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Integrating Learning and Business Process Management

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Abstract

Recent research activities in the field of TEL have created a new awareness for intelligent learning infrastructures. To foster the usage of innovative TEL in the workplace, it must be integrated into organizational business operations and aligned with their learning requirements. Being the semantic interface of organizational ICT infrastructure, business processes represent the potential linkage between learning and business IS. Today, most organizations and their supporting ICT systems have incorporated processes as central objects of control. They manage their businesses along their processes, starting with process design over process execution up to process control and monitoring that feed back into improved business process design. As this process lifecycle has become the central instrument of BPM, it lends to be the vehicle for a business-integrated learning management. This paper aims to position the thesis of a reciprocal relationship between business and learning processes being the prerequisite for prospective integrated workplace learning.

Keywords

Business Process Management, Learning Management, Process Lifecycle, Service-Oriented Architecture, Technology-Enhanced Learning.

Innovative Workplace Learning in a Business Process Context

Recent research activities in the field of Technology-Enhanced Learning (TEL) have created a new awareness for intelligent learning technologies. Innovative approaches in the field of personalized learning environment and interoperable learning object repositories have advanced (Najjar et al. 2003). Although the idea of adaptive, individualized learning material that is provided just-in-time is not new to the eLearning community, it gains a new momentum thanks to technological achievements of standardization efforts like Sharable Content Object Reference Models (SCORM) and Learning Object Metadata (LOM), flexible system architectures and complex user modelling (Cristea 2006). However, implementing these highly promising learning infrastructures into daily business remains a challenge not yet addressed. With hindsight on past information and communication technologies (ICT) innovations having failed to convince CIOs to release tight budgets, one may doubt that organizations will quickly introduce newest learning solutions either, irrespective of their potential business benefit. Only if they are closely aligned with business operations and their respective need for learning, innovative TEL will be adopted in the workplace. Without a sufficient integration between learning and business infrastructures, any workplace learning solution is doomed to fail. Within the scope of this paper, the term 'learning' refers to processes of spontaneous, informal individual learning as well as planned training actions, focusing on the improvement of certain skills of employees.

With most organizations having in use integrated business ICT architectures, it must be of top priority to understand where business applications such as Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Customer Relationship Management (CRM) and Business Intelligence (BI) tools refer to workplace learning applications. Searching for such interfaces between learning and business concepts, the business process entity reveals itself as intersection between both areas of analysis. A business process is defined as "a continuous series of enterprise tasks, undertaken for the purpose of creating output" (Scheer 2005). Overcoming functional isolation of departments imposed by structural or hierarchical organizations, process orientation has brought to business management a more dynamic, customer-oriented perspective on the operative, tactic and strategic activities. Business Process Management (BPM) has become an established approach in business management theory and practice over the last twenty years, the two most important concepts being Business Process Reengineering (BPR) and Continuous Process Improvement (CPI) (Scheer 2005; Hammer & Champy 2003; Imai 1998; Jiang et al. 2003). Implementing new or enhanced processes, which are usually supported by IT, aims at improving efficiency and effectiveness of business operations. Today, many organizations and their supporting ICT systems have incorporated processes as central business objects (van der Aalst et al. 2003). They manage their businesses along their processes, starting with process design over process execution up to process control and monitoring that again feed back into an improved business process design

(Harrington, Esseling & Van Nimwegen 1997). As this process lifecycle has become the central instrument of BPM, it lends to be the leverage for a business-integrated learning management.

An Intertwined Business and Learning Process Lifecycle

Being the semantic interface of business ICT infrastructure, business processes represent the potential linkage between learning and business systems. A business process provides the context information necessary to identify learning needs and design matching learning processes that are meaningful for organizational business goals and individual learning goals (Specht 2006). This paper aims to position the thesis of a reciprocal relationship between business and learning processes being the leverage for future workplace learning. In order to align both learning and business processes, a kind of continuous cycle must be defined which helps to intertwine the two processes. Learning and enhancing knowledge helps to perform business processes better ,thus to optimize them. Business processes again change over time and ask for new skills and competencies to be acquired. Once the business processes have been changed, a new learning unit must be planned to match the new business processes. In doing so, the learning process has to be aligned as close as possible to the prerequisites given by the business process.

