INTEGRATING EXTERNAL EVIDENCES OF SKILL ASSESSMENT IN VIRTUAL LEARNING ENVIRONMENTS

JUAN ANTONIO CABALLERO
University of Cadiz, EVALfor Research Group, juanantonio.caballero@uca.es

MANUEL PALOMO
University of Cadiz, Department of Computer Sciences, manuel.palomoa@uca.es

JUAN MANUEL DODERO
University of Cadiz, Department of Computer Sciences, juanma.dodero@uca.es

GREGORIO RODRÍGUEZ
University of Cadiz, EVALfor Research Group, gregorio.rodriguez@uca.es

Mª SOLEDAD IBARRA
University of Cadiz, EVALfor Research Group, marisol.ibarra@uca.es

Abstract: Learning Management Systems provide a set of facilities for the lecturer to create courses based on learning activities. However, assessing skills is rather limited because activities must be usually assessed with simple grades without considering the links between the activities and the skills aimed to be developed. As a consequence, limited feedback can be provided to the students, thus losing relevant information of the learning process. In this work we present a software architecture for web-based learning management systems to mitigate this issue. It consists of a web service that facilitates the assessment of skills and an extension to the browser that enables to mark and compile the evidences of assessments on web activities. The system has been applied to courses in a Moodle box where different skills that students must develop in an external wiki can be assessed while assessment evidences are tracked. All the software of this experience is fully functional and available as free software.

Keywords: skills assessment, learning management system, online learning, learning web service, free software

1. INTRODUCTION

In the last years, the use of the computer technologies has increased significantly. This rise has forced to do changes in educational environments, like universities or educational centres. Most of these changes are based in the use of Internet, leading new strategies in the educational process [1]. One of them is the massive installation of Learning Management System (LMS) in universities, high schools and educational centres to support learning processes. However, the learning processes can also take advantage of other technologies (those name Web 2.0): like writing blogs as handouts or using collaborative applications through Internet (for instance, wiki applications) [2].

Nowadays, the attention of higher education learning has focused in getting the skills by students, instead of getting traditional knowledge. The Bologna process in Europe (a set of international agreements to ensure comparability in the standards and quality of higher education qualifications) is an example of the use of concepts like skills or learning outcomes. The learning outcomes are defined as skills, and the students must be assessed according to the proficiency level of these skills acquired in the learning process [3]. So,
outcomes are taught through courses and developed in specific activities in those courses. When these activities are developed in digital artifacts some benefits are received like repeatability, producing better feedback, having a more transparent assessment process, etc. Therefore, it is necessary that the lecturers redefine new assessment strategies considering all of this.

The new skill-centered learning processes cause the assessment of these skills, not only single activities. Unfortunately, most LMSs have limitations to assess skills. In most of them, every activity can be assessed only with an undimensional (usually numerical) grade and links between activities and the skills developed in them are not consider. Additionally, a detailed feedback about the skills would be desirable to support this way of assessment [4]. Again, limitations about the feedback provided to the students after an assessment have been detected in LMSs. For example, Moodle, one of the most popular LMSs, does not allow to assess specific skills and there is not any built-in mechanism to link activities with skills. Additionally, it can not provide specific feedback for skills, only a text message for every task can be shown as feedback.

We propose overcoming these limitations of LMSs integrating them with external Web services. However, these integrations are not trivial. Since the first versions of
the IMS Learning Tools Interoperability (LTI) specification, some issues are set out about integrating of external applications and tools in a context where they are suppliers of functionalities and the LMSs are the consumers of them. The main reason is that the most of

This paper describes a system to assess skills developed in activities of a LMS using a Restful Web service loosely coupled. Besides, this system provides an extension to mark evidence that can be shown to the students as a feedback. The rest of the paper is organized as follows: Section 2 reviews the background of the state of the art. Section 3 introduces the architecture we implemented. In Section 4 we describe a case study of the assessment of skills in a real Moodle-based university course where the students use a wiki to write a collaborative project. In the last one, we provide a discussion along with conclusions and future research lines.

2. RELATED WORKS

Acquiring new skills is the main goal of current learning program. Therefore, it must be considered in based-technology educational frameworks as LMSs. Moodle provides different activities and customizations in the gradebook to create a learning process which assess skills [6]. Unfortunately, the assessment of these skills must be done manually it does not support marking the relation between activities and skills described.

A way to assess generic skills in engineering grades is the use of assessment -specific tools. For example, a set of rubrics were used in [7] to measure ability to work as a team, communicate effectively, apply creativity, and demonstrate a commitment to quality and timeliness. One noted strategy is using peer assessment procedures, where it is very common the use of ePortfolios [8]. Another choice we can see in the related bibliography is about serious games. They are computer systems that simulate situations based on real life to safely integrate these experiences in university curricula [9], [10], [11], [12].

