PERSONALIZATION OF E-LEARNING BY USING OF LEARNING PROCESSES WITH BRANCHING

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Abstract

In this paper, an approach to personalization of e-learning is proposed and implemented. This method provides different learning materials to various categories of students. The method of personalization uses fine-grained learning objects and learning processes with branching. Each learning activity uses atomic or complex learning objects. Evaluation activities measure achieved learning results and direct a student to appropriate next learning or other activity. Students also have the opportunity to choose one of offered learning or other activities, according to the overall design of a learning process. Using evaluation results, or students’ choice of suggested activities, a master model of a learning process may generate different learning paths to various categories of student, providing them different teaching materials for each lesson of an online course.

Keywords: e-learning; personalized e-learning; adaptable e-learning processes; learning objects; learning processes; personalization of learning.

1 INTRODUCTION

Learning process consists of learning and verification activities. Each online lesson may be specified as a learning process. Usually, this learning process is linear, providing sequential execution of learning activities. All students, in this case, must use all learning activities and use the same learning material. This is a drawback of linear learning processes, as students are different, have different knowledge background and levels, have different learning objectives, motivations and learning styles.

To improve the efficiency of a learning process, it is necessary to take into account these differences among students. This has been a favourite research topic, and many research approaches have been suggested [1]. Different adaptive and personalized e-learning methods have been proposed.

In this paper, an approach to e-learning personalization developed at the Belgrade Metropolitan University (BMU) is presented.

2 METHODOLOGY

Learning is represented as a process consisting of learning activities and other events that may evaluate learning results or may allow students to communicate with their instructor or other students. A personalized e-learning process provides learning activities that are the most suitable for a student. This means that they contain an appropriate amount of new knowledge, in line with his capabilities and objectives that a student can understand easier and learn faster.

It is usual that a course has some online lessons. Each online lesson may have many learning activities providing a different amount of new knowledge. Instead of using a linear learning process that provides the same amount of knowledge to all online students, the goal of a personalized e-learning process is to provide different learning activities, with different amount of knowledge to students with different needs, capabilities, and interests, or to different categories of students.

Each course has a syllabus specifying what a student must learn and know. As students have different background and starting knowledge, different learning capabilities and motivations, and may have different learning styles, it is necessary to offer them different learning processes with different learning materials. The best students usually expect and can learn more than is planned. Low-level students are interested only in passing exams and are interested to acquire the minimum of expected.

The goal of our personalization of e-learning is to offer different amount of knowledge to different categories of students. The exceptional students will be provided with the learning material allowing them to achieve knowledge levels above the red line. Good students will get the learning material that will enable them to achieve the planned, target knowledge levels, i.e. near the red line. Low-level
students should get the learning material that will allow them to reach the minimally acceptable knowledge levels (the green line). Each professor, as an author of a course, needs to decide what the minimal knowledge levels are for each of knowledge areas covered by the course. So, low-level students will now exactly know what they need to learn and to know to pass the exam. No more than that. It will be easier for them to prepare themselves for an exam.

To achieve these goals, it is necessary to specify and create few categories of students. Each of them will get the most suitable learning paths for each course with different learning materials. It is expected that these learning paths will provide more efficient learning for each of students' categories.

To realize the goals of personalization of e-learning process, the personalization method should allow automatic generation of different learning paths of an online lesson, one for each category of students. For instance, Figure 2 shows four different learning paths, each for one category of students. These four learning paths may be generated from only one master learning process shown at the top in Fig. 1.

Figure 1. An example of four generated learning paths from a learning process of a lesson.

Each learning activity provides an amount of knowledge suitable for one of the categories of students. Some of them may be similar, but with slight differences in their knowledge contents. Each evaluation activity provides the assessment of achieved results of learning. These results may be used to specify next, appropriate learning activity for each student. Instead of using evaluation results, a course designer may allow students to choose one of offered learning and other activities. This allows a student to use not only a learning path of his category but also to mix learning paths of different categories. A process branch may be automatically activated as the result of knowledge assessment of a student or may be chosen by a student. These are two basic branching options, and a course designer (usually a professor in charge for the course) needs to specify one or both of these choices in each of branching point of a learning process.

Figure 2 shows two typical cases of branching of a learning process. The first case of branching (Fig.2.a) is the result of the assessment of student's knowledge. The second instance of branching (Fig. 2.b) is the result of student's choice of one of offered learning or other activities.
A designer of an online lesson (typically, a professor) creates the master e-learning process model with many branches by using these two branching options. These are a very delicate task, as the master learning process model must supports all specified categories of students and must provide process branching that will provide appropriate learning paths for each of category of students. A designer of an online lesson creates a master e-learning process that is adaptable to student’s needs and preferences. So, the master e-learning process model may not be only a generator of fixed, planned learning paths for all categories of students, but also a tool that allows each student to control its learning process.

