

# Learning Path Specification for Workplace Learning based on Business Process Management

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**Abstract:** In modern society, workers are continuously challenged to acquire new skills and competencies while at work. Novel approaches and tools to support effective and efficient workplace learning in collaborative and engaging ways are needed. On the other hand, Business Process Management (BPM) is more and more employed to support and manage the complex processes carried out within organizations. We propose to use BPM also to drive workplace learning, with the advantage of aligning real tasks to training tasks. We introduce a specification of learning path that maps BPM tasks and activities into sequences of learning tasks that can be customized to learners competence. The learning path specification can be used to both drive learning sessions, and to inform a monitor that can assess learner's progress. We describe a platform that is under development, and provide a simple motivational example to illustrate the approach. The goal is to combine work and learning in natural and effective way.

## 1 INTRODUCTION

In the modern knowledge society education plays a key role. At all ages and in varying contexts we are called to assimilate a great amount of information and capacities that are continuously communicated thanks to pervasive Information and Communication Technologies (ICT). As a matter of fact, learning is no longer confined to formal courses in school or University, but happens more and more as a continuous and lifelong process.

Indeed, advanced countries see investing in people education and qualification as a necessary condition to overcome the economic crisis and support innovation and future recovery. One significant part of adult education needs to take place at work, where people must continuously develop new skills and competences to overcome evolution of processes and technology. A culture of collaborative workplace learning must be shared between employers and workers within a win-win strategy.

Hence, the need arises for putting in place means to support workplace learning, while successful individual learning becomes an important parameter for the successful functioning of an organization. In recent years, many training and e-learning methods and frameworks are developed to help the employees of an

organization to learn about the business activities they are involved. However the training and e-learning sessions were not as successful as aimed because:

- often the training session is out of working time, implying that workers need to devote extra-work time that is demanding and exhausting
- the learning curve for the training session itself was steep and apart from their business activities and hence workers were hesitant to take up the task
- setting up a learning environment similar to the working environment is very difficult for the company and usually costly and so workplace training becomes difficult for the company to setup

Companies look for alternative approaches to train the employees that can address the above issues. What companies are looking for is workplace learning in which employees can take lessons while they are at work. In our view the requirements for successful workplace learning should include:

- capability to simulate the actual working environment for the employees
- efficient and cost-effective set up of the training environment

- capability to track and customize learning tasks to the profile of the employees

On the other hand, nowadays ICT penetration within the functioning of business organizations is deep and it can be very confidently stated that they help in every step of the functioning of the organization. As the adoption of ICT increases, the interaction between actual physical business transactions and software technology become heavily intertwined and inter-dependent. Several methodologies have been proposed to make the integration of ICT and work procedures easier and more efficient. One such methodology is Business Process Management discipline, which helped the organizations to view their function as processes.

BPM have matured for the last couple of decades and has penetrated many large scale organization in their design of business process as well as the related software applications needed to execute the processes. BPM can also be easily integrated into legacy systems and other applications that reside outside of normal scope the organization's software applicational needs. Systems that are developed using BPM techniques are called as Business Process Management Systems. BPM success stories are many. Austin Energy, one of the leading energy utility company used BPM techniques to create an integrated IT infrastructure that spans the entire enterprise, to employ a powerful software framework for development, management and operations, enabling better service and to provide end-to-end monitoring, control and management of generation and distribution to improve responsiveness and utilization of resources levels. (IBM-BPM, 2009) With robust IT infrastructure available, there is a need now to use them for enabling learning at workplace.

We believe that the current methodologies of BPM techniques can help organizations build such workplace learning environment. This idea is at the core of the ongoing Learn PAd European Project, where we are developing a new approach and a platform to learning at work that exploits BPM models as both learning content and guide for personalized and collaborative learning sessions.

In the context of such wide goal, in this paper, we propose BPMS as a tool that can be used to develop workplace learning and training within an organization. Many facilities needed for using a BPMS to design a learning systems are already in place such as collaborative execution between different users, web-service integration, etc However BPM is not originally conceived for learning. In this work, we focus on defining a learning path specification that can be used to extend a BPMS for workplace learning. We

call it as Business Process Management-based Learning System (BPMLS).

