A BUSINESS PROCESS MANAGEMENT BASED VIRTUAL LEARNING ENVIRONMENT
Customised Learning Paths

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Abstract: Virtual Learning Environments (VLEs) such as Moodle help facilitate the management of educational courses for students, in particular by helping lecturers with course administration and students manage their own learning. However, problems still remain; in particular, e-learning environments provide a "one size fits all" approach to the learning process, where each student must follow the same learning path through course materials, regardless of their prior knowledge, learning requirements or of possible learning disabilities. This paper presents the development of an e-learning system based on Business Process Management (BPM) concepts, principles and technologies, which are used by the enterprise business community for managing workflow. The developed system allows for the creation of customised learning paths through course materials in a blended pedagogical approach within a custom VLE.

1 INTRODUCTION

e-Learning has in no doubt had a profound effect on the way training and education is delivered. In academia, e-learning is becoming vital for distance education, and often seen as complementary to the classroom environment, where it can help to strengthen the traditional pedagogy. It has been determined that different learners browsing and studying the same e-learning materials will generally show different learning behaviours according to their personal characteristics (Chuang, H., and Shen, C., 2008). This is because learners tend to meander through different paths through learning content. Although learners can learn to some degree independently in an e-learning environment, they have to determine "what to learn" and "where to go" at each learning node/decision, often consuming mental and physical efforts during learning that causes cognitive overload and results in student anxiety (Lin and Wu, 2007). Within the academic environment, a Virtual Learning Environment (VLE) (e.g. Blackboard, Moodle etc) is a software system that allows for the implementation of e-Learning. However, one of the limitations of existing VLEs is that they provide a "one size fits all" approach to the learning process through the course materials, as each student must follow the same learning path regardless of their prior knowledge, learning requirements or of any learning disability. This paper presents the design and implementation of an e-learning system that allows: a course writer to draw and configure using a graphical interface the paths possible through course materials; the course writer can see the statistical progress of a learner versus other learners, or the statistical progress of the entire cohort.

2 CUSTOMISED LEARNING PATH

Within the literature it is widely recognised that an important component of success in distance education is related with the ability to customise the learning process for the specific needs of a given learner (Colace et al., 2005). In general context, personalised learning is a potential approach to meeting future educational needs and may provide new alternatives that foster learning capacity among individual learners (Bentley and Miller, 2004). Jarvela (2006) states that personalisation of learning has become imperative, where personalisation of

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learning does not purely mean individualised learning, nor is it the opposite of social learning, but as an approach in educational policy and practice whereby every student matters - equalising learning opportunities in terms of learning skills and motivation to learn.

Heller et al. (2006) give a definition that *"customised learning aims at tailoring the teaching to individual need, interest and aptitude so as to ensure that every learner achieves and reaches the highest standards possible."* The decision to find alternative paths for learners raises a fundamental question as to whether the same expected learning outcome can be achieved by learners following personalised learning paths, supplemented with contingent teaching, where the lecturer does not have a fixed linear "script" but rather a diagnostic branching tree where audience responses to early questions determine what is performed next (Draper, 2004). Wolf (1995) also advocated this approach through Competence-Based Assessment and define it as: *"A form of assessment that is derived from a specification of a set of outcomes; that so clearly states both the outcomes - general and specific - that assessors, students and interested third parties can all make reasonably objective judgements with respect to student achievement or non-achievement of these outcomes; and that certifies student progress on the basis of demonstrated achievement of these outcomes"*. This definition encapsulates the important components of competence-based assessment; emphasis on outcomes; specifically, multiple outcomes, each distinctive and separately considered. For creating personalised learning paths and efficiently uncovering the knowledge or competence level of a learner, prerequisite structures on LOs and assessment problems, or on skills underlying those entities, are extremely useful (Steiner and Albert, 2008). Heller et al. stated that among the benefits of a personalised learning environment is the fact that the time taken to learn is reduced, and that learner's retention is improved.