The described method of personalization requires the following:

1. The knowledge planned to be delivered to students during an on-lesson should be given in small chunks of knowledge to allow delivery of different amounts of knowledge to different categories of students. It means a learning process should use learning objects with low granularity, with small knowledge units.

2. Learning Management Systems (LMS) should support the use of fine-grained learning objects and use of learning processes with learning activities providing these learning objects. Learning methods should encourage branching. Different branches represent different learning paths to different categories of students.

### 3 RESULTS

#### 3.1 Learning objects

Use of fine-grained learning objects is one of the preconditions for implementation of the proposed personalization method. A learning object is a small chunk of knowledge that a student must learn and represents a pedagogically feasible unit of knowledge. It can be atomic or complex. An atomic learning object (LO) contains a minimum unit of knowledge that is necessary for the student to know. An atomic learning object may have one or more sections. Each section has three components: Section Title, Abstract, and Content, which holds the actual learning content in the form of text boxes, notes, figures, code snippets, etc. [2]. A complex learning object contains many atomic learning objects. An online lesson usually includes both complex and atomic learning objects (Fig. 3).

Each learning object provides the following information:

- Title of the learning object
The most important information component of a learning object is the knowledge presented in the content part of a section. BMU has developed mDita Editor [4] as an authoring tool for development of multimedia knowledge presentations of e-learning materials (Fig. 4). An author can insert different forms of knowledge elements:

- Text
- Figure
- Snippet – a program code in Java, C++, C#, …
- Latex – for mathematical expressions
- Note
- Video clip
- Audio clip
BMU is using mDita Editor for creation of its e-learning materials for almost 200 online courses, and its Repository of learning objects currently contains more than 70,000 developed learning objects. Metadata are used for searching of learning objects, when an author needs to find a suitable learning object, already developed, for its online lesson. Use of the Repository of developed learning objects increases their reusability. Reusability of learning objects enhances the efficiency of the creation of online lessons, reduces their cost, and improves their quality.

Using the following parameters may do a search of learning objects stored in the Repository:

- Audience – the courses that are using the LO
- Object Title

Figure 4. mDita Editor, an authoring tool for creation of multimedia learning material.

Figure 5 shows a section of a learning object, as seen by students.

Figure 5. An example of a section as seen by a student using LAMS.
Figure 6. A simplified view of creation and production of an online lesson's learning material.

mDita Editor creates learning objects using DITA standard [4] designed for the organization of documents as collections of objects. Each DITA object is represented with XML. The Repository of Learning Objects contains DITA objects. DITA objects may be converted to HTML for Web content presentation of learning objects, or to PDF format, for presenting learning object as a PDF document (Fig.6). mDita Server is the software module of the developed systems that performs these conversions and manages developed DITA objects in their Repository. LAMS Sequence is a Web presentation of a lesson, with all activated learning and other activities, and with associated learning objects.

3.2 Learning process

To satisfy the specified requirements for implementation of the proposed personalization method, it was necessary to choose or to develop a LMS (Learning Management System) that meets these requirements, i.e. supports learning objects and learning processes with branching. After an evaluation of known LMS systems, Learning Activity Management System (LAMS) [5] was chosen for delivery of online lessons to students in two forms:

- Web presentations (in HTML) of online lessons using Web browsers, and
- Lecture Note as a PDF document containing a lesson in a printable form.

Each online lesson consists of a title, metadata, introduction and conclusion sections, and many learning, evaluation and other activities (Fig.7). The lesson designer has to decide how many learning activities are necessary and to specify an atomic or a complex learning object for each learning activity. He also has to choose one or more evaluation activities associated with each of learning activity. Based on the assessment of student's knowledge, as a result of a learning activity, a next activity is automatically activated. LAMS provides few evaluation activities:

- Assessment
- Multiple Choice
- Question & Answer
LAMS also provides a set of other activities supporting different kinds of communications among students, and between students and instructors. mDita Editor currently supports the following LAMS activities:

- Chat
- Forum
- Shared Resources
- Submit Files
- Notebook
- Notice board
- Picture Gallery
- Mind maps - see [7]

They are typically used at the end of each lesson but can be used anywhere in a learning process. They may also be used in evaluation activities. For instance, if a student does not post his opinion in the Forum, he cannot start with the next activity.

