

Adaptation of Online Courses for Students with Different Educational Backgrounds and Predispositions for Learning

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Abstract— In this paper a proposal for adaptation of course Algorithms and Programming will be presented. This course is in first year of academic studies at faculty of Electronic Engineering in Niš, University of Niš. In the past decade different approaches for adaptation in e-learning systems have been proposed. Also, categorization of students can be done in several ways and adaptation and personalization can be implemented for groups of students and for individual students. All this provides variety of possibilities for realization and it is important to choose the best approach for specific case. Within this paper, we will discuss and present the best solution for adaptation of the course which is attended by students with different educational backgrounds and predispositions for programming and algorithm creation, in order to facilitate the learning of the course material.

I. INTRODUCTION

It is not a rare case that one course is attended by students with different backgrounds and predispositions for learning. This is especially common in the first year of studies on faculties where students choose departments in the second year of their studies. Educational program of such faculties is usually conceived to have at least one elementary course from each department of the faculty, on the first year of studies. In some cases, content of these courses can be quite challenging for students with different predispositions for learning to comprehend and learn.

At the Faculty of Electronic Engineering at University of Niš, all students must take the course Algorithms and Programming in their first year of studies. Within this course, they learn the basics of algorithm's creation and programming. Teachers' experiences from this course have shown that each year, there are two groups of students. One group consists of students that pass this exam without any problems in first examination term. In the other group are students that have a big problem with learning and passing the exam. Usually students from second group leave this exam as one of the last exams on their studies. Also, the experiences of the teachers show that students that pass this exam without any problems, later usually choose Computer Science Department to continue their studies and those that had problems passing the exam, choose other departments.

Based on the experiences of professors and teaching assistants on this course it was established that each year there is huge number of students that have problems with learning this course's materials and passing the exam. The

main reason for this is that this course is attended by students with different background. They come from different high schools and some of them have never learned any basics that can be very helpful for learning this course's material. Those students have more challenges during preparing this exam. Another reason for this situation is that all students on Faculty of Electronic Engineering must take this exam. Many of them don't plan to go to Computer Science department and have no interest in programming and construction of algorithms. Furthermore, many of them don't have predispositions for this type of subject. Because of that, for them learning this material can be very difficult and thinking in that way can be very challenging.

Because of these differences between the students, it is important to use possibilities that come with e-learning systems and adapt and personalize the content of the course, so that all students can learn it more easily and pass the exam without too many difficulties. Also, it is extremely important that the content of the course remain the same, since it contains only the basic knowledge of the subject which all students that attend the Faculty of Electronic Engineering should be familiar with.

In order to achieve this goal, the adaptation and personalization of the course's content based on the student's background and predisposition for learning has to be done.

In the next part of the paper, adaptation and personalization in e-learning will be discussed first, and special attention will be given to approaches for adaptation of lectures. Also, adaptive e-learning systems will be explained with focus on ways for providing adaptation in e-education system. Further in the paper, the proposal for adaptation of course Algorithms and Programming at the Faculty of Electronic Engineering at University of Niš, will be given. Within this part of the paper, categorization of the students will be discussed, along with methods of their categorization into groups.

II. ADAPTATION AND PERSONALIZATION

With new possibilities in the world of teaching and learning in the past decade, personalization and adaptation of the e-learning systems is becoming important characteristic of these systems.

When designing system's adaptation it is very important to understand student's differences. Student diversity can be observed through three aspects [1]:

- Learning style – this concept refers to the fact that some students prefer specifics and observable phenomena and other are more comfortable with theories and abstractions. This concept also refers to the fact that some students better understand and remember visual information and others make better progress with verbal explanations [2].
- Approaches to Learning and Orientations to Studying – students have different approaches to learning. Some students have surface approach and remember only most important things and make no effort to understand the point of the lesson. Others have deep approach and go into details with every subject and finally there are those that have strategic approach and learn only what is needed to get the highest grade.
- Intellectual Development – most of the student think that knowledge is certain and they only need to learn same facts and repeat them at some point. But there are some students that see that knowledge is contextual and that they should make their own conclusions based on evidence and not only on professor's word.

For all these groups different approaches are required in order to personalize e-learning system so that it can be suitable for everyone. However, in the past decade term personalization of these systems is referring to [3]:

- personalization of the learning content based on student's preferences and background,
- personalization of representation of the learning content,
- and combination of the two.

