Adaptive Edutainment in UML

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Abstract: - Edutainment stands for education plus entertainment and tends to be one of the modern buzzwords in the area of contemporary technology-enhanced learning. Applying edutainment with adaptation to learner character sound even more promising thanks to delivery of various types of learning objects (including games) according needs, preferences, style, knowledge and performance of the individual learner. The present paper provides description of adaptive edutainment in UML, designed and delivered by ADOPTA (ADaptive technOlogy-enhanced Platform for eduTAinment). After explaining the motivation for this research, authors show how semantic structuring of the educational content may be used for both instructional design of the course and initialization of game instances used within the same course. There is discussed a field trial including UML content creation, narrative storyboard construction and application of logic games using educational content. The presented experimental results show very high appreciation of the adaptive edutainment in terms of efficiency and appeal to students.

Key-Words: - edutainment, adaptive e-learning, adaptive hypermedia systems, game, learning styles

1 Introduction
Modern technology enhanced learning methods try to improve the learning process by using non-traditional instructional paradigms. Some of them use computer games, other implement adaptive techniques to provide learning content in the most appropriate way [1]. Unlike conventional hypertext systems, according Fan [2] such adaptive and adaptable e-learning platforms are specially purposed to provide educational content in a way mostly satisfying needs of each individual student or a group of students. Following Brusilovsky [3] the adaptive hypermedia systems (AHS) are entirely oriented to individual specific preferences, knowledge, performance and learning style.

Other modern trend is game-based learning which offers an alternative way to deliver the educational content in the process of game. It is based on combining game situations and learning activities for achieving both high satisfaction and academic performance. Therefore, application of computer games in education is considered important because games are perfectly adapted to the development of competences of young people for a new era in which creativity and innovation are more important than the curriculum [4]. Educational games represent attractive and already well proven means for attracting attention and interest in given course topic [5, 6, 7]. Being at the same time entertaining, educative and cognitive, games do complement traditional instructional design [8].

In this paper, we present a way for creating and delivering of an adaptive courseware with edutainment elements by using ADOPTA (ADaptive technOlogy-enhanced Platform for eduTAinment) - platform for building edutainment (education plus entertainment) services [9]. For this purpose there is developed a course in domain of UML (Unified Modeling Language), which is used for teaching 30 students of Faculty of Mathematics and Informatics at Sofia University. The course is design to be adaptive to learning styles and current knowledge of each individual student. The results of adaptive training with game elements within this course are presented and analyzed at the last chapter of the article. Brief view of the ADOPTA platform, adaptive courses and edutainment in e-learning is presented in next two chapters.

2 Background

2.1 Edutainment in e-learning
Main goal of edutainment in e-learning is to enhance and improve traditional e-learning as add the positive effect of multimedia and add the positive emotions of game elements [4]. Therefore basic objectives of this area are the following [5, 6]:

- to make learning attractive to students
• to create a learning culture that matches student’s interests, goals, preferences and learning styles
• to make students proactive by involving them into practical problem solving and making them eager to understand complex situations - from the passive “learning by listening” to the active “learning by doing”
• to provide competition environments and rewarding expectations

Motivation is a key element to education and it is the main reason for a successful learning process. Learning process is at the same time cognitive and emotional. Intrinsically motivated students can experience deep learning and are more prone to reuse knowledge in other contexts.

There are identified different types of games such as follows sport games, fighting games (characters in battles), action (shooting) games, adventure games (movie scenarios plus quests), simulation games (physical and human driven processes), logic games (puzzles, mazes, word games, problem solving), role-playing games (RPG with characters in virtual worlds), strategic games (management of complex processes e.g. civilization evolution).

Edutainment in e-learning is an innovative paradigm of education. It is a new alternative method for training, which provides possibilities learners to be engaging actively in all learning process, learners to be motivated in the highest level and learners to receive fun while they study. This method of training can be used blended with adaptive systems or traditional ones and standalone.

2.2 Adaptive courseware delivery
While developing adaptive course, there are two main points which must be taken into account. The first of them is the choice of appropriate teaching strategies that will be realized within the course. The second one is the selection of a method for constructing an adaptive course. The choice of pedagogical strategies is based on the objectives set out in the course such as to make it suitable for learners with different levels of knowledge of students, different way of adoption of information, different ways of understanding, different goals, preferences, etc.

