Facilitating Work-based Learning Projects: A Business Process-oriented Knowledge Management Approach

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Abstract: The knowledge generated and acquired in workplaces differs from that generated and sustained within formal academic and disciplinary structures. It is interdisciplinary and situated, and cannot be organized and structured as a traditional discipline-based course. This paper proposes to use the business process as a framework to structure and organize work-based knowledge for facilitating the creation, transfer, and use of knowledge across work-based learning (WBL) projects within the networked learning community. This approach supports to represent and record externalized tacit and explicit knowledge and to find context-sensitive and task-relevant knowledge resources. We argue that IMS Learning Design (LD), with appropriate changes, can be used to represent WBL project plans and facilitate the creation and use of work-based knowledge through execution of the WBL project plan represented in LD.

1. Introduction

Work-based learning (WBL) is a class of university programmes that bring together the universities and work organizations to create special learning opportunities in workplaces (Boud and Solomon, 2003). In WBL, formal learning, informal learning and non-formal learning complement each other in progress toward formal recognition and accreditation of learning by universities (DEWBLAM, 2006). WBL has increasingly become an area of interest for the higher education sector (Brennan and Little, 2006).

The WBL programme is normally an individualized programme based on the learner's individual needs, interests and prior knowledge, and is also designed and planned to meet the needs of the organization (Boud and Solomon, 2003). The pedagogy is experiential in nature, centered on the application of learning in the workplace and evidence-based assessment of progress and achievement. This ensures that the workplace provides an opportunity for the practical application of knowledge and skills through action or problem-based projects (Thomas, 2008). A significant part of the WBL programme is one or more WBL projects. The majority of WBL projects can be conceptualized as research and involve learners in becoming practitioner-researchers (Costley and Armsby 2007). A WBL project may be defined and implemented in parallel to a real work project in the workplace and take the learner through a predefined learning process to reach some of the learning objectives (Fink et. al. 2007). A WBL project may be triggered by the need to

solve a work-based problem or review an aspect of work practice, or introduction of a new procedure (Armsby & Costley 2000). A WBL project differs from a dissertation in that it demonstrates a range of practical capabilities in the workplace. It focuses on activities within the workplace that lead to a product. WBL projects reflect a project cycle of activity: project planning, implementation and delivery, monitoring and evaluation (Middlesex, n. d.).

Designing and planning a WBL project is a complicated and time-consuming task because it should be unique to any individual. In the WBL community research on computer-mediated learning is limited (Bosley and Young, 2006). In the literature the research issue on technical support for planning and conducting WBL projects has not been addressed sufficiently. Especially, it is a challenge to support the gathering, storage, retrieval, and use of knowledge generated and needed in carrying out WBL projects. This paper proposes to adopt a business process oriented knowledge management approach to facilitate teachers, employees, supervisors, and representative of the organization who intend to create and share work-based knowledge. Facilitation is done through collaboratively designing and executing WBL project plans. We claim that IMS Learning Design (IMS LD, 2003), with appropriate changes, can be used to represent, communicate, negotiate, customize, and execute WBL project plans and facilitate the creation and sharing of work-based knowledge within and across WBL projects.

2. Knowledge Management for Supporting WBL Projects

The knowledge generated and acquired in WBL projects is either tacit or explicit. Tacit knowledge (Polyani, 1967) is personal knowledge embedded in individual experience (e.g., personal beliefs, perspective, and the value system). Tacit knowledge is hard to articulate in language (hard, but not impossible). Before tacit knowledge can be communicated, it must be converted into words, models, or numbers that can be understood. Explicit knowledge, however, is expressed or codified in symbols and can be communicated to other individuals by using these symbols (e.g., business process models and structured data objects in databases). Nonaka & Takeuchi (1995) discuss the modes of knowledge creation and conversion that are derived from explicit knowledge and tacit knowledge: socialization, externalization, combination and internalization (SECI). Their SECI model postulates a four-stage process through which tacit knowledge of individuals is shared with others through socialization, and then converted into explicit knowledge through externalization; new explicit knowledge is generated through combination with existing sources of explicit knowledge, and then reconverted into tacit knowledge through a process of internalization. While explicit knowledge can always be externalized, tacit knowledge can sometimes be externalized by indirect externalization through apprenticeships, conversation, mentoring, and storytelling, as recommended by Johannessen et al. (2001) and Lubit (2001). The recorded, externalized knowledge is called a knowledge artifact. The knowledge that is internalized in a person's head is called participant knowledge. Both knowledge artifacts and participant knowledge are knowledge resources of the organization (Holsapple and Joshi, 2002). Participant knowledge is affected by the arrival and departure of the knowledgeable participant and by participant learning. As opposed to this, a knowledge artifact does not depend on a