Adaptation of e-learning systems refers to a process where learning content is being delivered to learners adaptively, which means that the appropriate contents are delivered to the learners in an appropriate way at an appropriate time based on the learners' needs, knowledge, preferences and other characteristics [4]. It can be done by one of these criterion or few of them, based on the goal that is set to be achieved.

Adaptation and personalization of e-learning systems can be done for a group of students and for each student individually. Adaptation for each student individually means that every student in the system will have his own personal space which will be adapted based on his habits, interests, preferences and wishes. It can be done in different levels, from adapting only user interface to adapting every aspect of it with focus on the course's content. Since this can be very challenging, most systems today make adaptation for groups and not for every student individually. First they form a certain number of groups which are combination of criteria they want to use for adaptation of e-learning system and then they split all students in those groups by assigning each student to one group.

Personalization of LMS nowadays usually has focus on controlling which courses the student is allowed to view and restrictions within the course. Some e-learning systems allow personalization of student's profile, which refers to creating personalized calendar, editing user interface and adding additional widgets. These solutions usually do not include any kind of automatic adaptation of

learning content based on student's preferences and learning style.

Recently, there has been a progress in creating systems that adjust content based on student's profile, his habits, learning style, skills and preferences. There are many different ways this branch can be studied, developed and where the focus can be put. One solution that includes some of the characteristics is presented in [5] and refers to adjusting content by using environmental and location information for mobile learning in field of environmental sciences.

In the field of learning foreign languages, there were attempts of development of systems that recommend reading material based on knowledge level and preferences, and reading annotations which can be individual and shared [6].

Huge attention has been given to the e-learning systems that are intended for people with special needs for learning. These systems have focus set on the special needs of the users and adaptation and personalization is done based on those needs [7] [8].

On the other hand there are systems created for general use and not for some special area which provide adaptation of learning content. Some scientists went in another direction and proposed multi-agent systems that are learner-centric and improves learning outcome, satisfaction of learners and enhances education [9]. This approach uses multi-agents which communicate with each other and create content for each student based on his knowledge level and skills (past), preferences (present), learning performance, and objectives (future).

Most of all systems that provide personalization of content use algorithms and methods that choose proper content and subject based on user's profile. These systems make decisions regarding what would be interesting for the user, choose topics that are similar to those he already know, define a level of knowledge he can gain from the course based on his predispositions and present the content in personalized way. But for these systems it is not common to have predefined knowledge that one user should learn and do the adaptation of that system so that user can be comfortable learning it.

III. COURSE ADAPTATION

Within this paper we will discuss the best approach for adaptation and personalization of the course Algorithms and Programming at the Faculty of Electronic Engineering at University of Niš, in order to provide better material and learning conditions for different types of students. First, we will discuss the best way for dividing students into groups for which the adaptation will be done. After that, description of the workflow will be provided and at the end, solutions for personalization and adaptation will be proposed. Since the Faculty of Electronic Engineering in Niš uses Moodle LMS [10], we will propose a solution that uses possibilities of Moodle LMS in order to make adaptation for lessons' content.

A. Student types

In the previous part of the paper, it was explained that adaptation of e-learning systems and material can be done for groups of students and for individuals. Regardless of the choice, it is important to establish criteria by which the adaptation will be made. As it was already presented in

the paper there are different ways for establishing criteria for adaptation. In the case of the Algorithms and Programming course, those methods and algorithms are not suitable, since the goal is to teach all students the same material. The aim is only to adapt the presentation of the material based on the group they belong in. Because of that, we have decided to group students by two characteristics that we find relevant for adaptation we want to provide:

- by the background they have at the beginning of the semester,
- by their predispositions for programming and interest in the subject.

1) *Grouping students based on their background*

A first criterion for dividing students into groups is based on their educational background. This criterion is chosen because not all students come from high schools with same educational program. This results in having students that had never had any subjects that would give them basics for this course. On the other side, there are students that have done some programming in high school and have more than enough educational background to attend the course. These differences between the students' background require different approaches while explaining material to those students with no previous knowledge and to those that have some. Fig. 1 presents groups defined by student's educational background at the beginning of the semester.

