Personalized E-Learning for Distance Courses in Community Colleges

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Abstract: Personalized E-Learning systems have a potential to advance distance learning education to a new level. The evaluation of several personalized E-Learning systems in the context of regular classes offered by top research universities and teaching colleges demonstrated their ability to increase both quality of learning and student motivation to learn. However, the usability and the value of personalization, which adds another layer of complexity to E-Learning systems, is yet to be proved in the context of real distance learning courses offered by regular 2-year and 4-year colleges. The study reported in this paper explored whether the students enrolled in distance learning courses at the Community College of Allegheny County are able to use, understand, and appreciate several personalized E-Learning systems, which were not specifically customized for this category of students. The results demonstrate that some tools are used quite heavily, while other tools are used less than expected.

1. Introduction

Personalized E-Learning systems have a potential to advance distance education to a new level. This category of tools uses a range of approaches to adapt to the knowledge, interests, and preferences of individual students to deliver a superior level of support. The evaluation of different personalized E-Learning systems demonstrated their ability to increase both quality of learning and student motivation to learn (Brusilovsky, Sosnovsky & Yudelson, 2006; Kavcic, 2004; Kumar, 2005; Triantafillou, Pomportis, Demetriadis, & Georgiadou, 2004). Yet, the majority of classroom studies of personalized E-Learning systems were performed in either good research universities or top-level teaching-oriented colleges. Moreover, while most of the authors cite the potential impact of these tools for distance education, almost all classroom studies of personalized E-Learning systems were performed in the context of regular courses where Web-based tools served as an enhancement of classroom sessions, not as the primary way of delivering education. The success of personalized E-Learning systems used as additional sources of learning in top colleges does not immediately assure that these tools will be applicable in regular 2-year and 4-year colleges or in distance education context. The major problem here is that personalization typically requires more sophisticated interfaces. For example, adaptive hypermedia systems, capable of providing personalized guidance, typically introduce a number of additional interface features such as personalized icons. As a result, the majority of students in regular colleges, who are less prepared than students in top research universities and teaching colleges, may not be ready to use sophisticated personalized systems. A similar "interface" barrier may also create problems for personalized tools in distance education context. While in a regular classroom, faculty have multiple chances to demonstrate a personalized system and help students resolve their problems. However, students in distance education courses have to rely on their own skills and online help pages provided by a personalized system. At the same time the need for personalized e-learning applications in the distance education settings is even higher than in a typical classroom. A teacher in a distance learning course has a very limited set of tools to control and manipulate the educational process, his/her role is somewhat reduced, and is shifted upon the students, whose freedom and responsibilities become higher. In such settings the capability of an educational system to tailor its content for the needs of an individual student becomes more significant.

This paper presents some early exploration of this intriguing issue. Our goal was to explore to what extent personalized E-Learning systems, which proved to be successful as an extension of traditional courses in a research university, can be applied in distance education classes in a typical 2-year community college. To find the answers, we investigated the use of four personalized E-Learning systems developed at the University of Pittsburgh in distance learning classes offered by the Community College of Allegheny County. The rest of the paper introduces the systems used for the study, explains the design of the study, and provides an analysis of the study results. At the end, a brief discussion is provided.

2. The Systems

In total, we explored four personalized E-Learning systems in the context of two community college distance learning courses: QuizGuide (Brusilovsky, Sosnovsky & Shcherbinina, 2004), NavEx (Yudelson & Brusilovsky, 2005), Knowledge Sea II (Farzan & Brusilovsky, 2005), and WADEIn II (Loboda & Brusilovsky, 2006). These systems were originally developed to support introductory C programming courses at the University of Pittsburgh. The systems were not altered for the research study at the community college. All four personalized systems were available to the students through the same portal. Once logged in, the students can access each of the systems. As presented in section 5, the first two systems were used extensively and the other two very little. Below we provide some more information about the two heavily used systems and the kind of personalization that they used. As for the other two, it is sufficient to mention that Knowledge Sea II provided access to several online textbooks for C programming and WADEIn provided animated examples and problems on C expression evaluation.