participant for its existence. Representing knowledge as a knowledge artifact involves encoding that knowledge in an object, thus positively affecting its ability to be transferred, shared, and preserved (Kalpič and Bernus, 2006).

Since knowledge resources are valuable for the organizations and WBL projects, it has been recognized that teachers, learners, and relevant stakeholders need help with information and communication technologies (ICTs) to represent, gather, archive, and share the knowledge generated and required in carrying out WBL projects. Technologies produce value when they increase the accessibility of knowledge, reduce the time and effort to record and keep it, and further facilitate knowledge conversion process between the individual and the organization, and between the tacit and explicit knowledge. Many WBL practitioners use online communication tools like discussion boards, chat, messaging, emails, forums, and weblogs to share knowledge. For example, Costa (2007) reported that weblogs can assist in creating a WBL community in which ideas and tacit knowledge can be expressed, commented, and shared swiftly, thus facilitating a flow of knowledge that can then be applied into the workplace in a timely manner and stored for later use.

In the same vein, we propose to adopt a business process oriented knowledge management approach to help networked learning communities create and share tacit and explicit knowledge within and across WBL projects.

3. A Brief Introduction to Business Process-oriented Knowledge Management

A business process is a set of coordinated activities performed by people using resources under certain conditions in order to achieve a specific organizational goal. A business process model (BPM) is an abstract description of a particular business process or a set of business processes with common characteristics. In the context of business process re-engineering, a BPM is typically a representation of explicit knowledge about well-structured work process and the certain valuable knowledge produced and needed in performing activities is not explicitly contained.

In knowledge-intensive organizations, business processes typically become more and more knowledge intensive (Eppler, et. al. 1999). The emergence of knowledge-intensive business processes prompted the research on Business Process-oriented Knowledge Management (BPoKM) (Jablonski, et. al. 2001; Abecker, et. al. 2002; Papargyris, et. al. 2002; Abecker, 2004). The BPoKM approaches focus on aiding knowledge workers to effectively build up the knowledge and abilities that they need to fulfill tasks in their business processes (Strohmaier, 2005). The BPoKM is based on the assumption that the employees of a company normally perform their activities within defined business processes. Then, a BPM is used as a framework to organize knowledge archives as an organizational memory. Thus, a BPoKM system enables an automatic, context-sensitive storage and access of task-relevant knowledge in the operational processes of the organization (Abecker, 2004). This means that an employee can receive precisely the

knowledge resources needed to perform the current activity in carrying out the business process with an extended workflow management system. Additionally, the new knowledge artifact that the employee creates while performing an activity can be gathered and stored in association with the activity. The BPoKM systems are helpful to avoid the problems of traditional knowledge management systems, such as the need of additional work (e.g., handling keywords or tags), lack of time to look for information, and unawareness of the existence of pertinent information. They minimize the risk of losing vital knowledge when key individuals become unavailable or leave the organization.

4. A BPoKM Approach to Support WBL Projects

We propose to adopt a BPoKM approach to support WBL projects. Our approach can be characterized by: 1) building a business process model and knowledge repository, 2) making a WBL project plan by reusing, customizing, or creating a business process model, and 3) supporting contextualized learning through working with the project plan.

