above mentioned tools offer several features that try to support teachers in evaluating aspects of the effectiveness of the design of their online courses for improving their quality and for identifying opportunities for interventions and improvements. However, none of them has been used for assessing students' performance based on the analysis of data collected during the online course sessions. This is what LAe-R tries to do, as will described in the next session.

LAe-R tool

Lately, rubrics are becoming one of the most popular technique for the assessment of students' performance. They are used to evaluate a wide range of knowledge, skills, abilities in various learning subjects and activities (Wolf & Stevens, 2007; Arter & Chappuis, 2009). The Enriched Rubrics (ER) share the same form as the

'classic' rubrics and are represented in table form (see Fig 1). The horizontal axis of an ER shows the graded levels of performance along with the respective grading scale used for each level. The vertical axis presents the assessment criteria, which derive from the analysis of students' interaction and their learning paths during an online lesson (e.g. total number of activities-messages per student/team, proportion of writing-reading messages per student/team, social network density, proportion of learning resources read by student/team, etc.). ERs systematize, organize and simplify the process of evaluating students' performance, providing concise and measurable assessment criteria (strongly linked to the learning objectives) for both the learning products and the complex learning process, while at the same time documenting the differential result in students' attainment using levels of grading (Petropoulou et al., 2012).

	Exceptional Performance	Mediocre Performance	Low Performance	Results
	3	2	1	
Criterion 1				
Criterion 2				
Criterion 3				
.				
.				
.				

Levels of performance (scale)

Criteria or Dimensions

Performance Descriptors

Figure 1. Sample of an assessment rubric

The Learning Analytics Enriched Rubric (LAe-R) tool was created as Moodle plug-in (version 2.2+). It is an enhanced version of the existing rubric plug-in, thus being integrated as an advanced grading method. When creating an ER, a teacher can add types of criteria that are associated to LIAI such as collaboration, grades to assignments, study of learning resources (see Fig 2).
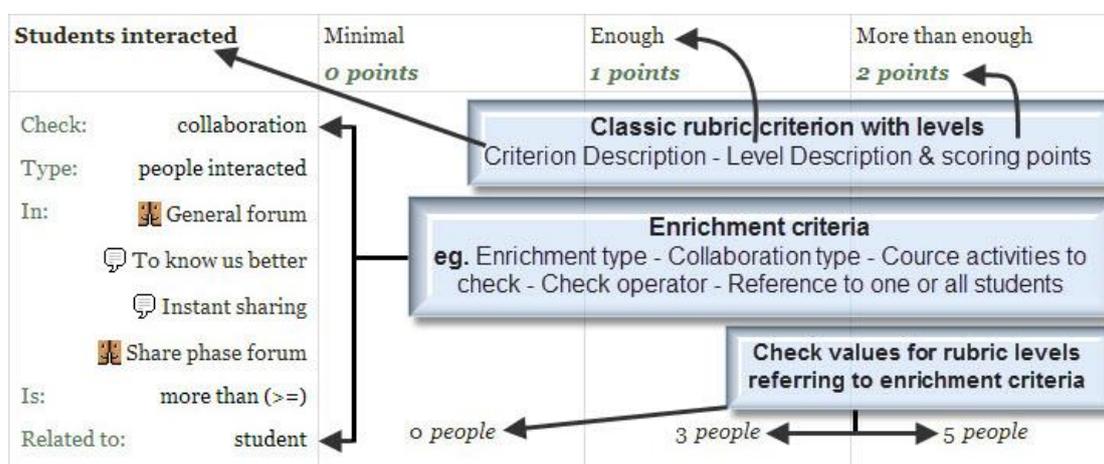
Figure 2. Screenshot of how a teacher can specify an assessment criterion in LAe-R

For assessing students' performance with regards to "collaboration", the tool analyzes and visualizes data such as forum posts (new or reply messages), chat messages and number of files attached to forum post messages. For assessing students' study behavior, the tool analyzes and visualizes the number of students' views upon specified learning recourses. Also, the students' performance in various assignments can be measured or aggregated by the LAe-R tool. By using "collaboration" and "studying of resources" indicators, the teacher can perform a quantitative evaluation on student performance, whereas using the "grades of previous assignments" a qualitative evaluation can be made, upon student assimilation of course material and/or adoption of educational objectives.

