Learner Adaptive User Interface: An Example Case

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ABSTRACT

There exists increasing demand for intelligent learning environments which are adaptive to learner’s preferences and tasks. This paper illustrates a study of the intelligent learning environment where the learner’s preferences are diagnosed using learner behavior patterns on user interfaces. In this research, a learning-style model by Felder & Silverman has been adopted as the most appropriate category for designing the behavior-based user interface customization.

Keywords: Adaptive User Interface, Learner modeling, Learning styles

INTRODUCTION

The computer mediated education in the 21st century knowledge-based society calls for an intelligent learning environment which is adaptive to learner's various needs and changing situations in a learning process. Such an intelligent learning environment can be embodied by having intelligent features such that the user interfaces are adaptive to user's learning styles and other behaviors. In other words, interfaces that support customization and can adapt to each individual’s specific preferences may be more effective than ones designed to be “one size fits all” (Karger & Quan, 2004). In this context, it seems to be meaningful to research into the system which can intelligently recognize the individual’s learning styles through learner’s behavior patterns on the user interface, and customize its user interface to fit the individual’s specific preferences and styles. Felder & Silverman (1988) have already performed research on classification of students, development of tutoring strategies, and the evaluation of learning strategies. Based on the study conducted by them, this study has demonstrated a case of the learning environment where the learning styles are diagnosed using learner models, the learner’s behaviors are recognized, and customized user interfaces can be, finally, reconfigured in an adaptive manner to accommodate the learning styles.

LEARNING STYLE & USER-INTERFACE DESIGN

A learning-style model by Felder & Silverman (1988) has been adopted in this research as the most appropriate category for designing the behavior-based user interface customization in that each learning style can be classified into two distinctive preferences. The Index of Learning Style (ILS), the learning-style model by Felder & Silverman, has four axes; Sensory(S) vs. Intuitive(N) in terms of information perception, Visual(V) vs. Auditory(A) in terms of information input, Active(C) vs. Reflective(R) in terms of information processing, and Sequential(Q) and Global(G) in terms of understanding process of information. The ILS paper proposes teaching techniques to address each dimension, discussing details of four dimensions of each learning style. Based on the discriminable characteristics of each dimension and the recommended teaching techniques, learner behavior patterns in learning contexts that seem to reflect each learning style preference have been hypothesized for this research. Moreover, user interfaces that seem to encourage learners to reveal their preferences were also designed based on the hypothesized behavior patterns. The details of the hypothesized patterns and interface designs will be discussed in the next section.

INTERFACE TO CAPTURE LEARNER BEHAVIORS

Systems concerned with user modeling for the automatic adaptation of interfaces focus on monitoring
events collected from the interface (Branco & Encarnacao, 2004). In this research, the learner’s behaviors on
the interface would be monitored to derive the learner’s learning style preferences from the interface events,
instead of using the ILS questionnaire. Therefore, interface layouts specified for the learner behavior
recognition have been designed using learning contents in architecture domains.

Global vs. Sequential: the ILS work states that the instructor should offer “the big picture or goal of a
lesson” before presenting the learning steps. From this viewpoint, it has been hypothesized that if a learner
wants to look through the overview of the contents at the beginning, they may be Global learners. Thus, as
seen in Figure 1, the overview buttons are located on the table of content screen for learners themselves to
determine to look over the big picture of the contents. Furthermore, Global learners may want to jump to the
section they are interested in by clicking the section hyperlinks rather than following the sequential order that
may be preferred by Sequential learners. Furthermore, on the content screen (Figure 2), Sequential style
learners may study in a steady order by clicking the next/previous buttons, while Global learners may jump to
select the content that they want by choosing the section directly.

Auditory vs. Visual: As Felder & Silverman discuss that Auditory learners prefer verbal explanation,
whereas Visual learners remember best when they see pictures, diagrams, flow charts, and so on, it has been
hypothesized that while Visual style learners may prefer images on the screen, Auditory learners may prefer
texts. Thus, the second interface layout in Figure 2 has content areas configured by both images and written explanations. The learners can choose either picture-driven or text-driven area in order to go
down to detailed information section for the contents. In the picture-driven area, the detailed explanations are mainly led by image objects in order to help the learners to establish an understanding of the learning contents. On the other hand, the text-driven area is led by written texts largely. Therefore, Visual style learners may be interested in the picture-driven section while Auditory style learners may get a deeper insight into the learning contents by reading the textual information.

Sensory vs. Intuitive: An interface design has been devised to figure out whether Sensory learners are
patient with the additional materials and spend more time on studying the details of the references when
additional contents or examples are given as references as illustrated in Figure 3. It is based on that ILS
regards Sensory learners as having attentiveness to details and Intuitive learners as being bored by details. In
other words, if students are interested in additional materials while they are studying main contents, they may
click the button for additional materials on the interface in Figure 3 frequently. The events derived from these
kinds of actions on the interface play a crucial role in figuring out the individual styles.
Also, in problem solving situations where learners have to match two correct pieces, Sensory learners may spend more time on performing actions and may have higher rates of correctness than Intuitive learners. This has been suggested in that while Sensory type learners are careful but may be slow, Intuitive learners are quick but may be careless, so an interface design has been devised to verify the assumption. The user interface works in the way that as soon as the students drag and drop a piece on the answer section, if correct, the piece is fitted in, but if wrong, it goes back to the original place. To illustrate, if student are careful to choose the answer and move to the puzzle section, they may have low trials and high correctness, but if they try it out without care, they may have high trials and low correctness. Therefore, their events in the problem-solving context may give information about their styles.