While using ADOPTA, an adaptive educational course is presented by so called narrative storyboard graphs [10]. Each narrative storyboard graph is composed of paths, which are suitable in different level for different learning style. Each path consists of one or more pages, where there are ordered learning objects. Learning objects are units of educational content and they can be different type such as narrative content, tasks, projects, essays, games, etc.

In recent years there have been developed many learning styles with several variations of them. In the present study, there are used widespread learning styles of the Honey and Mumford [9]. The family of Honey and Mumford is composed of four learning styles – activist, theorist, pragmatist and reflector. According to Honey and Mumford the preferred style is dominant but always adds to itself elements of other. Fig. 1 presents a distribution of appropriateness of different type of learning objects to different learning styles of Honey and Mumford’s family obtained by practical experiments described in [11].

3 Adaptive E-learning with Game Elements with ADOPTA platform
The present approach unites two ways of using semantically-organized learning content for technology enhanced learning, namely:

• Construction of narrative storyboard graphs by course instructors for adaptive e-learning with the ADOPTA platform, by means of using annotated content ontology and, as well, content annotations – both created by the ADOPTA authoring tool as explained in [10];
• Creation of educational game instances initialized by semantically-structured learning content, by course instructors using a game framework as shown in [12].

The idea explained below presents how to use annotated content organized in ontology, for these two purposes – adaptive e-learning and game-based e-learning. First at all, there will be shown the importance of semantic content organization for construction of efficient adaptive edutainment.

3.1 Semantically-Structured Learning Content for Edutainment
Most popular simple educational game types such as word-based, logic, board or problem-oriented games may utilize semantically organized course content in order to extract dynamically content terms, concepts, and semantic relationships such as subtyping, association, aggregation, instantiation and dependency. A model for such semantic structuring of educational content is presented in [13] by means of using UML (Unified Modeling Language) class diagrams. UML is for an intuitive and visual content modeling providing class hierarchies, instances, class attributes, and relationships. On other hand, OWL (Web Ontology Language) possesses more
powerful semantics for representing ontology [14] by means of data type properties, restrictions, properties types such as transitive, symmetric, inverse and functional types, Boolean combinations, enumerations, class unions, intersections and complements. However, there are available a plenty of UML modeling tools and only few OWL editors like Collaborative Protégé [14].

For the purposes of construction of both narrative storyboard and educational games course instructors need simple ontology tools, without specification of properties types, class unions, intersections and complements. The ADOPTA authoring tool provides means for creation of simple
ontology having two basic types of relations between learning objects – *is-a* and *has-a* [15]. The ADOPTA authoring uses semantic ontology graphs and is to be exercised separately from instructor’s learning design and is based on. A non-monotonous inheritance of metadata descriptions of both learning objects and ontology is used, where metadata of LOs is given in Learning Object Metadata (LOM) [16], while ontology metadata uses Ontology Metadata Vocabulary (OMV) [17].

3.2 Workflow of Construction and Delivery of Adaptive Edutainment Course

The process workflow of construction and delivery of adaptive edutainment using semantically-structured course content integrates the workflows explained in [10] and [12] as presented in for. 2. Creation of annotated LOs is possible by using the ADOPTA authoring tool. It provides export and import of LOs for a good system interoperability. Organization and annotation of LOs is of key importance because it facilitates their usage while designing and maintaining the storyboard graph of an adaptive course and, as well, for using it for initialization of game instances. LOs annotations about their appropriateness for specific polymorphic learning character (comprising of a combination of learning styles) and given complexity level are to be used for creating a storyboard graph providing adaptivity toward learning styles and knowledge level.

Construction of storyboard graph has to imply development of sufficient working (learning) paths covering different polymorphic learning characters, i.e. different combinations of style levels for reflector, theorist, activist and pragmatist. Next, the instructor should define a set of weights for each of these paths, where the set comprises four values showing appropriateness of the path for each learning style, following a pedagogical strategy. Finally, the adaptation control engine delivers course pages to the learner in an adaptive way. If some of them refer to hyperlinks of educational games, the learner can click onto such a link and play a game in new window.

As explained over, the semantically-structured content is used as well for extraction and usage in educational games in implicit way. For this purpose, a game developer should create such a game using the game framework and, next, the course instructor is suppose to initialize the game instance with the structured course content and to put a reference to it at some of the pages of the storyboard. Moreover, he/she will set some parameterization for a given game instance, such as level, personalization issues, usage of agents, etc. The game instance is played to the learner by the game player tool.