4.1 Building a Business Process Model and Knowledge Repository

Business processes relevant to WBL programmes can be identified, codified, and stored in the repository as reference BPMs. The BPM could be a descriptive model that abstractly describes how a business process has been performed (e.g., a best practice). It could also be a prescriptive model in which how a desired business process should/could/ might be performed (e.g., a pilot project) is intuitively articulated.

A BPM may have alternative and similar BPMs in the repository. For example, in the business of real estate development different business processes can be performed to achieve the same or a similar goal. They can be modeled and stored as alternative or similar models. In addition, A BPM may have sub-BPMs. For example, a real estate development process typically consists of series of sub-processes such as forming the development concept, carrying out a feasibility study, planning & financing, construction, and operation/sale.

Like a conventional BPM, our BPM specifies how people with different roles collaboratively perform activities in sequence and/or in parallel to create products/services by using resources and tools. For example, the real estate development process requires skills of many professionals such as market consultants, architects, and finance consultants. Examples of key activities need to do in the first step “forming the development concept” are evaluating lands/sites, investigating market for alternative uses, developing basic architectural design ideas and program, estimating cost, identifying sources of finance, identifying roles and project team, estimating project development cost, designing general project management system, and documenting a development concept. The development concept is the expected output of the first process.

Unlike a conventional BPM, our BPM is additionally used as a framework to organize knowledge. Proficiency competences needed at certain levels for each role to perform a knowledge-intensive activity in the business process would be specified. The relations between competences and the prepared learning materials useful for developing the competences will be defined in the system. Note that the knowledge generated and acquired in workplaces differs greatly from that generated and sustained by academic institutions. As Gibbons et al., (1994) and Scott (1997) distinguished, while 'Mode 1' knowledge (e.g., architectural design) is developed within formal academic and disciplinary structures in the context of discovery, 'Mode 2' knowledge (e.g., knowledge about a particular market) is developed through problem solving in the context of application. 'Mode 2' knowledge production normally takes place in cross-disciplinary project-based teams. These teams bring together a variety of disciplines and experience to solve or pose specific problems or undertake a task. Thus, 'Mode 2' knowledge cannot be authoritatively encoded in traditional forms of scholarly publication and structured as a discipline-based curriculum. The context of application, in contrast, describes the total environment in which scientific problems arise, methodologies are developed, outcomes are disseminated, and uses are defined (Nowotny et al. 2003). The use of BPM provides an opportunity to associate 'Mode 2' knowledge with the concrete situation in which the knowledge is developed and needed to perform a specific activity.

4.2 Making a WBL Project Plan

When making a WBL project plan, teachers, employees, workplace supervisors, and representatives of the organization can collaboratively identify the focus and knowledge requirements of the WBL project according to the prior knowledge and the needs of the employees, the past/ongoing/future workplace projects, the competence development plan of the organization, and the available WBL programmes and award requirements of the university. Then they can try to find appropriate BPMs in the repository. The factors to take into account are organizational aspects (e.g., work units, roles, required and objective competences for each role), task aspects (e.g., developing concept and making an architectural plan), product/service aspects (e.g., a building and a developing area), and others (e.g., estimated duration and cost, specific methods and techniques, the degree of detail, the degree of mature, the region and language). They can customize, refine, and/or combine the selected BPMs and even develop a new BPM. It should be clear that some knowledge-intensive activities could hardly be explicitly structured in advance. Hence, it should be allowed to specify certain sub-processes informally or as a set of unstructured activities. After the BPM has been designed, on the one hand, they assign the metadata (e.g., involved roles, task type, product type, and duration) of the BPM and indicate the relations with other BPMs and activities (e.g., alternative, similar, is_a_part_of, precede and succeed); on the other hand, they instantiate the BPM as a WBL project plan and assign roles to co-learners/workers, workplace supervisors and tutors.