QuizGuide serves over 100 interactive self-assessments questions grouped by quizzes. The questions themselves are not adaptive. Each student, when interacting with the system, gets a randomly instantiated version of each question. The personalization in QuizGuide is offered in the form of guidance, which helps students to select most appropriate questions. The system informs students about their knowledge and current learning goal by annotating quizzes with icon-based cues (Fig. 1). QuizGuide groups quizzes available to a student by coarse-grained topics. The link to each topic is assigned an icon showing a target symbol. The number of arrows in the target (from 0 to 3) reflects the system's assessment of student's knowledge of the corresponding topic (no arrows represent no or very little progress, three arrows representing very good knowledge). The system bases its judgment on the performance the student demonstrated with the quizzes attached to a topic. The color of a target in its turn encodes the relevance of a topic to the current learning goal of the class. As QuizGuide is the system designed to be used in the real class, every time, new topics are introduced along the course schedule, they become annotated with a bright-blue target. The topics, which serve as prerequisites for any of current-goal topics, receive a pale-blue target. All other passed topics, non-related to the goal of the class at this time, are assigned with grey targets. Finally, topics that have not been explored by the class yet are annotated with crossed targets.

The topics provide students with coarse-grained adaptation. This feature is good in helping students to find an appropriate content area to work on, but it is not capable to navigate them to a specific question. To support more accurate guidance QuizGuide also employs small target icons annotating single questions within a quiz. The color of a small target represents student's knowledge of the material associated with a question. The smaller student's knowledge are for the concepts involved in the question, the more focus the student is supposed to pay to this question, hence the brighter the target is. To help students to differentiate between similar questions, as well as attempt as many questions as possible, QuizGuide adds a checkmark to each correctly solved question.

NavEx (Navigation to Examples) serves a large set (over 60) of interactive programming examples. Similar to the case of QuizGude, the examples themselves are not adaptive and the personalization is offered through adaptive annotation. NavEx implements traditional zone-based annotation (Brusilovsky & Pesin, 1998), which divides all educational content into three "zones": 1) sufficiently known, 2) new and ready for exploration, and 3) new, but not-yet-ready. In addition, NavEx supports progress-based annotation, which shows current progress achieved while working with an educational object. The NavEx window consists of the left navigation frame and the content area (Fig. 2). In the navigation frame, the zone-based annotation is combined with performance-based annotation in a single adaptive icon. The goal of adaptive annotation in NavEx is to provide three types of information to students: 1) categorize examples as ones the student is ready or not yet ready to explore (not ready to explore example are annotated with red X icons, others – with green bullets), 2) represent the student's progress within the examples (displayed as partial filling of the green bullet), and 3) emphasize (using bold font) the most relevant examples for the student given his/her past history of browsing examples.