The process lifecycle serves as conceptual baseline to add business weight to the innovative learning infrastructures and thus make them economically sustainable. As Figure 1 illustrates, a business process lifecycle encompasses three steps (Scheer & Schneider 2006): At the outset, in order to master complexity of an enterprise environment, business processes are modelled according to business requirements. As the term implies, a business process model reflects business operations by focusing on relevant activities, their timely or logical interdependencies while leaving out secondary details. Thus, it serves as a basis for the second phase of implementing business processes into software systems. Therefore, the modelling phase is often assigned to the build time of business application software. Having the business logic, enterprise systems – most prominently ERP solutions such as SAP R/3 – automate business processes accordingly ensuring their execution as process instances (run time). As a result, a software-based process automation allows for measuring business key performance indicators (KPI) within the systems which feed back this information to business process (re)design (control time).

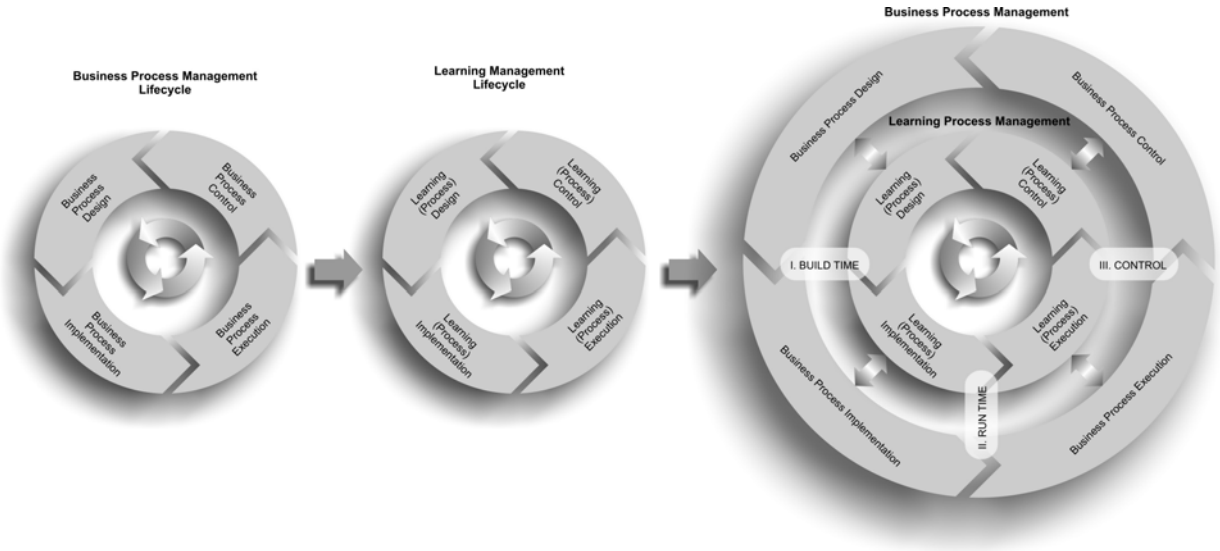

Figure 1: Integrated business and learning process lifecycles (Martin 2006)

Throughout the lifecycle, the process model represents business requirements, i.e. the factors that drive an organization's success or failure. As a business process focuses on functions which are to be carried out in order to achieve a certain output, an enterprise's overall performance depends on the proficiency of the employees in charge of these activities. This is where learning enters the stage: Functions of a business process model set learning goals. They define competencies for both individual employees and the entire organization necessary for smooth, effective and efficient process execution. Moreover, organizational roles assigned to process functions are made up by a set of skills and competencies. Given this demand-driven linkage between business processes and organizational learning, the process lifecycle suggests to be applied to learning processes as well. Structuring learning process management complementary to business process management in analogous phases of design, execution and control provides a common ground for interlinking business and learning process management

efforts. However, it must be understood that these interdependencies do not only occur within the phases but also across them. Thus, correlations as indicated in Figure 1 are primarily of illustrative, rather simplifying purpose. The following sections are to delineate potential synergies of combining the concepts of business process and learning management and its implications further.