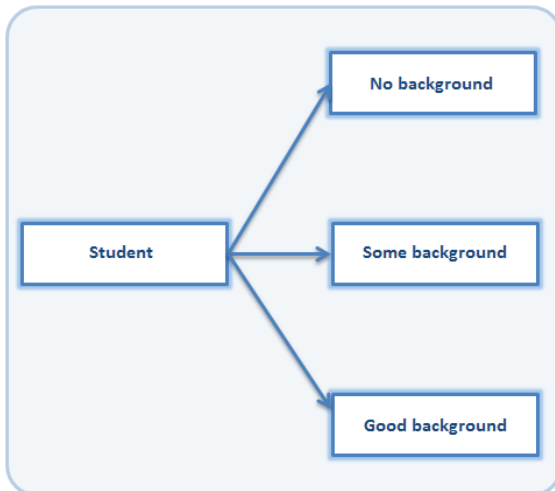


Figure 1. Groups of students based on their background

As it can be seen from the Fig. 1, all students are split into three groups based on their previous knowledge:

- Students with no educational background – this group consists of those students that have absolutely no educational background from this field of subjects. They come from high schools where they did not attend any subject from this field and are expected to have some problems attending the course and following the lessons. These students require more attention during introductory lessons of the course, in order to get them closer to the subject and enable them to more easily follow the classes later in the semester.

- Students with some educational background – this group consists of students that have enough educational background to attend the course with no problems in regards to understanding the subject and attending the lessons.
- Students with good background – this group consists of students that have more than enough educational background to attend this course. They come from special high schools for Computer Science and Informatics and have done enough programming during the high school.

2) *Grouping students based on their predispositions for programming and algorithm creation*

A second criterion for dividing students into groups is based on their predispositions and interest in the subject. Decision to include this criterion is based on the experience of the teachers involved with the course. The experience showed that many students that have attended this course do not have predisposition for programming and thinking in the way that is natural for programmers, regardless of previous experience. Because of that, this course is very hard for them and they have many problems in passing the exam. For that reason we decided to put this as a criterion for grouping students. Fig. 2 presents defined groups based on this criterion.

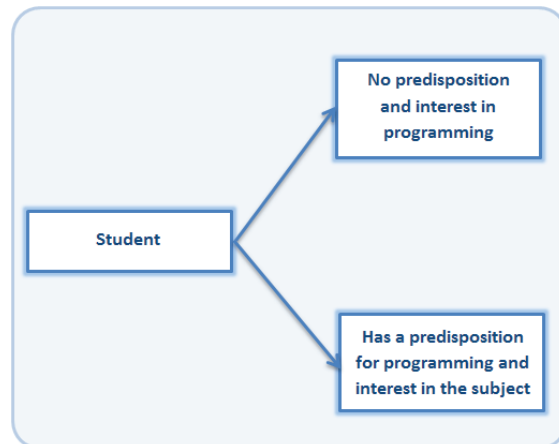


Figure 2. Groups of students based on their predispositions and interest

As it can be seen from Fig. 2, all students are split into two groups based on their predispositions for the subject:

- Students with no predispositions for the subjects – are students that have no predispositions and talent for programming and constructing algorithms. Usually these students entered the Faculty in order to choose some other department and not the department of Computer Science. Since they have no talent for this kind of subject, they need special attention in order to learn the teaching material of this course. It is important to teach those students to think in a way needed for this subject and to approach lessons in a way that will be familiar to them.
- Students with predispositions for the subject – are students that probably won't have any problems with this course. They have good predisposition for the course and are interested in programming and

algorithm construction. These students already know how to think in that way and needn't any special approaches for teaching. These students entered this Faculty with a goal to continue their studies on Department of Computer Science.

B. Student categorization

Students should be split into groups at the beginning of the semester. Fig. 3 presents a flow for categorizing a student into appropriate group.

Since Faculty of Electronic Engineering in Niš uses Moodle LMS [11], each student has a profile at Moodle LMS and at the beginning of the semester they enroll in the course. As it can be seen from the Fig. 3, at the beginning of the flow, student logs on the Moodle system and enrolls in the course.