As defined in (Janssen et al., 2008a), a sequence of activities and learning objectives customized to the needs and competencies of a learner is called a learning path. Therefore, after some background notions (Section 2), in Section 6 we introduce a definition of a learning path mapped on BPM models. Then in Section 4 we describe a BPMLS framework under development that can be for declaring and assessing learning activities of workplace learners. In Section 5 we walk through an example to show how the approach is used. Related work and Conclusions sections complete the paper.

## 2 BACKGROUND

This section will provide an overview of background concepts and technologies that are at basis of our work. In particular, our learning path specification uses and combines concepts and definitions related to:

- Business Process Management discipline;
- Business Activity Monitoring systems;
- Workplace Learning approaches;
- Learning Path specification.

We already introduced informally **Business Process Management** (BPM) in Section 1. More formally, we adopt here van der Aalst and coauthors operational definition of BPM (van der Aalst et al., 2003) as a discipline *supporting business processes using methods, techniques, and software to design, enact, control, and analyze operational processes involving humans, organizations, applications, documents and other sources of information.*

BPM spans over a complex life-cycle including stages of design, configuration, enactment, and diagnosis (van der Aalst et al., 2003). A **Business Process Management System** (BPMS) is a suite of software tools that leverage BPM concepts and covers some of the important components of the BPM life-cycle. Using a BPMS, process models are automated as workflow models that are then executed by a process engine. (Van Der Aalst and Van Hee, 2004)

**Business Process Management Notation 2.0** (bpmn.org, 2011) (in the following referred to simply as BPMN) provides a standardized graphical notation for modeling executable business processes in a workflow. A workflow contains a sequence of business activities, the work of a person, group, or any business applications. BPMN is one of the most suitable standards for developing process-oriented enterprise systems.

BPMS frameworks provide tools for: *i.* Process modeling, *ii.* Process Execution, and *iii.* Business Activity Monitoring (Van Der Aalst et al., 2003), among other things. In particular, **Business Activity Monitoring** (BAM) software can provide real-time access to critical business performance indicators for business activities executed by BPMS. BAM uses Complex Event Processing (CEP) techniques (Buchmann and Koldehofe, 2009), to process simple software-level events and derive higher level business events. BAM collects data of interest during the run-time business process execution. Collected data are later analyzed by Complex Events Processor (CEP) and correlated to Key Performance Indicators (KPIs) and Goals defined for the process models. (Calabro et al., 2015; Koetter and Kochanowski, 2012)

By adopting a model-driven approach, BPMS can easily be adapted for the design of platforms that can both inform and mimic business scenarios. This idea is at the basis of the ongoing Learn PAD project, which is developing a technology-enhanced platform for adult learning. In fact, when the modeled BP reproduces operational process in the offices, such platforms can provide opportunities for the employees to acquire knowledge by actually doing the activity. This kind of learning is called as **workplace learning** (Billett, 2001). Workplace learning emphasizes on participatory business practices for individual knowledge-gain. (Billett, 2004)

Within the learning context, **Learning path** is described as the chosen route, taken by a learner through a range of learning activities, which allows them to build knowledge progressively. (Clement, 2000) It can be used to formally describe learning scenarios. (Janssen et al., 2008a) A learning path includes a *learnflow* which contains orchestration details for learning activities, roles and other learning resources. (Mariño et al., 2007) Learning path specification should also define learning objectives or outcomes.

Many platform-independent Educational Modeling Languages have been proposed to describe learning path. IMS Global Consortium released the IMS-Learning Design specification that allows for defining the learning path as a Unit of Learning (UOL). (IMS-Global, 2003) Janssen and coauthors have provided a generic learning-path model that are mapped to IMS-LD designs. (Janssen et al., 2008a)

The aim of this paper is to introduce a learning path specification that can be integrated to BPMS for workplace learning. Our specification draws together the key concepts and definitions from Business

Process Management discipline as well as Workplace Learning approaches explained above.