Process Building Time

From Business Processes to Learning Processes

Best practices of BPM include modelling business processes in semi-formal diagrams that are easy to understand by business analysts and at the same time sufficiently formal to provide a technical basis for software implementation. Among myriads of notations, the event-driven process chain (EPC) has become a de-facto standard (Scheer 2005). Its strengths persist in the ease of use, i.e. simple syntax and clear symbolic representation that account for a wide field of applications ranging from process documentation, process optimization, cost control, up to implementation and configuration of standard software (Keller, Nuettgens & Scheer 1992). An EPC consists of two basic constructs: functions triggered by events that are connected alternately through directed edges to form a business process. Conjunctive, exclusive and disjunctive operators enable a non-linear flow of control. Such rather simple EPC diagrams may be extended by other constructs, i.e. input/output data or organizational units. Modelling tools such as the ARIS Business Architect by IDS Scheer AG provide even a higher variety of EPC entities to be assigned to process functions. Thus, the business process model goes beyond specifying what activities must be done and when. It provides additional details on a multitude of circumstances, which make up an employee's reality. Being enhanced in such a way, the business process becomes the context of learning, i.e. acquiring those skills needed to perform the process effectively. As process models have proved to be efficient and sustainable storages and references of organizational knowledge, there have been some approaches to integrate knowledge and business process management (Keller, Nuettgens & Scheer 1992). Some of those approaches propose models for knowledge structures and knowledge maps which integrate with business process models through the entity "knowledge" which is required for individual functions of a process (see Figure 2) (Allweyer & Jost 1999). However, such concepts have remained limited to knowledge structuring and modelling. They do not recognize the linkage between the execution of business processes and knowledge / skill acquisition by means of organizational and individual learning processes. Though, the contextual information given by a business process into learning goals provides the basis for business-oriented translation into corporate learning and training.

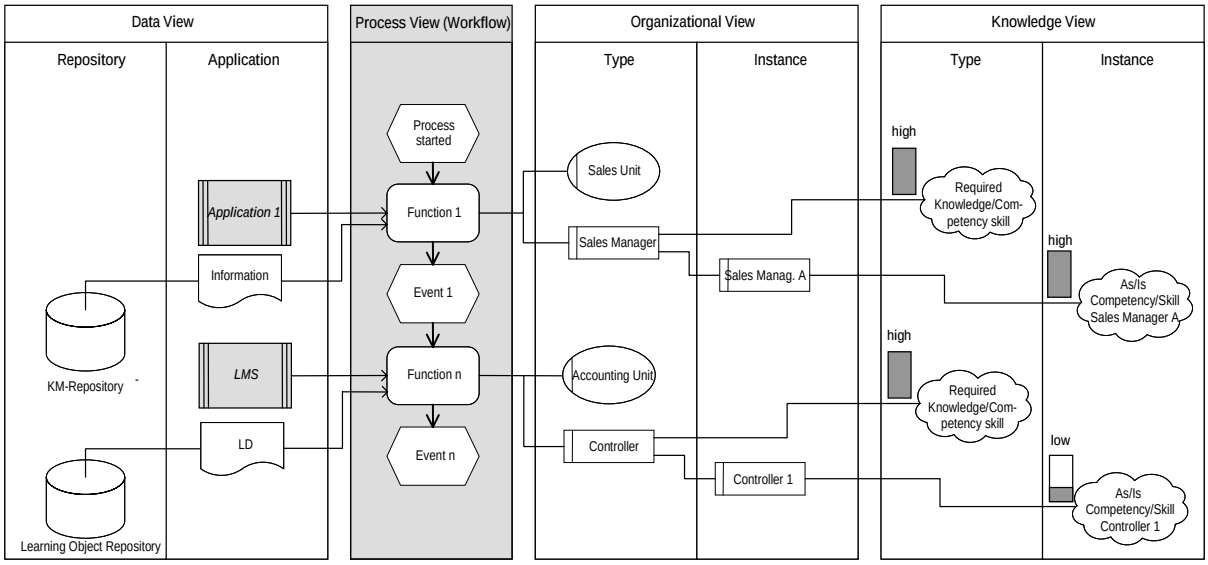

Figure 2: A business process as learning context

This is where learning design comes into play. Based on the learning context provided by the business process, learning processes will be described using learning design specifications such as the IMS-Learning Design by IMS Global Learning (Koper & Tattersall 2005). Their focus lies on specifying the learning flow scenarios composed of various methods, plays, acts and roles. Like business process workflows, they determine the sequence according to which the learner passes learning activities in specific environments (Koper & Tattersall 2005). Thus, learning processes represent frameworks for focussed provision of learning material at the right time and at the right point of the sequence within a certain business process.

Integrated Authoring Management

The design of learning processes refers to learning objects which represent the actual learning content. They need to be produced in a purposeful manner fulfilling business needs and leveraging internal resources (EXPLAIN Consortium 2005). This requires a close matching between business needs and requirements on the one hand and learner's individual competencies and needs on the other. These requirements are represented by the operative business processes and their respective functions. Thus, managing and changing business processes brings about changes in competency requirements (Prahalad & Hamel 1990) that need to be met by flexible content delivery (Martin & Wolpers 2005). Correspondingly, updated role assignment, e.g. by new employees or restructuring, also has consequences on learning gaps within the organizations.