For example, suppose that a teacher wants to assess a criterion regarding the amount of "students" that one student has "interacted" with, in two course forums and two chats (see Fig. 2). There will be three (3) levels of performance: 1) when the student has interacted with less than 3 people, 2) when the students has interacted with 3 or 4 people, and 3) when the student has interacted with 5 people or more. Using the more than (>=) operator, these three levels create a distinct set of points according to enrichment level check values: A) [0,1,2], B) [3,4] and C) [5, 6, ...), so if a student has interacted with 7 other different students, he/she will be at level 3 of that criterion. Moreover, the score of that student in the previous example might have to do with his/her performance in comparison to other fellow students for the same criteria. This is called "global scope evaluation" and uses percentages for all logical comparisons. So, if all students (including the one being evaluated) have interacted with an average value of 6 people, the number 6 will correspond to 100% of students' average and the above example should accordingly use as level check values a) 0%, b) 50% and c) 83%. All the teacher has to do in order to make such a comparison, is to change the "related to" sub-criterion in enrichment from "student" to "students" and also make corresponding changes to level check values.

At the current version of LAe-R, collection and process of data is performed in various Moodle database tables according to enrichment criteria in order to produce learning analytics (see Table 1).

Table 1. Basic database querying characteristics

Enrichment type	Collaboration type	Database Table
Collaboration	Simple occurrences	log
Collaboration	File submissions	forum_posts
Collaboration	Forum replies	forum_posts
Collaboration	People interacted	forum_posts / chat messages
Study	Num of Learning Resources	log
Grade	Assignments grades	grade_grades

LAe-R was developed according to all coding guidelines specified by Moodle standards. All defined classes, procedures and functions included in the code, are compatible with the Moodle platform architecture. All the significant changes which had been made from Moodle version 2.2 to 2.3 affecting crucial parts of the plugin's functionality were taken into account and minor adjustments were made so that LAe-R is fully compatible to both versions. The plugin was successfully approved by Moodle evaluators and was successfully published.

LAe-R usability evaluation study

Based on recent studies regarding the utilization and user acceptance of new software products/tools (Venkatesh et al., 2012), an experiment took place at the University of Piraeus in Greece, during spring semester of 2013 for 5 weeks. 32 students of the MSc program on "Didactics of Technology and Digital Systems" majoring in "E-Learning" participated. All postgraduate students were teachers from primary and secondary schools and they were experienced in designing complex learning scripts for online courses.

The experiment was carried out in two phases: At first students were informed about the enriched assessment rubrics during a three hour lecture session. The concept of these rubrics was presented along with examples (including the ones mentioned in the previous section). Specific emphasis was given to the interaction analysis indicators which had to be incorporated into the "classic" assessment rubrics.

In the second phase, the students formed teams of two or three members. They were asked to:

1. create complex CSCL scenarios on various school subjects, using computer supported learning methods and/or inquiry based science learning methods, as well as instantiate them as Moodle courses

2. design and submit enriched assessment rubrics for the assessment of students' performance in the Moodle which they have designed

