Evaluation of Learning Styles Adaption in the ADOPTA E-learning Platform

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Abstract: *One of the key factors in the future e-learning is possibility of adapting educational content to student's learning styles. This allows e-learning systems to enhance their efficiency and to simulate behaviour of individual learning. This paper presents an experimental evaluation of adaptive courseware delivery in ADOPTA (ADaptive techn*O*logy-enhanced Platform for eduTAinment). The experiment was carried out with two groups of students and aimed to evaluate the effectiveness of educational materials adapted to the individual student's learning style and knowledge. Results from the experiments were analyzed and it was concluded that students taught by adapted learning materials have achieved higher academic results and are more satisfied by such a type of e-learning courses.*

Key words: *Evaluation, Adaptive Hypermedia Systems, E-Learning Platforms, Learning Styles.*

INTRODUCTION

The growth of adaptive e-learning systems has increased greatly during the last decades. Nevertheless, online training is often criticized for not supporting learner centred education but reproducing traditional learning materials in online form [1]. One of the best ways for adapting educational content to learner needs is using goals, preferences, learning styles and knowledge background of individual students [2]. Nowadays, there are proposed many adaptive e-learning systems which support some of these adaptation parameters such as AEC-CS [3], ILASH [4] and iWeaver [5].

This paper focuses on the evaluation of courseware delivery with learning style adaptation through an experimental field trial using the ADOPTA (ADaptive techn*O*logy-enhanced Platform for eduTAinment) platform [6]. Eighty four bachelor students at Sofia University were involved in the experiment divided into two groups aligned in both number of students and their previous assessment results. The first group took modules of a classical non-adaptive course in XML technologies via Moodle while the second one passed the same modules as an adaptive e-learning by means of ADOPTA, with instructional design adapted to individual learning styles of the Honey and Mumford style family [7]. Thus, each student of the second group obtained learning materials, which are appropriate for her/his learning style and performance. To achieve the experiment objective, there were compared assessment results of both student groups, and, as well, a survey about adaptivity was conducted with students of the second group. The survey was used mainly to evaluate usability, reliability and functionality of the ADOPTA adaptation control engine, with a strong emphasis on effectiveness and usefulness of adaptive courseware delivery. The assessment results of both groups were used to evaluate performance of students trained with the same courseware in non-adaptive and adaptive mode.

DESIGN AND DELIVERY OF ADAPTIVE COURSEWARE WITH ADOPTA

The ADOPTA platform follows a generalised model of adaptive hypermedia systems [8]. This model consists of three main sub-models – Learner model, Domain model and Adaptation model, which respectively describe learner profile (knowledge, learning style, performance, goals and preferences), available educational materials stored in form of learning objects (LO) and their organization of domain ontology and, finally, different pedagogical scenarios adapted for different learning styles and performance.

Learning style of individual learners is determined by pre-tests while learner performance is assessed by tests at control points of the scenarios. This allows scenarios to be implemented as courseware delivery adaptive to students learning styles and performance. The platform itself consists of three main modules – authoring tool, instructor tool and adaptation control engine, which uses the above mentioned three sub-models for controlling the adaptation process [6].

Adaptive courses in ADOPTA are presented by directed narrative storyboard graphs containing two types of nodes (pages) – content nodes and control point nodes. Each path within the graph between two control point nodes is named working path (WP). Each WP represents a pedagogical strategy and has weights defining its appropriateness to the learning styles. The content nodes contain an ordered list of LOs (text, images, audio/video, tasks, educational games [9], etc.). LOs possess complexity rank (easy, medium, difficult, more difficult, and most difficult) and may be visible or not for an individual student according to her/his present performance. Learner performance is assessed in control points by a test with questions concerning learning materials in the current WP. Questions in these assessment tests are generated by the adaption engine depending on LOs visited by the learner.

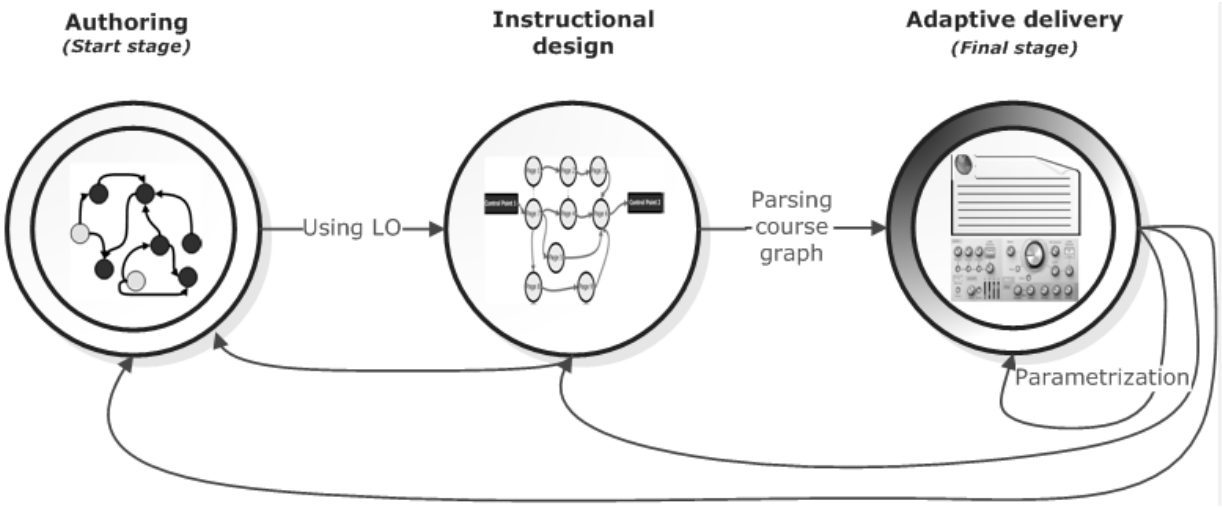

Fig. 1: Stages in adaptive courseware design and delivery

The process of adaptive courseware design and delivery consists of three main phases as shown in fig. 1. Each of the phases provides results for the next one. The process starts with creating of LOs, organizing them in ontology graph and their description by metadata. At this stage, it is very important to connect LOs of type question to the appropriate LOs of narrative content because, as mentioned above, in the third stage learners are assessed based on questions about the visited LOs. Moreover, an ontology graph has to have sufficient number of various LOs suitable for all learning styles. At the next stage of the process, instructors design course storyboard graphs, distribute LOs of previous phase on content nodes and set weights of WPs for each learning style. In the last phase the adaptation control engine chooses and deliveries adaptive learning content to students.

LEARNING STYLE ADAPTATION FIELD TRIAL

For the evaluation of adaptive courseware delivery of ADOPTA, a bachelor course about XML technologies and languages at Sofia University was used. The instructional design of the course has two main streams and WPs, which follow them. Educational

content in one of them is intended for theorists and in the other - for the opposite learning style, i.e. activists. For example, those students who have a learning style with higher value for activists will be directed by adaptive machine to the corresponding WP.

As shown in fig. 2, the two main WPs in several sections are divided symmetrically in two others sub-paths (one in dot line and the other in continuous line) which are next merged again. This design produces two sets of WPs: one of them contains all the WPs for activists but the other contains all WPs for theorists. The purpose is to add LOs to these WPs (respectively for activists and theorists) intended for both pragmatist and reflector. Thus, at some of the transitions from one page to another within the storyboard graph students pass through learning objects (e.g., course tasks) designed respectively either for pragmatist or for reflector.

In order to avoid the maintenance and initialization of all WPs weights, we are set only the weights of the two main WPs as shown in fig. 2 for the paths starting from page P1 - for activist-pragmatist/activist-reflector and respectively for the paths starting from page P2 - for theorist-pragmatist/theorist-reflector. The weights of the other WPs (discovered by the instructor tool) are not set and, thus, they are initialized with negative values, which prevents theirs usage by the adaptation control machine.

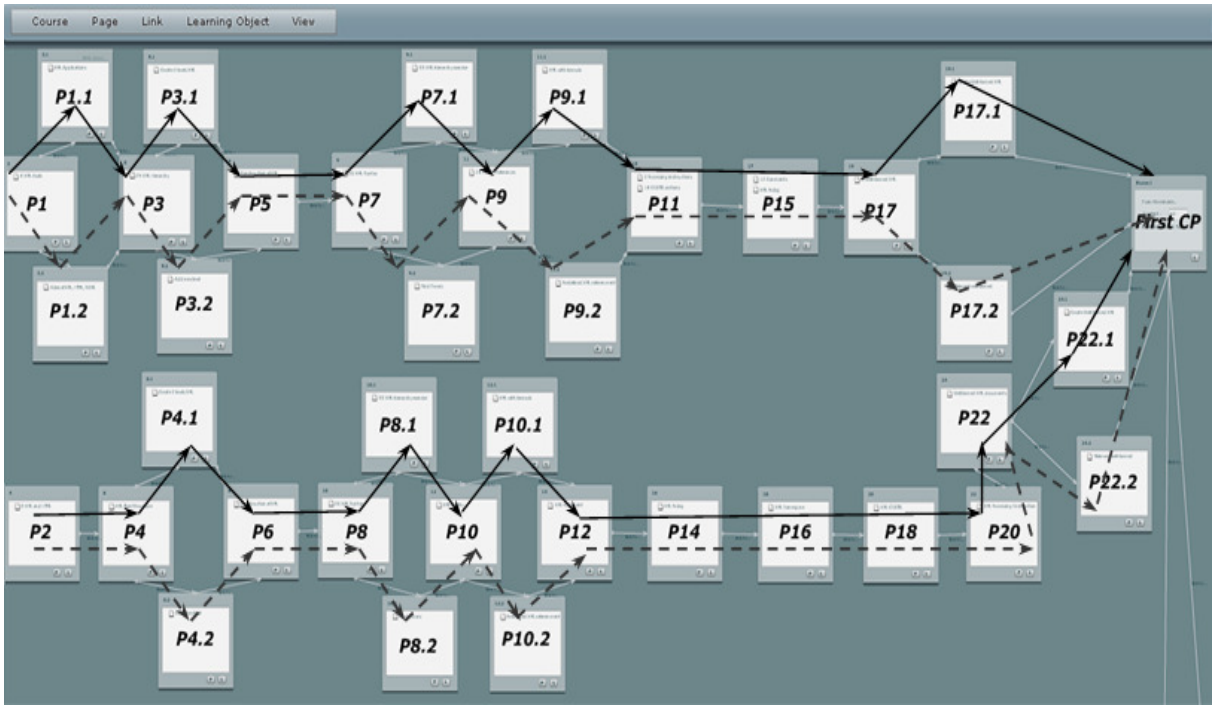

Fig. 2: Partial view of a narrative storyboard graph in the ADOPTA instructor tool

PRACTICAL EXPERIMENTS AND RESULTS

The main objective of the experimental field trial consists in evaluation of courseware delivery using the ADOPTA platform offering learning style adaptation. In conducted experiments participated 84 four-year students of the bachelor program in Software engineering at Sofia University, Bulgaria. The students were divided into two groups having equal number of participants. Both the groups had equal average student performance shown by previous assessments of the students included into a group. The first group passed some modules of a traditional, non-adaptive course in XML technologies given by Moodle, while the second group took the same modules in adaptive mode using ADOPTA platform. The instructional design of the adaptive modules was specially adapted to individual learning styles and student performance shown during the

course. Thus, each student of the second group obtained learning materials, which are most suitable for her/his individual learning style and performance.

Students from both the groups had passed through the same assessment obtained by two tests - one intermediate and one final for the course modules taught into the scope of this experiment. The assessment results of both student groups are presented in fig. 3. Obviously, students who take the adaptive version of the same course show better performance – their average test result is 77,89%, whereas for the first group the average test result is 67,14%. The median, dispersion and standard deviation values for the adaptive e-learning equal respectively to 76,67%, 1,51%, and 12,3%, while for the non-adaptive learning assessment their values are 70,00%, 2,23%, and 14,95%. Both the student groups have 42 students and equal average performance shown in former assessments, thus, we may conclude the adaptive delivery of the same courseware is more effective than the traditional one. Really, the traditional course presents the same course content but without any adaptation to style of learning and student performance, therefore, adaptation makes learning more appealing and productive.

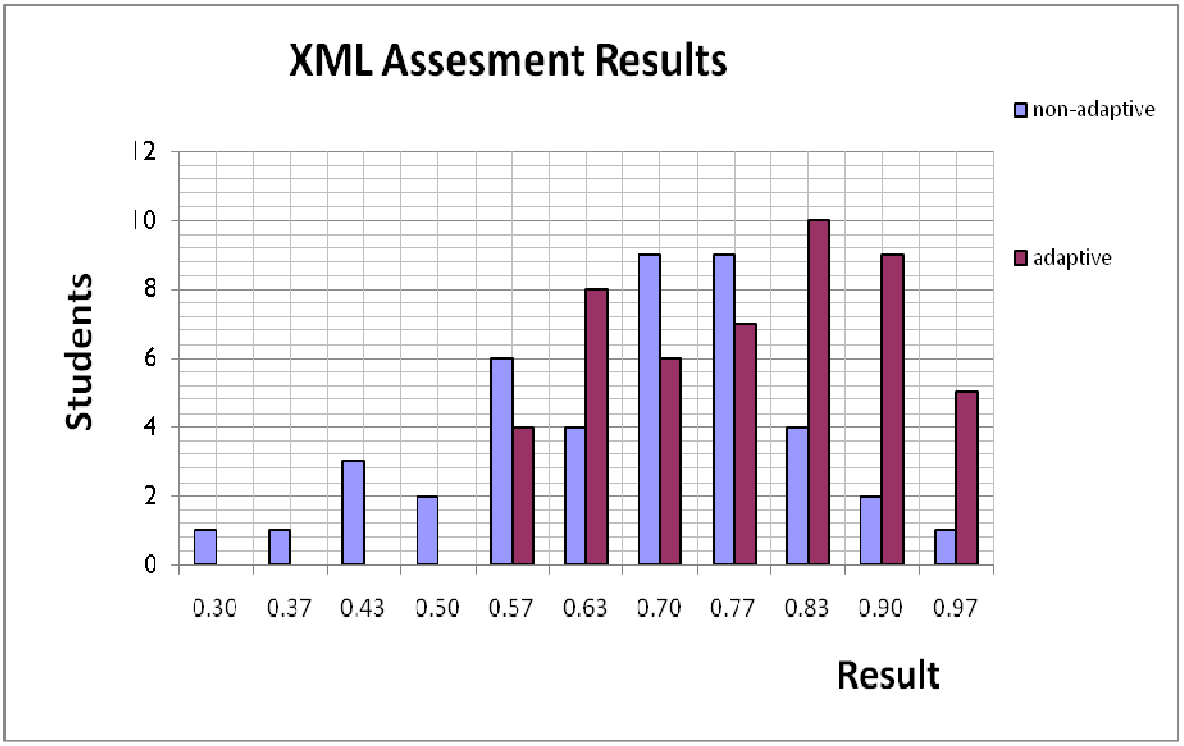

Fig. 3: Assessment results for non-adaptive and adaptive courses

In order to assess the usability, reliability and functionality of the ADOPTA adaptation control engine, a survey was conducted with students of the second group. The most important questions asked for students' opinions about adaptive courseware delivery. Fig. 4 presents students answer for several of the questions using 5 levels Likert scale with the levels: 1=*strongly disagree*, 2=*disagree*, 3=*not sure*, 4=*agree*, and 5=*strongly agree*. The text of these questions follows below:

1. Do you think that learning objects presented in this course correspond to your learning style (theorist / pragmatist / reflector / activist)?
2. Do you think this platform does adapt the lectures on the subject content to your learning style?
3. Were the assignments, exercises, topics for essays and games interesting and valuable for you?

4. Were the test questions shown within the assessments in accordance with the presented learning content?
5. Do you prefer an adaptive e-learning platform to platform non-adaptive one with similar implementation?

The results presented in fig. 4 show a strong polarization of opinions of students passed adaptive e-learning with ADOPTA – there are few students who are not sure. In general, the majority of students regard adaptive learning as a more arguing and effective way of technology-enhanced learning than the traditional non-adaptive one.

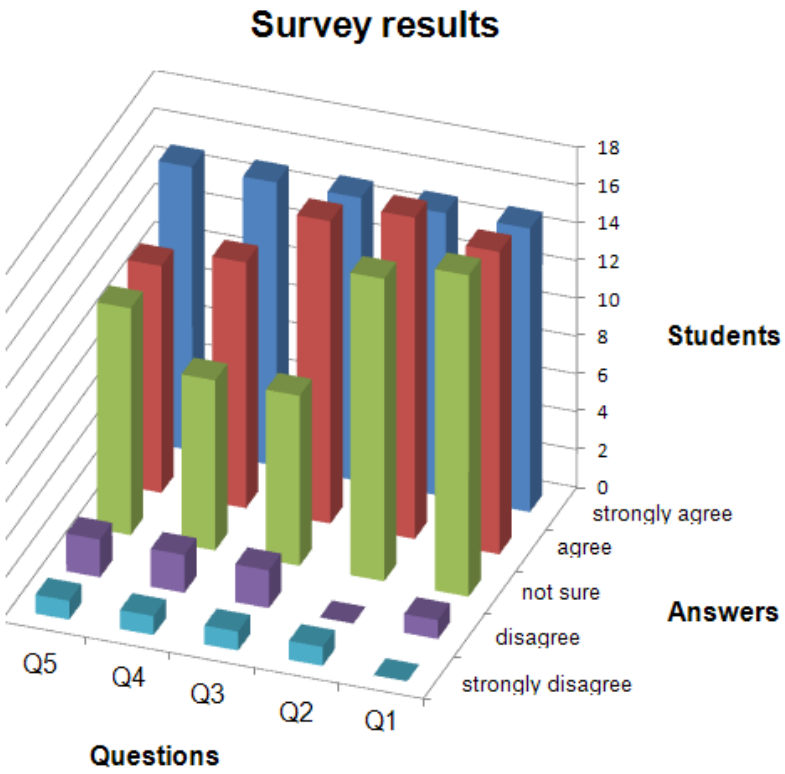

Fig. 4: Excerpt from the survey results

CONCLUSIONS AND FUTURE WORK

The empirical evaluation of adaptive courseware delivery developed and executed in ADOPTA platform is presented in the paper. The results from the survey discussed over reveal that adaptivity to learning styles is well accepted by the learners. As well, the student group which took the adaptive course demonstrated better results during assessment tests. The presented results concern the learning styles of Honey and Mumford, however, ADOPTA allows using any other family of learning styles.

For preparation of the experiments, there has been taken into account the criticisms addressed by De Bra [10] for evaluations of adaptive systems whereby adaptive content for the experimental group is developed first and, next, the same course material but without adaptive properties is used for the control group. Bearing in mind that remark, for each of these two groups there was developed a different course using the same course lessons – adaptive and non-adaptive. On other hand, both the groups were equivalent concerning number of students and their knowledge and skills, which is a guarantee for objective and precise results.

While the presented results concerned evaluation of courseware delivery mainly adaptive to learning style of each individual student, adaptivity to student performance was achieved only by a threshold grade for passing the control point after the assessment or,

otherwise, to return back and to follow another work path when the shown performance is below threshold. Next experiments will evaluate a deeper adaptation to individual student performance. For this purpose, there will be developed (using the ADOPTA authoring tool) learning objects with different level of complexity. Next, these objects will be placed onto the pages in the storyboard graph. The adaptation control engine will ensure showing or hiding some of them to given individual learner according to his/her assessment results demonstrated at the control point. Thus, learner with higher assessment grade will find more complex learning objects when traversing next work path in the storyboard graph.

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