Furthermore, the processes of learning material development (authoring) are business processes themselves with multiple departments involved. Many interdisciplinary competencies and detailed knowledge (technique, tools, project management, media production, and didactic expertise) are needed to produce learning objects, web-based trainings (WBT) or other training material. The time needed by internal experts (e.g. from Research & Development departments) is comparatively high, because their know-how is required for the development of content, but explaining their – often implicit – knowledge is not a routine activity at all (Polanyi 1966; Nonaka & Takeuchi 1995). Existing tools support only singular aspects of the learning process production, but do not provide holistic process integration within the overall ICT landscape of an organization.

Current authoring tools mostly start to support this process at the point of the actual technical development of training media. But they do not provide support for the internal experts in conceptually designing and preparing learning material production already during their individual task processes (e.g. product engineering). Furthermore, all activities involved in learning production throughout the enterprise must be organized in transparent and lean processes. Engineering these processes towards efficiency and effectiveness must be of top priority. This entails integration of data, people and functions with the aid of collaborative and workflow-supporting systems. Hence, the challenge is to provide an integrated, tool-supported authoring process with all involved departments sharing required information while seamlessly cooperating with each other. The authoring process has many interfaces with the process of product engineering for example and therefore provides possibilities for potential reduction of complexity, redundancies and optimization of effectiveness and efficiency through process integration (Chikova, Leyking & Martin 2006).

These issues are to be analysed and conceptually overcome within the project EXPLAIN (http://www.explain-project.de) funded by the German Federal Ministry of Economy and Technology. EXPLAIN focuses on authoring processes and aims at an intelligent, business-process integrated ICT environment that empowers organizations to flexibly implement their learning objects in the course of their major business processes. The main objective of the innovative cooperative project is to develop a new generation of authoring management platforms (Zimmermann et al. 2005). This will facilitate a simplified proprietary learning material development process and will enable organizations to produce their own multimedia trainings.

The project's development approach is based on a systematic analysis and reengineering of as-is authoring processes in cooperation with professional content development companies and industrial enterprises. This approach should link authoring and business processes in an integrative manner through utilization of existing interfaces and, together with easy-to-use and low-priced implementation tools, improve the acceptance and usage in enterprises. From here, an integrated platform supporting the authoring processes of content management, content development as well as project management including open interfaces to learning management systems and authoring tools is developed step-by-step (see Figure 3). Beyond process integration, a variety of additional services will further facilitate specifying, producing and managing media and content (Chikova, Leyking & Loos 2006).

