

Visualizing Student Models for Social Learning with Parallel IntrospectiveViews

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ABSTRACT

This paper reports a novel visual metaphor of parallel views on open student models and a new design of the IntrospectiveViews interface implementing this metaphor. The interface allows visualizing not only the student's own model, but also displaying parallel views on the models of her peers and the cumulate model of the entire class or group. In the paper, we describe the application of parallel IntrospectiveViews for visualizing models representing student progress on the QuizJET parameterized questions.

Categories and Subject Descriptors

H.5.2 [User Interfaces]: Graphical user interfaces (GUI);

General Terms

Design; Human Factor

Keywords

Visualization, Open Student Model, Assessment

1. INTRODUCTION

Engaging students with social learning technologies has become an important trend in modern e-learning. One of the biggest challenges is to provide support in the social learning context, at the same time allowing students feel in control. One of the popular solutions to address the issue of control is so-called open student modeling, an approach that allows the students to observe and reflect on their progress. In particular, visual approaches for open student modeling were explored to provide students with an easy-to-grasp and holistic view on their progress [2-3, 8]. However, most of the open student modeling research focuses on a representation of an individual student ignoring the social aspect of learning. In contrast, several social visualization approaches explored in e-learning context [1] focus mainly on student communication and collaboration rather than on their progress. Our work attempts to explore the prospects of open student modeling and student progress visualization in the context of modern social e-learning. In this paper, we

report our work on social interface for visualizing open student models in the context of parameterized assessment/self-assessment questions.

The social interface presented in the paper expands our earlier work on improving student access to parameterized questions, which support student learning and self-assessment of their knowledge. Main goal of that work was helping students to locate the right educational content at the right time. In the past, we explored *semantic* and *personalized* approaches to guide students. Semantic approach means building ontology of topics and using it to arrange the questions into topic folders on an e-learning portal. It provides students an approximate guidance to the question within the logical structure. Personalized approach means using student models and adaptive navigation support to guide students to personally relevant questions. This paper explores *social* guidance approach motivated by collaborative tagging systems. In a collaborative tagging system a user is frequently guided to the right information *socially*, by other users. Exploring tagged bookmarks of a user who is similar to you usually helps finding valuable resources. Similarly, we hoped, exploring semantically structured progress of learners similar to you can help to select most appropriate learning content. Semantically-structured social visualization could be very important on both stages of social guidance: recognizing peers as similar and grasping their progress to select most useful content. This paper investigates the value of a specific social visualization approach - parallel visualization of multiple student models using *IntrospectiveViews* - in finding the right questions. In the next section, we provide a short literature review on the related work. The system and study design are presented in the following section. Finally, we summarize this work and discuss the future research plan.

2. RELATED WORK

2.1. Open Student Modeling

A range of benefits have been reported on opening the student models to the learners, such as increasing the learner's awareness of the developing knowledge,

difficulties and the learning process, students' engagement, motivation, and knowledge reflection [2-4]. Dimitrova et al. [5] explore interactive open learner modeling by engaging learners to negotiate with the system during the diagnosis process. Chen et al. [7] investigated the active open learner models in order to motivate learners to improve their academic performance. Both individual and group open learner models were studied and demonstrated the increase of reflection and helpful interactions among teammates. In [22], Bull & Kay described a framework to apply open user models in adaptive learning environment and provided many in-depth examples.

2.2. Social visualization in E-learning

Vassileva and Sun [6] investigated the community visualization in the online communities. They summarized that social visualization allows peer-recognition and provides students the opportunity to build trust in others and in the group. Bull & Britland [23] used OLMlets to research the problem of facilitating group collaboration and competition. The results showed that by optionally releasing the models to their peers increases the discussion among the students and encourages them to start working sooner. CourseVis [8] is another example, yet one of the few open user model systems that provide graphical visualization for multiple users of groups to teachers and learners. It helps instructors to identify problems early and prevent some of the problems with distance learning.

2.3 Parameterized Assessment

This paper is focused on open student models that are built based on the student's performance on parameterized questions. Parameterized technology essentially uses randomly generated parameters within a small amount of question templates generated by the content creators and produce many similar, yet sufficiently different questions. As demonstrated by a number of projects such as CAPA [9], WebAssign [10], COMBA [11], parameterized questions can be used effectively in a number of domains allowing to increase the number of assessment items, decrease authoring efforts and reduce cheating. A few

projects that applied parameterized question generation in e-learning systems for programming domain [12-14]. A range of architectures for exploring adaptive technology on dedicated adaptive interfaces has been reported in [15-16]. The added value of adaptive link annotation for an e-learning portal has also been studied in [17].

