Supporting Self-Directed Learning Skills in Learning Management Systems

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Abstract: This project aims to develop support for self-directed learning in Moodle by incorporating opportunities for reflection and self-assessment for learners. We will develop a module that will track a learner's progress and represent it in terms of important concepts taught within a course. The resulting student model will enable the sys- tem to recommend activities suited to the learner's needs and abilities. Students will be able to inspect his/her stu- dent model, which promotes reflection and deep learning. The introduction of adaptive self-directed learning capa- bilities will pave the way for the next generation of learning management systems, as currently their focus is limited to managing learning resources.

Keywords: Learning management systems, self-directed learning, self-assessment, reflection

1. Introduction

One of the main challenges for the 21st century learners is to be able to learn from a multitude of resources such as the web, lectures, text books etc. and to master complex ideas that are frequently evolving. They also need to mas- ter the skills to become effective lifelong learners transcending the boundaries of the traditional classroom. Self-directed learning has been described as "a process in which individuals take the initiative, with or without the help of others," to diagnose their learning needs, formulate learning goals, identify resources for learning, select and implement learning strategies and evaluate learning outcomes (Knowles, 1975). Therefore supporting today's learners to acquire self-directed learning skills is an effective way of helping them to face the 21st century challenges. Some of the intelligent learning environments that successfully facilitate self-directed learning are MetaTutor (Azevedo et al., 2010), Help Tutor (Roll et al., 2011), Betty's Brain (Wagster et al., 2007), SQL-Tutor (Mitrovic et al., 2007) and Crystal Island (Rowe et al., 2010). Even though these systems are very effective, they need a lot of resources and development time (Anderson et al., 1995; Mitrovic et al., 2003). On the other hand, Learning Man- agement Systems (LMSs) are widely used in education throughout the world, but fall short of providing customised support to develop self-directed learning. Moodle (Moodle, 2012) is one such LMS that is currently used by more than 11 million users in 208 countries speaking 78 languages. In this project we explore the effectiveness of facili- tating self-directed learning skills such as self-assessment and reflection within the context of learning management systems.

2. Overview of the project

This project consists of several phases. We intend to extend Moodle by (i) providing a way for resources and activities to be related to domain concepts by *concept tagging* (ii) developing a student model of their knowledge based on their behaviour in Moodle according to the domain concepts (concept tags) (iii) facilitating reflection and self-assessment by opening the student model and (iv) automatically providing customised *recommendations* (actions that can be done within Moodle). These recommendations will be based on their student model and what the system knows about the resources and activities available. This extension will be available as a plug-in to the global Moo- dle community. Only the first phase has been completed so far.

2.1 Concept tagging to associate resources to Concepts

Currently, Moodle does not associate resources and activities to domain concepts i.e. the system does not know what domain concepts are used in any particular resource or activity. Here, the domain concepts refer to the domain taught in a particular course. Moodle does not contain any intelligence with respect to any domain. Currently, the system knows about resource and activity *types* but it cannot say how each instance of the resource or activity re- lates to domain concepts. For example, Moodle can currently identify an item as a *forum message* or a *question* in a *quiz* but it cannot associate that particular forum message to *Fractions* (a mathematical concept) or a particular question to *Isobaric transitions* (a thermodynamics concept).

The proposed extension addresses this shortcoming by allowing teachers to create *concept tags* at any point in time, which can then be used to "tag" resources or activities. Each concept tag is simply the name of a concept in the chosen domain. The teacher decides the *granularity* of the concepts. Figure 1 represents the teacher's view of con- cept tagging in the domain of Organic Chemistry. We now explain the process of concept tagging.