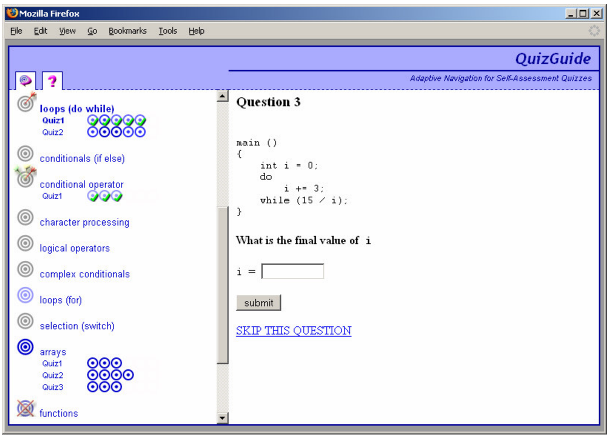

Figure 1: QuizGuide Interface

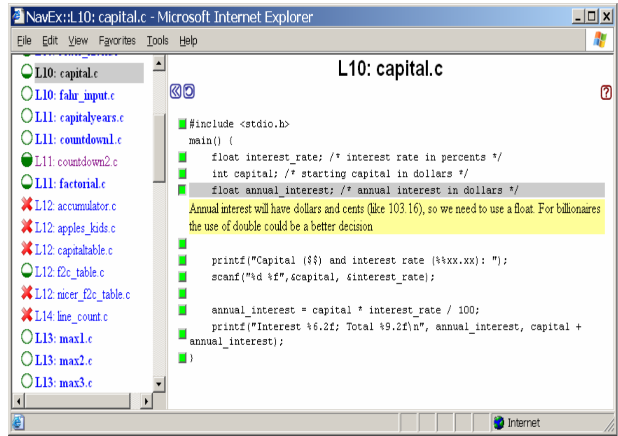

Figure 2: NavEx Interface

3. The Study

Two computer information science courses, namely, an introduction to programming using the language C (CIS145), as well as an advanced course in data structures and computer programming using the C++ language (CIS245), were used as the samples in the pilot research study. Both courses were taught at a two-year community college. Both courses were delivered as distance learning courses using a Learning Management System-Blackboard. The duration of each of the courses was ten weeks. There were 12 students (4 females and 8 males) in the CIS145 course and 9 students (1 female and 8 males) in the CIS245 course.

The first course was called Programming in C and the prerequisite for the course was that the students were required to have prior computer programming experience. The content of the course included the following topics: program structure, data types and variables, bit operators, control structures, input and output, one and two-dimensional arrays, as well as an introduction to pointers and data structures. The second course was called Data Structures and Programming: C++. It also had a prerequisite, namely, a course in object-oriented programming and design using the Java computer programming language. Course topics included software design and development, with a focus on data abstraction and information structures implementation. Additional course topics included instruction on the C++ computer programming language, as well as in-depth instruction and application using various data structures, including arrays, pointers, lists, stacks, queues, and trees.

During the third week of the semester, students from both of the courses were given instructions on taking the Felder & Soloman Learning Style Inventory (http://www.engr.ncsu.edu/learningstyles/ilsweb.html). The purpose of the learning style inventory was to measure a student's learning styles which were categorized into four areas. These included the following learning style types: active and reflective, sensing and intuitive, visual and verbal, as well as sequential and global. Students were also directed to review their cognitive learning styles and strategies, given the results of their inventory assessment.

The personalized systems were introduced during the fourth week of instruction. The students were given user ids's, as well as passwords to login to the portal, which provided access to the E-Learning systems. Additionally, students were given detailed information on the purpose of each of the systems, as well as general instructions on how to use them. The usage of the system was encouraged, but it was not a mandatory course requirement. At the end of the course, the students who had used the E-Learning systems were asked to fill out a questionnaire regarding them. The questionnaire asked them to rank each system in terms of their usefulness in the context of the course, as well as to answer a range of questions about each specific E-Learning system.

4. The Results

As was discovered by analyzing the student's rankings of the four systems, two of the systems – QuizGuide and NavEx emerged as clear leaders. As shown in Tab. 1, 63.64% of the students like the NavEx best and ranked it as the number 1 system. 90.91% of the students are satisfied with QuizGuide and nominated it as their first or second choice. The two other systems lagged behind being typically ranked 3rd or 4th. The log analysis demonstrated the same situation: QuizGuide and NavEX were used quite considerably, but the other two got little to none practical use. We can speculate that the students were most interested to work with interactive quizzes and examples and less motivated to access static text pages served by Knowledge Sea II. As for cWADEIn, which is also a highly interactive tool, a likely reason of its lower popularity was the nature of offered content. cWADEIn allows the students to practice evaluation of C expressions, a topic typically learned during the first two weeks of a course. Since the systems were introduced during the 4th week, cWADEIn content was well behind the frontier of students learning interests. In addition, the interface of this system was the most complicated of the four. The combination of low need and s higher learning threshold could explain the low use of this system.

