Article 4

Enhanced Collaborative E-learning for Programming Using Open Learner Model

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Abstract
Open learner model is mainly used to depict learner's achievements and progress in particular subject using variety of qualitative representations ranging from simple representations such as skill meters to more complex Bayesian network models. Currently, open learner models are only available for individual learners and mostly used separately from e-Learning systems. Therefore, this paper proposed an enhanced model of collaborative e-learning by integrating open learner model that will represent students' achievements and milestones while learning introductory programming course. The aim is to produce learner models using graphical skill meters that are not only used to reflect individual performances, but also a group of learners' academic achievements and milestones. Through this, learners will be able to reflect their own performances in introductory programming subject and become more engaged and responsible towards their own progress.

Keywords: *programming; e-learning, collaborative; open learner model*

Introduction

Introductory programming courses are allegedly one of the most challenging courses among the first year students in Computer Science field (Yadin, 2011). The average passing mark for this subject was recorded at only at 67 percent in fifteen different countries all around the globe including United States, United Kingdom, Indonesia and Australia (Watson & Li, 2014).

The complexity of the programming subject itself that resemblances engineering activities with high demands of intellectual capabilities becomes the most apparent reason for the high failure rates in the subject (Valentin et al., 2013). Other factors involved the complexity of the programming languages used, the lack of interest and motivation in learning programming and variations in teaching and learning styles and strategies (Kalelioglu & Gulbahar, 2014).
In order to improve students' performance in introductory programming course, recent studies have showed many usages of information and communication technologies (ICT) such as multimedia courseware, interactive games, mobile applications and e-learning systems (Tsai et al., 2011). Meanwhile, with the emergence of the Internet and e-learning platforms, collaborative e-learning systems have been seen as potential efforts to increase learners' interests, engagements, communications and collaborations especially to support distance learning activities. Previous studies include the developments of Supporting Collaboration and Adaptation in a Learning Environment (SCALE), Programming Assignment aSsessment System (PASS) and AutoLEP (Verginis et al., 2011; Wang et al., 2011; Law et al., 2010).

Nevertheless, most of these collaborative e-learning platforms do not provide users with the open learner models; models that help to visualize learners' achievements, milestones and even problematic areas in certain subjects. Furthermore, most of the open learner models are often developed and used separately with the e-learning systems. In addition, these open learner models are also usually used to cater individual learners (Bull & Kay, 2007).

Therefore, this paper will propose an enhanced model of collaborative e-learning system that is integrated with open learner models. This system will support not only individual learners but also groups of learners. The aim is for the learners to be more engaged with their own performance as well as their groups' achievements in introductory programming course. Open learner models used in the system will support the idea of self-assessment and self-regulated learning, reflect their milestones and marked their problematic areas in certain topics in the introductory programming course.

Related Works

i. Collaborative e-learning system for programming

Collaborative e-learning system is rapidly changing the landscape of our education system. Most of the features of typical e-learning systems were enhanced in order to support groups' collaborations and discussions over the Internet. This concept is famously being described as computer-supported social learning (CSSL) system that offers support to foster groups' communication and collaborative activities (Halimi et al., 2011).

In learning programming, several collaborative e-learning systems have been developed such as the COLLEGE that stands for COLLaborative Edition, compilinG and Execution of programs that facilitates the collaborations and communications between students. It is also aimed to improve students' cognitive abilities and motivations (Chang & Chen, 2008). Other than that, a project named EduJudge has been constructed to integrate with the UVA Online Judge, which is an existing online programming trainer. It is aimed to provide an educational environment that supports collaborations among teachers and students in terms of providing automated evaluation systems, interactive communications and helping to improve students' motivation (Verdú et al., 2012).

Recent study has also showed the use of collaborative online problem solving with computer games to improve students' metacognitive skills, engagements and motivations in learning computer programming (Bernard & Bachu, 2015). Other than that, one project named as Protus 2.1 is being developed to provide recommendation in programming tutoring system by applying collaborative tagging (Vesin et al., 2016). The advance intelligent tutoring system that is used to learn basic concepts in Java programming will direct learners' activities and recommends relevant actions, thus improving students' interests and engagements (Vesin et. al, 2016).

ii. Open learner model and collaborative e-learning

According to Bull and Kay (2007), there are two types of open learner model visual representations that can be used to represent learners' achievements, which are the simple or complex learner model. Simple learner models will normally present simple skill meters that display learner's level of knowledge, difficulties and learning process for every selected topic (Bull & Kay, 2007). In the other hand, the complex learner models will use varieties of modeling techniques such as knowledge tracing in cognitive modeling or Bayesian networks to present information that is more detailed to the learners (Bull & Kay, 2007).

Up until today, not many researches have been done in developing open learner models that support online collaborations. They are mainly being developed for individual learners and often separated from the e-learning systems. For instance, one project that combines open learner model with a competence-based feedback for collaborative language learning done by Kickmeier-Rust et al. (2014) or helping to scaffold students' reflection towards collaborative brainstorming by Clayphan et al. (2014). Moreover, Alotaibi and Bull (2012) have also used the Facebook with the open learner model named OLMlets to investigate the effectiveness of online collaboration and learner's interactions.