Active vs. Reflective: Felder & Silverman (1988) point out that an Active learner is someone who feels more comfortable with active experimentation. Conversely, Reflective learners process information reflectively and want to have intervals to think about what others have told. From this viewpoint, if Active learners have arguments about an issue in discussion situations, they may expose their opinions freely to teachers or friends, but Reflective learners may compare their arguments with others at first. An interface has been intended to verify this hypothesized behavior. Based on the outline of the user interfaces explained above, a learning content in architecture domains has been developed by using Flash to conduct an experiment.

**BEHAVIOR PATTERN EXTRACTIONS MODULE**

In order to verify the hypothesized patterns and extract the hidden behavior patterns of learners in each learning style dimension, a patterns extraction module has been developed. In particular, in this research, an algorithm for finding association rules that implies certain associated relationship among a set of objects (such as “occur together” or “one implies the other”) (Karuna 1997), was utilized.

There are three main steps in extracting the learner’s behavior patterns and verify the patterns for this research (Figure 4). At first, after a learner conducts their learning actions on the user interface explained in the previous section, the learner’s events are recorded on a XML file. A collection of the individual events is defined as an array of actions. Then, all learners’ arrays of actions are reconfigured as a set of objects by counting the number of the same behavior patterns, comparing patterns, conditioning specific patterns, extracting some patterns, etc. Among the set of objects, Apriori algorithm can find association rules that implies associated...
relationships.

An example of events that are derived from a learner on the ILS module is demonstrated in Figure 5. The XML record shows that the learner clicked the introduction button and expansion button to look over the structure of the contents on the “Table of Contents” screen. Note that the illustrated results were obtained in an experiment conducted with 27 students on architecture styles and cooking contents. In Figure 5, “CaseDropL” means that the frequency of learner’s events on dragging and dropping on the problem-solving interface is low. As shown from the results \([S \leftarrow \text{CaseDropL}] \ [\text{CaseDropH} \leftarrow N]\) in Figure 5, Sensory learners are associated to low frequency of the event in dragging and dropping on the problem-solving situation, but Intuitive learners are related to high frequency. It means that sensory learners tend to be careful to solve problems, but Intuitive learners tend to be quick and careless in a problem-solving situation as predicted from the ILS work. In addition, it is also identified that sensory learners are more interested in additional materials and details, while intuitive learners are not from the association results of ([S \leftarrow \text{AddBH}] and [N \leftarrow \text{DetailCL}]). Here, clicking the button for additional materials frequently is abbreviated to “ADDBH”, but “ADDBL” is vice versa. Moreover, clicking the button for looking at the detailed information frequently is abbreviated to “DetailCH”, but “DetailCL” is an opposite case of “DetailCH”. Therefore, this experiment verifies the behavior patterns of Sensory and Intuitive learners in the learning context.

**ADAPTIVE INTERFACE**

Based on the user interface-based behavior patterns, individual learning styles can be identified. Therefore, it is possible to develop an intelligent tutoring system that is adaptive to the learning styles and preferences. A prototype of an intelligent learning environment that is adaptive to learning styles and situations has been developed on the subject of heritage alive of an old temple (Kim et al. 2005).

Figure 6 illustrates a basic screen layout to reflect the suggested design guidelines and implement adaptive user interface features. Based on multimedia information guidelines (Lim 2002; Shin et al. 2002), the screen is subdivided into three pairs of widget placeholders. Each pair consists of primary and secondary information area. Emphasis on certain information is manipulated by swapping these two areas in a pair. For example, image data widget is located at the left-side position (primary information area) with larger portion of area compared with the right-side text data widget when the interface is customized for the Visual learning style (Figure 7). On the other hand, left side widget is replaced by text data widget in case an Auditory style learner is using it. In case of Sensory and Intuitive styles, video and audio data widgets are customized to give a contrast to each other. As shown in Figure 6, positions of video and audio data widgets are swapped according to the style change. Swapping the positions of Q&A Board and Bulletin Board is to reflect the difference between Active and Reflective styles. It is based on the experiential assumption that the Active
style learners tend to actively ask questions and involve in discussions in terms of learning while the Reflective learners prefer to gain information by browsing and reading what others wrote.

Figure 6. Screen Layout Guidelines

Figure 7. Interface Adaptation

CONCLUSION

The learning environment demonstrated in this paper aims toward extracting learner’s behavior patterns on the user interface and developing the intelligent learning system which can enhance the learning efficiency and experiences by providing effective user interfaces and learning contents according to the users learning style. Thus, an intelligent learning system that recognize the behavior patterns in order to accommodate the individual learning styles can be developed. This study is the first step towards the intelligent learning environment in order to support the individual learner.

ACKNOWLEDGEMENTS

This research was supported by the Korean Ministry of Science & Technology through the Creative Research Initiative Program. Flash programming support by Myung Jin Lee has been provided.

REFERENCES


