Personalized System of Distant Education

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Abstract
In the last years there was a fast development of the Internet technologies, which was followed by the possibility of using them almost on every field of life. One of these fields is distant learning, or e-learning. Day after day it is becoming more and more popular and many schools use teaching platforms as the alternative solutions to the traditional teaching. Nonetheless, there is still not perfect software supporting such teaching, satisfying the needs of all learners. This paper is a description of the implementation of a personalized distance learning system.

Key words
personalization, e-learning, classified features, implicit profile, education path

PERSONALIZATION OF WEB PORTALS
Growing and diverse requirements of portals’ users contributed to undertaking works related to the adjustment of the portals to the individual needs of users, or to their customization. For people using the Internet it is not enough that they can independently adjust the appearance of the browser or the page to their preference. They expect that the browser itself will adapt to their needs. The expectations of people using educational portals are the same. In addition, the users of online courses demand an individual approach. Hence the need for personalization.

There are many definitions of modern personalization. One of them is cited in (Mobasher, Cooley & Srivastava, 1999): personalization can be defined as the use of preferences of individual users to dynamically adapt content services to meet their needs. User preferences can be obtained directly from the people using the portal or through passive observation of the behavior of the users during their work on the web. In these solutions, a site has been defined as an object that can be modeled for people using it (users), by matching between subjects and objects and determining sets of actions recommended by the personalization process. Another definition of personalization was presented in (Eisenbardt, 2008): personalization is the process of matching the program, website, and the entire system to individual needs and preferences of individual users or groups of users. With such a defined process of personalization, the conveyed information is gaining context and becomes more adapted to the situation in which a person using the site is. According to (Staś, 2007): personalization is adapting settings, appearance or behaviour of an application, to the individual needs of the user. As for web portals, personalization is the "use of known, discovered profiles of preferences for the dynamic adaptation of the content to the needs of individual service users".
From these definitions of personalization one can deduce that its main task is to bring the websites to the needs and expectations of users, aiming thereby to increase the level of user satisfaction. With regard to e-learning, through personalization the students are presented with the best possible individual, dynamically modified content of teaching, which to a much better extent meets their expectations (Dębska & Kubacka, 2011).

Mechanisms of individualization of the education process should follow a series of personalization (Staś, 2007). It consists of three elements: knowledge, planning, and contact. The element knowledge requires maintaining a constant and consistent knowledge of the user based on which the contact with the user (element planning) is designed. Contact should be planned and carried out so that it was possible to increase the knowledge about the user (element contact). These elements form a cycle shown in Figure 1.

![Figure 1: Cycle of personalization – on the basis of (Staś, 2007)](image)

Implementation of the cycle of personalization should be carried out continuously. In this way it becomes possible to adapt the results of the personalization to the changing adaptive conditions of learners (Staś, 2007). In addition, the characteristics which a web portal should possess to be called a personalized portal are:

1. dynamism,
2. intelligence,
3. automaticity.

We can say that a site is dynamic when it adjusts to the individual needs of the users. And it is not just about the web interface, but the response of the portal to the behavior of the user. The intelligence of the site is determined by using the techniques of exploration and knowledge processing to its creation. Automaticity is aimed at uploading the appropriate data after the individual exploration of the page content. It is also assumed that personalization should be done in a transparent manner, that is unnoticed by the user and not requiring taking any further action by him (Dębska & Kubacka, 2011).

**METHODS OF DATA COLLECTION OF PORTAL USERS**

For the purposes of personalization data are collected on each student. They can be collected in two ways: explicit or implicit. Explicit profiling, also referred to as direct profiling, involves collecting data directly from the user. This is done by filling in a questionnaire or survey. This method of profiling takes place for example in setting up an email account, an account in an online shop, or when signing up for the e-learning training. In this method, the user determines his/her own preferences of the portal contents. The disadvantages associated with this method of profiling include high subjectivity and the reluctance of people to fill out forms (Dębska & Kubacka,
Implicit profiling, also known as alleged, is based on observing the behavior and reactions of users. The information of the user preferences are collected then (e.g. by creating schemes of web sites browsing). The data saved in logs, cookies or session paths are collected this way and then they are placed on a server and next they are analyzed. The information system takes the data into consideration and then it adjusts the portal content to their expectations (Dębska & Kubacka, 2011).

In case of e-learning portals both methods of obtaining the data are used. The data obtained explicitly include personal data, the student credit book number but also the tests results and the number of approaches to solve the test. The time spent on solving lessons and tests are the data obtained implicitly by automatically running applications placed on the portal. The user profile is created on the basis of these characteristics and it is then used in preparation of the educational offer.

Collection of data about users helps prepare user-friendly interface. On the educational portals, we are dealing with two types of interfaces: a student and a teacher interface. The flexibility of each of them can be ensured by the tools of artificial intelligence, such as agent systems (Liang, Zhao & Zhu, 2008).

