Business Process Modelling & Execution Application in Work Education Domain

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Abstract **– This paper describes a workflow based approach towards work-place education. Proprietary workflow description and execution environments are used to create a certain application. In order to overcome existing difficulties and functional deficiency in reviewed systems and approaches, we designed a specific modular structure, which contains six modules. Thus, a multiple process engines utilization feature is proposed. Future development in the field of Adaptive Learning Process Generation is envisioned as well.**

Keywords **– workplace, workflows, business processes.**

1. Introduction

Nowadays, more and more companies and industrial organizations look for solutions in order to help improve their employees' competencies in line with the dynamics of the new technology environment, applying active training in the workplace [1].

A software system that meets these requirements has to provide functionality for selecting and offering the learner units, which are tailored to his/her professional and individual profile. Such a selection of learning units and related activities can be represented as a business process modeling activities at the workplace. Very important question is selection of the units and the order in which they are represented. Researchers offer different approaches in order to solve this problem: tracking the history of learner activities within the current or previous training sessions, content-based filtering (learners are recommended learning units similar to those of learning objects in the current session [2, 3]), association rules on the basis of which learning units (learners with a similar individual profile are used along with objects from the current session) are recommended. The study of such approaches is presented in [4]. In recent years, it is argued that besides information on ongoing activities, the learner needs additional information to make more precise recommendations for the next units, which are to be offered to the trainee. For example, providing adequate personalization for the learning path [2], additional information is needed on the learner's personal profile, its level of knowledge and/or skills, individual learning style and current learning objective. Other informational elements are used - metadata for learning objects, incl. content type and interactivity level (to match learner profile), information concerning the role of a trainee and his/her position in the certain organization, working context of a learner regarding the last completed task or business process, etc. The listed information approaches use ontologies to perform the taxonomy and dependencies between learning objects, and they are applied in cases when a learning path has to be created by learning units. The relevant methodologies combine four basic approaches: identifying similarity of user profiles, pre-creating learning paths, filtering, and semantic proximity. The learner's context has a dynamic character and includes previous knowledge, interests, speed and learning style, and pursued learning objectives. The system is continually being filled with new implicit knowledge that company employees possess [5]. The LearnPad project is a specific example of an app which uses workplace meta-models, process models, learner models, organizational model, context model, and competency model [6]. ProSyWis is a process-based software system which uses a dynamic and adaptive knowledge intensive process management

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approach, and in that manner combines classical control-flow support with declarative process modeling, rule-based activity identification, activity prioritization, processing a complex event, casework and interpersonal co-operation [7]. On the basis of the same conceptual framework WebSphere (IBM), jBPM (JBoss), webMethods (Software AG), YAWL (Open Source) are developed. Research papers discuss different Business Process Modeling Languages (BPM), and two basic modeling approaches which are based on the graphical model representations and rule specifications [8].

The essential part of the on-the-job training process is knowledge measurement. Some developments [9] demonstrate experience in using workflow management systems in the knowledge measurement process by measuring various parameters, such as the speed, by which an employee performs a particular task in the workflow. Some authors [8] discuss the "lack of built-in knowledge measurement tools" of business process management systems (in the context of workplace training). Other aspects of knowledge management and workflow management systems are discussed in [10]. Informational extraction for user knowledge is not discussed as a problem. The approaches have different disadvantages concerning knowledge measurement in workflow analysis, which is an obstacle in creating adaptive approaches for workplace training.

A **major disadvantage** is the fact that the work flow management systems examined have no tools for easily definition of abstract learning objectives and metadata for training activities related to the possibility of making conclusions – no matter how they are achieved. Adaptive e-learning systems (ALSs) are a relatively new direction in the e-learning development and they will enter different areas soon, incl. automated workplace learning. A simplex method for automated curriculum generation is examined closely [11]. It is developed on the basis of a learning description, including objectives and activities (and their metadata), and uses predicates and functions borrowed not only from the Bloom Taxonomy [12].

Another disadvantage is the lack for the opportunity, by which the same processes need to be executed by various process engines, which can implement those processes in different ways/ contexts. Therefore, the easy creation and integration of a different process engine is the essential part of a process based Work Place Education.

2. Administrative Procedures in Plovdiv e-University (PeU)

As a higher education institution, the University of Plovdiv (PU) implemented a number of administrative procedures, related to the educational process. This study aims to propose a model for automation of administrative services. The model of administrative procedure is represented as a business process, which is a series of steps representing elementary (atomic) activities performed by a subject. A subject in a business process model is a person involved in the process who participate in one, several or all steps of the process. For example, a subject can be an administrative person (an inspector in student affair department, a dean or a rector) or a student. The business process can be initiated by different subjects (e.g. by a student). Each step in the process is modeled by a class, whose fields represent the characteristics of the object, by which one or more elementary actions are performed. The steps order is governed by administrative/ normative rules, but this does not lead to uniformly ordered events for the different processes, only to similarity in the way they decide to put them in use. Sometimes the process can continue in different directions. Differences are not exhausted with predefined ready-made schemes. The recording of new events in a business process follows the procedure for each participant separately. The specific nature of the activities inherent to a particular employee or group of employees with the same profile will be marked as a role.