4 Field Trial

This chapter represents an experimental field trial of adaptive edutainment aiming at evaluation of courseware delivery with learning style adaptation. In the practical experiments, there have participated 30 students of the master program in Software engineering at Sofia University, Bulgaria. The experimental field trial was conducted by using the adaptive course with game elements in UML specially designed for this purpose. Below there is provided a short description of that adaptive course.

4.1 Adaptive Edutainment Course in UML

The adaptive edutainment course in UML uses semantically-structured learning courseware, as described in 3.1. For this purpose, all the UML 2.3 diagrams have been described in means of LOs organized in ontology and annotated by using the LOM standard. Fig. 3 presents a part of the UML use case diagram ontology. There are shown two basic types of relationships among LO – sub-typing links (*is-a*) and referential links (*has-a*). For example, Extend, Include, Communication and Generalization are for possible sub-types of Relationship, while Use Case Diagram refers to (may contain) Actors, Use Cases and relationships, and Use Case refers to Scenario as its instance.

![Fig. 3: UML use case diagram ontology](image)

Table 1 provides the types of LOs used for the UML course and, as well, the quantity of learning objects per each type. As shown in the table, there are used five game objects with UML content – each of different type and described in details in [15], as follows:

- Hangman game
- Anagram game
- Relations game
- Memory game with no intelligent agents
- Memory game with intelligent agents

<table>
<thead>
<tr>
<th>Learning object type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative Los</td>
<td>127</td>
</tr>
<tr>
<td>Exercise tasks</td>
<td>40</td>
</tr>
<tr>
<td>Projects</td>
<td>34</td>
</tr>
<tr>
<td>Essays</td>
<td>40</td>
</tr>
<tr>
<td>Games</td>
<td>5</td>
</tr>
<tr>
<td>Assessment test questions</td>
<td>94</td>
</tr>
</tbody>
</table>

Table 1: Types of LOs used for the course

The LOs ontology was used during construction of the narrative storyboard graph. The instructional design of the course (fig. 4) has two main streams - one intended mainly for theorists, and another - for the opposite learning style, i.e. activists [11]. These two main paths are divided into two others sub-paths and next merged again, in order to add LOs intended respectively for both pragmatists and reflectors. Thus, there are provided sub-paths for any one of the four combinations of learning styles shown in fig. 1. For an efficient adaptive learning, appropriateness of LOs types for different learning styles has been evaluated in previous works [10, 11].

Fig. 4: Narrative storyboard for adaptive edutainment course

1 Do you find the learning courseware (including the games) was well adapted to your learning style?
2 Do you find the learning courseware (including the games) was well adapted to your present knowledge level?
3 Do you think usage of such games makes the adaptive course more efficient in terms of gained knowledge and skills?
4 Do you think usage of such games makes the adaptive course more interested and appealing for you?
5 Do you have any previous experience with game-based learning?
6 Do you will recommend the adaptive course with games to other students?

Fig. 5 presents students' answers using 5 levels Likert scale with the levels: 1=strongly disagree, 2=disagree, 3=not sure, 4=agree, and 5=strongly agree. The results show very high appreciation of the adaptive edutainment in terms of efficiency and appeal to students, while the majority of students have no previous experience with game-based learning.

Fig. 5: Experimental results

5 Conclusion
Thanks to its merits, adaptive edutainment may improve substantially traditional e-learning teaching. Adaptive e-learning provides different educational content to individual learners or group of learners according specific learning characters features, such as learning styles. On the other hand, edutainment makes e-learning more appealing and effective, as far as students gain new practical knowledge and skills without traditional effort of studying theory and doing exercises. Games embrace various interesting problems which are to be solved in an implicit manner.

ADOPTA (ADaptive technOlogy-enhanced Platform for eduTAinment) is developed at Sofia University, Bulgaria and uses learning styles and student performance for controlling courseware delivery via navigation through the storyboard and content selection in an adaptive way. Games
contribute essentially to that. Both the narrative course storyboard and educational games make use of educational content semantically-organized in ontology. The adaptive course in UML with game elements has demonstrated very promising results. The same approach is going to be undertaken for teaching students in verification of Object-oriented programs, by following a specific educational framework [18]. Thus, usage of both ADOPTA and the game framework makes creation of new adaptive edutainment courses straightforward, fast and easy.

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References: