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Developing Services for E-Learning Courses Adaptation

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This paper introduces services for tailoring e-learning courses according to students' characteristics. We describe sophisticated services that enable creation, organization and implementation of adaptive courses, based on the student model. The main aim of the research is to leverage the learning process, as well as the students' achievement by extending Moodle LMS features with services for learning resources and activities adaptation. Advanced technologies and techniques were harnessed in developing adaptation services, such as web services, business intelligence tools, expert system and various adaptation techniques. Three criteria were used in adaptation: students' knowledge from the learning domain, students' learning styles and students' interests. The architecture and the main features of the services for adaptation are described in the paper. The developed services for course adaptation were used within the teaching and learning processes at the Laboratory for e-Business, Faculty of Organizational Sciences.

Keywords: services for adaptation, adaptive e-learning, learning management system, tailoring e-learning courses.

1. Introduction

Modern e-learning systems include a set of complex processes, different elements, services and users' roles. The users of these systems belong to heterogenic groups considering their characteristics. At the same time, e-learning systems provide various types of learning resources: tutorials, e-books, scientific articles, etc. Each learning resource is specific and has a different way of presentation, content structure, area of study, etc. The number and quantity of education content increases rapidly. In the development of an effective e-learning platform one of the most important requirements is to identify users' characteristics and then use the obtained information for the creation and realization of educational processes (Aixia & Wang, 2011). Currently, research shows that a majority of educational institutions use the so-called learning management systems (LMS) (Graf, Liu & Kinshuk, 2010; Graf, 2007). These solutions provide a variety of features that enable management of: courses, e-learning activities, e-learning resources, collaboration, etc. LMSs appear to be the best possible solutions for the realization of teaching and learning resources (Barać, 2011; Despotovic, Markovic, Bogdanovic, Barac & Krco, 2012; Graf, Liu & Kinshuk, 2010). LMSs are focused on the support for all processes in e-education (Brusilovsky, 2004; Graf, 2007). The main goal is to enable users to use appropriate services that facilitate the organization of teaching and learning processes. At the same time, communication tools such as forums, chats, wikis, etc. improve interaction during courses realization. However, LMSs deliver the same course content to each student, including the same course organization, resources and services (Brusilovsky & illan, 2007; Graf, Kinshuk & Ives, 2010). They do not consider any students' characteristics, such as: knowledge level, motivation, learning styles, expectations, etc.(Essalmia, Ayeda, Jemnia, Kinshuk & Graf, 2010). Managing courses without taking into account these issues very often results in failure (Dekson & Suresh, 2010).

The main goal of the paper is to improve the learning process by developing services for adaptation. These features enable extending the Moodle LMS, without a need to create new solutions for e-learning. Students should be provided with personalized courses that are adapted to their characteristics and educational needs.

2. Providing Adaptive E-Learning Courses

Adaptive e-learning courses are an emerging issue in the modern e-learning systems (Despotovic et al., 2012). Adaptivity of e-learning courses is reflected in the adaptation of forms of learning materials presentation, methods of communication, interaction, collaboration, organizing the pace of courses in accordance with the requirements and characteristics of students (Brusilovsky, 2011; Graf, Kinshuk & Liu, 2009; Kock & Paramythis, 2011). Adaptation techniques are (Atif, Benlamri & Berri, 2003; Brusilovsky, 2004, 2011): adaptive interaction, adaptive content delivery, adaptive content discovery and creating, adaptive collaborative support. Two approaches can be noticed in scientific research within the area adaptive of e-learning: developing adaptive web-based systems and extending LMS features. Adaptive web education systems (AWES) have been developed on the basis of theoretical concepts of adaptive hypermedia (Brusilovsky, 2004, 2011; Graf, 2007, Graf & Kinshuk, 2008). However, these systems have a few drawbacks (Brusilovsky, 2004, 2011; Brusilovsky and Millan, 2007; Graf & Kinshuk, 2008). First of all, creation of such systems and their integration into educational process is a quite complex and rather expensive process that requires a high level of involvement of all users. One of the most common problems is the inability to reuse the created learning resources. The basic features of e-education system, such as: administration of courses, learning content, etc., is complex to use in adaptive systems. There are no common services for communication and social interaction among participants in e-education. The other approach implies using all the advantages of the existing LMSs and enhancing them with personalization features[ref]. This approach is used in the paper. The Moodle LMS is one of the most comprehensive solutions that provide numerous functionalities and services (Graf & Kinshuk, 2008, Barać, 2011). Moodle is flexible for implementing new components and integration with other systems and technologies (Graf, 2007).

2.1. Adaptation criteria

E-learning systems incorporate the concept of adaptivity through the development of a model of the student (Tzouveli, Mylonas & Kolias, 2008). The model of the student includes information about learning objectives, prior knowledge, pace of learning, behaviour, way of interaction and communication (Bruslovsky, 2011; Tzouveli et al., 2008). Student modelling is the process whereby an adaptive learning system creates and updates a student model by collecting data from several sources implicitly (observing user's behaviour) or explicitly (requesting directly from the user) (Bruslovsky, 2011). Most frequently used personalization parameters are presented in figure 1 (Brusilovsky and Millan, 2007).

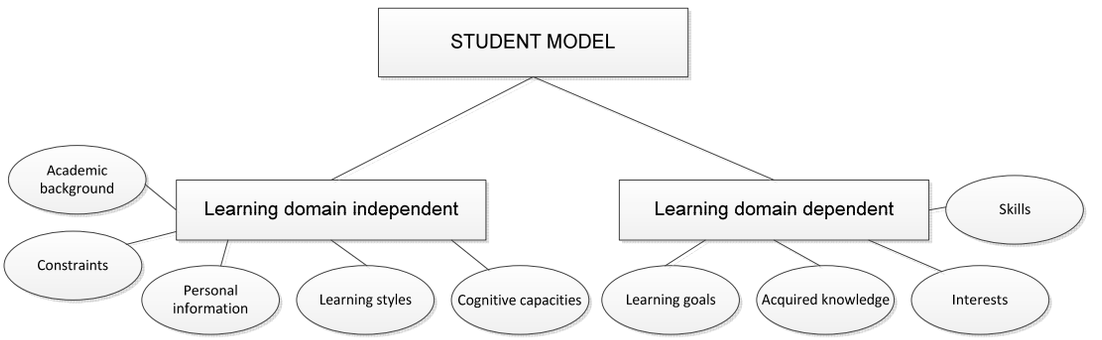

Figure 1: Common characteristics in student model

Three types of the parameters were used for implementing personalized e-learning courses:

- Learning style
- Preknowledge
- Interest and expectation

In order to gather data about these factors, we developed questionnaires and tests. Students' preknowledge is assessed by tests with 20 questions from the domain area. Based on the test results, each student is classified as: beginner, intermediate or advanced. Information about learning goals and expectation is gathered via a questionnaire.

There are several different learning style models presented in literature; however, Felder-Silverman Learning Styles Model (FSLSM) is often used for providing adaptability regarding learning styles in e-learning environments (Felder & Silverman, 1988). Felder-Silverman model describes a single student along four dimensions: 1) Active and reflexive learning style; 2) Sensitive and intuitive learning style; 3) Visual and verbal learning style; 4) Sequential and global learning style. The questionnaire to determine the learning styles of our students was created by adjusting the Index of Learning Styles Questionnaire (Felder & Silverman, 1988; Mihailović, Despotović-Zrakić, Bogdanović, Barać & Vujin, 2012).

3. Developing mechanisms for e-Learning courses adaptation

3.1 Expert system for students modelling

In order to create student model expert system "ELAB" was developed. The system aimed to define attributes that describe each student's characteristics based on data collected through the knowledge test and a questionnaire about their learning styles (Buche & Querrec, 2011). The "ELAB" expert system makes a decision in five steps (Barać, 2011). The first four steps are related to four dimensions of the FSLSM model. The fifth attribute is defined in accordance with the achievement on learning domain knowledge. After selecting a student and a course, the teacher can assign attributes to the student (Figure 2). Firstly, teachers choose a test/questionnaire, i.e learning style dimension and the expert system defines the attribute value for the chosen criteria.

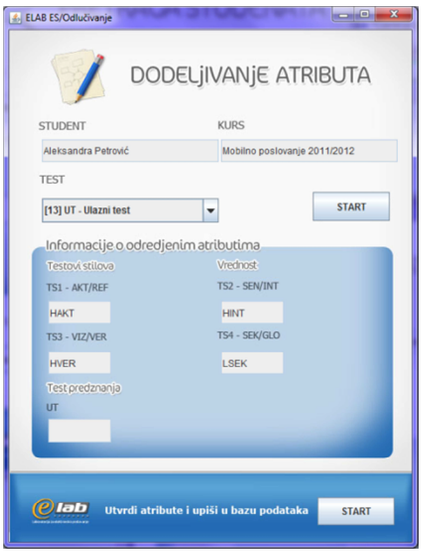

Figure 2: Assigning attributes to a student

Figure 3 presents the final output of the system. In the example presented bellow, the expert system concluded that the student is quite active, intuitive, verbal (HAKT, HINT, HVER) and a little bit sequential learner (LSEK). At the same time, the student achieved high result on the knowledge test related to course Internet technologies (id=7).

Figure 3: Recorded attributes for a student

3.2 Services for courses adaptation

In the development of the services for adaptation application, one of the key requirements was not to change the Moodle LMS solution core, but to develop an application that would be independent of a particular LMS. Implementation is realized through the following (Barać, Bogdanović, Milić, Jovanić & Radenković, 2011):

- PHP application that implements adaptive mechanism
- New Moodle LMS block and module that would present adapted learning objects and activities
- Extend the existing Moodle LMS database by adding new tables

The application was developed using modern programming paradigms. It is flexible, dynamic, service oriented and with a rich user interface. Key components are implemented as Moodle modules and blocks and do not require any changes in the existing Moodle system. The architecture of the proposed solution is presented in figure 4. Within the Moodle LMS, a module and a block for adaptive mode have been created. The module enables adaptation of a: group, student, course, learning resource/activity, collaboration, etc. The application uses the existing MySQL database. Adaptation mechanisms get data both from several Moodle tables and student model tables (Expert system outputs). In order to foster adaptive collaboration an SMS service was implemented, as well as an Android application for sending information to students.

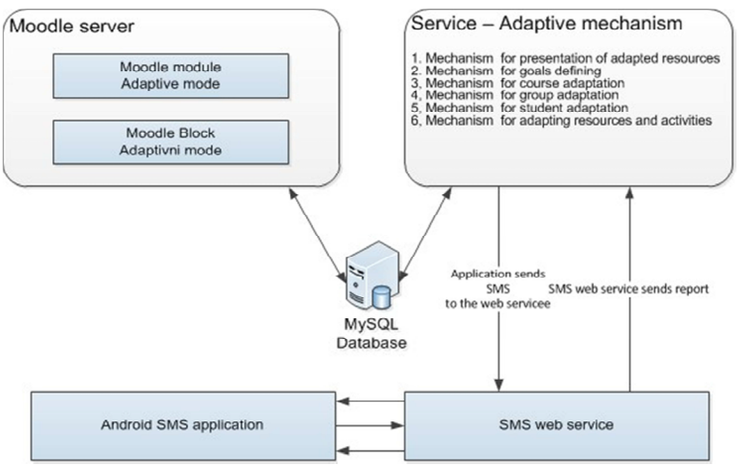

Figure 4: Architecture of the adaptive mechanisms application

The adaptive mode of the course is presented in Figure 5. Only learning resources and learning activities that fit the student's characteristics are presented to them. In the example, the student has a low level of knowledge in the area of JavaScript. Therefore, in adaptive mode they are provided with a resource "Prak-

tikum“, a version adapted to their styles, and an introductory test. A student can add an “Adaptive resources“Moodle block. Then, only they can see all adapted learning resources and activities within the course.

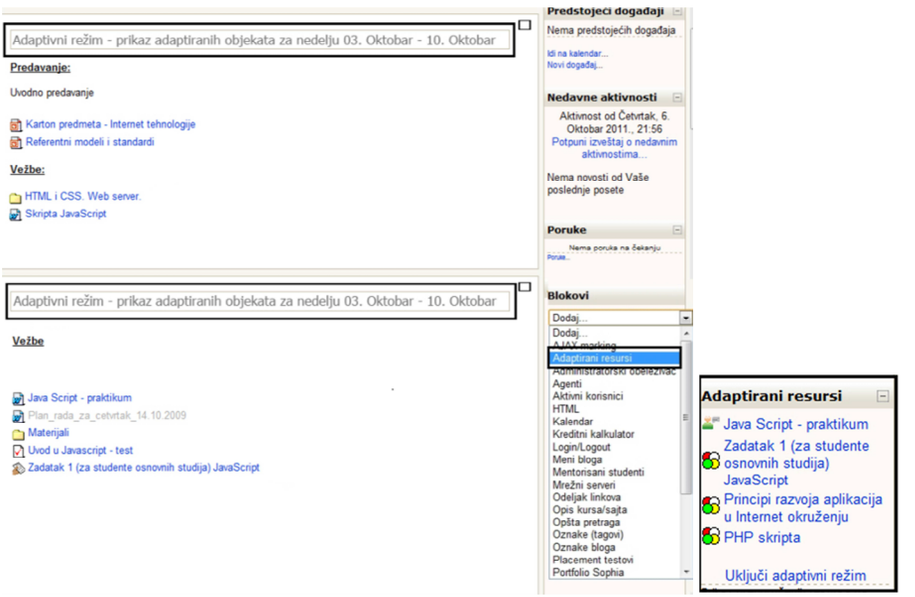

Figure 5: Moodle course “Internet technologies” in adaptive mode

The application enable teachers to add adaptivity to the existing courses. The following features are available to the teachers:

- Creating and defining adaptation criteria
- Adaptation criteria management
- Managing questionnaires and tests
- Learning resource and activity adaptation
- Group personalization
- SMS messages management

Within the application four different type of adaptation criteria could be defined: dynamically created text, number, predefined text, combination of predefined text. The service for adaptation criteria management is shown in Figure 6.

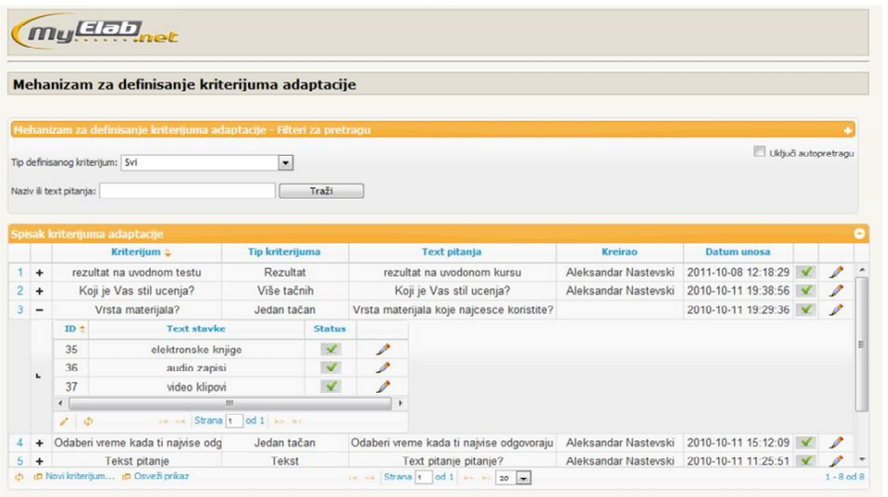

Figure 6: Service for defining adaptation criteria

Figure 7 shows an example of defining adaptation criteria that is based on the level of knowledge at the introductory test. The teacher can set a number of points for each category of knowledge (beginner 0-5, intermediate 5-8, advanced 8-10). When the teacher classifies the learning resources and activities, they can choose for which category of students' knowledge each should be presented.

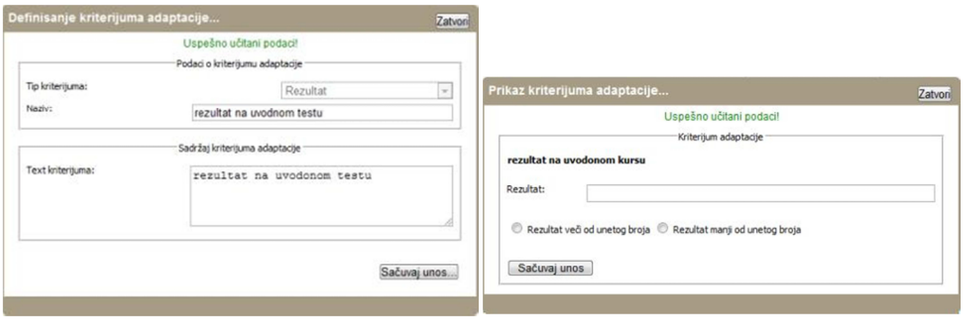

Figure 7: An example of defining adaptation criteria

Further, the service for adaptation enable a group level personalization, i.e. learning activities and resources are adapted to a group of students (Figure 8.). This type of adaptation can be quite effective and economic when a large number of students is enrolled in the course. The teacher can choose the criteria that are to be applied in group personalization. For instance, if a criterion for group adaptation is a FSLSM model dimension sequential/global and the value of the criteria is GLO (global learning style), it implies that all the learning resources and activities that are adapted for students with a global learning style, will be presented to that particular group of the students.

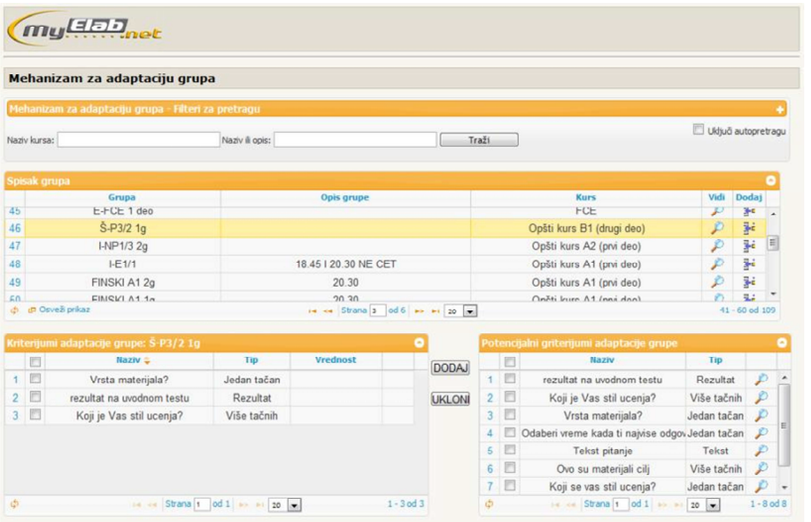

Figure 8: Adaptation on group level

Figure 9 shows learning resources and activities adaptation. After selecting a course, all the resources and activities from the course are presented to the teacher. The teacher can choose each learning resource/activity and define adaptation criteria to be applied for it. For instance, if adaptation criteria learning style FSLSM dimension active/reflexive, value *AKT* is chosen for learning activity *forum,* the forum will be delivered only to student that has an active learning style. For each learning resource and activity, more than one criterion can be selected. A learning resource/activity will be delivered to a student only if all the selected criteria are in accordance with the attributes from the student model.

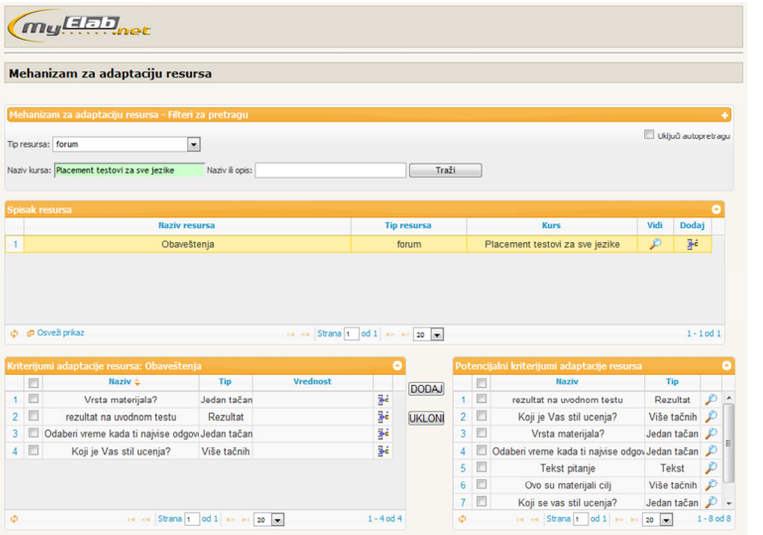

Figure 9: Adaptation of learning resources

Conslusion

This paper presents adaptive mechanisms that enable LMSs to generate courses that fit students' characteristics. The adaptation services enable tailoring Moodle courses and features based on the data from the student model. Adaptation was performed considering three criteria: students' knowledge from the learning domain, students' learning styles and students' interests. The architecture and the main features of the adaptation mechanisms were described. The main contribution of the paper is reflected in the fact that the proposed mechanisms combine the advantages of LMSs with those of adaptive learning systems by enhancing LMSs with adaptivity.

The evaluation of the system should provide additional information about users' experience in using the system, as well as data about the system performances and impact on the learning process outcome. Future research is directed toward improving adaptation mechanisms and automation of the adaptation process, as well as a complete integration of all processes into adaptive e-learning system. Mechanisms for adaptation could be improved by introducing ontology and concepts of the semantic web. Integration of social networks and developing services for social interaction should improve students' loyalty and motivation for learning

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