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IMPLEMENTATION OF ADAPTIVE E-LEARNING THROUGH WORKFLOW TECHNOLOGY

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Abstract: *The aim of this paper is to propose a solution for an adaptive E-learning system that is capable of creating learning content adaptable to the individual needs of each learner. The objective of this paper is to propose a feasible solution for integrating E-learning into an enterprise workflow system in order to be able to support an adaptive goal oriented course. The proposed system will be able to analyze learner's study habits and potential knowledge gaps in order to create learning content specifically customized for each student. The proposed solution is modeled for the Metropolitan University's E-learning system.*

Keywords: *E-Learning, Distance learning, Workflow management system*

1. INTRODUCTION

E-learning systems have been used to improve the learning curve of students, as well as to enhance the communication and collaboration not only between a student and a teacher, but between classmates as well. The usual E-learning systems are integrated web-based systems that support numerous learning activities, ranging from class notes and lectures to evaluation activities such as tests and quizzes. This integrated system is often referred to as Learning Management System (LMS). Using the typical web-based LMS, teachers have an option to design the syllabus for the course, and post all the learning materials, from lecture notes, presentations and videos, to homework assignments, tests and quizzes. However, the common drawback of a typical LMS is their static content and the necessity for teachers to create all the material for the course. Once posted, presented materials are the same for all the students in the class, since most of the LMSs are designed as "one size fits all" systems. These types of systems are not flexible, and they lack the ability to adapt the content to each individual student, while disregarding student's interests, knowledge background and learning style.

Zrakic et.al. proposed a solution for creating adaptable courses by implementing the cluster method [1]. In this study, students were placed in clusters based on their learning style preferences. Although the premise of this study incorporated students' different learning styles, the clusters of students were formed solely based upon their initial preferences, without allowing them to change these preferences later. This is somewhat limiting, as students' preferences may change throughout the course.

Apart from academic environments, adaptive E-learning can be implemented in other areas, as its application in the business process has proven itself very useful. Individualized learning is referred to as Workflow Learning™. Adkins gives a definition of "Workflow Learning" that assumes integration of enterprise software and E-learning into one workflow using service oriented architecture (SOA) [2]. Implementation of E-learning through a workflow allows individualizing learning content using various parameters that are customizable to learner's needs.

TEAL project proposed a solution for a task embedded adaptive E-learning that was integrated in enterprise workflows [3]. The goal of the project was to design a task-oriented E-learning course that is user-tailored so that employees can solve their problems autonomously and competently. We adopt the concept of the idea of context-specific, proactive information delivery, goal-oriented E-learning, and we extend it for the academic scenario.

In our work, we propose a model for adaptive LMS which will allow students to choose their learning methods at the beginning of the course and be able to change it later if their preferences change. Furthermore, our model takes into consideration that not all students have the same knowledge background and will adaptively create lessons based on their learning style preferences and previous knowledge needed to master a given topic.

Paper is organized as follows. Section 2 presents the current E-Learning system and learning methods used at Metropolitan University that will be used to demonstrate the adaptive learning model throughout the paper. Section 3 proposes a solution for integration of adaptive E-Learning into a workflow model, while presenting the adaptive learning context through three main phases. Section 4 illustrates a technical solution for the proposed workflow, through implementation of the adaptive goal

oriented course. Section 5 concludes this paper and gives recommendation for future developments and improvements.

2. CURRENT E-LEARNING SYSTEM

Current E-Learning system of Metropolitan University is designed as a web-based system with static predefined learning material (Figure 1). This system is an Oracle LMS. It is an independent entity, and it is not integrated with business processes of eduction management system, which include processes such as enrolment and student information. This information is essential part of the LMS, and the lack of integrated systems has led us to search for innovative solutions that would support business processes of the University along with educational ones.

