Process-driven Learning- and Knowlegde-Environments

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Abstract:

Companies realize that well educated employees are an increasingly valuable asset in successful organizations. Thus, they strive to improve the performance of their human resources at the workplace and, at the same time, feel the pressure to forecast, adapt and react quickly to market changes. Employees have been proven to perform better in learning scenarios if their needs are addressed individually. So far, technology has not provided any successful solution for learning at the workplace that deals with both organizational and individual requirements. This paper outlines the foundations of the successful EU/IST PROLIX IP-proposal in which its consortium will couple business and learning processes to enable companies to control their development processes while enabling employees to successfully acquire further qualifications.

1 ICT-supported Learning- and Knowledge Environments

1.1 Learning and knowledge supported business process execution

In the past it has been shown that the goal of an effective operating can only be reached by critical rethinking of organizational structure models and business processes which are focused on an optimized relation to internal and external target groups. Promising concepts for the acceleration, cost reduction and transparency of business processes result from the process-oriented approaches of “Business Process Reengineering (BPR)” [1] and “Continuous Process Improvement (CPI)” [2]. The implementation of enhanced or new processes – usually supported by ICT – shall lead to the aimed improvements of efficiency and effectiveness. Hereby the staff´s knowledge affects exceedingly the execution of business processes and its performance [3]. The employees act as a central resource that holds the relevant know how or in other words the companies “intellectual asset” [4]. Thus, their qualification as well as the constant enhancement of their knowledge constitutes an important precondition for the process optimization and its benefits.

In this context, business process modeling and management, knowledge management as the overall term (including for e.g. information retrivial techniques, data-warehouse technology as well as document- and content-management environments) and eLearning have become key terms and proven concepts which can iniciate a lifelong learning phase to secure the a learner centered continuous qualification improvement and the companies success. Taking the ICT as

a core factor for the exchange of information and the execution of transactions, the double effect appears:

1. *Knowledge management and eLearning support the acceptance by providing current information and improving the employees know how during the process execution,*
2. *Knowledge management and eLearning themselves are objects for raising questions about the alignment to business processes as wells as their support by technical, organizational and didactical instrument, concepts and tools.*

The aim of eLearning consists in the didactically structured mediation of relatively time-constant contents that can be segmented into basic knowledge, specialized knowledge, concept knowledge and methodical knowledge. The learner is able to use the mediated knowledge and methods for the independent fulfillment of his daily tasks at the workplace. Knowledge management deals with the constant identification, storage, supply, distribution and further development of current core knowledge. Thereby, the deficits particularly consist in the provision of loose data and information. Following the consecutive understanding of the terms "information" and "knowledge", information only turns into knowledge through the accumulation of applied and action relevant contexts by the employees [5].

1.2 The need of convergent knowledge for the business process execution

It is obvious, that the two approaches turn out to be complementary and ensures the supply of relevant knowledge along the whole value chain, from basic via further education up to the continuous quality assurance of state-of-the-art knowledge in the everyday working surroundings. The dynamic and complexity of change processes as well as the significance of employees as potential knowledge carriers indicates the high importance of intelligent designed knowledge supply and education processes [6]. The identification and combination of distributed, specialized knowledge carriers and knowledge bases within a *convergent knowledge environment* is realizable with the deployment of modern ICT infrastructures. The accumulation of basic knowledge, enriched by consistent, specific and up-to-date information in the sense of a dynamic, intelligent (education) organization takes place with the development of integrated eLearning- and knowledge environment. The specific interaction between the ICT-systems contributes to an integral satisfaction of any knowledge need. Though the described synergy, similar approaches are not or only insufficiently given in practice and research [7; 8].

1.3 Research Questions on the development of process-driven learning and knowledge environments

Currently, many different typs of information and knowledge supporting systems exist on the market that support a broad spectrum of functionalities but lack in particular cases a comprehensive approach to meet all requirements of companies. Here, one has to refer to the term of the company memory, which is supported by business intelligence tools and metadata repositories, like organizational memory (information-)systems (OMS) [9; 10] or learning object repositories (LOR). Scientific papers, which deal with the embedding into the organizational and individual working context exist only for a short time.