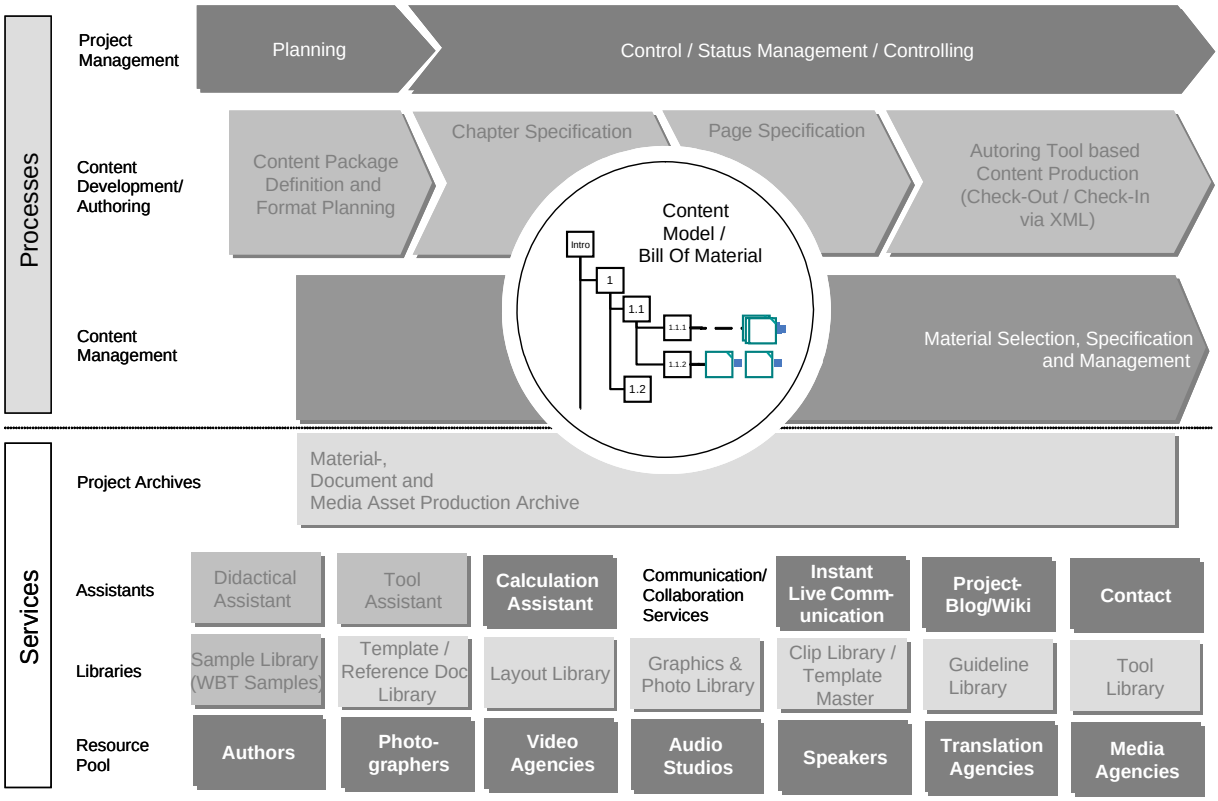

Figure 3: Process and service landscape of the EXPLAIN authoring management platform

The resulting EXPLAIN authoring management platform follows the thesis that it does not make sense for corporate training managers to run and maintain their own authoring infrastructure within the enterprise and have all the skills in an internal team – unless the volume of media production is on a very high level. Therefore, the approach of EXPLAIN is to enable enterprises to produce their own learning material independently as well as to respond to ad-hoc learning needs in a cost-effective and time-saving manner. This intelligent solution will provide a multitude of authoring tools, assistants and services on-demand over a web-based platform. The central element in the overall process is represented by the content model, which, similar to a bill of materials used in product design and development, integrates all required activities along the structure of a learning module. Thus, it provides an interface between the processes of content management, content development as well as project management. Furthermore, the platform offers value-added services to the project team, like support in didactic issues, in selecting appropriate tools, in retrieving external media experts (photographers, audio studios, translation agencies, etc.), as well as the provision of ready-made template and media asset libraries. These services will also support communication and collaboration activities within the team and by this increase the process efficiency for review and creative team processes (Zimmermann et al. 2005; EXPLAIN Consortium 2006).

Process Run Time

In a next step, the learning material produced has to be distributed in a purposeful manner, i.e. it must be delivered at the right time to the right workplace learner at the right place. Problems regarding today's workplace content delivery through eLearning systems persist in the disregard of the learner's active information need in context of his daily work. It has been proven that it discourages the learner, if information that is very present in his daily life is merely depicted by learning objects or complete course structures (Niegemann et al. 2004). Currently, information and knowledge supporting systems usually provide only information according to the estimated user's need, whereas standard of knowledge, learning goals and learning units are neglected. Due to their function-oriented architectures and focus, the drawback of – more or less – monolithically knowledge supporting systems is the missing consideration of the learner's (individual) view on the presented information (Martin & Wolpers 2005). In consequence, training activities often fail without creating any benefit. This can be avoided through sophisticated and integrated learning management, by providing a personalized learning unit adapted to the current business process context, bridging the gap of knowledge without great redundancies. Therefore, the entire ICT landscape of an organisation must integrate such a user-friendly, learning-goal-oriented and didactically-prepared generation and presentation of

information units. Without any linkage to the core IT-infrastructure, learning environments remain too distant from the points of interest, i.e. the functions of business processes requiring trained employees.

One, if not the most significant leverage for TEL within BPM is the automation of business processes through an enterprise's system landscape. Not only workflow management and ERP-systems feature process orientation as one of their major selling points. In the meanwhile, BI tools, content management systems (CMS), CRM and SCM applications as well as most enterprise solutions have been integrated into business process automation. So far, the execution of learning processes is restricted to learning management systems (LMS) or related infrastructures with little or even no interfaces to core business systems. Thus, the way from learning demand within an employee's daily business to the actual learning process remains rather rigid, inflexible and far too slow to be effective.

As delineated above, semi-structured business process models represent the access point to realize enterprise strategy-driven business requirements. Analogously, organizational learning requirements (triggered by business requirements, derived from business processes) are transferred into learning processes to be adapted by employees assigned to these processes. Once learning goals prescribed by business processes have been addressed by learning objects integrated into learning processes, they represent the instruments to improve the overall business performance, which is eventually threatened by skill and knowledge gaps or changes within the business process.