3. SYSTEM AND STUDY DESIGN

3.1. QuizJET: Parameterized Questions of Java Evaluation Toolkit

QuizJET is a system for authoring and delivery of parameterized questions for the Java programming language. It generates parameterized questions for assessment and self-assessment of students' knowledge of a broad range of Java topics. Each QuizJET question (Figures 1.a and 1.b) asks the student to predict the results of execution of a specific Java program (i.e., mentally execute the program and enter the final value of some variable of the text to be printed by the program.) All questions are parameterized, i.e., include a random parameter, which QuizJET instantiates when the question is delivered to a student. As a result, the student can attempt to answer the same question multiple times with different values of the parameter, which helps to achieve the mastery level. The implementation and functionalities of QuizJET were described in detail in [18].

QuizJET questions are semantically organized into topic folders and displayed under a tree structure through the course management portal (Figure 1.c). In addition, to every question we associate a set of concepts, which semantics is defined in a domain ontology. The domain ontology (<http://www.sis.pitt.edu/~paws/ont/java.owl>) was developed by the TALER Lab at the School of Information Sciences, University of Pittsburgh. It is formalized in the OWL-Full ontology language and contains more than 300 classes related to the Java programming language. The classes are connected via three relations: subClassOf, partOf-hasPart and relatedTo.

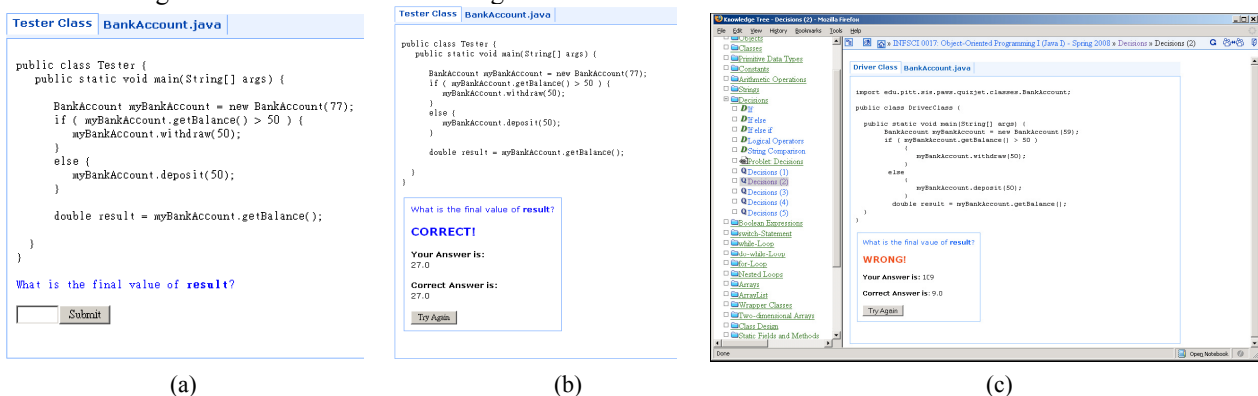


Figure 1. The presentation (a) and evaluation results (b) of a QuizJET question; Hierarchical portal interface (c)