A problem regarding today's eLearning systems persists in the disregard of the active information need of the learner in terms of his daily work. It has been proved that it is discouraging the learner, if information that is very present in his daily life is merely depicted by learning objects or complete course structures so that they often fail in creating an increase of benefit. This can be avoided by providing a personal learning unit fitted to the current task context and offering the needed state of knowledge without great redundancy. Contrariwise, information

and knowledge supporting systems can profit from the user friendly, learning goal oriented and didactically prepared presentation of information units. These provide usually 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 achitectures and focus, the drawback of – more or less – monolithical knowledge supporting systems is the missing consideration of the learner's (individual) view on the presented information. A context-senitive presentation of the content, classified according to eLearning categories will complicate the access to the subject from the knowledge management's point of view. A dynamic classification according to the organizational as well as the individual view of the learner will remove such barriers. Beyond this, the change from function- to process-orientation is well known in the field of Enterprise Resource Planning (ERP) [11]. Thus, comprehensive architectures and integrated information systems exist for a nearly 20 years and are well known in the company's daily business. In addition, classical ERP-systems have already been extended by customer relationship mangement (CRM) and supply chain management (SCM) tools and functionalities. In this context, the term of ERP II has to be named [12]. Recent research questions in the field of ERP resp. ERP II deal with their further development by implementing or embedding knowledge- and expierence-based databases and logics – like complex business rule sets – which supports the decission making processes of the organizations emplolyee [13].

Derived from the experiences and expertise in the field of ERP, major research questions could be "Why are knowledge supporting achitectures and systems still (and extensivly) seperated?" and "How could a comprehensive architecture doeslook like?".

2 Process-oriented learning and information exchange

2.1 PROLIX – Towards a process-oriented learning and information exchange

The future challenge consists in the development of an interoperable ICT-architecture, that interlink eLearning to knowledge management systems and other relevant enterprise-wide information systems, therefore enable the dynamic accumulation of eLearning content with up-to-date information in an organizational-, individual- and application specific way. Beyond that, strategies, concepts and methods have to be provided, that contribute to the satisfaction of heterogeneous learning and knowledge needs. IT-supported mechanisms for the composition of systematic interaction and interchange relations, as well as the creation of effective concepts for the measurement of learning phases will complete the concept. The outlined approach experiences an expansion by the intelligent and context-sensitive distribution of relevant knowledge to the "*point of business process execution*". Through the stronger decentralization and dissociation from physical infrastructures, an area-wide information and content supply by interacting knowledge systems can take place. In distributed organizations one has to think about a multi-channel support with information and flanking education measures, real time information about status of processing and availability as well as other dynamic contents. Intelligent control concepts and tools for the technology supported transfer of current knowledge and education measures to the learner's interface, which account for the respective appropriate infrastructure, are necessary.

The knowledge distribution to the customer causes an integration of internal and external, customer oriented process flows and supports the understanding of transaction oriented cause-and-effect relations, which aligns individual and organizational learning goals. This means, the flexible knowledge distribution on the basis of an improved technology support provides

relevant information to the employees enabling a faster internal 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. Contrariwise, market changes and customer needs can be detected by the companie staff and documented systematically. In effect, business processes and services can be better adapted and the "quality of learning" will be improved as a whole and can be carried out in a more efficient way. The fulfillment of the defined goals will be outlined by the activities of the successful EU/IST IP-proposal "*Pr*ocess-*o*riented *L*earning and *I*nformation e*X*change (PROLIX)", which will be described within the next sub-sections.

2.2 The PROLIX approach

As shown, the overall goal of PROLIX is to research, analyze and develop a flexible and adaptive *service-oriented architecture* and system which is capable of aligning training and knowledge production of people faced with so-called "*complex situations*" such as work and business process changes, or other complex multivariable learning environments, which cannot be solved with traditional eLearning or knowledge management approaches [see Figure 1]. Often, such situations also require a mix of individual and group learning and of learning- and knowledge-acquisition and/or production and the harmonization with their daily work.