4.3 Executing a WBL Project Plan

After planning, the participants can start to perform activities following the WBL project plan. To perform an activity, the learners can get basic guidance from reading the activity description. In addition, the knowledge needed to perform the activity can be acquired through reading relevant learning materials (about mode 1 and mode 2 knowledge) available and accessible in the activity workspace while working on the expected output. The facilities to search personalized learning materials are based on user models and the mappings between the competences and learning materials. The issue of how to organize this is beyond the scope of this paper and will not discussed in detail. If the learner has problems or questions, s/he can use communication tools (e.g., a chat and a forum) to discuss the problem and seek for solutions with co-learners/co-workers, workplace supervisors, and teachers. The discussion (e.g., chat protocol) can be recorded and stored in the activity workspace. Learners are also encouraged to write and comment on their ideas, work experiences, and reflective reports during and after the completion of the task. Such externalized tacit knowledge will be helpful for getting assistance, being assessed, and sharing and converting knowledge. While carrying out a WBL project, the learner is not only learning how to do his/her existing job, but also extending his/her present work (Boud and Solomon, 2000). Unlike in a real work project, learners can try to use alternative strategies and explore new strategies to get the work done in a WBL project. If the learner develops a new work strategy to fulfill the task successfully, s/he is encouraged to describe the strategy informally (externalized tacit knowledge). The learners and teachers can discuss and improve the new strategy. If the process becomes mature and can be formally modeled, they can articulate the work process and put it into the repository as a new BPM (converting tacit knowledge into explicit knowledge).

It is important to note that the externalized tacit and explicit knowledge (knowledge artifact) created in an activity can be stored automatically or manually (depending on the policy selected) with the activity. Since the context is known due to its embedment in the business process, the knowledge creators do not need to assign keywords or categories to the knowledge artifact (it is not easy to do so especially for describing tacit knowledge). Later on, when other learners need to do the same or a similar task, the knowledge artifact can be found easily without the need to describe knowledge using keywords. In addition, it is technically possible to build the connection between the knowledge artifact and the knowledge creators/holders within the networked learning community. Thus, the BPoKM approach is helpful for avoiding the problem to get a large number of inappropriate knowledge resources just because the content of the knowledge artifact and context of its development and application are not (and even cannot be) precisely or appropriately described and matched.

5. Using IMS Learning Design to Facilitate WBL Projects

Implementing such a business process oriented knowledge management system for supporting WBL projects will meet with many obstacles. Apart from, for instance sociability, privacy, and security problems, there are many technical challenges such as

competence model, user model, task ontology, dynamic change of the BPM, and maintenance and update of the knowledge base. In this paper we focus on discussing the issues about process modeling languages for representing WBL project plan.

Currently many process/enterprise modeling languages have been released and used to represent BPMs such as OMG's UML Activity Diagram (version 2.2) (UML, 2009.), Business Process Modeling Notation (BPMN, 2004), XML Process Definition Language (XPDL, 2008), The Process Specification Language (PSL) (ISO 2003), Architecture of Integrated Information Systems (ARIS) (Scheer 2000), and ArchiMate (ArchiMate, n. d.). Existing modeling languages have different foci (e.g., organizational aspect, process aspect, technical aspect, or visualization aspect). For different purposes, different modeling languages have been used to implement BPoKM systems. For example, the PROLIX project (PROLIX, 2006) uses the ARIS framework to integrate training courses into business processes (Leyking, et. al. 2007). Yet Another Workflow Language (YAWL, 2007; van der Aalst and ter Hofstede, 2005) is used in the APOSDLE project (APOSDLE, 2006) for the workflow based process representation of the task model. However, the target users of these languages are IT specialists, business designer and business analysts. In addition, existing BPoKM approaches mainly support workplace learning (in-house training) with a real workflow (including technical infrastructure, documents, and products) in an organization for improving effectiveness and efficiency of the real work. They do not intend and are not suited to support research-oriented WBL projects that involve teachers, learners, and supervisors from different organizations within a networked learning community.