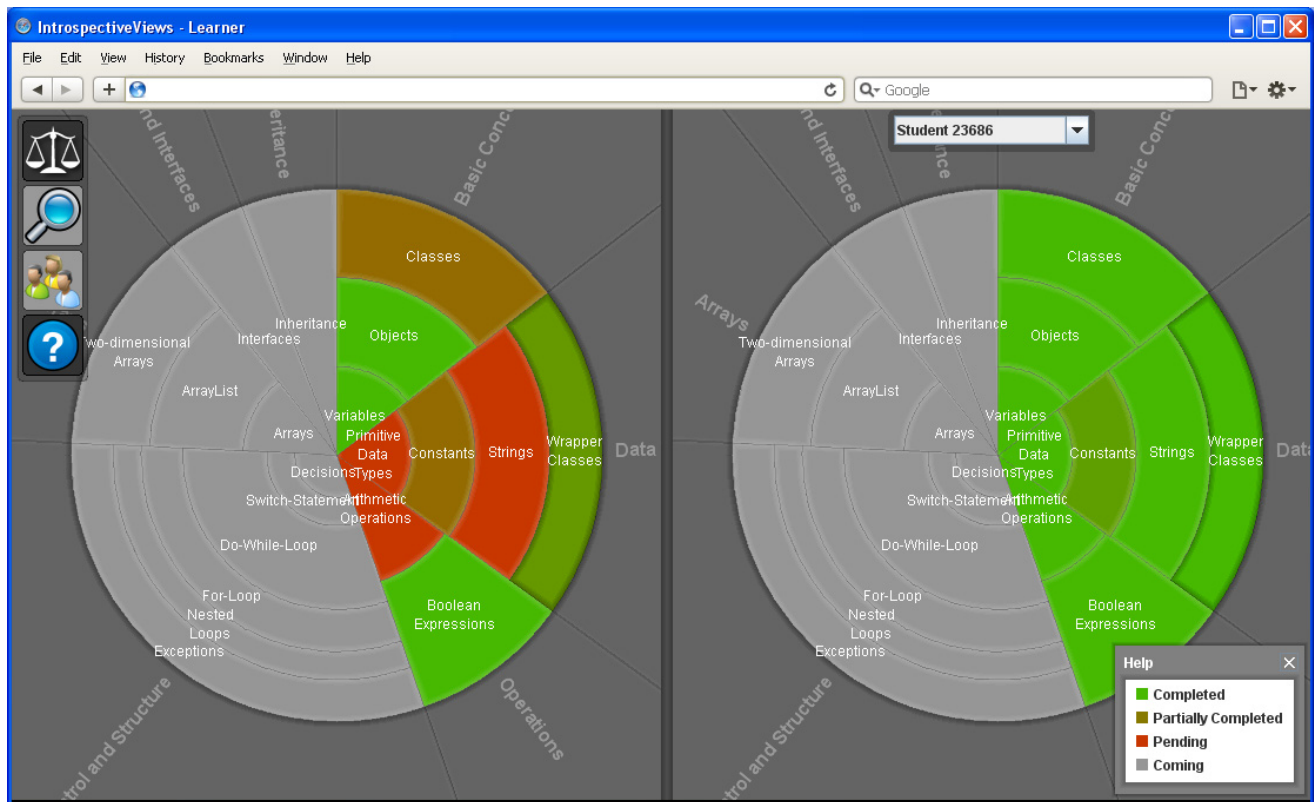


Figure 2. Parallel IntrospectiveViews. Left pane – visualization of the student’s own progress; right pane – visualization of a peer’s progress. The circular sectors represent the lectures and the annular sectors represent the topics of individual lectures. The shades of the sectors indicate whether the topic has been covered and for the covered ones, denotes the progress the student has made. Color screenshots available at: <http://www.minerva-portals.de/research/introspective-views/>

3.2. IntrospectiveViews Interface

IntrospectiveViews was first proposed for scrutinizing semantically-enriched user interest models in [19, 20]. In the interface user interests can be visualized as a set of keywords displayed on a circular surface, which is gradually painted in shades between red and blue according to the hot-and-cold metaphor. The background color of keywords represents the degree of interest, i.e., the items on the red surface are the ones that the user is interested in and the items in the blue one are the ones that she is not interested in. In addition, the items can be grouped in circular sectors by type, i.e., the semantic class they belong to (e.g. person, company, country, etc.). Also, following Shneiderman’s visual information seeking mantra [21], IntrospectiveViews offers an overview of all items present in the model, allows for zooming into different parts of it and filtering according to different criteria, and provides details on demand.

3.3. Integration of QuizJET and IntrospectiveViews

We have adapted IntrospectiveViews to fit the context of social learning by introducing the parallel views on student models. The adapted version visualizes not only the student’s own model, but also the models of her peers and the class on average. We believe that the visibility of activities of others can motivate the student to progress and

perform better in the class. Also, it can allow finding peers who can help with difficult topics, hence increase the social interaction among the students.

In this paper, we demonstrate the application of parallel IntrospectiveViews for visualization of student progress on QuizJET questions semantically organized into topics and lectures. Figure 2 shows parallel IntrospectiveViews for a student in a class on Object-Oriented Programming (OOP). The visualization consists of two panes: the left pane displays the student’s own model, whereas the right one displays someone else’s model. By default, the right pane displays the average progress of the entire class, but the student can switch to the progress of a specific classmate by selecting the classmate’s name from the combobox menu located at the top of the right pane. Each pane visualizes the student progress in the form of a pie chart consisting of circular sectors representing the class lectures. The lectures are displayed in a clockwise order denoting their pre-requisite sequence, i.e., the order they are taught in the class. Lectures may consist of one or several topics, which are represented as annular sectors placed within the circular sector of the corresponding lecture. For example, in Figure 2, Basic Concepts is the first lecture in the Introduction to Object-Oriented Programming class and consists of three topics, namely, Variables, Objects, and Classes. The radius (width) of annular sectors denotes the amount of readings,

quizzes, and exercises assigned to the topic. In a similar way, the span of circular sectors indicates the amount of learning content assigned to the corresponding lecture. Such a representation allows the student to easily estimate the amount of work she has to spend on each individual topic or lecture.