3 BUSINESS PROCESS MANAGEMENT BASED VIRTUAL LEARNING ENVIRONMENT (BBVLE)

3.1 Business Process Management (BPM)

BPM refers to: aligning processes with the organisation's strategic goals; designing and implementing process architectures; establishing process measurement systems that are aligned with organisational goals; and, educating and organising managers to manage processes effectively (Bosilj-Vuksic et al., 2005). It ensures continued improvement of business performance by managing the processes and their components: organisational structure, policies, business rules, regulations, human resources, and ICT. BPM refers to: aligning processes with the organisation's strategic goals; designing and implementing process architectures; establishing process measurement systems that are aligned with organisational goals; and, educating and organising managers to manage processes effectively (Bosilj-Vuksic et al., 2005). It ensures continued improvement of business performance by managing the processes and their components: organisational structure, policies, business rules, regulations, human resources, and ICT.

Figure 1 illustrates the lifecycle of a BPM system right from the inception of a business concept. A business concept is: modelled in a business modeller; implemented and deployed in a business run-time engine; monitored in a business monitoring activity system (e.g. dashboard); and, analysis/optimisation is performed based on feedback for continuous improvements.

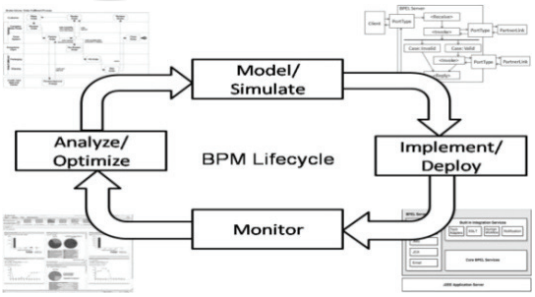

Figure 1: End-to-end life cycle of BPM.

The purpose of exploring BPM is to manage learning processes in an automated manner and to ingrain customised learning paths within a learning process workflow model. Therefore, a BPM-based VLE solution is a software system that uses BPM concepts and technologies to enable the full learning process to be defined in a computer language, thereby, allowing possible multiple learning paths.

3.2 Design of Customised Learning Paths

The paper focuses on the design and implementation of customised learning paths in a learning process

through course materials using the following BPM technologies:

Business Process Modelling Notation (BPMN). BPMN is a core enabler of BPM. It is a standardised graphical notation for drawing/modelling business processes in a workflow system. BPMN elements are made up of simple diagrams that use a small set of graphical elements. Figure 2 shows the core sets of BPMN elements, which fall into four categories: 1) Flow objects: These include event (i.e. start, end and intermediate events) activity (i.e. task) and gateway (i.e. a diamond shape and will determine different decisions). 2) Connection objects: This allows flow objects to be connected together. 3) Swimlanes: These serve as a mechanism to organise activities and responsibilities on a process diagram. 4) Artifacts: These allow developers to bring some more information into the model/diagram. In this way the model/diagram becomes more readable.

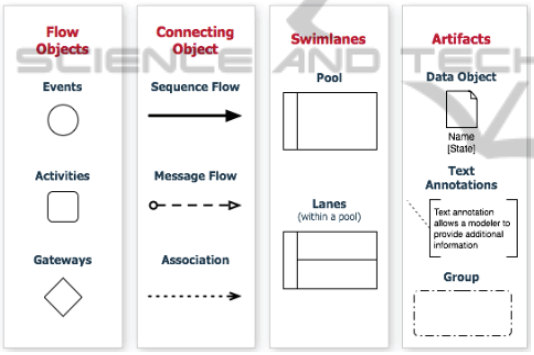

Figure 2: Core set of BPMN elements.

In our BPM-based VLE, BPMN is used to model learning processes/activities. The course writer is able to draw out the mode and extent of a workflow that enables adaptive customised learning paths through the course materials.

Java Process Definition Language (JPDL). BMPN is not executable; therefore, it needs to be converted into a computer executable language. JPDL is a JBoss process orchestration language that is executable in a workflow engine. It is an intuitive process language that expresses business processes both in graphical and XML form. To bind tasks together, jPDL has an extensible control flow mechanism. The BPMN model designed by the course writer is converted into a JPDL. The generated JPDL is an XML that can be deployed into workflow engine and access by any BPM client.

4 IMPLEMENTATION AND RESULTS

Figure 3 shows a screen grab of our BPM-based VLE implementation (all web-based). The figure shows the learning interface for students and a monitoring interface that allows the lecturer to view learners' progress. The system uses information collected during introductory tests to ascertain that a learner meets any prerequisites. Also, during the learning process, as the learner begins to navigate through each topic, the system is able to infer learner's knowledge using the results from the learner's competence-based assessment (mastery level) on a specific topic; this inference is a basis for building the individual learning path for each learner. The implementation of a customised learning path in a learning process within the system encompasses an approach where a general LO is the ultimate goal but individual learner's learning behaviour within a learning process determines the learning path in achieving the desired LO.