It seems that, for our purposes, there are two conflicting requirements for choosing a process modeling language. On the one hand, it should have sufficient expressiveness to model business processes. On the other hand, it should be as accessible as possible for ordinary teachers, employers, employees, supervisors, and other stakeholders to understand and use. Thus, it is required to explore the trade-off between expressivities and usability. In addition, the process modeling language should be formal so that the computer can understand and enact the BPMs represented in the language. Moreover, it would be nice if the language can be used to represent both discipline-based courses and WBL project plans in a homogeneous manner, and that the same learning environment can support both explicitly formalized learning and the non-formal/informal learning in workplaces. Considering all these requirements, we propose to use IMS LD as a framework to represent WBL project plans and organize work-based knowledge.

IMS LD was developed to allow lesson plans and best practices to be structured using a common language based on a formal representation and archived in a machine readable and searchable repository. It is a pedagogy-neutral modeling language and can be used to model a wide range of pedagogical strategies such as rationalist and cultural-historic strategies (Koper 2001; Sloep et al. 2005). It has many features (e.g., activity-centric models, embedded sub-processes, and explicit role models) that are exactly required to represent a WBL project plan as discussed in the last section. Recent studies also reported that, although ordinary practitioners still had some problems, they could successfully build learning designs at level A and partially at level B if they were given access to user-

friendly authoring tools (Neumann and Oberhuemer, 2009; Griffiths, et. al. 2009). Therefore, IMS LD is a good candidate provided we can decrease the technical complexity of the modeling language and increase the expressiveness to sufficiently represent a WBL project plan. In this section, we discuss some initial ideas to modify IMS LD for facilitating a WBL project.

Introduce "artifact": The concept of an *artifact* needs to be introduced in order to represent the knowledge artifacts that are created/used in the WBL project. A knowledge artifact may be an expected output of an activity such as an architectural plan or an unpredictable, externalized tacit knowledge such as a recorded reflection. Although sometimes it is technically possible to represent a predictable output using the concept (or construct) of the *property* in IMS LD, such a simple model with a primitive data-type (e.g., a string, an integer, a file, and a URL) is not sufficient to implement the system functions needed. For example, to model an architectural plan or a recorded reflection it is possible to model it using a *property* with a data-type "file" or "text". However, more information has to be modeled with the artifact content such as artifact_type, description, state, owner, contributors, creation_time, and access_rights. These artifact attributes are needed by the system to manage and retrieve the knowledge artifact. If these attributes are defined as separate *properties* (note: *property group* is not suited here because all members of the *property group* must have the same data-type), it is impossible for the system to manage the relations between these user-defined *properties*. In addition, the *property* cannot be used to represent an unpredictable knowledge artifact such as a reflection recorded, because a *property* has to be declared explicitly at design-time. The introduction of the concept of *artifact*, if done properly, will provide a way to model and support processes of knowledge creation and sharing in WBL projects.

Use a generic term "activity": Not only learning activities but also working activities are performed in WBL projects. Although taking place at the same location, they are not the same. Work is directed towards producing some output. Learning is directed towards the acquisition of knowledge or the capacity to gain further knowledge. Many work assignments require employees to engage in learning before the work can be effectively completed. In fact, WBL typically emphasizes learning beyond the immediate and necessary requirements of work completion. The knowledge that is the object of learning may or may not be closely related to whatever the organization produces now or in the future (Boud and Solomon, 2000). However, to the external observer the activities associated with each may not be easily separated. Moreover, with respect to the LD specification it would not be necessary to distinguish between learning activity and working activity, because their differences in internal structures and relationships with other elements are not significant from the perspective of modeling. Analogously, the boundary between a *learning activity* and a *support activity* becomes blurred sometimes in a WBL project. For example, if a market consultant helps a finance consultant to estimate cost, it is difficult to declare it as a support activity or a learning activity from the perspective of modeling, because both consultants learn from and support each other. Thus, it is suggested to abandon the distinction between learning and support activities and use a generic term "activity" to represent all kinds of activities. Furthermore, users

should be allowed to define attributes as activity-properties for describing context in order to make it easy to manage and find activities.