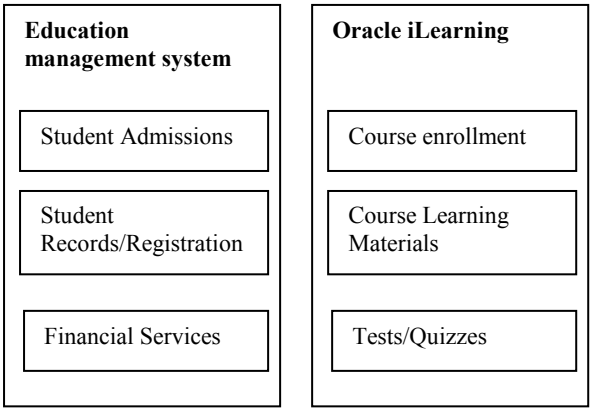


Figure 1. Current LMS at Metropolitan University

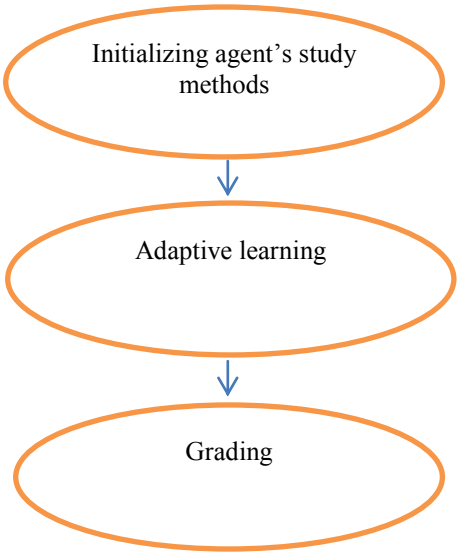
Course materials are organized based on the semester duration. Duration of the semester is 15 weeks; therefore, the course is organized into 15 lectures. For each week, student is provided with a lecture in written format, typically 20 pages in length, and a presentation of the same material with voice recording. For each week student is expected to complete a short test and homework, which are graded as a part of his cumulative grade towards the course. Furthermore, as a capstone of the student's knowledge in a particular course, the student is expected to do a project to demonstrate and apply learned material. Project is also graded and is a part of the cumulative grade.

Even though students are provided with different type of learning materials such as lecture notes and presentations with voice recordings, these materials are not evenly used by all students. While some prefer just to read lecture notes, others only use presentations. Furthermore, students' backgrounds in certain subjects are very heterogeneous. Roughly speaking, based on a student's background in the prerequisite knowledge, a student can be categorized into three groups: low, medium and advanced knowledge levels. Students who can be placed in the group with a low knowledge level are students who have a hard time following the basic and advanced materials, while those who have advanced knowledge prefer to study at a faster pace and are studying more advanced topics. Students that can be placed in middle of the knowledge scale typically do not have a problem with learning, as the materials are adapted to their level. This has led us to seek a new solution that can adapt learning materials to each student based on the individual knowledge background in a given subject. This is done by providing additional material that can either help students compensate inadequate knowledge or introduce more advanced topics to students who wish to learn at a faster pace. Furthermore, this additional material is customized and embedded in student's learning materials, while making sure that student learns the set course goals.

3. WORKFLOW MODEL OF ADAPTIVE E-LEARNING

As previously described, the main drawback of an existing E-learning system at Metropolitan University is the fact that system is not integrated with the business process (education management system). Integration of the two would allow a more efficient system with a better performance which would in turn provide a system that can support adaptive E-learning. This integrated system will allow students to get information about potential learning goals and adjust the learning process to the current student needs. When a student is signing up for classes, he is assigned courses for the semester where each course is presented as a 15-module course. This is realized by executing a software module in the workflow system which task is to manage student enrollment. Once the student is enrolled and access to the learning modules is provided, the student is able to learn material through a series of steps of adaptive learning, implemented through the workflow model.