The goal of this study was to evaluate the usability and acceptance of LAe-R by teachers/practitioners. The basic quantitative data which were collected via anonymous online questionnaires in the Likert scale are shown in Figure 3a & Figure 3b. The first figure displays the statistical results concerning the satisfaction gained by the practitioners by the use of the tool, whereas the second figure displays major usability issues concerning the ease of use stated by the practitioners regarding the employment of the tool's main functions.
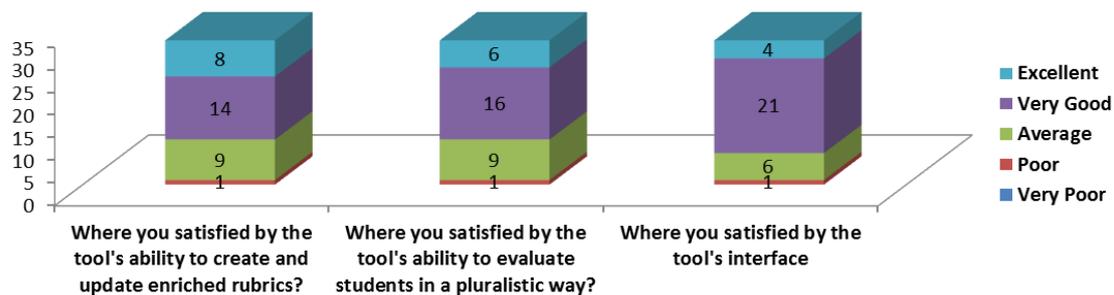
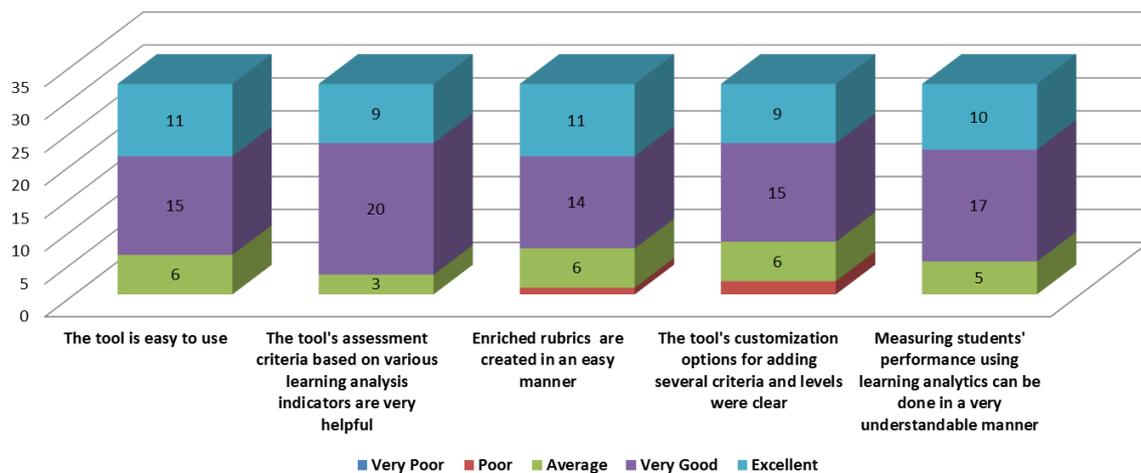**Figure 3a. Level of user satisfaction from the LAe-R tool**

Figure 3b. Evaluation findings about LAe-R tool's usability aspects in creating enriched rubrics

Regarding LAe-R, teachers stated that they felt comfortable using this tool which was easy for them to work with and were satisfied by its' interface. The majority of the participants stated that they found LAe-R very useful, quick and easy to work with. Performing student evaluation in a pluralistic way seemed effortless to the practitioners. Very good reviews were also noted for LAe-R's online help that contained detailed videos and Moodle docs.

Furthermore, teachers/practitioners gave feedback comments via the open questions of the online questionnaire such as:

- Add more criteria in an enriched rubric thus allowing a teacher to assess other aspects of learning interaction in a Moodle course such as contribution to wikis.

- More sophisticated indicators like the centrality of a social network analysis could also be used

- LAe-R should offer more appealing ways to visualize LIAI in pies or charts.

Concluding remarks

Following the latest trends in education, it is renowned that Learning Analytics is an emerging new research field with many tools implemented in order to produce such information and provide to educators the resources in order for them to acknowledge and evaluate the derivatives of their educational process. This paper presented LAe-R tool which seems a very promising assessment tool that could fill-in the gap in assessing students' performance in Moodle, using the wealth of learning analytics with learning and interaction analysis indicators. Currently, LAe-R has been developed with the intention to support teachers in their ongoing summative assessment tasks, using a variety of LIAI embedded in criteria. Despite its advanced assessment features and customization options, the tool was greatly accepted and adopted by educators. Future work will include the enhancement of LAe-R, based on the practitioners' feedback, giving emphasis on visualization aspect and more indicators. Also, more field-testing will be conducted with teachers, that will enact Moodle courses based on complex learning scripts from different disciplines. We also plan to enhance LAe-R with an recommendation component for students so that LAe-R could be used for formative evaluation as well.

Acknowledgements

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