The shade of each annular sector denotes whether the topic has been covered and, for the covered ones, indicates the progress the student has made with respect to the topic. The sectors painted grey represent the topics that have not been covered yet, whereas the sectors painted a shade from the color range red to green represent the sectors that have been already covered. For the covered topics, the interface displays the student progress. The progress, in the current implementation, is the ratio of successfully completed quizzes to the total quiz count in the topic. If the ratio equals 0, i.e., no quiz has been successfully completed, the sector is painted red. If it equals 1, i.e., all quizzes have been completed, the sector appears green. The shades in the range between red and green denote partial completion of the quizzes.

Similar to the previous design of IntrospectiveViews [19, 20], the current implementation supports a number of information visualization tasks postulated by Bed Shneiderman [21]. It allows getting an overview of the entire model, but it also allows zooming into a certain part of it in order to get a better view, which is especially important for visualizing models that consist of a large number of topics. Also, it provides details on demand, e.g., by clicking a sector, the interface will display the contents of the corresponding topic, in the current implementation, the list of quizzes for the topic (Figure 3). For each quiz, the interface provides a visual cue indicating the student progress and displays the total number of attempts the student has made on the quiz and the number of successful attempts. By clicking a quiz label the interface will display the quiz in a new window. In that way, having found uncompleted quizzes, the student can quickly open each of them and complete the pending task.

Such visualization can help the student to plan her class work by providing an overview of her progress in the class and showing the topics that she has already completed and the ones that she has to work on. In addition to that, the ability to view someone else's progress allows the student to quickly find the peers that can help with a difficult topic or quiz. For example, if the student experiences difficulties in completing some quizzes, using the parallel views, she can find a classmate who has already successfully completed those quizzes and ask for help. Finally, the ability to view the average progress of the entire class allows the student to relate her progress to the one of the whole class and estimate whether she is ahead or behind of the class on average.

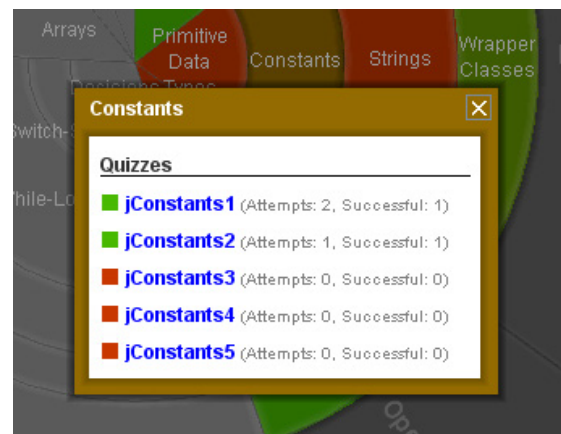


Figure 3. Quizzes of the selected topic.

4. SUMMARY AND FUTURE WORK

In this paper, we have presented a novel visual metaphor of parallel views on open student models in social learning systems. We have described the implementation of this metaphor using the integration of the IntrospectiveViews interface and the QuizJET student modeling approach. We believe that such a visualization can substantially enhance social learning, foster a better cooperation among students, improve their performance, and become an attractive tool for accessing learning materials.

Currently, the interface is being used in the Object-Oriented Programming class at the School of Information Sciences at the University of Pittsburgh. Upon the completion of the class, we plan to evaluate the interface by asking the students to fill out evaluation questionnaires. This will help us to find out its problems and weaknesses, which we will address in the next versions.

In addition to that, we plan to add a number of new features. One of the most important extensions planned is the comprehensive privacy management. Our aim is to provide the student with flexible mechanisms to control the access of others to her model. Apart from that, we plan to enhance the zoom function by displaying different levels of details at different zoom levels. Also, we are going to extend the comparison mode to allow the student to view multiple progress charts at one time as well as to sort them either by the overall progress or the progress in a specific topic.

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