Given the close linkage between learning and business process management as well as the advanced automation of both concepts, combining business systems and learning systems promises to leverage a series of synergies:

- *Learning needs identified at the point of action* within a business process can be directly translated from the given context to adequate learning processes that help to close the competency gap and therefore improve the individual performance in the process.
- Information and explicit knowledge generated and used within business processes such as product development can be *directly transferred to the content development* (authoring systems) instead of laboriously collected ex-post.
- Personalized, adapted learning activities are integrated into ongoing business tasks and challenges (*ambient workplace learning*).
- The impact of accomplished learning processes on the business process performance can be measured, compared to business goals and benchmarks and therefore provide feedback for future training design, ranking of available learning objects for that business context, etc.

To achieve these objectives, innovative and extended methodologies, architectures, frameworks and tools that support the process-oriented deduction, retrieval as well as the distribution of relevant knowledge to the workplace learner are needed. The fulfilment of this vision will be tackled by the activities of the EU/IST Integrated Project on *"Process-oriented Learning and Information eXchange (PROLIX)"* (URL:http://www.prolixproject.org). PROLIX's major goal is to align people and processes in complex and dynamic working situations by addressing the needs of employees and companies at the same time. Due to this, it is aimed at creating and implementing an open, service-oriented TEL architecture for process-driven learning and information exchange that supports a complete organizational and individual learning process lifecycle (Martin & Wolpers 2005).

Overall and seen from a managerial point of view, PROLIX significantly contributes to BPM within companies that need to evolve to a holistic learning organization enabling the integration of learning processes into daily working tasks. In order to master pace of the globalizing world, a corporate culture of change must provide strategies, methods and concepts to satisfy diverse individual and organizational learning needs. Thus, learning is seen as a key enabler of BPM. Mechanisms and concepts for a company-wide introduction of TEL have to be coordinated with company philosophy and vision. Aligning learning with business processes based on advanced technology and skill matching is profitable for companies as well as their employees. The key innovation in PROLIX consists of a process- and competency-driven framework for interlinking business process (intelligence) tools and management efforts on the one hand with knowledge management and learning management on the other. Accomplishing this complex endeavour will open new segments of TEL and provide sustainable and transferable results, which contribute to the emergence of the information society as a whole.

PROLIX is based on independent software components, deployed in a highly distributed and flexible setup. The PROLIX service-oriented backbone is comprised of a total of 7 components, each of them focused on different phases of the integrated business and learning process lifecycle (see Figure 4).