Proposed Model of an Enhanced Collaborative e-Learning with Open Learner Model

The proposed model as depicted in Figure 3 represents new elements that are integrated in the enhanced collaborative e-learning system for programming. As shown in Figure 3, the enhanced factors for the proposed system include collaboration concepts and open learner model. To begin the collaborative activities, firstly, the collaborative groups were formed. In this case, the lecturers have to assign the collaborative group members and upload the collaborative activities such as online quizzes in the e-learning system. Using the concept of collaboration, the online quizzes were done in groups where the group members communicate via the Web 2.0 tools provided in the system such as the chat rooms or forums.

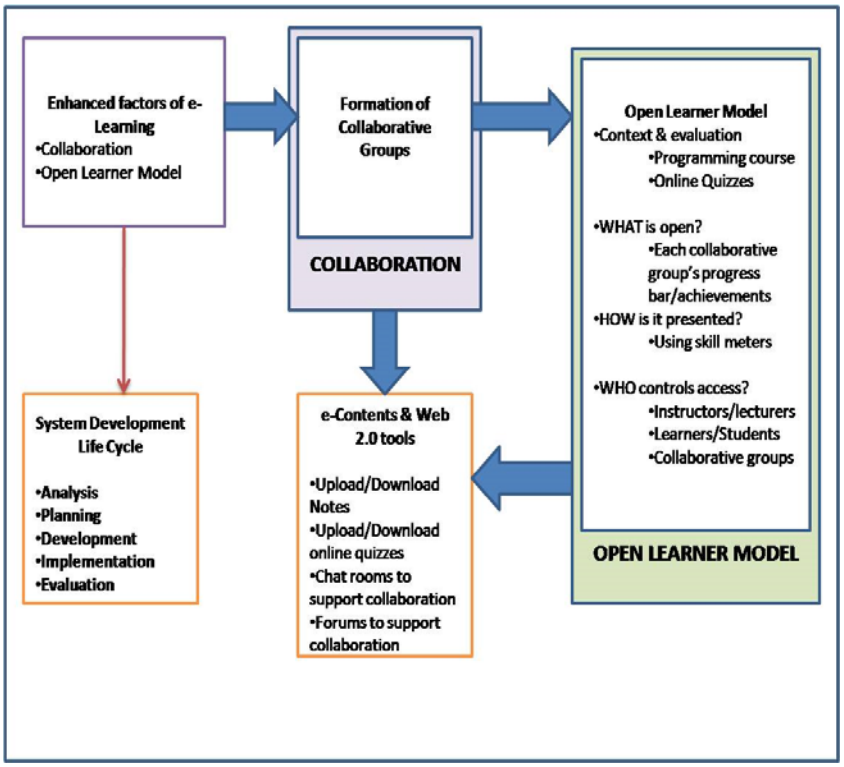

Figure 3: Model of an Enhanced Collaborative e-Learning for Programming With Open Learner Model

Meanwhile, for the open learner model, the Student Models that Invite the Learner In (SMILI) Framework is referred. Based on the framework, four parts were considered, where the first one was the context and evaluation. In this part, we have addressed the open learner suitability for the overall interaction and the types of assessments. For this project, the introductory programming course was selected and the online quizzes for each topic were developed. Two types of questions were created; multiple choice and short structured questions. For each type of questions, there are also six levels of cognitive development based on Bloom's Taxonomy cognitive domains. The levels are the knowledge, comprehension, application, analysis, synthesis and evaluation.

Next, we need to address the visibility of the open learner models in the system and the visual representations used for it. Considering the students have answered the online quizzes, the open learner models were presented for both individuals and collaborative groups. In this case, the simple visual representation using skill meters were developed. The skill meters will show three types of progress; the percentages of successfully answered, not successfully answered and not answered questions. Each individual can view their own open learner model for each topic in the course and their team members' open learner models. This idea is to encourage the learners to improve and motivate each other, thus, supporting engagements and team motivations.

Finally, the accessibility and control of the open learner models were also being considered. The enhanced collaborative e-learning system will provide method for the lecturers to evaluate and analyze learner models. Furthermore, the open learner models provided in the system are also

interactive and change according to the learners' performances, thus, providing mechanisms for self-evaluation and self-regulated learning.

Conclusion

One of the advantages of using e-learning system is that it supports multi users from dispersed locations with less cost and few barriers. The enhanced collaborative e-learning system proposed in this paper, will not only support individual learning activities, but also provide mechanism to allow online collaborations and communications among group of students. Furthermore, this system also has a unique ability to represent learners' achievements in a form of visual representations called the open learner model. Individuals or collaborative groups are able to reflect their own progress and address their problematic topics in the introductory programming course by just referring to the open learner models.

The open learner model is not being used as definite marks for the students, because the aim is to allow the learners to reflect their performances and improve them from time to time. Therefore, the visibility, accessibility and changeability offered by the open learner models can be seen as one of the efforts to increase students' engagements and motivations in learning programming, thus, helping to improve their performance in this subject. Future research will involve the adaptive e-learning system with the open learner model plays an important role to make learning programming via online system more personalized.

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