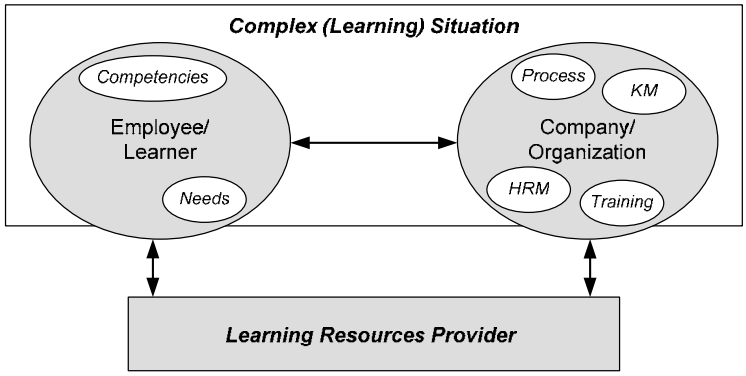

Figure 1: Complex (Learning) Situation

In order to couple business processes with learning processes, PROLIX will use a multi-feedback architecture that provides controlled feedback channels for the automatic tailoring of learning experience to the single learner and the learner´s performance controlling. Here, the origin is a so called *Complex (Learning) Situation* (see Figure 1). These situations have in common, that a heavy learning need arises for employees. For e.g they occure, when changes in the employee's tasks, the renewal of the organizational structure the employee is involved in or the business processes he is responsible for or in general any other situation with multiple parameters that define the learning have to be done. The need is either driven by the employee wishing for further qualification or by the company that intends to improve the company profile by educating their employees. Thus, the approach especially focuses on mixing formal and agile learning taking tacit and explicit knowledge into account and relying on individual and collaborative learning strategies. From this complex situation PROLIX will predefine and then dynamically assign the right number and type of variables translating the complex situation into a *Learning Objective Profile (LOP)*. This LOP will have competencies linked to:

- *User and/or team profiles,*
- *Context information in the form of a ontological commitment to the context ontology,*

- *Corporate cultural profile specific to the pilot domain.*

The project´s technology aims to deliver web services integrated on the basis of a service-oriented architecture to ensure a maximum of flexibility while, at the same time, capture and reflect the possible varying and changing company and user requirements and adapt to the evolving markets. The web services (or alternatively named "modules") have been identified by breaking the PROLIX approach down into the various necessary technological and pedagogical needs and components which are captured within an all-ambrassing architecture. Based on this flexible architecture, each module is selfsustainable, thus reducing the risk of a single point of failure within the system. Furthermore, based on the company requirements PROLIX foresees the possibility that there might be several implementations of one module, each tailored to the needs of the various areas of application. Additional *service components* will be realized in a distributed environment that does not stop at company boarders, such as intranets. Nevertheless, PROLIX explicitly recognizes the resulting need to provide secure and reliable means of communication and data exchange between serveral organizations or distributed networks.

2.3 The PROLIX architecture

The overall guiding principle is the significantly improved performance and "just in time (JIT)" or "assembling on demand"-education of the employee. The learning employee should be able to learn directly at his workplace when the need for (futher or ad-hoc) education is identified without any large delay. Furthermore, the adequate content must be targeted to his individual learning goals, style and behaviour in the first place and should also take his existing compentencies or compentencies lacks into consideration. In order to follow this guiding principle, it is necessary to adjust emerging or acyclic learning phasis as much as possible to existing and known learnig scenarios. Organizations need to understand that only by providing the necessary means to learning at the workplace that they will be able to react quickly, cost-effective and successful in fast changing markets and situations.

One way of achieving this is the tight coupling of business- with learning processes in corporate environments as proposed in the PROLIX project. The project´s vision is a ICT-system for business process driven learning at the workplace, focused on the single learner, their needs as well as the corporate requirements. In addition, the single learner will be able to initialize a learning task himself enabling self-guided learning in existing corporate (knowledge and educational) environments. The overall architecture that also serves as the basis for PROLIX is outlined in Figure 2. It is fully based on web services [14] and standards[1], so that it can be integrated in (already existing) corporate environments simply and effectively and also be accessed by the employee on short notice.