	QuizGuide	NavEx	cWADEIn	Knowledge Sea II
1	36.36%	63.64%	0.00%	0.00%
2	54.55%	9.09%	27.27%	9.09%
3	9.09%	27.27%	36.36%	27.27%
4	0.00%	0.00%	36.36%	63.64%

Table 1: Overall Satisfaction of QuizGuide, NavEx, cWADEIn, KnowledgeSea

	CIS145(C)	CIS245(C++)
% participation	62.5%	100%
	QuizGuide	
Time spent	1'03"14	0'4"29
Question Attempts	90.5	8.4
Quizzes Completed	13.5	3.2
Question Successful Rate	49.89%	29.10%
	NavEx	
Time spent	0'48"02	0'21"06
Examples	26.7	22
Example Revisit Rate	28.73%	69.10%
Number of Examined Lines	101	125.14

Table 2: The Usage of QuizGuide and NavEx

Tab. 2 shows further analysis of student interaction with the two systems (QuizGuide and NavEx). As shown by the data, the balance of the system usage in the two classes was very different. Students from CIS145 spent a lot of time with QuizGuide, 1 hour 3 minutes and 14 seconds on average. Within the vast amount of time spent on QuizGuide, students had 90.5 question attempts. There were 13.5 questions completed and the question successful rate is 49.89%. The time spent by CIS145 students in NavEx was slightly less. However, the number of visited examples and examined lines was quite impressive 26.7 and 101 accordingly. This usage data are comparable and even higher (for NavEx), with the typical use of these systems in the C programming classes at the University of Pittsburgh. In contrast, the students of CIS245 used QuizGuide much less, while their usage of NavEx was much higher and comparable with NavEx usage in CIS145. Interesting the example revisit rate in CIS245 (69.10%) was very high. The observed balance can be explained by pointing out a difference between C and C++ languages. While C is considered a subset of C++, the input/output statements in these languages are different. Since about a half of all QuizGuide questions required knowledge of C output, which was not presented in CIS245 class, the questions were much less useful for CIS245 students. In contrast, the understanding of C input/output was not necessary to benefit from NavEx examples – the explanations for other code lines was equally interesting for C++ students. Yet, C is a subset component of a C++ course, so the overall usefulness of the examples was still lower when compared to CIS145.

The remaining part of this section examines data from the questionnaires. The questionnaires included a number of Likert-style questions about the E-Learning systems. Most interesting, the purpose of the research study was to examine the student feedback about the usefulness of the systems and about their personalization features. Fig. 3 shows a subset analysis of these questions. As the data shows, 91.67% of the students agreed or strongly agreed that QuizGuide should be used again when teaching the courses. 75% of the students agreed or strongly agreed that the online self-assessment quizzes contributed to their knowledge and over 60% agreed or strongly agreed that QuizGuide helped them to improve their problem-solving abilities. Students particularly noted in the free-format text that the system was very helpful and useful to their learning. Additionally, it allowed them to work at their own pace.

The personalization features were also praised. Over 60% of students expressed positive or strongly positive opinions regarding the guidance value of adaptive annotations. 75% of the students agreed that the system correctly reflected their level of knowledge in the corresponding topic. Furthermore, none of the students answered negatively on the questions that the researchers asked.

