UML Class Diagram as a Navigational Support for E-Learning

Fathi Essalmi (1), Leila Jemni Ben Ayed (1), Mohamed Jemni (1), Kinshuk (2)
(1)Research Unit of Technologies of Information and Communication (UTIC)
Ecole Supérieure des Sciences et Techniques de Tunis, University of TUNIS
5, avenue Taha Hussein, B.P. 56 Bab Menara 1008 – Tunis – Tunisia
Fathi.essalmi@isg.rnu.tn, Leila.jemni@fsegt.rnu.tn, Mohamed.jemni@fst.rnu.tn
(2)School of Computing & Information Systems, Athabasca University, Canada
kinshuk@ieee.org

Abstract

Several researches have demonstrated the effectiveness of graphical languages in knowledge representation and the numerous advantages of using graphs in the context of learning. On the other hand, many researches in the e-learning domain have focused on the personalization of learning materials by using adaptive educational hypermedia. However, most adaptive educational hypermedia systems do not benefit from the power of graphics because they do not use an expressive graphical language for presenting educational hypermedia to the learners. Our approach fills the existing gap between current educational hypermedia languages with the learners’ requirement of a standard graphical language for the visualization of adaptive hypermedia and the navigation through it. In this way, new possibilities are added to adaptive hypermedia expressiveness such as the presentation of the relations between concepts and the organization of these concepts in compartment allowing the arrangement of their semantics.

1. Introduction

The personalization in E-Learning domain has the promise of representing the learning content according to the learner profile. But while the specification of learning content, learner profile, and the adaptation method constitute the basis for the personalization, it is also fundamental to exploit an expressive language for representing the adaptation results such as the concepts adapted to the learner and the relations between these concepts. In fact, the adaptation result offers some knowledge to the learner, and to communicate knowledge, we need a communication language.

Adaptive navigation support enables presentation of learning contents in the form of hypertext, such as links, and guides the learners during the learning process by presenting these links through certain metaphors that indicate which links are recommended by the system at a certain time. There are several alternatives proposed in this direction. For example, ELM-ART uses colored folder ( ) and bullet icons ( ) to provide adaptive navigation support [8]. In the case of INSPIRE, other colored icons ( , …) are used to mark the educational materials [4].

The current adaptive navigation supports do not use a standard language with a precise semantic. The lack of this standard language is a constraint for communicating learning contents especially when learners use the system for the first time or when they move from one system to another. In general, use of standards in the human-computer interface provides a consistent solution that reduces uncertainty, and simplifies usage for the users [7]. Furthermore, there is a growing demand for visual representations using the powerful graphical displays to respond to the learners needs [3] whereas the current adaptive navigation supports do not benefit from the high expressiveness of graphical languages which allow presentation of different classes, objects and relations in a spatial view. Several researches have demonstrated the advantages of using graphics, figures and images for learning. For example, in the case of problem-based learning, Reinhard et al. [6] have shown that graphics facilitate problem solving processes and can display the salient features of a problem space and allow the visualisation of parts of the goal structure in the form of intermediate nodes.

In this paper, we propose an approach for the representation of adaptive hypermedia with class diagrams of UML. In this way, the learners do not only benefit from the personalization of learning materials, but they also visualize the learning materials in a global view and benefit
from the effectiveness of graphical language in knowledge representation and the numerous advantages of using graphs in the context of learning.

This paper is structured as follows: section 2 presents the motivation of our approach, section 3 illustrates a discussion on the effectiveness of our approach and section 4 concludes the paper with a summary of this research and some future directions.

2. Motivation

There are three reasons why we propose to use UML as an adaptive hypermedia language for E-Learning. First, UML is a graphical language and benefits from the mentioned advantages of using graphical languages to communicate knowledge and for learning. Second, UML is standardized by the OMG (Object Management Group) and therefore benefits from the advantages of using standards. Third, UML is very expressive.

Figure 1. An example of UML adaptive hypermedia

As shown in the left part of Figure 1, the class diagram allows the understanding of the concepts in an adaptive way and the understanding of the relations between them. For example, we can visualize in this diagram that an object is an instantiation of a class and a class is composed of method and data, etc. Furthermore, this diagram allows the organization of concepts in compartments which differentiate between the links to knowledge and the links to pedagogical activities.