Using artificial intelligence terminology, we will define a student who has a goal to learn a module, an agent. An agent begins with studying by accessing a module. In our case, there are total of 15 modules that correspond to 15 lectures in a course. A goal oriented adaptive course can be realized through three phases in adaptive E-learning system which receives requests from the University's workflow management system. Before accessing the modules, agent has to go through the initial phase, followed by the adaptive learning phase and a course grading (Figure 2).



topic			
Deadline definition	Defined by teacher	Defined by student	-

Figure 2. Adaptive E-learning phases

3.1 INITIAL PHASE – DETERMINING AGENT'S LEARNING PREFERENCES

The goal of the first phase in Adaptive E-learning, after initial approach to the course, in the workflow management system is to determine the agent's learning preferences (Figure 3). The agent's learning preferences are initially determined through a questionnaire which the student answers at the beginning of the course. However, if during the course the agent decides to change his preferences, he can always do so. Based on the questionnaire, the agent defines what learning methods motivate him to study. For example, if the interest is to determine whether the student prefers to study by reading learning modules in text format, by listening presentations with voice recordings or by using both methods. Based on the choices the agent makes, he will be provided with adaptive learning modules in the next stage.

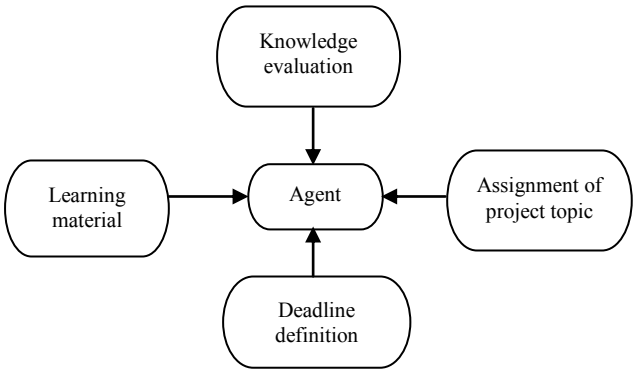


Figure 3. Adaptive model for initial stage – Determining agent's preferences

The questionnaire that the agent fills out in the initial phase is designed in such a manner so that it addresses specifics of learning methods. Results of the mentioned questionnaire define following parameters: type of learning material, type of evaluation process, deadline definition, and assignment of project topic. Table 1 represents these parameters and types of options that are provided to an agent.

Table 1. Parameters used during the initial stage

Parameter	Type 1	Type 2	Type 3
Learning material	Text format	Presentation with voice recording	Combined
Knowledge evaluation	Quizzes	Problem solving	Combined
Assignment of a project	Defined by teacher	Defined by student	-

3.2 SECOND PHASE – ADAPTIVE LEARNING

Once the agent has initialized the process, as described in the initial phase, he can access the second phase. This phase is the core of the adaptive learning process. In this phase, the agent's learning material is customized to his specific needs. However, it is assumed that the module learning goals are defined a priority by a teacher. Based on these learning goals and the knowledge level that the student has, the learning module can be created. The learning module consists of multiple learning objects which are used to fulfill previously defined goals and the agent's learning needs to overcome any potential obstacles in the learning process.

Using learning goals a set of learning objects are identified. A learning object may require a prerequisite knowledge in a certain area. The agent is tested in order to determine whether he has enough knowledge to be able to successfully learn a given learning object. The agent's knowledge is tested using a method that he defined in the initial phase. The result of this evaluation process is to assess whether the agent has the knowledge gaps in the areas required to learn the given module most efficiently. If knowledge gaps are identified, the learning module is dynamically adapted and additional learning objects are added for each existing knowledge gap. Since the agents have different level of knowledge, creating learning module in such way will allow each agent to have customized lecture adapted to his knowledge deficits.

3.3 THIRD PHASE – GRADING

Once the agent feels that he has mastered the learning module, he can access the grading part of the module – quizzes and homework assignments. As described previously, quizzes and homework are part of each lecture. Student has quizzes and homework for all 15 modules.

Part of this phase is also a project requirement. Based on the student preferences defined initially, projects and project deadlines can either be defined by an agent or by a teacher. A project is not tied necessarily to any of the learning modules, but it is a mandatory requirement for an agent to pass it in order to finish course evaluation grading process.