1) **Adding a tag for the first time:** For example if a teacher wants to tag Lecture 3 notes (Figure 1), he/she needs to simply type the tag into the text box and click the Add Tag button or press the Enter key. The user does not have to use the Add button each time a concept tag is typed out. He/ She can type all the concept tags for a resource and then press the button. Add simply automatically updates the lists of used tags and unused tags maintained by the system (appears in the bottom left corner of Figure 1).
2) **Use an already specified concept for another resource:** The teacher does not have to type the entire concept tag every time it is used to tag a resource. As can be seen in Figure 1 (the tag "reactions" for the resource "Lecture 2 notes"), concept tag will automatically be completed
3) **Tagging multiple resources:** A teacher does not have to complete tagging a single resource before moving onto another. He/ She may move between multiple resources and tag them in any order.
4) **Remove a tag's association with a learning resource:** The cross ("[X]") associated with every occurrence of a tag can be used to remove the tag's association with a learning resource. If a removed tag has not been used by any other resource, the system will add it to the list of unused tags. These stags are available for future use.
5) **Removing a tag permanently:** A tag can be permanently removed by removing it from the used or unused tags lists. Whenever this happens for a used tag, the system will automatically remove all the references to that tag from the learning resources.
6) **Viewing a resource:** Both teachers and students will be able to navigate the resources using the concept tags (Fig- ure 2). This view not only helps the student to focus on a particular concept, but also helps to understand the overall structure of the course. A user will be able to view a resource by clicking on the resource. All defined concepts

will remain in the system for use in subsequent occurrences of the course.

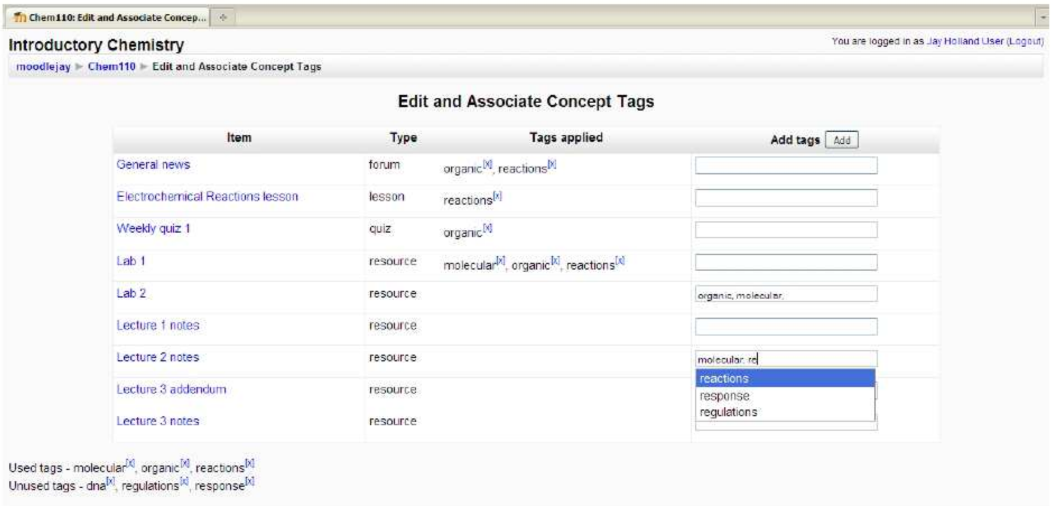

Figure 1: Tagging a resource with concepts

2.1.1 Pilot study on the usefulness of concept tags

A preliminary think-aloud study was conducted to explore the usefulness of concept tagging. Five University of Canterbury and Lincoln University academics from different backgrounds participated in the study. Tasks expected were creating new tags for an existing resource, uploading and tagging a resource and importing tags from a Moo- dle glossary and filling in a questionnaire. All participants except one clearly indicated that they would recommend concept-tagging. Three participants indicated that they would use this extension in their courses while the other two remained neutral. A detailed description of the study is presented in (Elmadani et al., 2012).

2.2 Student modelling each student's knowledge

A student model contains detailed information about the current knowledge level of a student. This can be used to provide the student with a record of their progress related to concepts, as well as guide students towards material that will help improve their knowledge (Anderson et al., 1995; Mitrovic et al., 2004)

Figure 2: Navigating resources using concepts

Model Structure: The proposed student model will be broken down into concepts (using the concept tags). For each concept, the student model will record how much the student has covered of that concept (i.e. how many of the course resources associated with that concept have been seen), as well as how much the student still has to cover. The 'covered' area is divided further into correct and incorrect knowledge. The details of the student model will depend on the granularity of the concepts as chosen by the teacher (when creating concept tags).