### 3 LEARNING PATH SPECIFICATION

IMS-LD and Janssen et al (IMS-Global, 2003; Janssen et al., 2008a) learning path specifications emphasize on learnflow that consists of a sequence of activities and learning objectives based on the competencies of the learner. However, when it comes to defining learning path for business process models, specification of learnflow and learning objectives differ due to the following reasons:

- Learning flow for workplace learning should align to the business activities of an organization. What an employee learns should conform to the business process sequence rules established by the organization.
- Learning objectives of workplace learning should be correlated to Key Performance Indicators (KPIs) of business activities that are executed during the learning process.
- Learning path should be able to capture different business scenarios of the same business process. An employee's business activity may change based on the inputs he receives during the business process execution

The above key aspects are captured in our learning path specification. Our specification maps KPIs of business processes to objectives of the learning path. Figure 1, represents the model of our learning path specification. We extend the BPMN model to introduce attributes related to LearningPath. This specification allows defining Learning path on top of BPMN specification. In the figure, classes of BPMN model are represented in gray background. Classes with the yellow background are related to the learning path specification. An overview of the model is explained in detail below.

A Business Process Model defined using BPMN.2.0 specification can have one or more Learning Paths. Learning Paths are defined only for BPMN models with parameter *isExecutable* set to true. This is to ensure that learning paths are defined only for deployable BPMN process models (refer BPMN Specification). Each instance of Learning Path model represents one learning session, and executes a process instance in BPMLS, with KPIs and monitoring parameters defined by the Learning Path model. Learning Paths fulfill learning objectives which are represented as KPIs. KPIs are used to

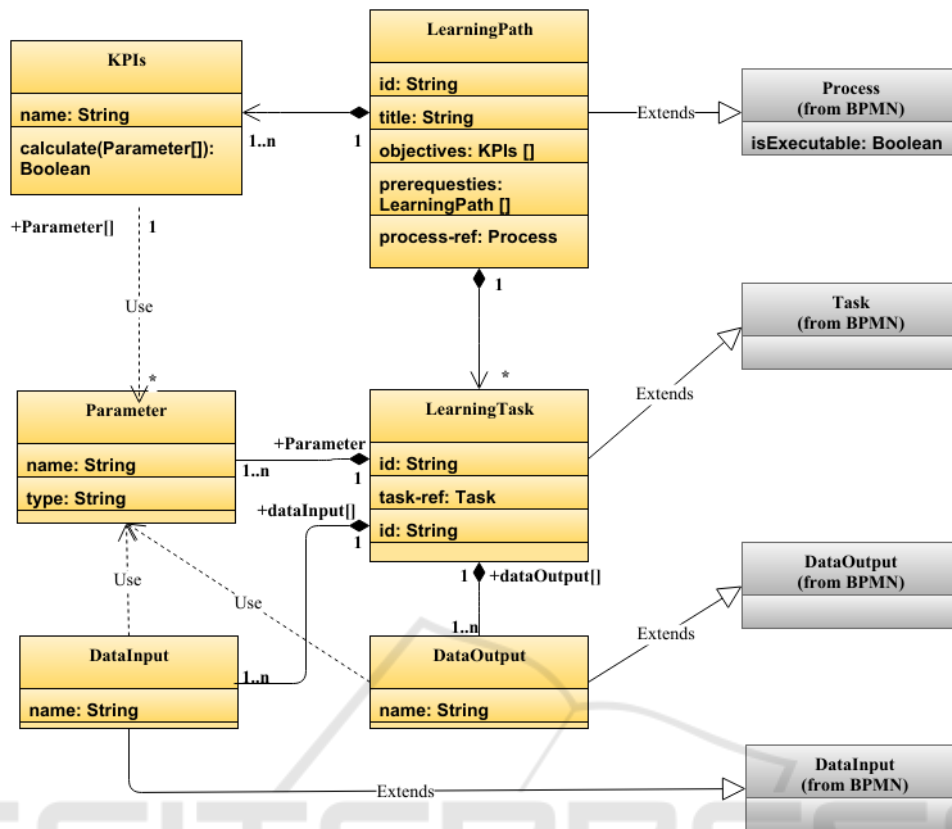


Figure 1: Learning path specification for business process model.

evaluate key business metrics that are crucial during the execution of the process instance. Mapping KPIs to Learning objectives ensures that learning sessions caters to the business goals of the organization.