UML adaptive hypermedia is a major source of information which orients learners during the learning process and benefits from the well expressiveness of UML. In particular, the class diagram is the most used diagram of UML [2], and it is a good candidate for the representation of knowledge in the form of concepts and relations [1, 5]. The class diagrams have the advantage of being capable of presenting a global view of learning contents by organizing the adaptive links in semantic classes and visualizing the relations between these classes. While working with the class diagrams which present the adaptive hypermedia, the learners can benefit at the same time from the power of graphics in the context of learning, the expressiveness of UML, and from the organization of adaptive links in class diagrams and their presentation according to the learners’ characteristics.

3. Discussion

In this section, we discuss the effectiveness of UML class diagram as a navigational support. To do so, we present in Table 1 a comparison of class diagram navigational support with classical navigational support.

Table 1. Comparison of class diagram navigational support with classical navigational support

<table>
<thead>
<tr>
<th></th>
<th>Class diagram navigational support</th>
<th>Classical navigational support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardization</td>
<td>Yes.</td>
<td>No.</td>
</tr>
<tr>
<td>Explicit separation between concepts, knowledge links, and pedagogical activities.</td>
<td>Yes.</td>
<td>No.</td>
</tr>
<tr>
<td>Recommendation by mean of color.</td>
<td>Yes.</td>
<td>Yes.</td>
</tr>
<tr>
<td>Graphical display of relation between concepts.</td>
<td>Yes.</td>
<td>No.</td>
</tr>
<tr>
<td>Recommendation by mean of graphical relations between concepts.</td>
<td>Yes.</td>
<td>No.</td>
</tr>
</tbody>
</table>

Concerning the standardization, UML is standardized by the OMG. In order to explain the rest of table 1, we present the alphabet (set of elements) which allows visualizing the navigational support in a global view. This alphabet is composed of concept, knowledge link, pedagogical activity link, and relation between concepts. We present for each concept its representation with UML and its meaning in the context of educational adaptive hypermedia.

Concept: a concept is presented by a class. Each concept can be presented by two types of links: The knowledge links and the pedagogical activity links. These links may be attached with colored icons for learners recommendation (as an example, see Figure 1).
Knowledge link: a knowledge link is placed in the second compartment of the class and allows presentation of the knowledge on the current concept by a simple click. For example, in Figure 1, the definition of the concept method is presented in the frame of content.

Pedagogical activity link: a pedagogical activity link is placed in the third compartment of the class and allows the learner to do an activity in the context of the current concept. An activity can be: doing an exercise, entering the chat room, and so on.

Relation between concepts: a relation associates the concepts together and allows more comprehension of the concept semantic. Relations include the composition (\(\subseteq\)), the generalization (\(\supset\)), and the association (\(\rightarrow\)) which communicate a semantic through their name. Assume, for example, that a learner has followed the concept “Method” (presented in Figure 1). According to the relation between the concept “Method” and the concept “Static function”, he/she can understand that there are common semantics between the two mentioned concepts. In this case, learner benefits from this fundamental relation in two ways. First, he/she knows the fundamental relation between the two concepts “Method” and “Static function”. Second, learner distinguishes that the concept “Static function” can be easily reached given that he/she has followed the concept “Method”. This last understanding is a specific recommendation for the learner.

The table shows that the class diagram (of UML) navigational support has 5 significant characteristics from the above mentioned characteristics where the classical navigational support has 1 significant characteristic. This result can be explained by the fact that UML is a standard, very expressive language and benefits from the numerous advantage of using graphic in the context of learning.

4. Conclusion

In this paper we have described an approach for the representation of adaptive hypermedia with the class diagram of the standard graphical language UML. In this way, we can benefit at the same time from the presentation of personalized e-learning material and the high expressiveness of the graphical language. In this work, we have focused on the structure in which adaptive hypermedia is presented with UML and we have showed the utility and the feasibility of using UML as an adaptive hypermedia language. In fact, with UML, we have in particular the capability to represent the concepts to be learned, the relations between them, and their recommendation according to the learners’ characteristics. All these communicative features enable learners to visualize learning materials in a global view in which they have the appropriate knowledge to guide their learning.

After a planned experimentation, it is possible that the students’ interests with UML presentation capabilities will be partial. In this case, we will introduce the hypermedia representation capability as a new personalization parameter in the learner profile and develop a personalization process which allows displaying the adaptive hypermedia by taking into account the adaptive hypermedia language as a personalization parameter among others personalization parameters.

5. References