Creation: A student model will be created by processing various inputs. Candidates for use in creation of the student model include activities such as quizzes, *lessons*, and forums. Resources that are graded map naturally to stu- dent knowledge - for example, if a student sits an online quiz about fractions, and gives the correct answers to ques- tions related to the concepts of "fraction addition" and "fraction division", then we can adjust these concepts posi- tively within our model, implying that the student now knows more about these concepts. Resources that are not graded are more difficult to map onto student knowledge and will require further exploration.

2.3 Open student models (visualisation) for student reflection

Open student modelling has been shown to be beneficial to student learning (Bull et al., 2007; Gakhal et al., 2008; Lazarini et al., 2007; Tchetagni et al., 2007; Van Labeke et al., 2007; Zapata-Rivera et al., 2007; Mathews et al., 2012; Mitrovic et al., 2007) as it provides an opportunity for each student to reflect on their own progress. One way to visualize the student model we propose is shown in Figure 3. This visualisation shows a set of skill meters for each concept, each displaying the correct, incorrect, and not covered material as a summary. These me- ters can be expanded to show a summary of the activities that the student has participated in, which are tagged with these concepts. Normally open student models in intelligent tutoring systems (ITS) indicate a student's progress in a specific instructional task (Duan et al., 2010), the task that is focus of the ITS. However, this student model can be used in all the courses that a student currently enrolled for. We are also exploring the possibility of having a visualisation of the overall student knowledge, indicating a learner's progress in all courses they are currently enrolled.

2.4 Customised recommendations to guide students

Using information from the student model and knowledge about the tagged resources, a recommendation algorithm will be developed to guide students to resources or activities that encourage active learning. Recommendations can suggest different actions for different students. One aspect of the *recommendation algorithm* will explore the con- cepts a student is having the most difficulty with according to their model, and point them to resources that have been tagged with these concepts. Another aspect of the recommendation algorithm might encourage students who are competent in certain concepts to participate more in the related discussion forums.

These recommendations for each student will appear on their course front page within Moodle in a similar method to news items, with the latest at the top. An example of how the recommendations will be displayed is shown Fig- ure 4. Although the recommendation algorithm could have a large number of recommendations, only a few will be chosen to be displayed, so not to overload each student. Selection of recommendations to be displayed would be explored. The full list of recommendations would be accessible by each student from the plugin's web page within the system.