3. Business Process Prototype in PeU

Business process model (in the case of the administrative procedure at PU) in the automated information system PeU is created with business process management system EMSG [9]. EMSG's paradigm is based on supporting multiple business sub-processes and managing dependencies between all business process events. EMSG offers tools to break a business process into sub processes, and collate data from all nodes. Such tools are available in many WfMS, but the EMSG emphasizes the complexity and the scope of analyzes. Programming dependencies are rationalized by defining a specific database model, associated with the so-called "cursor movement". The terms "chronological cursor" and "chronological model" of the database are introduced. The chronological cursor [11] is an interface technique whereby all events are recorded as steps arranged in a single dossier, according to the events chronology. Correct sequence of the steps is only required for events that are indisputably related to each other. For example, if a task is assigned to one employee and then a report on the employee's performance is entered, this is the case in which the mandatory assignment has to precede the report. When dealing with many different events, there are cases in which there are no strict mutual dependencies. All steps are visualized in the interface, arranged in a row that does not accurately describe all the sequences, but does not contradict the proper sequence of events, as well. This is achieved by internal administrative rules in the organization, and by control programming in the EMSG. The system allows two approaches concerning process modeling.

The first approach requires a predefinition of the entire administrative procedure with attention to that the sequence of steps for each item refers to metadata, has to be available for the participant role relating the business process particularly. In this model, the system visualizes the process for the user, focusing on the steps in which the participant with a particular role is concerned. Visually markers are often used – represented with different colors and forms for the steps that must be performed by the user.

Another approach allows adaptive process generation. The set of the elementary actions involved in the business process is stored in the database, and they are represented by steps which do not have predefined links in defining the sequence of execution, but the certain metadata to support adaptive generation. Depending on predefined customizable goals for the user in the business process, a sequence or process can be automatically generated, which require appropriate steps in accordance with the metadata, including the description of the particular role (dean, rector, student, inspector, etc.). This approach allows resources to be adapted as participant's role and goals, and visualize only the individual steps of the process to which it relates. For this purpose, a subsystem Generate Protocols and Processes Generator (will be presented elsewhere) is used. The EMSG interface, called the "chronological cursor", resembles the traditional way of arranging documents in a folder/file. The step order is a good basis for intuitive analysis and evaluation of events in their sequence. The step order corresponds to the sequence of occurrences of events which are well known from practice and administrative rules. While the interface cursor is on the one-step window, it is treated as a cursor in the database. In the EMSG, the cursor moves the steps in the order of entry. With the attention to the classical understanding of the cursor in RDBMS, the cursor goes through the rows of a table. In the EMSG, the cursor passes through different table rows, but they are data from the same file. Sub process programming requires certain implementation tools, which are developed separately for the sub-process context and the context of the common business process. The compliance with the requirements of the general process is called the general context. EMSG is a specialized platform for complex information systems of the WfMS type, and its developed mechanisms reflect complex procedural, technological or administrative requirements. For example, when changing the legal framework, procedural dependencies often change, which immediately change requirements for already formed dossiers. The main objective of the EMSG is to provide the appropriate tools for implementing data control by applying two basic concepts of "context" and "compactness".

The context in the EMSG consists of multiple identifiers of the available fields of the dossier referenced to a Petri node. The right to input, update, view or delete data is determined (by calculation) in a similar node. All data operations are performed with the identifiers from this context. For example, the context changes each time when the key is pressed during a text input, or when a list is populated, because each entered symbol becomes accessible and complements the context.

Compactness in EMSG is a simultaneous computation by triggers in all nodes of the dossier before visualizing the result. By the means of the calculations called "compactness", all parts of the file visible on the screen can be enriched with the results of these calculations. In a workplace learning system, compactness can be used to mark various workplace gaps and mistakes made by a learner, and hence, in the case of adaptive approach, to reassess the current state of the learner and his/her position in the space of goals [11].

Conclusion: The creation of a business process modeling system on the basis in which automation and implementation of e-learning forms at a workplace require participation in administrative procedures including different nature. It implies the design and implementation of 6 modules with the following functionalities:

- Module 1: Description and execution of working processes.
- Module 2: Adaptive generation of workflows (within a specific workflow).
- Module 3: Modeling and "pursuing" of adaptive goals in the context of a user role as well as personal goals in the context of individual users.
- Module 4: Modeling and triggering of "monitoring" processes that can retrieve

information about how workflows work in the context of different dossiers.