A Learning Path can have one or more Learning tasks. **LearningTask** class is extended from the **Task** of BPMN. Learning Tasks define one or more Parameter objects which are used to calculate KPIs during the learning session.

**LearningTask** can contain a set of **DataInput** objects that defines a set of input data that is expected for the corresponding learning task. Similarly **DataOutput** objects defines output data expected from the learning task. **DataInput** and **DataOutput** are extended from their counterparts from BPMN specification.

In this section we have provided a learning path specification for business process models. In the next section we will provide an architectural framework that uses this specification for building BPMLS. In Section 5, we provide an example to explain how the business process and learning are related, and how learning path specification help in business process learning.

#### 4 FRAMEWORK FOR BPMS-BASED LEARNING SYSTEM

BPMS which can be used for modeling and execution of BPMN-based process models can be extended into BPMLS, if we can define:

- **A Model to specify Learning Path on top of Business Process Models:** This is what we provide in Section 6.
- **A Platform to Design Learning Models:** It can be a tool developed on top of BPMS modeling tools. This work is currently in progress, and we are not covering this in this paper.
- **Methods to Monitor and Assess the Learning Progress of a User:** Preliminary result of this can be found in our work. (Subramanian and Bertolino, 2016)

In this section, we will provide the architecture of BPMLS. The framework is conceived such that an employee who needs to learn about a business process can log into the system and will find an environment

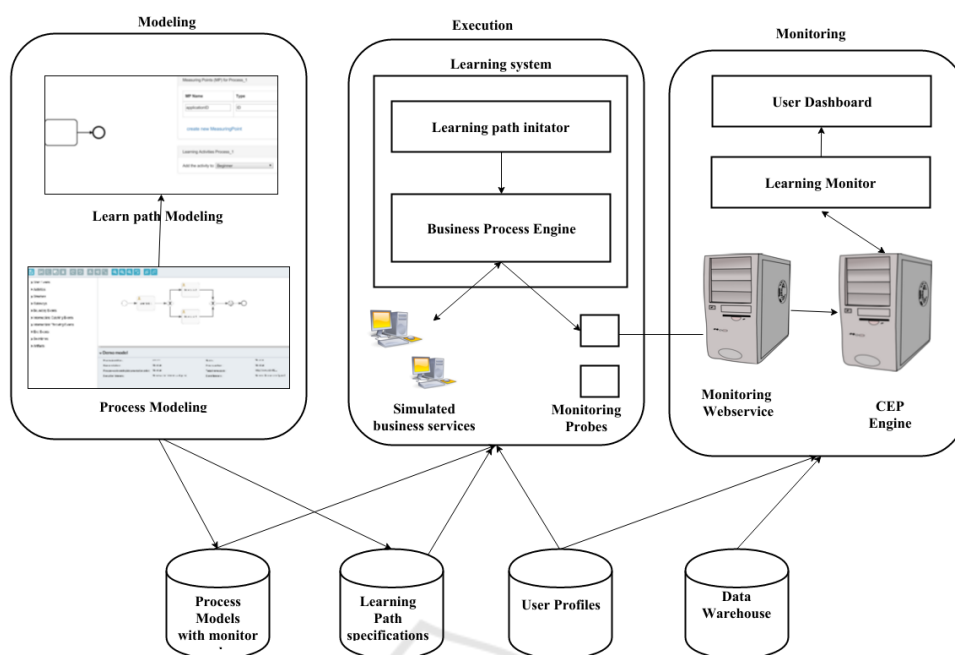


Figure 2: Framework of BPMS based Learning and Monitoring System.