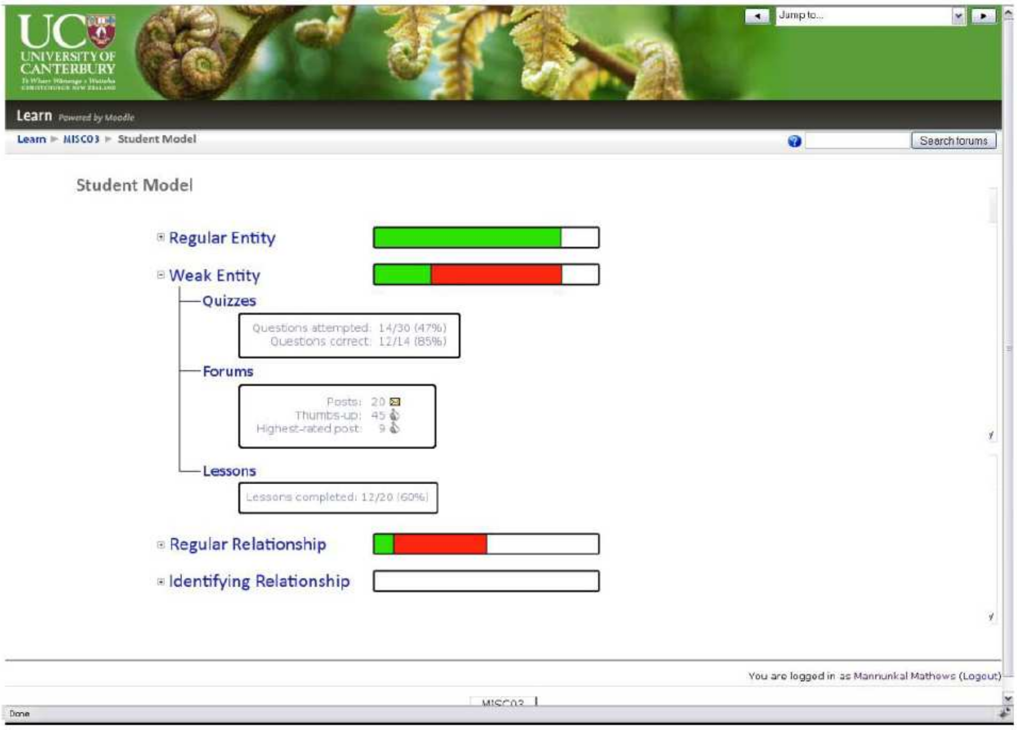

Figure 3: An example student model visualisation

2.5 Evaluation

The primary goal of the planned evaluations is to ascertain the extent to which the opportunities provided by the proposed extension to facilitate self-directed learning are utilised by students and whether the students found the added opportunities beneficial. Secondary goals include assessing the individual user experience, as it would have an effect on other factors that are important to the continued use of the system (for example, motivation). To achieve these goals, two types of evaluations are planned; (i) objective evaluations based on the data collected from the system (such as usage statistics) and (ii) subjective evaluation based on questionnaires and interview responses from both teachers and students.

Figure 4: Example recommendations box

As we believe conducting the evaluation in an authentic leaning environment is beneficial in gaining valuable insights into how teachers and students actually use the proposed system, the study will take place in a real classroom environment with real students, teachers, and courses. Due to ethical reasons, we cannot separate one class into control and experimental groups. Therefore, we would gather data over two separate occurrences of the same course, ensuring that the teacher, course material, and overall methodology of teaching remain the same over the two occurrences. The first occurrence of the course would be the control group and the second occurrence, the ex- perimental group. Data from both occurrences would then be gathered and analysed. To understand students' behaviour in using the proposed components, we will collect usage data for each of the main components. For example, we can evaluate the student model by how many times they access the model, how much time they spend inspecting the model, which parts of the model students access, and explore patterns of be- haviour related to viewing the student model. We plan to gather similar types of data for usage of the recommenda- tions. We will gather subjective data from students and teachers using interviews and questionnaires. This step will help us to gauge the extension's ease of use, enjoyment of use, support for engagement and reflection, etc.

3. Conclusions and future work

This paper discusses a project in which we plan to explore the effectiveness of facilitating self-directed learning skills such as self-assessment and reflection within the context of Moodle, one of the most widely used leanring management systems. We intend to extend Moodle by (i) providing a way for resources and activities to be related to domain concepts by concept tagging (ii) developing a student model of their knowledge based on their behaviour in Moodle according to the domain concepts (concept tags) (iii) facilitating reflection and self-assessment by open- ing the student model and (iv) automatically providing customised recommendations (actions that can be done within Moodle). As the first step, we have implemented concept tagging for Moodle. A preliminary study conduct- ed to investigate the effectiveness of concept tagging indicated that the participating teachers thought it was a useful idea and expressed their willingness to use it in their courses. This project has also attracted a lot of interest from e- learning support groups in three tertiary institutions in New Zealand. We now plan to make the concept tagging available for summer courses at University of Canterbury to investigate how it will be used in different courses. Teachers who will teach these summer courses will be interviewed to understand their subjective impressions of concept tagging. Data collected by Moodle will also be analysed to understand how students have used concept tagging. After making the necessary refinements the student model will be implemented and the evaluations men- tioned in section 2.5 will be conducted. Facilitating self-directed learning in Moodle, a widely used learning envi- ronment will pave the way for next generation learning management systems. Our proposed extension will have the potential to support millions of users in the global Moodle community to become effective life-long learners with strong self-directed learning skills.

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