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Applying Work Flow Reference Model in Adaptive Learning

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Abstract, In this paper we will present part of our current work towards the developing of an e-Learning platform using the Work Flow Reference Model in combination with adaptation algorithms. The basic idea is to take advantage of the efficiency, the robustness and the interoperability that the WfRM (Workflow Reference Model) offers, to design a learning procedure, and the use of adaptation algorithms in the decision nodes aiming to increase learning effectiveness and efficiency.

Introduction

Workflow systems are currently the leading technology for supporting business processes. This technology manages the execution of the tasks involved in a business activity, the scheduling of resources and the control of the flow of the associated information required by performers to execute the tasks. Typically the tasks involved in the business process are interdependent in that the execution of one task is conditional upon the execution of one or a number of other tasks. Workflow management systems employ a process model to capture this flow of execution between tasks. This model is used by a workflow management system to schedule and coordinate the execution of these tasks. Production workflows based on this framework have been developed to automate the coordination of the activities for processes that are typically characterized by well-defined procedures and are highly repetitive in nature. (Mangan and Sadiq 2002).

Many software vendors have WFM products available today which involve WFM technology and there is a continual introduction of more products into the market. However, there are, as yet, no standards defined to enable different WFM products to work together, which is resulting in incompatible "islands" of process automation.

In the context of our work we decided to use the WFM Coalition Reference Model. The WFM Coalition has been established to develop appropriate specifications for implementation in workflow products. It is intended that such specifications will enable interoperability between heterogeneous workflow products and improved integration of workflow applications with other IT services. The model is graphically described in (fig. 1.)(WFMC 1995)

The use of the WfMC workflow model or any other workflow model, most of the times require very well predefined procedures. In the case of an adaptive learning procedure this could be a strong shortcoming since personalised learning refers to the continuous adaptation of the learning environment to meet the individual learner's characteristics, i.e. physical abilities, skills, language, technical and cultural background, knowledge, expertise, interests, preferences, etc. Thus personalised (computer-based) learning environments are defined by their capability to automatically, continuously and dynamically adapt to the changing attributes of the learning context, which is, in turn, defined by the individual learner characteristics, the type of the educational material, etc. (Sampson, Karagiannidis, Kinshuk, 2002).

We argue that a good way to overcome this shortcoming is, from the one hand to model the procedure with as many alternative pre-defined paths as the designer can predict, and from the other hand to invoke applications that use adaptation algorithms to decide the specific path that the corresponding learner will follow.

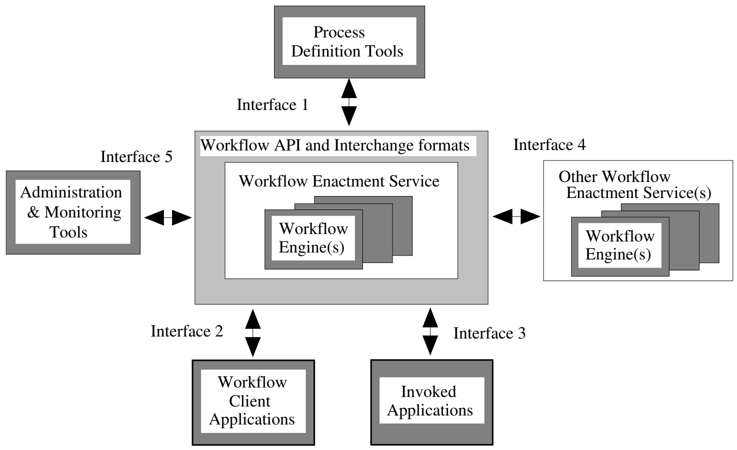

Figure 1. Workflow Coalition Reference Model

The Proposed Implementation

The system we have developed incorporates:

- A graphical interface for the definition of the workflow of the learning procedure. (fig. 2)
- The Workflow engine which transforms the set of work-steps that define the learning procedure to a work-list for the participants in the procedure (Tutor, Learner). One of the most important functions of the engine is to administrate the appropriate learning tasks based on the rules of the procedure. For example if the learner has successfully accomplished a task then he can proceed to the next one.
- An interaction application where the Learner is administrated the current work-list and has the ability to choose which of the tasks to accomplish
- Interfaces with external applications (e.g. learning material, evaluation etc)
- An administration application to allow control over the whole procedure by authorized users (e.g. the Tutor)