mimicking the real business process for learning purposes. Project Learn PAD, of which this work is a part, aims at developing a learning environment that supports, among other things, a procedural learning approach based on simulation and monitoring (learning by doing). This research work will provide methods to define learning path as well as to execute and monitor the learning progress during a learning session. Since providing actual components for creating a learning scenario is beyond the scope of this work, we will use existing business process engine for process execution. Later we will integrate our framework with the simulation environment of Learn PAD. The framework provides components: *i.* to define learning path for business process models, *ii.* to create a learning session and deploy the corresponding process instance in a process engine (simulation engine in the later period of time, when it is been developed). *iii.* to monitor the learning session to verify if the learning path satisfies the learning outcomes. The overall framework of our BPMS-based learning system and monitoring system is given in Figure 2.

The architecture covers three phases of a BPM life-cycle, namely Modeling, Execution and Monitoring. During the modeling phase, learning paths are defined for a given process model based on our specification. A document will be created for each learning path. When writing this paper, we are in the process of developing a tool for XML serialization of the **LearningPath** specification. The document will contain the business process model as well as of the learn-

ing path model.

During the execution phase when one of the learning path is selected for execution, model-transformation technique is applied to transform the learning path model into business process model. Model-transformation from Learning path model to Business Process model is an ongoing work and is beyond the scope of this paper. Some of the initial work can be found at (will be reference to submitted paper not included due to double-blind review procedure).

After the transformation is complete, a learning scenario will be created by executing the corresponding process instance in BPMLS business process engine. Monitoring uses BAM techniques to monitor the learning path execution and provides real-time results of the learning progress.

In the next sections, we will see an example and the prototype that we developed for the execution of learning path model.

## 5 MOTIVATIONAL EXAMPLE

In this section we will see a motivational example, to understand the learning path specification that was defined earlier.

European Union Framework Program (FP7) provide funding opportunities for many organizations within Europe to support Research and Development. Organizations working within FP7 programs should understand the complexity involved during the suc-

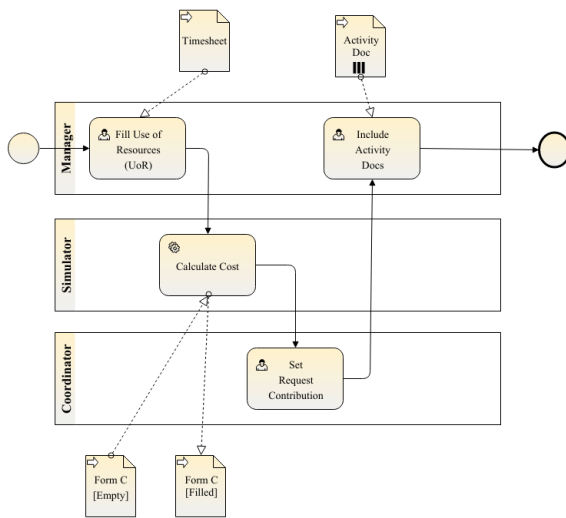


Figure 3: Example Process- Periodic Budgeting Report.

successful execution of their projects. Understanding the different processes involved is crucial for the success of the project. For example, participants in an EU financed project are obliged to report periodic budgeting activities for the tasks performed within the project. This process is quite complex but yet extremely important for the employees of the organization to understand. Workplace learning for such scenarios is the need of the hour for such organizations. We will consider below a motivational example that will highlight the usefulness of our learning path specification workplace learning for the above scenario. Figure 3 represents a simplified BPMN model for the periodic budgeting report of an organization that is involved in the FP7 project. It is a collaborative process between a project manager and a project coordinator. In the first task 'Fill Use of Resources (UoR)', the project manager has to fill a predefined timesheet form to reflect the different resources used for the project during a particular period. Next task is an automated service task (typically a web-service call), that mimic the process to calculate project costs based on the timesheet filled earlier. At the end of the 'Calculate Cost' task, a filled 'Form C' document will be provided to Project Coordinator. The coordinator will set a contribution in the next task called 'Set Request Contribution' based on the details available in Form C. In the final step, the manager has to attach a list project activity documents relevant to the project. The task is called 'Include Activity Docs' in the business process model. With the submission, the process will be completed.