Introduce new activity structures: The current version of LD enables to specify the control-flow at two levels using pre-defined structures. A *play* consists of a set of *acts* structured as a recommended sequence (note: it is not a strictly controlled sequence except to explicitly specify the completion of the acts). An *act* consists of a set of unstructured *role-parts* that can be performed in arbitrary sequence or in parallel except if they are used to explicitly specify temporal relations between these activities using *conditions*. In addition, two *activity structures* (*selection structure* and *sequence structure*) make it easy to specify lower-level control-flows in a hierarchical structure. However, in order to specify various process structures in WBL projects, more activity structures (e.g., alternative structure and concurrent structure) at any level may be required. Although *conditions* can be used to model some types of control-flows, it is very difficult to model complex, hierarchically structured work processes. Sometimes it is even impossible to exactly model some situations because the semantic of "*show/hide activity*" is different from that of "*start/complete activity*". It is not only an issue for the design of the user interface of the modeling tool, but also an issue for the design of the modeling language itself. Because of the technical complexity of this issue, we do not discuss it in anymore detail.

Replace the personal-property with the role-member-property: When defining a *personal property* (e.g., the user name) with LD, every participant will individually have this property. However, if a property is relevant to a particular *role*, use of *personal property* will be not appropriate. For example, if the proficiency level of the competence "architectural design" of an architect is calculated as a mean of assessment results (represented as competence levels) of all supervisors, the *personal property* is not suitable for modeling the assessment result of the supervisor, because only the supervisor is arranged to assess the competence of the architect and other roles do not need this property. Note that use of the *local/global property* is not suited to model this situation either, because the exact number of supervisors in each run is unpredictable. It is proposed to replace the *personal property* with a concept of "*role-member-property*". A *role-member-property* can be regarded and defined as an attribute of a person with a particular role. Like a *role-property*, a *role-member-property* is associated with a *role*. Unlike a *role-property* that represents a common feature of all members of the *role*, a *role-member-property* is used to model the same feature of each role member individually. According to this concept, a *personal property* of IMS LD (like the user name) can be defined as a *role-member-property* of the root-role. It is also needed to enable accessing *role-member-property*, for example, to calculate the mean of assessment results assigned by all supervisors. Then, introduction of the *role-member-property* will make it easy for WBL practitioners to build and share role models and for the system to manage and find participant knowledge.

6. Conclusions and Future Work

Work-based knowledge exists inside and outside an organization in explicit and tacit forms. In order to support effective and efficient learning in WBL projects it would be nice if the knowledge developed in past WBL projects can be archived and reused. The challenge is how to facilitate people to find and acquire knowledge, and to convert and represent tacit and explicit knowledge. In this paper, we propose to adopt a business process-oriented knowledge management approach to facilitate WBL projects. This approach can be characterized by: 1) providing a collection of BPMs and use a BPM as a framework to anchor knowledge in the work activities where the knowledge is developed and required; 2) enabling teachers, learners, and other stakeholders to develop a WBL project plan through reuse, customization, combination of BPMs; and 3) scaffolding learning by executing the WBL project plan, delivering context-sensitive and problem-oriented knowledge artifacts, and supporting the production, conversion, and representation of tacit and explicit knowledge in the context of application. Through analyzing the requirements for the process modeling languages, we propose to use IMS LD, with necessary changes, to represent WBL project plans. We suggest introducing the concept of an “artifact”, using a general term “activity”, enriching control-flows to some extent, and replacing the “personal property” with the “role-member-property”.

The TENCompetence project (TENCompetence n. d.) has developed an infrastructure that can support the creation and management of networks of individuals, teams and organizations. Within these 'learning networks', participants can create, store, use and exchange knowledge resources, learning activities, units of learning, competence development programmes and networks for lifelong competence development. The tools provided by the infrastructure can be used to create WBL programmes, manage e-portfolio, conduct assessments, and deliver learning modules. However, the tools provide insufficient support for creating WBL project plans and gathering/delivering context-sensitive and task-relevant knowledge resources. It will be an interesting research work direction to extend/modify LD authoring tool according to the suggestions made and develop/integrate knowledge management functions with the LD player. After that, the application of the TENCompetence infrastructure in WBL can be tested and evaluated.