4. WORKFLOW IMPLEMENTATION

In order to be able to implement adaptive goal oriented courses at Metropolitan University, the University's LMS needed to be evolved from a static and non-adaptable

LMS. Improvement of this system was done by adapting an open source Sakai platform for E-learning in order to integrate two main components and their processes – Educational management system and E-learning system shown in Figure 1. Sakai allows more flexibility and easier integration of administrative and educational processes in the University's information system. For the implementation of the workflow logic on which the entire business process of the University is based, along with processes of the E-learning system, an open source business process management and workflow engine Bonita was used.

The posing challenge is to provide an existing Sakai adapted LMS with proper adaptivity and personalization for University needs. Improved LMS should not only integrate the Education management system with the E-learning system, but should also provide the E-learning system with additional capabilities such as personalization, adaptability and adaptivity. Even though using the Sakai platform provides us with better flexibility, much work is needed in order to adapt Sakai to be able to implement adaptive E-learning.

Adaptation of Sakai based E-learning system is possible through implementation of Adaptive Learning Environments (ALE). However, most of the existing open source solutions for E-learning, including Sakai, have not completely bridged the gap between the static and dynamic learning content. These solutions have an option of adaptability of the system that allows the system to be modified to fit particular requirements of individual clients, so that they can implement their preferred ontology. Therefore, ALE has to be integrated into Sakai LMS. Figure 4 illustrates a possible way of the integration where service oriented architecture (SOA) has a role to provide a reliable communications channel as an interface for information exchange between Sakai and ALE.

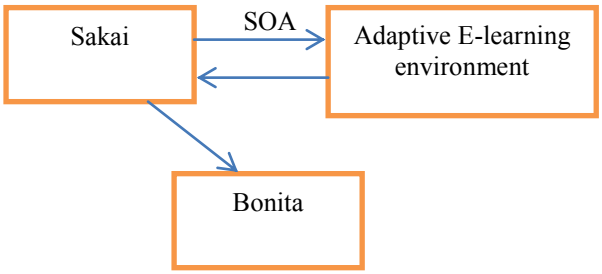


Figure 4. Integration of Sakai LMS and adaptive E-learning

Proposed model for adaptive goal oriented course is embedded part of the Sakai LMS within ALE. Changes to the Sakai LMS are reflected in addition of following adaptive tasks:

- Using student's preferences to decide which learning methods suits him best
- Knowledge assessment for identifying knowledge gaps
- Using learning goals and knowledge gaps to depict outline for customized lectures
- LMS retrieval of learning objects and their delivery to a student in a form of a lecture.

Each learning module has predefined goals that are used by LMS to generate lectures. LMS generates learning modules based on these learning goals by assembling learning objects necessary to fulfill these goals. In addition, more learning objects can be added to the learning modules to customize each module to the specific needs of each student. These learning objects are retrieved and filtered from learning object repository based on information retrieved from the workflow. In particular, the focus is on knowledge gaps that are identified in evaluation of background knowledge. Additional learning objects are embedded with learning objects that were assembled based on general learning goals of the course. Learning objects are searched and filtered based on their text index. Learning object repository is used to store and manage learning objects as well maintain general learning goals for each course. Once all learning objects are assembled they are presented to the student in a format that he prefers. Described workflow for adaptive E-learning is shown in Figure 5.

5. CONCLUSION

In this paper we have proposed a workflow management system that can be used to implement an adaptive goal oriented course. This model provides flexibility that most static E-earning systems do not have, by adding possibility of implementing dynamic generation of lectures. Lectures are composed of multiple learning objects out of which core learning objects are assembled based on course learning goals, while others are added on a need-to-know basis when knowledge gaps are identified in the student's knowledge. In addition, workflow management system allows the student to choose learning methods that are most adequate to his learning style.