Though it is a simplified version of EU budget reporting, the above example is still complex enough to be reproduced in a standard Learning Management

System (LMS). We will see how our BPMLS framework makes it easier for creating a learning environment for such scenarios.

## 5.1 Learning Path for Periodic Budget Reporting

Our First goal is to provide a learning path specification for the above example. Figure 4 provides the instance model of the Learning Path specification. The instance captures one learning scenario for the example. The learning path is created for the budgeting scenario of 'Project X'. The details of the sample project scenario is provided as **DataInput** to the learning task 'Fill Use of Resource'. Note that in the representational figure just the name of the project is provided. However additional details can be provided as an array of **DataInput** object (not provided in the figure for the sake of brevity). The learning task also contains a **Parameter** object called 'Total Time' that will be used within **KPI**. 'Set Request Contribution' is another learning task of the learning path specification. It also contains a **Parameter** object called 'Request Cost' to capture the cost set by the project coordinator.

Both the **Parameter** objects are used within the calculate function of **KPI** class which is defined as:  $TotalTime < 100 \ \&\& \ RequestCost < 10000$

The KPI function verifies if the collaborators of the 'Project X' is able to fill the forms accurately. In our specification, KPIs are used to monitor if the 'Total Time' entered by the project manager is less than 100 (hours) and the 'Request Cost' entered by the project cost is less than 10000 (Euros). And this KPI is set as learning objective of our learning path specification. This way our learning path specification can ensure that the learning scenario caters to the business goals of the organization.

## 5.2 Prototype Evaluation

A prototype was developed to evaluate the learning path model transformation and assessment techniques. Learning path specification are created as mentioned above. Model transformation is performed in a semi-automated way, where the BPMN models are generated automatically and later manually updated with the additional learning tasks parameters. We already have developed a semi-automated model transformation technique in our work. (reference to submitted work, omitted here for double-blind process) We are in the process of automating the transformation technique.

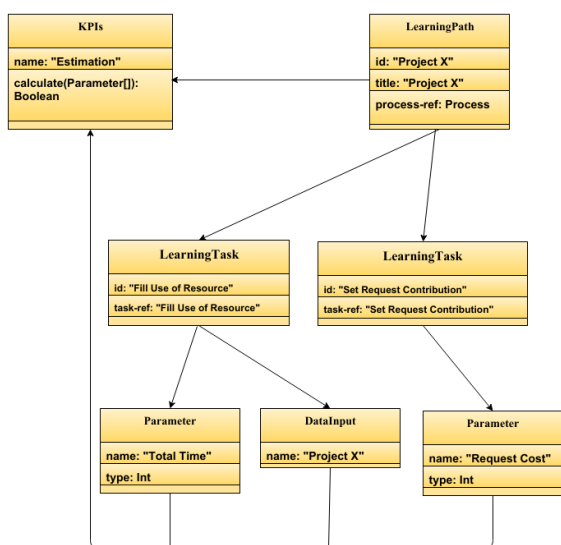


Figure 4: Learning Path Specification- Periodic Budgeting Report.

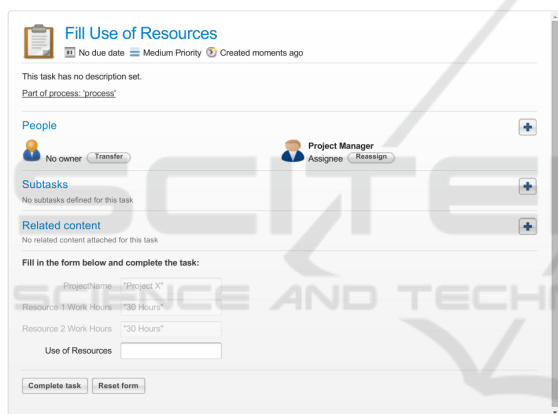


Figure 5: Learning Path Specification- Periodic Budgeting Report.