Acknowledgement

The work on this paper has been sponsored by the TENCompetence Integrated Project that is funded by the European Commission's 6th Framework Programme, priority IST/Technology Enhanced Learning. Contract 027087

References

Abecker, A., Hinkelmann, K., Maus, H. and Müller, H.J. (2002). *Geschäftsprozess-orientiertes Wissensmanagement*. Springer, Berlin.

APOSDLE (2006). Retrieved from: www.aposdle.tugraz.at/

ArchiMate (n. d.). Retrieved from: http://www.archimate.org/eg/home/

Armsby, P. and Costley, C. (2000). Research driven projects. In Portwood, D. & Costley, C. (Eds), *Work-based learning and the university: new perspectives and practices.* Birmingham: Staff & Educational Development Association.

Bosley, S, and Young, D. (2006.) Online learning dialogues in learning through work, *Journal of Workplace Learning*, 8(6): 355-366.

Boud, D. and Solomon, N. (2000) Work as the curriculum: Pedagogical and identity implications. *Paper presented in Conference Working Knowledge: Productive learning at work*, December 10-13, 2000, Sydney, Australia.

Boud, D. and Solomon, N. (Eds.) (2nd Edn. 2003) *Work-Based Learning: A New Higher Education?* Buckingham, SRHE & Open University Press.

BPMN (2004), Business Process Modeling Notation (BPMN), Retrieved from: http://www.bpmn.org/

Brennan and Little, (2006). *A Review of Work-based Learning in Higher Education*. Department for Education & Skills.

Costa, C. (2007). A professional development weblog: supporting work-based learning in a TAFE library, *Australian Library Journal*, 56(1), p36-55.

Costley, C. and Armsby, P. (2007). Methodologies for undergraduates doing practitioner investigations at work. *Journal of Workplace Learning*, 19(3): 131-145.

DEWBLAM: Development of European Work Based Learning Approaches and Methods, DG EAC funded project (2006), *Work-based Learning Guidelines*, p.3, Florence.

Eppler, M. J., Seifried, P. M. and Öpnack, A. R. (1999). Improving Knowledge Intensive Processes through an Enterprise Knowledge Medium. *In Proceedings of the 1999 ACM SIGCPR conference on Computer personnel research*, 222 – 230, New Orleans, Louisiana, USA.

Fink, F., Rokkjær, O., and Schrey, K. (2007) *Work-based Learning and Facilitated Work-based Learning*, Retrieved from: http://www1.unifi.it/tree/dl/oc/d8.pdf

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M. (1994). *The New Production of Knowledge: The dynamics of science and research in contemporary societies*. London: Sage.

Griffiths, D., Beauvoir, P., Liber, O. and Barrett-Baxendale, M. (2009). From Reload to ReCorse: Learning from IMS Learning Design Implementations, *Distance Education*, 20(2), 201-222.

Holsapple, C.W. and Joshi, K.D. (2002), A knowledge management ontology, in Holsapple, C.W. (Eds), *Handbook on Knowledge Management*, Springer, Berlin, Vol. 1, pp.89-128.

IMS LD (2003). IMS Learning Design Specification. Retrieved from: http://www.imsglobal.org/learningdesign/index.cfm.

ISO (2003). Industrial Automation System and Integration -- Process Specification Language. No. 18629-11, International Organization for Standardization.

Jablonski, S., Horn, S. and Schlundt, M. (2001). Process Oriented Knowledge Management. *In Eleventh International Workshop on Research Issues in Data Engineering: Document Management for Data Intensive Business and Scientific Applications*, pp.77–84, Heidelberg, Germany, IEEE Computer Society.