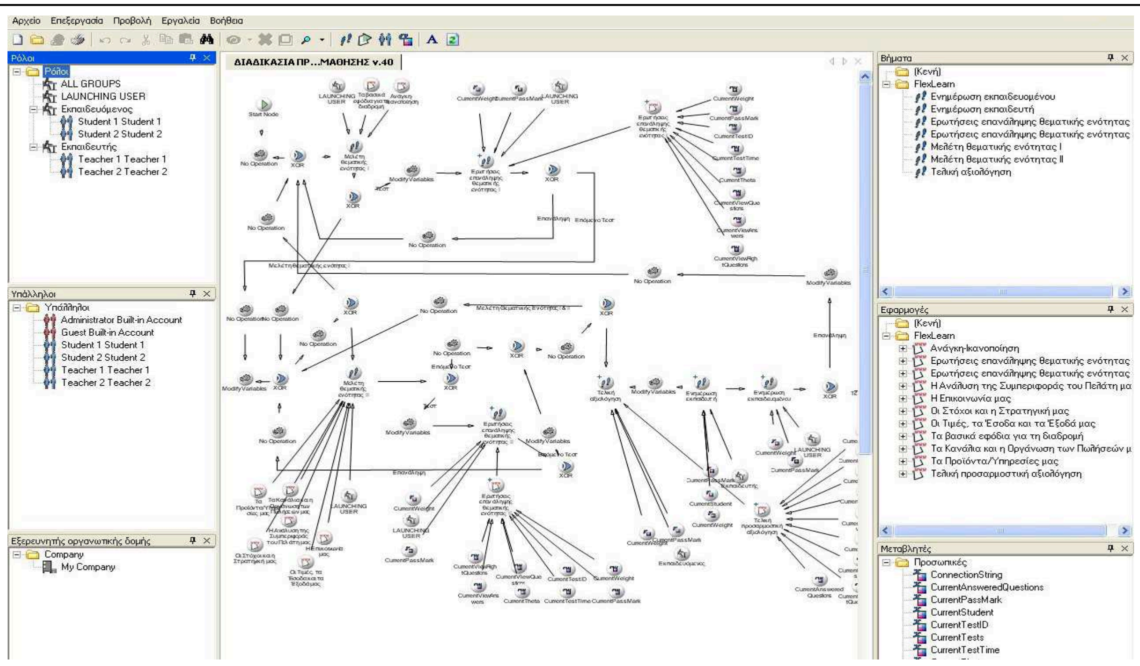

Figure 2: The workflow desing interface

According to the WfMC standard the following modules could define the learning procedure (each module will represent a node or a step in the final workflow that describe the whole procedure):

- Learning Modules (e.g. Studying of material, testing, evaluation)
- Variables' Definition Module. This module is responsible for the definition of the variables' values. These values will be stored by the work flow engine to the corresponding variables
- Algorithm Definition Module. This is where the algorithms are developed in to scripts. They are executed by the workflow engine and define the "flow" of the procedure.
- Executing Modules. These modules trigger the execution of a new procedure by the workflow engine.
- Termination administrators (Tutor, Learner)
- Decision Rules (AND, OR, XOR)
- Variables (e.g. grade). The variables are of a predefined type and their values are initialized on their definition. These values can be changed by:
    - The variables' Definition Module
    - An invoked application (triggered by the execution module)
    - The Termination Administrators

An instance of a workflow is illustrated in (fig. 3)