If you use the agenda systems, the agent of the student interface provides a flexible interface to interact with the learner. It provides the student with the feedback, test results, receives recommendation from another agent and displays them to the student. In addition, students can use the on-line help to solve the problems encountered during the process of learning. It should be noted that if a student uses the personalized system for the first time, he/she must register as a user and enter some basic information about themselves. Then the student interface agent sends the information to the student's account in the database (Liang, Zhao & Zhu, 2008). User data are gathered here in a transparent manner.

The second interface, the teacher interface, is administered by a teacher agent interface. Through this interface, teachers can update, delete, or revise and test the items stored in the repository of courses and testing. The teacher may also direct the response documents to the response repository, respond to students' questions. The system described in (Liang, Zhao, Zhu & 2008) is fully personalized, meets all the criteria for personalization.

**PERSONALIZATION OF e-STUDENT PORTAL**

The e-Student portal is an educational portal of the State Higher Vocational School in Krosno. In order to match the educational content to the individual student better, to facilitate the assimilation and understanding of its contents, the work on personalization of the portal has been started.

A test course in the subject *Algorithms and data structures* has been created. The course material has been varied because of the degree of advancement of students, each of the stages has been given a number of educational path. Students in the advanced group learn on the path No. 3, the average group path No. 2, and elementary path No. 1. The division of students is done by grouping. It is based on the past user behaviour, characteristic groups are created and people with similar characteristics (similar profile) are included in them. Then, for each student a classification process is performed, i.e. it is checked out which group he/she fits best and on this basis resources are made available to him/her, the most suitable for a particular group, i.e. those which should meet their needs best.

The course in the discussed subject was also enriched with the preliminary classification module. It consists of the lesson content and tests covering the prerequisites.
conditioning the participation in this course. Initial classification is performed using cluster analysis. As a result, the student is qualified for the primary learning paths and thus he/she is provided with the educational content suitable for his/her level of knowledge. If a student is not classified even to the elementary group, he/she is required to revise some earlier parts of learning material. The students from the elementary group, in turn, are supplied with the learning material according to the educational content stored in the subject card. The students belonging to the average and advanced groups are given the materials prepared in advance, the content of which extend beyond the basic frame of the subject. Studying the content and learning the additional parts of material will allow the students to develop their competence and skills.

Grouping algorithms, making the initial classification is described in detail in the work (Dębska & Kubacka, 2008). On the basis of the following characteristics: exam grade in mathematics, exam grade in the basics of programming, test results from the following sections: the basics of programming and mathematics, students are connected in 3 homogeneous groups. Each of them will be provided with the appropriate educational materials. It should be noted that the positive passing of these subjects is a prerequisite to register for the course *Algorithms and Data Structures*.

After completion of the first and each subsequent module the student is subjected to reclassification, and the path of education is determined for him. As a result, the classification system becomes a dynamic and evaluating system, responsive to the improvement or deterioration of every student's education. The attributes that are taken into consideration while creating the individual educational path after passing successive lesson modules are following characteristics describing a student:

- the current path of education,
- the results of the previous test,
- time needed to complete the test,
- number of approaches.

The analysis and tests of the time measurement algorithm which is implemented in the Moodle platform version 1.9 showed that the results of the time measurement is wrong. Therefore another application measuring time of students’ activities has been created. Its main purpose is measuring students’ activity time in such a way that will reflect the real activity time of a student working on the educational portal. To gain the expected effect, the user activities on the portal were carefully analyzed. It was not enough just to analyze the registry of entries in the students' database but it was necessary to research the activities in the portal window as well. It was crucial to eliminate a situation when after the user leaves the place, minimize or closes the window or because of the lack of activity within the window, the time is treated as the active work time. Such an approach opens up new possibilities of the control of students using the portal. Calculated time does not reflect the period in which the portal was opened in the browser but actual time in which you focus on the material contained therein. The application makes it possible to calculate a separate activity time for all course resources. This allows you to check how much time a student spent on the acquisition of a particular material and how much on e.g. a test, which allows to evaluate the effectiveness of the learning process (Debska, Musiał & Sanokowski, 2011).

Characteristics describing the student are used to determine the most effective student learning paths. The current number of pathway is saved to the database and it becomes a feature to be considered at the next classification.
For the purpose of the program classification the Moodle database has been expanded by an additional table, called block_treminder, which apart from the student identification features contains a number of an educational path where he/she currently is. The number of an educational path is saved in the column rank (Fig. 2).

```
<table>
<thead>
<tr>
<th>id</th>
<th>courseid</th>
<th>useri</th>
<th>itemid</th>
<th>grade</th>
<th>timeseen</th>
<th>attempts</th>
<th>rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
</tbody>
</table>
```

Figure 2: An example of a table for the users who start a course on e-Student portal

The table is made for every student enrolled on a course. It consists of 8 columns with the information from other tables of the Moodle database as well as with the data saved after completing the test. The column id is an identifier increased automatically. Courseid contains the identifier of the course, which is taken from the courses table. In the column userid there is an identifier of the user, taken from the users column. Itemid is an identifier of a completed module taken from the grade_items table. Grade is a user’s grade taken from grade_grades table. Timeseen is the time in which a test (quiz) was completed, expressed in seconds. Attempts is the number of approaches to solving the test. Figure 3 shows a fragment of a table containing the data recorded after completing a test by the students.

```
<table>
<thead>
<tr>
<th>id</th>
<th>courseid</th>
<th>userid</th>
<th>itemid</th>
<th>grade</th>
<th>timeseen</th>
<th>attempts</th>
<th>rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>879</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>989</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>678</td>
<td>1</td>
<td>3</td>
</tr>
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<td>4</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>878</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
```

Figure 3: A table after completing a test by the students.