We also can find multiple-choice tests as assessment tools. An example where students had used Moodle quizzes for formative e-Assessment is a project subsidised by the Institute of Education Sciences at the Universitat Politecnica de Catalunya [13]. However, cognitive skills and application of methods cannot be assessed via multiple choice tests and equivalent forms of basic assessment items [14].

Others e-Assessment tools for assessing cognitive skills have been found, like EASy (The E-Assessment System), a tool developed by University of Münster for assessing higher-order cognitive skills in an online environment for general mathematical proofs [15], [16]. It has been identified that with this tool it is not easy to share question banks because the questions were developed specifically. Also, this tool was developed specifically for skill assessments rather than knowledge assessment and it does not support e-tutoring with feedback facility.
Web functionalities (where the learning experiences are developed) are offered by external applications and Web services in the cloud and they can change in an unpredictable way. So, it complicates developing decoupled integrations [5].

Another Web based e-learning tool is ACME. It has been developed by the University of Girona specially targeted towards continuous assessment of the student’s skills in an initial mathematics course [17]. According to Soler et al. [18], the system can be adapted to subjects other than mathematics, but is not an open source tool.

Therefore, literature does not provide a general open source system which was able to support both skill and knowledge e-Assessment in a convincing way [19].

3. SOFTWARE ARCHITECTURE

In this section we describe the architecture we implemented. In essence, the system proposed is a group of decoupled Web applications which interact between them. Firstly, we have EvalCOMIX, a Web service for e-Assessment which allows creating assessment tools and use them to assess activities in a LMS. Secondly, we have Gescompeval. It is a Restful Web service used for managing skills and learning outcomes. It allows lecturers to assess their students in skills through assessment tools that EvalCOMIX integrated in a LMS. Both EvalCOMIX and Gescompeval have their corresponding integration in Moodle 2.X (EvalCOMIX_MD and Gescompeval_MD respectively).

In addition we have EvalChrome, an extension for the Google Chrome Internet browser. This extension allows to assess any activity of a Moodle’s course from the Internet browser. Besides, the lecturer can mark evidence of the Web page which he is visiting. For instance, if the lecturer is assessing a wiki page where a student has written some homework, he will be able to save the evidence of this assessment through EvalChrome. Figure 1 show system architecture. Next we comment each component in detail.

![Figure 1: Architecture of the system](image)

EvalCOMIX

First we have EvalCOMIX. It is a Web service for e-Assessment integrated into a LMS. EvalCOMIX enables you to perform two types of activities. First of all it provides a system to design and management assessment tools like Rating scales, Checklists, Rubrics, etc. [20] These tools are composed of dimensions, subdimensions and attributes.
In the second place, once EvalCOMIX is integrated within an e-learning environment (Moodle, LAMS, etc.), it allows to use the tools created to assess any learning activity of the LMS. To use EvalCOMIX, an integration with the LMS Moodle as a block has been developed and it is called EvalCOMIX_MD [21]. It uses the API of EvalCOMIX to create the tools and assess with them. This integration provides three ways of assessment configuration for the learning tasks which belongs to a Moodle course: teacher assessment, self assessment and peer assessment.

EvalCOMIX_MD provides an assessment table which contains every activity of the course. From this table, the lecturers can configure the assessment type or assess the students. The students will be able to assess themselves or other classmates. The grades got are shown in the table, but the lecturer can also send them to the LMS gradebook to consider these grades with the others of the course.

**Gescompeval**

Secondly, we have Gescompeval, a Restful Web service implementing a MVC (Model View Controller) architecture. It is used for managing skills and learning outcomes and retrieving information of them using its API. The skills and learning outcomes are in an educational context, therefore they refer to abilities and/or skills which a student acquires in an activity, course or career.

Gescompeval consists on a Web interface and a Web server. The API of Gescompeval only offers resources to get data, not to post them, so a Web interface is necessary. Through the Web interface the users can do CRUD (Create Read Update Delete) operations and connect the skills with some learning outcomes and vice versa. These connections are not used in other options, but through the API you can get them and use them in order to get information. For example: in a LMS, a lecturer gives a grade G to a skill C for a student S. If the lecturer wants to get the grade of a learning outcome O which is connected with the previous skill C, he can consider the grade of that skill through the connections to get an average mean for the grade of the learning outcome O.