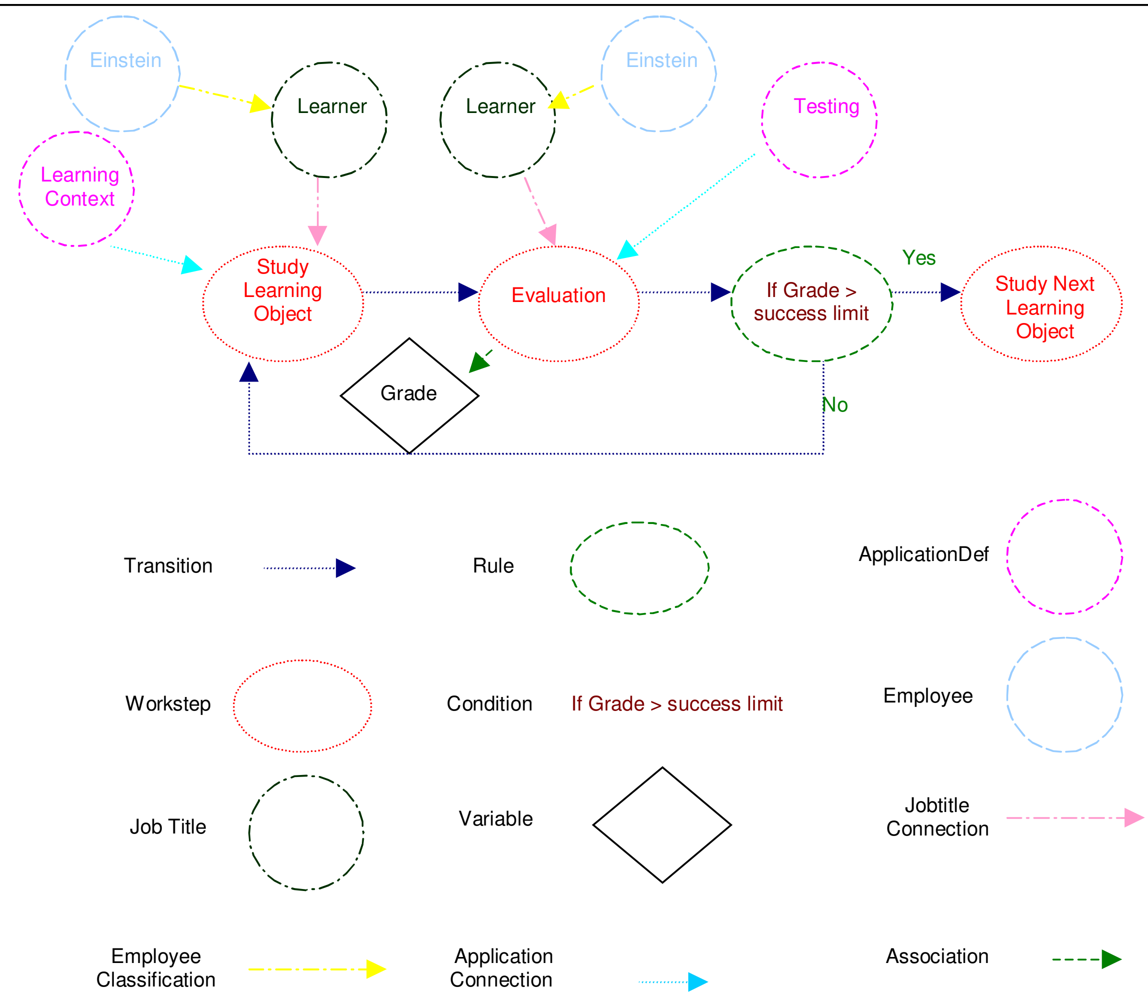

Figure 3: Sample workflow

Adaptation actually takes place when the learner reaches a testing work-step. We consider that evaluating correctly the learner's level of knowledge acquisition is a critical factor to effectively define the appropriate path through the learning workflow. In order to achieve that, the system invokes external CAT (Computer Adaptive Testing) applications based on the three parameter (3-PL) Item Response Theory model. (WAiner, Dorans, et al, 2000)

Although the learner is administered many tests during the learning procedure we confronted the evaluation procedure as a whole. For each test, and in the context of IRT, not only the prior estimation of learner's ability is considered the initial for the current test, but also the estimation of the current ability is based on the whole answering history of the learner. Thus at each evaluation work-step each learner confronts a personalized test and the system returns "adapted" values to the variables that the workflow engine uses to decide the next step, resulting a personalized procedure as a whole.

Adaptive methods were also used in order to decide *when* to engage learners with a service, *how* to best contribute to solving a problem, *when* to pass control back to users, and *when* to query users for additional information. We have actually focused on the time thresholds that trigger help from the system side, using a simple probabilistic algorithm we have developed. (Lamboudis and Economides, 2002), (Lamboudis and Economides, 2002).

Discussion

This paper has briefly described an implementation of a learning environment using a combination of a workflow management system and adaptive methods. We argue that this a feasible and cost effective approach. The system is tested in the context of the "Introduction to Informatics" course in the University of Macedonia. Actually is part of a bigger project that also incorporates keystroke analysis and biometrics to enhance security. Our work is currently focused on the IRT model, running numerous pre-tests in order to correctly evaluate the question items.

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