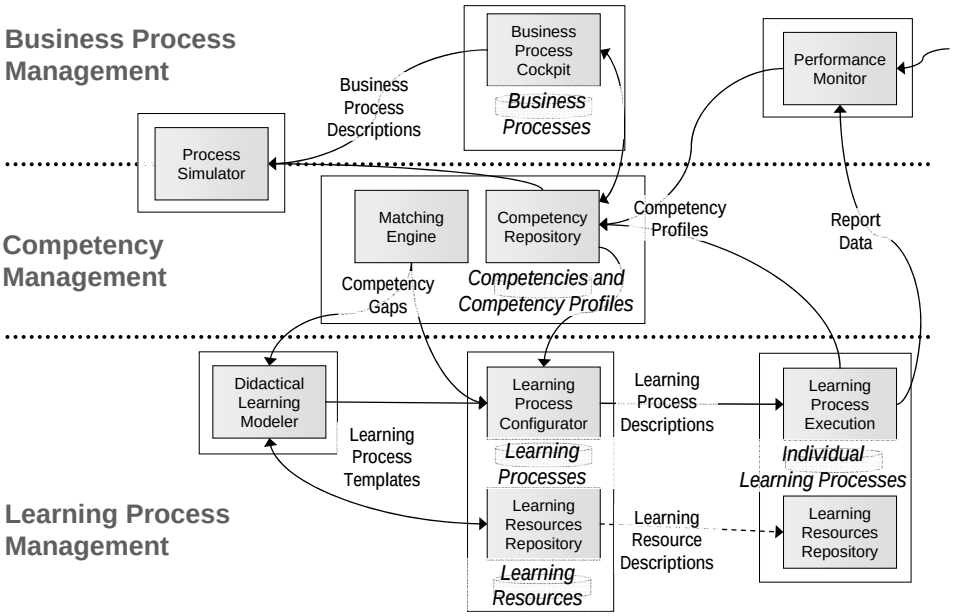

Figure 4: An overview of the components and data flow in PROLIX

The **Business Process Cockpit** provides the modelling environment to create, update and optimize the business process design as well as to enhance it by roles and required competencies. The later are received from the **competency repository** which stores and manages competencies and competency profiles centrally. Not only the competency definitions and descriptions are stored here, but also any assignment of competencies to objects such as tasks, learning objects and employees. After the business process expert has modelled the new competency-enhanced business process, its description is sent at the **matching engine component**, for extracting the competency gap between the provided and the required business process resources. After the matching engine has performed a number of possible assignments of competent persons to the business process tasks, it invokes the **competency-oriented process simulator** web-service by sending the assignments with the business process description at the process simulator. Given the business process and a possible assignment of persons to tasks, the process simulator can simulate the process execution and extract some predefined Business Process Performance Indicators (PI) e.g. execution time and execution cost. The simulator then returns the simulation results at the matching engine, which uses the PIs information to select the most appropriate assignment and returns it to the Business Process Cockpit. After the new business process has been decided, the employees need to be trained to be able to cope with their new tasks when there is a competency gap. This is where the **Learning Process Configurator** comes into play. The Learning Process Configurator retrieves the competency gaps that need to be covered and configures a personalized learning process for each of the employees that are required to acquire new competencies. In the path to personalize the learning experience for each individual employee, the Learning Process Configurator can ask from the **Didactical Learning Modeller** to provide a personalized learning model for each (group of) user(s), again in the IMS Learning Design format. After the Learning Process is fully configured and personalized, the focus moves at the **Learning Process Execution Platform** (LPEP). The LPEP, based on an extension of CLIX learning environment, retrieves the pre-configured learning processes from the Learning Process Configurator repository, stores them in the local repository, and starts the actual training for each user. The learning experience is complemented with testing/evaluation material, specifically targeted for verifying each of the competencies that the learning material provides. At the end of the training, the newly-acquired competencies for each learner and her performance to these competencies (i.e. their grade in the evaluation tests) are saved in the competency repository for future reference. As the final step of the lifecycle the purpose of the **Performance Monitor** is twofold: (a) to evaluate the learning process and the learners directly after the learning process, and (b) to assess the performance (through performance indicators) of the new or modified business process during its execution. These performance indicators are sent to the Business Process Cockpit to be integrated at the Business Process description, so that they can be used from the Business Process expert for further optimization.

To allow for flexibility and interoperability demanded of the architecture backing PROLIX, the integration of those heterogeneous and distributed systems is realized by the usage of middleware solutions. Attempts of workflow management systems and enterprise application integration systems (EAI) paved the way for the most recent approach: Service-oriented architectures (SOA) (Bieberstein 2004; Krafzig, Banke & Slama 2005). These differ from previous IT architectures by loose, but standardized, specified coupling of distributed components and integration over open standards. SOA connects software through a pool of abstract services that provide a well defined, self-contained functionality of a software module. It enables the on-demand composition of

enterprise software and therefore provides enterprises with a high degree of flexibility combined with an optimal support for their business processes. Thus, SOA has grown from a theoretical concept to one used in practice. Today, one of the most common realizations of the SOA paradigm is the usage of Web Services as they take advantage of the ubiquitous usage of internet technology and standards (Alonso 2004). Web Services are based on XML messages (Simple Object Access Protocol, SOAP), and XML interface definition (Web Service Description Language, WSDL) (Christensen et al. 2001). and thus are particularly suited to connect the PROLIX components running in different software environments.

Central in the whole PROLIX learning lifecycle is the PROLIX portal. The portal, based on PXE (Intalio PXE 2007), integrates and orchestrates all the other components and presents a universal workflow for each user. This includes the management of a task list for users as well as the automatic creation of new user (and component) tasks, dependent on the specified workflow configurations.

Process Control and Monitoring

Combined business and learning process control allows measuring the impact of learning and training on the execution of business processes within the organization. It is important to get a feedback about the learning in order to improve adaptive, individualized learning material and learning design. Controlling learning processes from a business perspective is of great importance in order to know about the impact of the training on the business process execution and the process performance, as it is the main purpose of training to lead to improved processes. This means, employees who are already trained should perform better in their daily work. If not, the training is not sufficiently adjusted to the learning goals which correlate with business goals. Then the training content has to be (re-)engineered in order to optimize its effects on business process execution. In order to reveal the impact of workplace learning on the overall process, training measures must be added to the already common KPI of process monitoring system. This is where the true ROI ("Return on Investment"), i.e. the added value, is quantified and provides feedback for process improvement.