- Module 5: Modeling and putting into action "virtual users", e.g. "virtual student".
- Module 6: Process description generator (EMSGDescGen).

4. A model of administrative process in PeU (Module 1.)

The prototype of Module 1 is based on EMSG. It includes a description of steps, triggers, "matrices", "templates", workflows, and data classes. Approaches for integration with external databases using workflows have also been used. PeU system is used for the administrative servicing of procedures at the University of Plovdiv. This paper presents a business process model for the automated execution of an administrative procedure.

We will introduce a model of the "Student Re-enrollment" procedure. Administrative persons who are involved in this procedure are an inspector, a student, the dean of a current faculty and the dean of a receiving faculty. In the private case of relocation between programmes in the same faculty, the deans of the host and the current faculty have the same role. The "Move Student" administrative procedure described in the Higher Education Act starts with the precondition that "the student has successfully completed the first academic year in accordance with the state requirements." In the business process model, this step is reflected as a "Student Status". If the prerequisite is not met, the next step in the process is final and the process ends. Namely, fulfillment the state requirements, refers to the process which is branched out. Thus, two sub-processes can be implemented: "Moving a student to another programme from the same faculty" or "Moving a student to another faculty/higher education institution". The sub-process "Moving a student to another programme in the same faculty" starts with a move request – a step initiated by a student, in which participate the "inspector" (responsible for accepting and reflecting the received document) and the "dean" (resolving with "approval" or "refusal" of the application). At this step, the process is branched to the final step (in a negative resolution) or to a sub process that models document flow associated with a displacement procedure. In the case of a positive resolution, another step is taken, in which documents are prepared to report the assessments and student status. Sub process "Enroll New Student" is modeled in two steps - preparation a set of student enrollment documents, which is executed by the student, and a step performed by the "inspector" who accepts the student's documents, and generates an enrollment order for the student on the basis of Dean's resolution. Then the process ends. In the step that allows the process to be branched to step "Move student to another faculty", the subject in "student" role initiates the steps "Application to Dean of the current faculty" and "Application to Dean of the receiving faculty", and the subjects in the roles "Dean of current faculty" and "Dean of the receiving faculty" are the resolutions on the application document. In this part, the process is branched to end step execution (negative resolution) or to a sub-process starting after a positive resolution. In the sub-process, the first step is performed by a subject in the role of the "inspector", who draws up a report of assessments and student status. The next move is the "Student enrollment" sub-process, involving the subjects "Student" and "Inspector". After the successful completion of the sub-process, the entire procedure is finalized.

The analysis of the administrative procedures shows that there is direct dependence between certain steps, which have to be executed in a strict sequence, determined by the normative base and the "Higher Education Act", regulating the sequence of elementary actions, as well as the order in which they are being executed. Such requirements are not imposed at all stages of the administrative procedure, allowing steps for which there are no statutory requirements, including the order of their implementation which has to be independent in the database, called and repeated on those places in the process where they are executed in the administrative procedures.

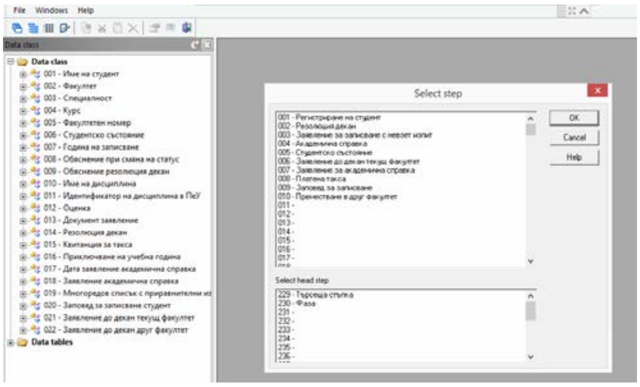

Figure 1. Classes for storing information and multiple steps

The model of each business process is an abstract template of the administrative procedure. Each time a process starts, it is referenced (initiates) with real data for a particular administrative procedure and its participants. Figure 1 presents the classes plurality responsible for storing the information and the steps needed for modeling it.

Classes containing student data are named as faculty number, programme, student status, year of enrollment, grade. Classes containing details of the documents involved in the administrative procedure are explanation of the status change, such as dean resolution, application, academic report, fee receipt, enrollment order. The steps that build the business process model are generated on the basis of existing classes.