The application that determines the number of the group is an external program that runs after the time that has been designed to deal with the content of a lesson module and it has the characteristics of an agent program working in real time. Features of the student that are included in the classification, have been given the following weights:

- the test result – weight 0.4,
- previous learning path – weight 0.3,
- the time of completing the test – weight 0.15,
- the number of attempts – weight 0.15.

The results of the work of classifier is saved in the rank column. The classifying algorithm was described in detail in (Dębska & Kubacka, 2012).

**THE RESULTS OF THE CLASSIFICATION SYSTEM**

In order to measure the effectiveness and correctness of the classification system, a group of 57 participants of the course Algorithms and Data Structures were examined. As the result of the preliminary classification program, the group of 57 students was divided into 3 homogenous groups, interpreted as 3 disjoint subsets of students qualified for the advanced, average and elementary levels. The number of students in particular groups are as follows: 8 persons were qualified to the third group (advanced) and assigned to the third learning path, 28 to the second group (group of students with knowledge at the average level) and 21 to the first group (students
who will be educated at elementary level). Test course has been divided into the following 4 sections (modules of the course):

- estimating the complexity of algorithms,
- RAM machine,
- the dynamic structure,
- sorting algorithms.

Each section ends up with a test checking student's knowledge. After a deadline, by which the students are supposed to solve the test, a classifying program is started. Basing on the characteristics mentioned earlier, it directs the student to the right path of education. Specific number of students who were put into the right paths of education after completing each module of the course, has been compiled and presented in Table 1.

<table>
<thead>
<tr>
<th>No of the learning paths</th>
<th>Module 0</th>
<th>Module 1</th>
<th>Module 2</th>
<th>Module 3</th>
<th>Module 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary classification</td>
<td>Section estimating the complexity of algorithms</td>
<td>Section: RAM machine</td>
<td>Section: dynamic structure</td>
<td>Section: sorting algorithms</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>10</td>
<td>22</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td>33</td>
<td>21</td>
<td>29</td>
<td>27</td>
</tr>
<tr>
<td>1</td>
<td>21</td>
<td>14</td>
<td>14</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1: The number of students at each educational path after completing each module of the course Algorithms and Data Structures

After the first module the classifier assigned 14% of students to the path no 3, 49% to the path no 2 and 37% to the path no 1. After completing the section RAM machine, 17% were assigned to path 3, 58% to path 2 and 25% to path 1. After the next section, 39% were assigned to path 3, 37% to path 2 and 24% to path1. After the last module, 35% were assigned to path 3, 47% to path 2 and 18% to path 1.

Detailed analysis of the results allows to draw conclusions that only seven people completed each module remaining on the same educational path all the time, including the 5 students belonging to the average group and 2 belonging to the elementary group. Learning paths designated for other people have changed. In 7 cases students finished the education at a lower level of education than the one that was originally defined for them. However, 43 people in the study changed the educational path to a higher one.

**CONCLUSIONS**

The personalization of the educational e-Student portal was made possible thanks to the use of modern technology achievements. The described method allowed to introduce the method of individual educational paths to the e-Student portal used by the students of the State Higher Vocational School in Krosno for self-education. Knowledge of website users is collected continuously. Data regarding time spent on the lessons, grades obtained in the tests, the number of approaches to tests are recorded and stored in the Moodle database. Everything happens on a continuous basis so that it is possible to adjust the results of the personalization process of adaptation to the changing conditions of learners. The adopted solution met all the assumptions of modern personalization process. The e-Student portal is characterized by dynamism, intelligence and automaticity of the assessment of the level of perceptive abilities of the students using the blended learning method. In response
to user behavior, the content presented to him/her is automatically adjusted to his/her expectations and abilities. Results of this study show that the portal fulfills all the requirements. By carrying out a series of personalization it helps to improve performance and the quality of education. The results of the students also contribute to improving the quality of materials that are made available to them. Students are encouraged to taking up creative activities, learning to be systematic and independent in the acquisition of knowledge, while working with a group at the same time. The authors will be conducting further research, leading to improvements of the portal and to improvements of the portal personalization mechanism.

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Biographies

Barbara Dębska is an associate professor at Rzeszów University of Technology, and Head of the Department of Computer Chemistry. Her main research interests are chemometrics, expert system technologies and designing decision support systems for chemistry and the chemical industry. Another field of her interest is e-learning methods in teaching and learning in higher education.

Agnieszka Kubacka is assistant in the Institute of Technology in Department of Informatics at State Higher Vocational School in Krosno. Her research also concern with e-learning system, especially organizing and personalization of the learning process and using for these aims of artificial intelligence methods. She is co-author of several articles about using modern technology in online education.

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