Once the application for managing an index of skills and getting information is available, an integration with a LMS was created to use these skills and learning outcomes. This integration is called Gescompeval_MD and it is a block extension for Moodle 2.X that uses Gescompeval’s API for showing information about assessments of skills and learning outcomes previously created in Gescompeval. This extension allows to assess skills and learning outcomes using EvalCOMIX learning tools allowing the lecturer to connect the skills developed in an activity with the subdimensions of a tool which is used to assess that activity. So, Gescompeval_MD allows to know the grade of each student in a certain skill/outcome through reports that will be able to be showed.
In the first place, the desired skills and learning outcomes must be created using Gescompeval Web service. Then, with Gescompeval_MD a lecturer can include the skills and learning outcomes which will be worked by the students in the activities of a LMS’s course. For instance, if a lecturer wants to include three skills which are developed by the students of the course, previously he must select those skills from a box which lists all the skills and learning outcomes created in Gescompeval Web service. After selecting the skills and adding them through a button, they will be included in the course.

With the skills and/or the learning outcomes included in the course, a lecturer can link some of these with subdimensions of EvalCOMIX assessment tools that have been created in that course. To do that, the lecturer must select a subdimension belonging to one of his EvalCOMIX tools. An example of this is shown in figure 2, where a combobox allows the lecturer to select an EvalCOMIX tool and below a listbox to select the specific subdimension on that tool. After clicking in the “Connect” button, he will be able to link some skills and learning outcomes included in the course with the subdimension previously selected. Now, the skills will get the grades from the subdimensions which they are connected with and will combine those grades to get the final one doing an average grade. Finally, the grades of each skill will be shown to the user to provide formative feedback through a report.

![Figure 2: Selection of subdimension snapshot](image-url)

There are two types of reports: global reports of all students in the course and individual ones of a certain student. Besides, with a check box a lecturer can choose if the connections between skills and learning outcomes must be kept in mind. These reports show dynamic diagrams developed using Google Charts (an example of these diagrams are shown in figure 6). When the user places the mouse pointer over a certain part of the chart, some information is showed in a popup window: code, name and value of the skill/outcome and tasks of the course where the skill/outcome has been developed. In addition, if the user has developed the activity in a Web page (for example a wiki page) evidence collected can be shown here through some URLs which point out the specific sections of a page where the skill has been assessed. This evidence is marked using EvalChrome.
Finally, we have EvalChrome. It is a plugin for the Google Chrome Internet browser which allows to assess the tasks of a Moodle course from a Web page (for instance, for a wiki page) and mark evidence of the assessment done. EvalCOMIX_MD is used to get information from Moodle and EvalCOMIX, so it must to be installed and configured in the Moodle system where the lecturer had the courses. Besides, the tasks to assess had to be configured with an EvalCOMIX tool. The Moodle system is indicated through its URL, which is written in the configuration page of the plugin. If the lecturer wants to access to another Moodle application, he only has to change the URL.

To assess a student, first of all the lecturer must be logged in Moodle. When he clicks over the EvalChrome icon, a new window will open on the Web page. In this new window (which can be hidden or closed to facilitate browsing in the previous windows), a lecturer will be able to select one of his Moodle courses, its activities and finally the student who he wants to assess. Once all these parameters had been selected, an EvalCOMIX tool will be displayed to do the assessment. An example of an EvalCOMIX tool displayed from EvalChrome is shown in figure 3.

![Figure 3: An EvalCOMIX tool displayed from EvalChrome snapshot](image)

Once an assessment is done, if the lecturer wants to add evidence of the assessment done (for instance "this section of the wiki explains why this student has a B grade in a subdimension of the tool"), this can be done through the pencil button, it is on the top of the EvalChrome window. Then, the lecturer can select a text of the Web page and opening the contextual menu, a new option called "EvalChrome" will have been available.

From the new option of the contextual menu, the lecturer can select the subdimensions of the tool which has been used to assess. Once the lecturer had selected one subdimension's name, an information message will appear and the evidence will have been saved and linked with that subdimension for the assessment. If the lecturer wants to delete the evidence marked for one assessment he can do it from the screen where the tool is shown.
Gescompeval_MD. In these reports, when the lecturer got the dynamic information of a skill/learning outcome (code, name and activities where it has been developed) a list with some URLs will be shown too. Those URLs link with certain sections of the Web pages assessed. Therefore, the list is the set of evidence marked for the grade that a student has in a skill. This information is got through the relation between Skill-Subdimension-Evidence.

4. CASE STUDY

In this section we introduce the scenario of our case study. It was developed in an elective course on Functional Programming of the degree on Computer Science and Engineering in University of Cadiz (Spain) in 2013/14 academic year. Six students enrolled the course. Theirs assessment was done manually, using Gescompeval and EvalChrome later. This course was coordinated by one author of this paper, who anonymized student’s data. One collaborative task of this course was a wiki about Haskell knowledgment. We assess students’ performance in the skills of written communication and autonomous learning in that wiki. Later, we mark evidence about the assessment from the wiki Web page.