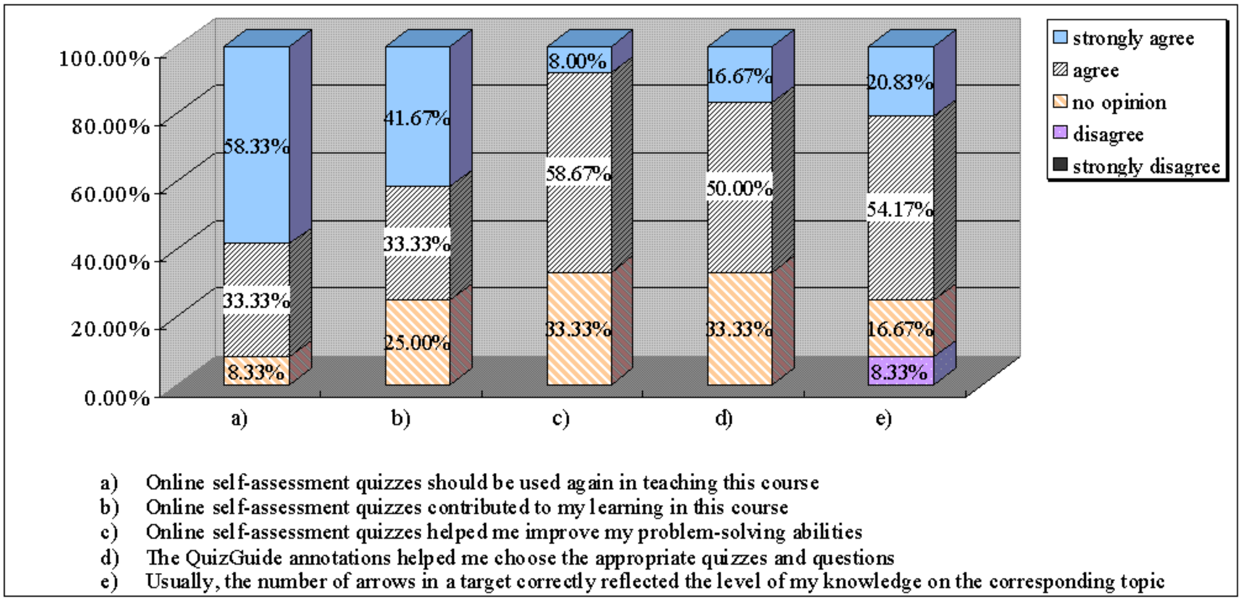

Figure 3: Subjective Evaluation of the Systems

The students also found the colors, targets, and checkmarks to be easily understood. They expressed a positive attitude toward the icon representations and also found the interface to be very easy to use. However, some of students indicated that they did not pay a lot of attention to the annotations or they found that the mouse cursor going over the icon was relatively distracting. Nevertheless, according to students' free-format feedback, it's confusing at the very beginning while using the system, however, it became clearer after reading the directions or trying the system for a while. The majority specifically noted that the system worked just fine.

Additionally, we tried to find correlations between the student's usage of the systems and their learning styles. While the relatively low number of subjects does not allow us to find any significant differences, there are still some interesting observations. The learning styles of the subjects were not evenly distributed: 75% of the students are self-reported as sensors and 66.7% of them are visual learners. 58.3% are both sensing and visual learners. It may explain the reason why QuizGuide was highly used, for sensors love problem solving and enjoy hands-on experiences. Indeed, for those who are extremely sensing in learning, they actually spent more time on QuizGuide and tried more the quizzes on the system. It's the same with the NavEx system as well. They browsed more the examples and examined more lines on the examples. Yet, as far as this online course is concerned, using the systems, reading course materials and other online educational activities are highly visual engaged, instead of listening to the lectures or any other in-class discussions. We expected that Knowledge Sea II would be somehow used more by visual learners rather than verbal learners, but we found no evidence of this.

5. Summary

Our study of personalized learning tools in the context of distance learning courses offered in a community college setting demonstrated that at least some class of personalized E-Learning systems are heavily used and appreciated in this context. The usage of QuiZGuide and the NavEX system, which both serve interactive content with relatively simple navigation support, was comparable and even higher than their usage in a comparable course at a research university (University of Pittsburgh). While some students commented that additional layers of complexity added by personalization made the systems confusing at the beginning, they were able to master these systems with no other additional help, other than the provided written instructions. At the same time, two other personalized systems were used much less in their original context. While we can speculate about the reasons for these differences, further studies are required to better understand the reasons causing lower use of these systems.

Acknowledgements

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