Future work will focus on optimizing the process of searching and filtering learning objects from the repository. This process needs to be optimized in such a manner so that agent's learning module can be adapted to

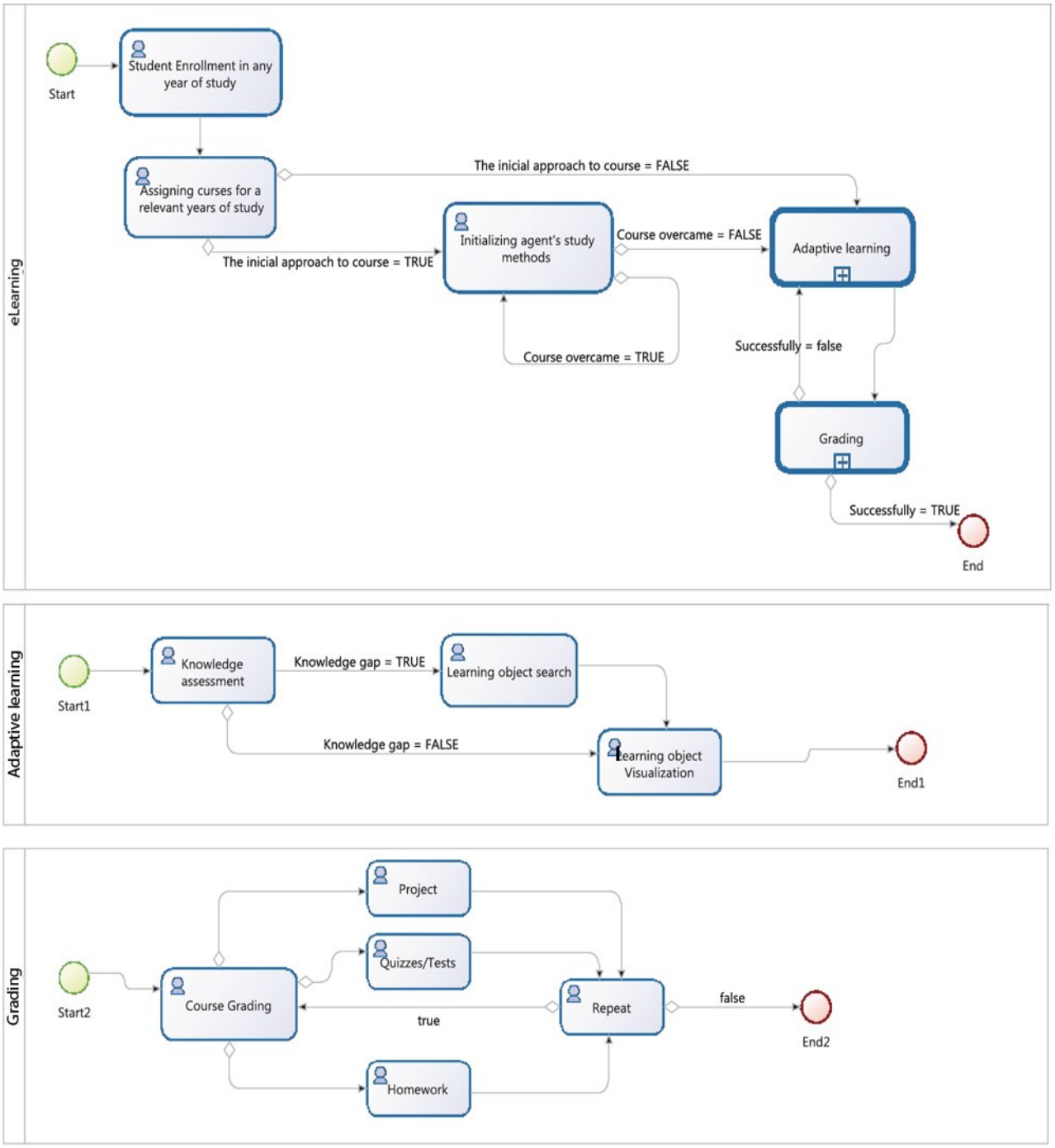


Figure 5. Workflow for adaptive E-learning system

various levels and learning goals. Furthermore, the type of learning material is determined only through an initial phase and agent's preferences based on the questionnaire. However, further determination of types of learning materials that are best suitable for a given agent will be determined based on the agent's usage and learning success in all courses that the agent is attending at the time. This will be expanded into determination of gap knowledge that will also be based on overall evaluation of agent's performances in other courses. Future work will involve implementing the proposed models and integrating the entire system through Sakai adaptation and its integration with adaptive E-learning environment.

ACKNOWLEDGMENT

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