The integration of learning design, learning management, learning material production and distribution into the business environment and infrastructures creates a comprehensive learning experience for the learner, embedded in learner-oriented business process flows. This supports the understanding of transaction-oriented cause-effect relations, which aligns individual and organizational learning goals. Flexible knowledge distribution on the basis of an improved technology support provides only relevant information and learning material to the employees. Thus, it reduces time lags caused by competency deficiencies while enabling faster readiness for business tasks, faster decision making as well as a shorter response time to stakeholders. This generates a better performance in the business execution by the employee and an added value for the customer that contributes to a higher customer satisfaction.

In order to couple business processes with learning processes, the project PROLIX will provide a multi-feedback architecture that offers controlled feedback channels for the automatic tailoring of learning experience to the single learner and the learner's performance controlling. For controlling purposes the user performance during the learning process and afterwards can be monitored. Based on the collected and analysed data, respective adjustments to the learning process, the user profile and the learning process selection criteria are carried out. This multi-step feedback mechanism enables a flexible and continuous adaptation to evolving and arising learning needs, controlled by user as well as company requirements (Martin, Leyking & Wolpers 2006).

Recently, the question of how to effectively control learning processes has gained significant attention by both, practitioners and scientists. Scientists have focussed mostly on the issue of how to measure corporate learning success (Kirkpatrick 1998), but hardly on how to influence it. Instruments are often derived from related measures such as "service quality" (Jiang et al. 2003) without proving the applicability. Furthermore, existing models do not provide a high explanatory power of training related effects (Buchester 2003). In many cases, practitioners still rely on smile-sheet questionnaires and balanced score-cards with low reliability as their central tool for managing learning. Therefore, it is utterly important to provide measures for corporate training, especially how informal learning processes – that account for 80% of corporate learning (o'Driscoll & Cross 2005) – can be involved in controlling processes.

The resulting learner performance will be measured both in terms of competencies acquired and in terms of effectiveness in solving the original problem, performing the task or coping with changes caused by business process management efforts. By means of this measure and feedback process, a supervision and evaluation of the learner's execution is achieved. If the learner does not perform according to requirements, additional learning processes to improve the learner's ability to comply with the learning situation are initiated. Thus, the PROLIX approach includes a feedback mechanism that ensures a "self-healing" process to improve the learner performance. Having gathered the skills based on the defined learning goals, the same procedure will happen on higher skill levels, so that a continuous procedure is a result. In order to achieve a better integration between learning and workplace, a set of publicly available measurement tools (e.g. transfer scales with high reliability)

and reaction patterns should be available. Hereby, direct input for an evaluation-driven learning management is provided by identifying stimuli (e.g. customers are dissatisfied with quality of documents delivered), and appropriate reactions for learning (e.g. point to WBT on "How to write reports effectively").

Learning process control is regarded as a permanent activity and integrated into BPM, which is initiated on time, ideally before a competency gap will appear. IT is able to steer planning, information and controlling processes of a learning management lifecycle. As a result, not only direct learning success is measured, but also indirect effects to the business processes. The identified cause-effect relations between learning input and work output will enable the definition of process and role patterns for evaluation-based learning process management and thus enable and realize feedback to the business process responsible on the performance of each employee.

Conclusion and Outlook

Research about business process and learning management infrastructures so far has been limited to the analysis of either one or the other system category. Thus, they are barely able to connect to each other according to the usage of knowledge in certain working conditions, occurring learning needs or the identification of competency gaps and the detection of appropriate learning objects to fulfil the needs. To improve the individual and the organizational knowledge base continuously, it is necessary to base personnel development on a common business-driven ground of requirements. Vice versa the employees' qualification as well as their continuous competency development constitute an important precondition for an effective and efficient business process execution. Altogether, the goal to be pursued can be formulated as accelerating the "Time-to-Competency", i.e. organizational ability to anticipate cause-and-effect relations of changes in market, process and competency requirements better and faster.

This paper has proposed the major challenge being the ICT-supported integration of the learning and business process lifecycle backed by a flexible and interoperable ICT-solutions such as SOA for TEL interlinking learning with relevant enterprise-wide information systems. Given the results of the two research projects EXPLAIN and PROLIX, and other ongoing efforts to implement service-oriented learning systems (Dagger et al. 2007; Westerkamp 2006; Wilson, Blinco & Rehak 2004), it remains to be evaluated in practice how the vision of satisfying emerging learning and/or knowledge needs in the workplace and enabling the dynamic accumulation of learning content with up-to-date information in an organizational, individual and application specific way can be realized through SOA.

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