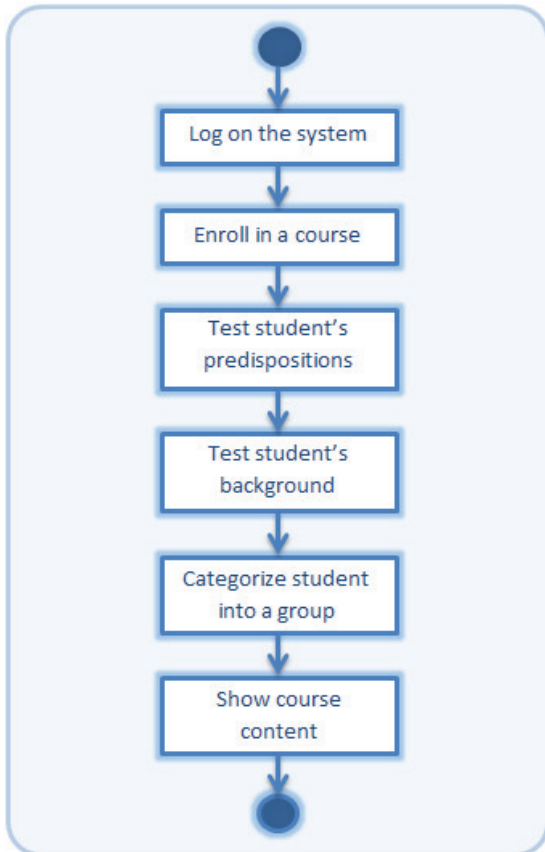


Figure 3. Categorization of students into groups based on their background, predispositions and interests

At this point students should be divided into groups based on criterion that was presented in previous part of the paper. This is done with two-step student testing: first step is to determine their predispositions and after that to determine their background. The results of both tests will show in which group student belongs. Testing can be done by using appropriate Moodle Quizzes. For this part, mobile application MoodleQuiz [12] can be a very useful tool for testing students, since it provides possibility to test them out of the classrooms.

First, student will take the test that estimates their predispositions for the subject. Questions for this test will

be constructed in consultation with psychologist in order to make reliable estimation of student's predispositions. At the end of the test student won't be able to see the test results, since test is not of such nature.

In the second step, students will take the test that estimates their educational background. Questions for this test will be prepared by teachers, since they can make the best estimation of the previous knowledge that is enough for student to take the course. Correct answers in the quiz will not be presented back to the students, since that is not relevant in this case.

After both tests are done, system will categorize students by their results into groups. At the end, students will receive only a number of the group they were categorized in and beside the regular content of the course, adapted content for their group will be presented to them.

Although two criterions that are used for student's categorization make six combinations, we will create four groups of students (four student's profiles). Fig. 4 presents groups that are created based on both criterions. As it can be seen from Fig. 4, groups are defined as: profile 1, profile 2, profile 3 and profile 4.

In *profile 1* are students that have no educational background and have no predispositions for this kind of subject.

In *profile 2* are students that have no educational background but have predispositions for this type of subject.

In *profile 3* are students that have some educational background or have good educational background and have no predispositions or interest in the subject.

In *profile 4* are student that have some educational background or have good educational background and have predispositions and interest in the subject.

Decision to group students with some background and those with good background in the same profile was made because students from both groups are able to follow lessons without problems and does not need special approach for explaining the lessons.

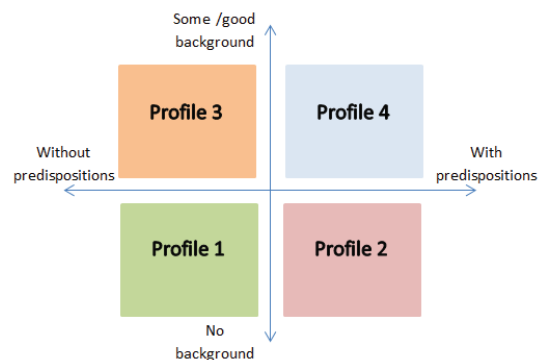


Figure 4. Student's profiles

C. Course adaptation

After students are categorized into groups and their profiles are completed, they will be offered two sets of course material:

- standard course material, that is same for all students.

- personalized material that is adapted for group they are assigned to.

In that way all students will be able to see standard lectures, but also they will have possibility to learn from adapted material. The content of both materials will cover all topics but the approach in explanations will be different in adapted material.