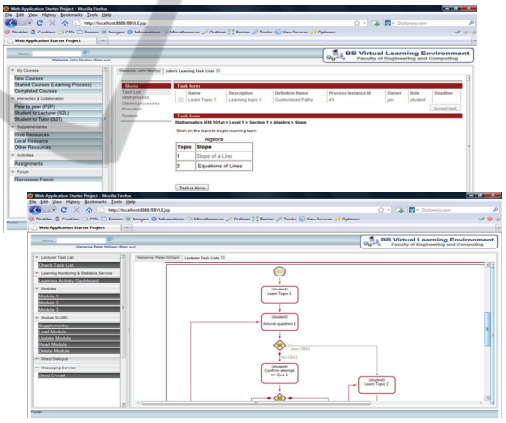

Figure 3: Student/lecturer BPM-based VLE web interface.

4.1 Implementation and Deployment of Customised Learning Path

Using the basic BPMN elements mentioned previously, an example customised learning path is modelled in BPMN as shown in Figure 5. The swim lanes in the overall diagram represent the activities and responsibilities between learner and lecturer. Learning through each topic in the course material is modelled as task lists that need to be fulfilled by a learner. Competence-based assessment in this example is modelled as a simple question to test a learner's competency on particular topics. The JPDL version of our modelled customised learning path is deployed in JBoss JBPM runtime engine.

4.2 Monitoring Instance of a Learning Path on a Dashboard Console

Dashboard provides real-time alerts based on business metrics when business processes are in need of intervention. In our current implementation, the major benefit of this added functionality is for the detection of lack of progression (of the individual or cohort). The course writer can act in real-time using the monitored data, rather than detecting problems at semester-end/major assessments.

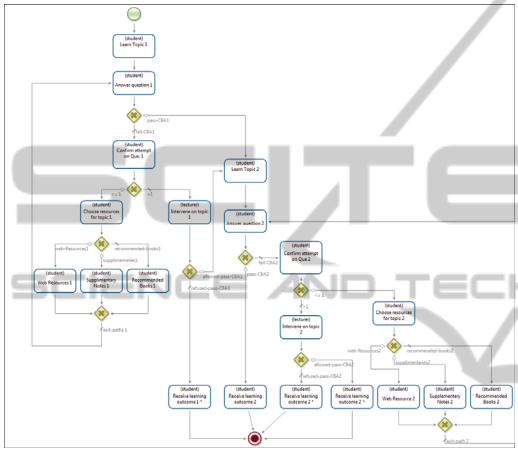

Figure 5: BPMN diagram of a customised learning process.

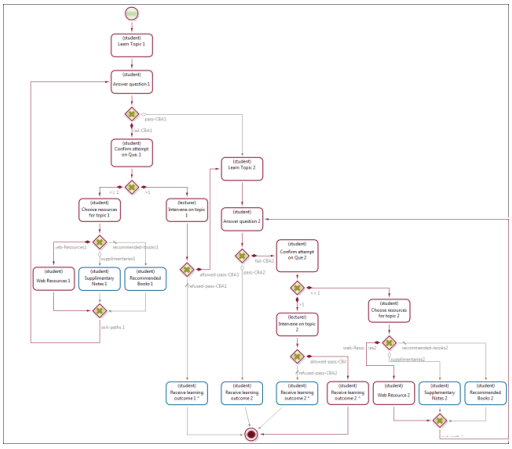

Figure 6: Learning path of a struggling learner captured, monitored and given support by lecturer (Path followed in red).

The chain of the deployed learning process can be viewed by the lecturer within a BPM dashboard as shown in Figure 5 (if no learning process is invoked). Figure 6 captures the learning footprint of a learner's learning path that is struggling through the course note and needs supports.

5 CONCLUSIONS

In this paper we have presented a software framework and prototype system implementation that uses BPM technology to allow course writers to define and model customised learning workflows, which can contain multiple learning paths. The drawback and disadvantage of our BPM approach lies in its complexity. However, as the open source BPM frameworks, on which we rely, are only beginning to gain traction we expect the level of complexity to reduce over time through the addition of more assistive and visual design tools.

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