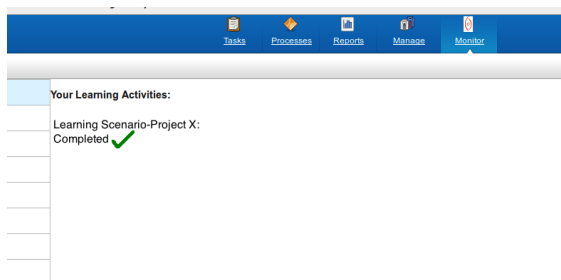


Figure 6: Monitoring- Periodic Budgeting Report.

For the Process Execution Engine, we used Apache Activiti, an open-source Java-Based BPM Platform. (Rademakers, 2012) For learning path monitoring we used Drools Fusion (Drools Fusion 6.0.3, 2015) based CEP engine. Apache Activiti Explorer was used to design, and execute the process mod-

els. Learning path model and its corresponding business process models, CEP rules were created separately. The explorer interface was modified to detect and display the learning progress to the users. Figure 5 provides a screenshot in which the 'Fill Use of Resources' task is executed. Figure 6 provides a screenshot of a simplified web page where the progress of the learner is registered.

## 6 RELATED WORK

Using BPM concepts for the management of collaborative learning processes have long been considered by the research community. Marino and coauthors (Mariño et al., 2007) proposed a method to transform learning design models defined using the IMS-LD specification to business process execution model called XML Process Definition Language. The goal was to use IMS-LD for defining a learning design and use business process engine as a delivery platform for the learning designs. In (Karampiperis and Sampson, 2007), Karampiperis and coauthors examine using of BPMN as a common representation notation for learning flows modeled using Business Process Execution Language (BPEL) and present an algorithm for transforming BPEL Workflows to IMS-LD learning flows.

Vantroys and Peter (Vantroys and Peter, 2003) presented Cooperative Open Workflow (COW), a flexible workflow engine that can be used to transform IMS-LD into XPDL designs to enact the learning models in the platform. Another e-learning platform called Flex-el (Lin et al., 2002), is also been built on top of workflow technology. It provides a unique environment for teachers to design and develop process-centric courses and to monitor student progress. Project TRAILER, BPMN is used as a model to define a methodology and developing tools to learning as well as the management of competences and skills acquired through informal learning experiences, both from the perspective of the user and the institution or company. (Penalvo et al., 2012; ?)

Above discussed methodologies and platforms focus on using BPM techniques and technologies for designing learning specifications for academic scenarios and do not focus on workplace learning.

Regarding learning path specification, Janssen and coauthors proposed learning path information model that can represent a formal learning path model. (Janssen et al., 2008b) However, the specification is generic and does not address the requirements of workplace learning based on BPM. We already raised the issues in Section 6.

As far as we know none of the existing work focus on using BAM for workplace learning monitoring. In their work, Adesina et al focus on visually tracking the learning progresses of a cohort of students in a Virtual Learning Process Environment (VLPE) based on the Business Process Management (BPM) conceptual framework. (Adesina and Molloy, 2012) Their work focus on learning specifications for academic scenarios and do not focus on workplace learning. Tracking the learning progress also do not leverage upon BAM systems.

Our work defines a precise specification that can be used for defining learning path for business process models, as well as transformation techniques for using standard business activity monitoring techniques to monitor learning progress of an employee.

## 7 CONCLUSIONS AND FUTURE WORK

Our work aims at exploiting the potential of BPM to support effective and realistic workplace learning activities. BPMS solutions used at work are very powerful and widely used, but they are not conceived for training. To the best of our knowledge there is no existing proposal for adapting BPMS to learning needs.

Our work stays within the context of the European Learn PAd project, that aims at exploiting enriched BPMN models for deriving both recommender systems and simulation sessions used expressly for learning the modeled sequence of tasks.

This work, in particular, aims at filling the gap between BPM used for work, and workplace learning needs. We introduced a specification of learning path that extends the standard BPMN specification by including learning relevant concepts. The development of a platform using such definition both for driving the learning session and for assessing learners progress is still ongoing. We are currently refining platform implementation, and testing it on several scenarios defined within the Learn PAd project.

## ACKNOWLEDGEMENTS

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