Johannessen, J.A., Olaisen, J. and Olsen, B. (2001) Mismanagement of tacit knowledge: The importance of tacit knowledge, the danger of information technology, and what to do about it, *International Journal of Information Management*, 21(1), pp. 3-20.

Kalpič, B and Bernus, P. (2006) Business process modeling through the knowledge management perspective, *Journal of Knowledge Management*, 10(3), pp. 40-56.

Koper, E. J. R. (2001). *Modelling Units of Study from a Pedagogical Perspective: the Pedagogical Meta-model behind EML*, Educational Technology Expertise Centre Open University of the Netherlands. 2001, Retrieved from: http://hdl.handle.net/1820/36

Leyking, K., Chikova, P., Martin, G., and Loos, P. (2007). Integrating Learning and Business Process Management, *in Proceedings of the 18th Australasian Conference on Information Systems*, 981-990, Dec. 5-7, 2007, Toowoomba.

Lubit, R. (2001). The keys to sustainable competitive advantage: Tacit knowledge and knowledge management, *Organisational Dynamics,* 29(3), pp 164-78.

Middlesex University (n. d.) Projects in Work Based Learning, retrieved from http://mdx.ac.uk/wbl/cfe/projects.asp

Neumann, S. and Oberhuemer, P. (2009). User Evaluation of a Graphical Modeling Tool for IMS Learning Design. *In proceedings of the 8th International Conference on Web-based Learning (ICWL)*, pp. 287-296. August, 19-21, 2009, Aachen, Germany: LNCS 5686, Springer.

Nonaka, I. and Takeuchi, H. (1995) *The Knowledge Creating Company*, Oxford University Press, Oxford.

Nowotny, H., Scott, P. and Gibbons, M (2003). Introduction: `Mode 2' Revisited: The New Production of Knowledge, *Minerva*, 41(3), 179-194, Springer Netherlands.

Papargyris, A., Poulymenakou, A. and Samiotis, K. (2002). Knowledge Processes Embedded in Task Structures: Implications for the Design of a Technical and Organisational Solution, *in Proceedings of the 4th International Conference, Practical Aspects of Knowledge Management,* Lecture Notes in Computer Science, Volume 2569/2002, p. 425-436, December 2–3, 2002, Vienna, Austria.

Polanyi, M. (1967) *The Tacit Dimension*, New York: Anchor Books.

PROLIX project home page, (n. d.) retrieved from: http://www.prolixproject.org/index.php

Scheer, A.W. (2000). *ARIS - Business Process Modeling*. Springer Verlag.

Scott, P. (1997). The changing role of the university in the production of new knowledge. *Tertiary Education and Management* 3(1), 5-14.

Sloep, P. B., Hummel, H., & Manderveld, J. (2005). Basic design procedures for e-learning courses. In R. Koper & C. Tattersall (Eds.), *Learning design: A handbook on modelling and delivering networked education and training* (pp. 139-160, 367-385). Heidelberg: Springer Verlag.

Strohmaier, M. B. (2005). *B-KIDE: A Framework and a Tool for Business Process Oriented Knowledge Infrastructure Development*, PhD Thesis, Publisher: Shaker Verlag.

TENCompetence (n.d.) TENCompetence project websit. Retrieved from: http://www.tencompetence.org/

Thomas, T (2008) Bringing Learning to the Workplace, *Paper presented in a synopsis of the inaugural lecture,* retrieved from: http://www.lsbu.ac.uk/esbe/engineering/pdf/Bringing_Learning_to_the_Workplace.pdf

UML (2009), UML 2.2 superstructure Specification, Retrieved from: http://www.omg.org/spec/UML/2.2/Superstructure/PDF

van der Aalst, W.M.P. and ter Hofstede, A.H.M. (2005) YAWL: Yet Another Workflow Language. *Information Systems*, 30(4), 245-275.

XPDL (2008) XML Process Definition Language website. Retrieved from: http://www.wfmc.org/xpdl.html

YAWL (2007). YAWL workflow language website and tool. Retrieved from: http://www.yawl-system.com/newyawlwebsite