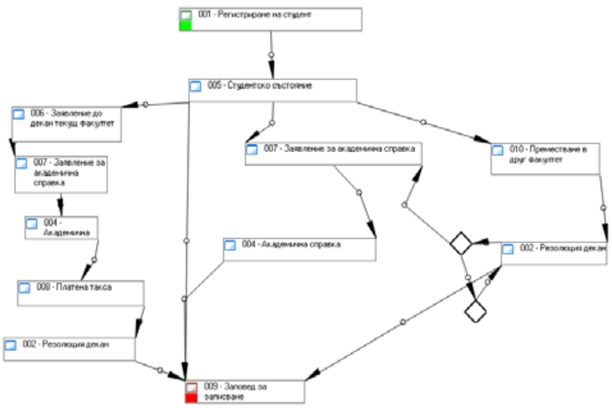

Figure 2. Model of „Move Student" process

Figure 2 presents the process model in the system. From the user's point of view, the sequence of steps is to be taken while considering a particular role (dean, rector, inspector, student, etc.). It is visualized in different colors for the individual user. The control over the execution and successful completion of a step, as well as the transition to the next step in the process are realized through system triggers. Steps 006, 007 and 008 may be performed simultaneously or sequentially, depending on the context of the process execution. Step 002 provides a branching process depending on the result of fulfilling the condition therein.

Another execution context (Module 6.)

In order to demonstrate the ease of development and utilization of another process execution engine, different from the default one, we created a process description generator (EMSGDescGen). The aim of the generator is to automatically generate a natural language description of a process by using its metadata (for example step data, class data, process data). The generated contents and texts (currently in Bulgarian language) can be used for initial education of "newbie" employees, who are not proficient enough with their new job positions. Furthermore, the generated texts by EMSGDescGen can be used as software descriptions and supplements contents for the usage concerning company software, which covers the processes, that are already described in Module 1.

The algorithm of text generation is hereby presented and discussed.

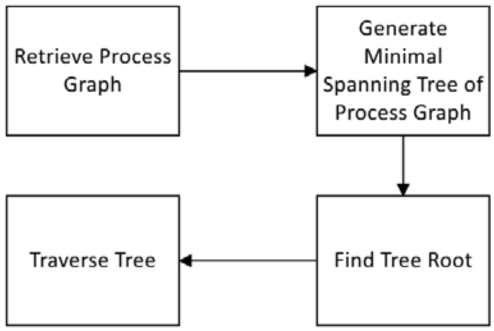

Figure 3. EMSGDescGen's Text Generation Procedure

The current implementation of EMSGDescGen's algorithm requires no additional metadata, other than already defined process metadata in Module 1. The text generation templates are «hard-coded» in the Algorithm itself.

Firstly, the *process graph*, defined in Module 1, must be retrieved form Metadata Database. The next step is generation of *Minimal Spanning Tree*, based on Process Graph. We assume that each edge in the graph has the same weight of «1». Then, the *Root Node* of the generated Minimal Spanning Tree has to be identified.

Secondly, a *Tree Traversal* Recursive algorithm is invoked. The Algorithm's partial implementation in *TypeScript* is presented in Fig. 4.

```
 function    TraverseTree(t:    Tree,    nodeId:
number, text: string){
        if(isStep(nodeId)){
                let     stepName     :     string     =
getStepName(nodeId);
                let     stepControls     :     Array     =
getStepControlList(nodeId);

                text+=stepName+" in order to be
added requires the following data: ";

        stepControls.forEach(function(controlId:
number){
                        let controlName: string =
getControlName(nodeId, controlId);
                        text+=control_name;

        if(!is_last_in_List(stepControls,
controlId)){
                                text+=", ";
                        }else{
                                text+=".";


                        }
                        //... code omitted
                        let nodeAncestors: Array=
getAncestors(nodeId);

        nodeAncestors.forEach(finction(nodeIdAnc
estor: number)){
                                TraverseTree(t,
nodeIdAncestor, text);
```

```
                    }

        if(nodeAncestors.size()==0){
                                return;
                    }

  });
        }else if(isProcess(nodeId)){
                    //.... code omitted, call
recursive process algorithm

        }
  }
```

Figure 4. Implementation of Tree Traversal Recursive Algorithm

The EMS Programming Language Matrices have an "external script" definition and invocation feature. In the current implementation the external script is TypeScript, and the external interpreter command is "node". This is a powerful feature in the context of usage of external process execution engines. In the context of EMSG, the Matrix mechanism is utilized.

5. Conclusion

Until now from all 5 modules, only Module 1 & Module 6 are implemented. Modules related to the implementation of adaptive approaches to e-learning at the workplace (Modules 2 and 3) are the subject of a further development based on the prototype presented and the EMSG working framework. The implementation of the "monitoring processes" and "virtual users" modules (Modules 4 and 5) should utilize the capabilities that EMSG provides for trigger definition, and a specific type of process monitoring tasks in a sample of dossiers. However, it is necessary to develop tools for easier and intuitive definition comprising the relevant triggers, incl. trough modifications of the tools that are currently in use.

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