In this model, personalization of course's content and its adaptation is done by teachers on the course. At this point, it is considered that this should be done manually and that they are most adequate for this task.

For presentation of personalized course's content Moodle Lessons [13] are used. The idea is to create four Moodle lessons for each topic on the course. Each lesson will belong to one group of students and will be adapted according to their needs. Moodle Lessons module provides many possibilities for setting up the lesson [14]. For purpose of adaptation and personalization of the lessons we believe that the following settings are appropriate:

- Lessons will be password protected and student will know passwords only for lessons that belong to his group.
- Each lesson will contain questions that will navigate the student through the lesson.
- Student will be able to exit the lesson whenever he wants, but will be obligated to start from the beginning the next time he opens the lesson.
- Student can open the lesson as many times as he wants.
- Lessons will be used only for learning and practice so student won't be graded by success on them.
- Lessons will depend on each other, so that student will have to complete previous lessons if he wants to open next. In this way we are ensuring that student have background knowledge for the lesson he is opening.
- Lesson will be available after the lessons topic is presented by the teacher in the classroom.
- Lesson will not have a deadline.

With these setting we will provide lessons that will guide students through the topic and evaluate their knowledge at the same time. After every lesson they will know how well they have learned the lesson and if there is something they did not understand.

Since this module provides easy way of customization of content, it is a suitable tool for presenting material in different ways, appropriate for different groups of students.

This model for adaptation and personalization of the course will be supported by one service presented in Figure 5. After student finishes the test of his predispositions and the test of his educational background, this service will process answers that student gave on the test and put student into appropriate group. After that, service will store this information into Moodle database and send group's number to the student. Service will be in charge for retrieving and using this information when it is required. This will be done when lesson's password is sent to the students. This service will send only passwords for those lessons that are within the group that student belong in. Furthermore, this service will be responsible for

presenting appropriate lessons to the students, so that student sees only his group's lessons and not all of them.

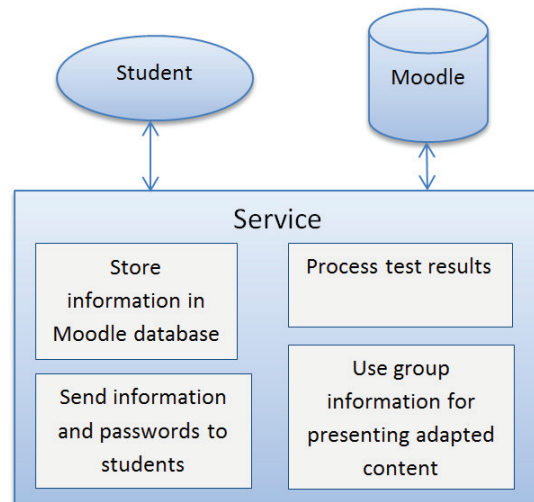


Figure 5. Service for handling student's groups in Moodle LMS

IV. CONCLUSION AND FURTHER WORK

In this paper we have described adaptation of the course Algorithms and Programming at the Faculty of Electronic Engineering in Niš. But this model of adaptation is suitable for any course that requires fixed knowledge of all students by the end of the semester and is attended by students with different educational background and predispositions. The proposal for presenting the personalized material is done by using Moodle LMS, since it is used on Faculty of Electronic Engineering in Niš.

In order for this model to become functional, some adaptations of Moodle Quiz are required, in this case that refers to MoodleQuiz application. The adaptation refers to the last part of the application, when quiz results are presented. Since this testing does not require results to be presented back to the student, handling this type of quizzes should be added to the application.

Furthermore, this system requires a development of a service that will handle student groups for adaptation of course's content, which includes processing test results, storing and retrieving group information and using it for course adaptation and personalization.

Also, this model includes small adaptation of Moodle and Moodle database so that information about a group to which a student has been assigned in, can be stored in the database and properly used when needed. This means expansion of Moodle database and implementation of functions that will cover this functionality.

As it is presented in previous part of this paper, with this model for teaching, at this point we offer students both personalized and non-personalized content. Our goal at this stage is to create prototype of this system and test it. First goal is to put student into appropriate groups, so that material is suitable for them.

If the prototype proves successful in dividing students into groups and if the statistics show that exams passage rate grows and students find it acceptable to use, we will

move to second stage, which means cutting non-personalized material content out of the course.

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