As BMU has four BSc programs in informatics, it is needed to evaluate students’ computer programs automatically. Instead of using external services that provide automatic testing of computer programs, BMU decided to develop its own software for automated testing and evaluation of software. The first such software is named Java Grader, as it checks programs written in Java [6]. Currently, these programs are limited to only one class, but on-going development will in near future allow testing of programs with many classes. Figure 8 shows detailed test cases and automatic testing of a Java method. An activity of the external grader may contain one or more tasks. Tasks are presented within one page in the order defined by the author. Each task consists of:

- the text of the task
- entered solution in the form of a method of the Java programming language that is checked by the system
- parameters based on which the system checks the answers
- expected results according to set parameters
3.3 Examples

Figure 9 shows an example of an e-learning process with two branches created with LAMS Designer module of mDita Editor. This e-learning process contains five learning activities with five learning objects, and some other activities specified after the first learning activity (LO=01), and after the conclusion section, in two branches.

Branching may not be related to any evaluation. Branching activity may also give an opportunity to a student to decide which of the offered optional process branches he wants to choose. In any case, e-learning process designer must specify branching conditions. It is necessary to specify conditions for activation of each of branches. These conditions use results of previous activities of LAMS, such as Forum, Multiple Choice, and Assessment.
Figure 10 shows the specification of conditions for activation of the Branch 1 of the process from Fig. 10. It will be activated if the activity Forum–Odgovor 2 has a post.

![Figure 10. Specification of conditions for activation of the Branch 1.](image)

Figure 11 show another example with an e-learning process that allows a student to choose one of offered learning and other activities in four steps of the process.

![Figure 11. An example of a process in which a student chooses one of the offered optional activities in four project steps.](image)

Editor allows learning process designer to specify a process model that can generate different learning paths for various categories of students. Also, mDita Editor supports the design of e-learning processes in which students may have more control of their learning, by choosing one of offered learning and other optional activities.
4 CONCLUSIONS

The proposed approach to personalization of e-learning in this paper allows that online students in a class may use different online learning materials and different learning paths. This allows a Higher Education Institution (HEI) to offer to their students a possibility to choose one of the offered categories of students. The best students will finally have an opportunity to learn more than it is planned, as in common cases when all students have to follow the same program and to use the same learning material.

The best students may have an opportunity to get deeper knowledge in some knowledge areas, but also a possibility to horizontally expand their knowledge in new knowledge areas, thus improving their multidisciplinary knowledge and skills. Course designers (professors) may use Optional Activities to allow each student to choose optional learning and other activities anywhere in a learning process, and as many times as it is needed.

Low-level students, struggling only to pass exams, now have an opportunity to know exactly what they need to learn to pass their exams. They will get a learning material that contains only the minimal amount of knowledge for passing an exam. This will allow them to easier prepare them self for their exam. As a consequence, HEI may expect an increase of success on exams and fewer dropouts. It is recommended that each student decides in which category he wants to belong. During the course, they may change their categories. At the end, they may choose the exam questions and problems prepared separately for each of categories of students. But, they also take the risk not to pass the exam if they chose a more difficult exam option. The implementation of the proposed approach to personalization of e-learning require that an HEI must:

- use fine-grained learning objects to allow differentiation of learning materials for different categories of students;
- use different learning objects for various categories of students for the same learning topic;
- use an LMS system that supports learning objects with small granularity and use of learning processes with branching.

Obviously, professors have to prepare more learning materials to support needs of all categories of students.

Giving an opportunity to students to choose learning and other activities in a learning process, provide them with a freedom to individually customize a course that best suit their need. For instance, students on a master course usually have different learning background and initial knowledge levels, as they come from different bachelor studies and HEIs. By using Optional Activities, they may choose learning activities that may fill their knowledge gaps, and to follow easier more advanced topic of the course.

On the other hand, use of personalized and adaptable learning processes (use of Optional Activities)

- improve the quality of education,
- allow students to develop their individual capabilities and satisfy their different learning needs,
- improve the efficiency of education, and
- may reduce dropout of unsuccessful students, as they now can easier prepare their exams.

E-learning does not need to be restricted only to students of online programs. Students of traditional, in-class (face-to-face, F2F) study programs, may also use e-learning and personalized online learning materials. This is the case at BMU, where all students (in-class and online) use the same learning materials delivered online.

BMU is now ready to implement the proposed approach to personalization in a pilot course, offering three categories of students: A (the best), B and C (low level). If the results are positive, the proposed personalization of e-learning will be gradually implemented to all courses and programs. This will be possible, as the groundwork has been done. Each course has developed many fine-grained learning objects. Using them as “Lego boxes,” they are now ready for development of models of learning processes that will generate different learning paths, with different learning materials, to different categories of students.
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REFERENCES