First, we created an assessment tool with EvalCOMIX which had one dimension and two subdimensions (figure 4). One subdimension was used for assessing the organization of the wiki page (where the skill of written communication was developed) and it was a 80% of the total grade of the tool, while the other one assessed the autonomous learning shown through some new content in the wiki and it was a 20% of the grade. The organization was assessed with three attributes: infobox included, text divided in sections and references included. They could be assessed with No (if the attribute was not achieved) or Yes (if it was achieved). On the other hand, the autonomous learning was assessed with one single attribute: applying extra knowledge don’t taught in seminars. It had the same values that the previous attributes: No if no one extra content was detected and Yes if some was detected.

<table>
<thead>
<tr>
<th>Rating scale for assessing a wiki</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>80% Organization of the wiki</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30% infobox included</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>30% Text divided in sections</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>30% References included</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>20% Autonomous learning in the wiki</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>30% Extra don’t taught in class</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Figure 4: EvalCOMIX assessment interface snapshot

Once the tool was designed, we defined the skills that we were going to use in Gescompeval. Later, we included them in the course and finally connected them with the subdimensions of the tool in this way:
Autonomous learning in the wiki subdimension with Autonomous learning

In the second place, we assessed the students through EvalChrome from the wiki Web page (it also could be done from Moodle with EvalCOMIX). Selecting Programming Functional course, Forum of wikis task and the specific student. Once the student was assessed, we activated the evidence note and added evidence for each subdimension. To do that, we selected an edition of the wiki and then open the contextual menu of the browser. For instance, in figure 5 is shown how we added an evidence for the organization of the wiki. This evidence indicates that the wiki content was divided in sections. When it was added, a Web link to the specific section of the wiki (in the image a link to the content chart) was saved and related with the subdimension selected.

Finally, after we assessed the students and added the detected evidence, through Gescompeval reports we obtained grades in the skills for each student. In addition, the evidence previously added was shown through a list of Web links which indicates sections of the wiki. An example of this is shown in figure 6 where there is one graphic for each skill developed in the course (the skills assessed in the wiki and others).

With a conventional assessment, every student had a single numeric grade and a text message as feedback for the activity. While with Gescompeval and EvalChrome, we obtained grades for skills worked in the subject like written communication or autonomous learning, so they could be considered for the final grade. Besides, with the links got
grades of every skill or learning outcome assessed in the course.

5. CONCLUSIONS

Skills are important in professional career. Their development enables students to integrate successfully in employment and social contexts. Unfortunately, most LMS do not support skill assessment and do to consider their links to learning activities. We proposed an architecture that solves this issue in a Moodle-supported course. The implemented was built using a Web service for skill assessment and a Web browser plugin for evidence collecting.

On the one hand Gescompeval_MD allows a lecturer to include the skills and learning outcomes that will be developed by the students through course’s activities. Besides, the lecturer can connect some of the skills added to the course before with subdimensions of EvalCOMIX assessment tools. To do that, the lecturer must select a subdimension of his EvalCOMIX tools. After that, he will be able to link some skills and learning outcomes included in the course with the subdimension previously selected. Now, the skills will get the grades from the subdimensions which they are connected with and will do an average of those grades to get the final one. In summary, the lecturer conducted this process in a manual way and achieved its goal effectively.

On the other hand EvalChrome is a Web browser extension that allows the assessor to mark evidences in an external activity of Moodle (a wiki of MediaWiki). The grade obtained is saved automatically in Moodle as an EvalCOMIX grade and with Gescompeval it is used for getting skill's grades too. Besides, the lecturer has marked evidence from the assessment done as a list of Web links. Again with the use of Gescompeval, a formative feedback about the skills developed was received by the students through the reports. The feedback was composed of specific values because it came from the assessments done manually by the lecturer.

As stated at the beginning of this paper, the skills assessment in a course of a LMS is very limited, just like the feedback provided to the students. With the system presented, both limitations are overcome and new possibilities are offered about skills assessment.

As a future work, we have the possibility of exporting Gescompeval reports with customize options would add more feedback to the lecturer and it could be a more specific information. Additionally, we want to do a comparison with EvalCourse, a system with a Model-driven architecture which obtains indicators of the work of students [22], to check the results obtained in a Moodle course and how both systems could be complementaries and study the applicability to mark evidences in serious games [12].

ACKNOWLEDGEMENTS
This work has been funded by European Union under the OpenDiscoverySpace (CIP-ICT-PSP-2011-5) project.

REFERENCES