[1] Open standards play a decisive role in developing a process-driven learning environment of general applicability that has to be accepted by different roles, professionalism and business objectives. Therefore PROLIX focuses on utilisation of shared open standards and intends to expedite these in the particular focus of the project. This has been conducted with the goal to describe eLearning content, organizational knowledge or information stored in repositories as well as business processes in an abstract format and independent from the provided technology. Herefore existing and common standards will be supported.

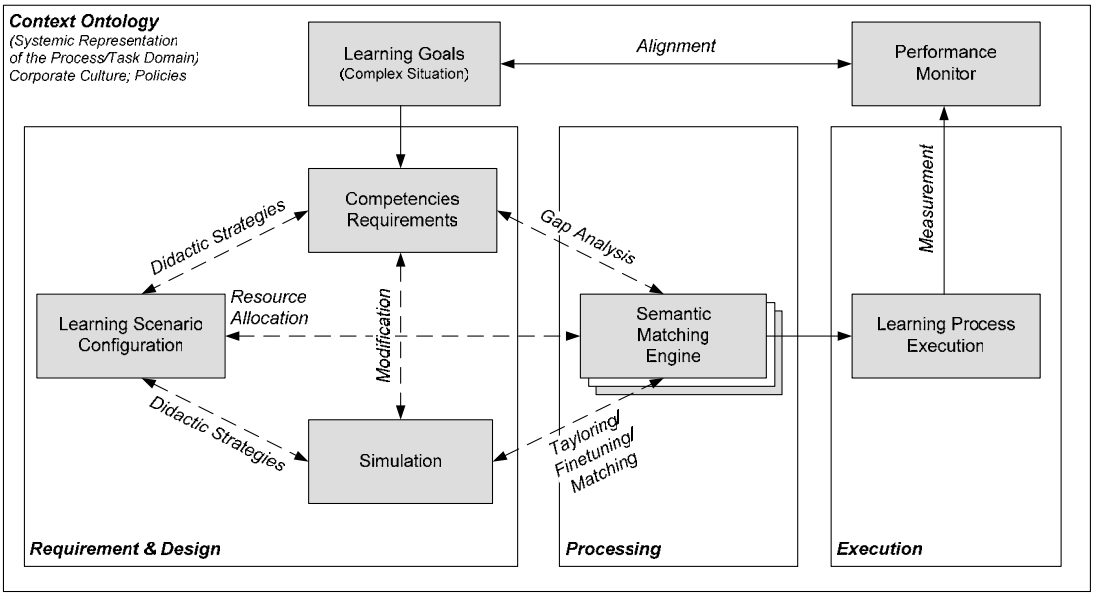

Figure 2: PROLIX architecture

The *Semantic Matching Engine* matches the "problem profile" with the available competencies which is based on the PROLIX context ontology to make the matching "meaningful". The defined competency requirements are now linked to the problem as a specific "problem competency profile". This engine consists of a *multiple criteria system* using the ontology for forecasting the achievment of every module and the retrievial of coherent meaningful (context-relevant) data exchange stored in distributed repositories and its exchange between any other module involved. The matching engine is geared towards accepting dynamically variable parameters. Here, one has to refer to the IMS RDCEO (http://ltsc.ieee.org/wg20) specification as the standard for competence definitions. Furthermore, the matching engine will also clarify the questions: "*Who are the best suited personnel to carry out the task at hand?*" or "*Which is the competency gap of employees that need to carry out the task?*". Based on this problem competency profile, one of two possible scenarios will be carried out relying on the respective employee competency profiles:

1. *Find the best employee(s) to perform the problem,*
2. *Upgrade the competencies of the current involved personnel of this job.*

In the following, the *Learning Scenario Configuration (LSC)* identifies appropriate learning material and -strategies based on didactical model. The didactical-structured content is necessary to fill the identified gaps. The LSC uses the semantic matching engine in order to propose the best fitting scenario to solve the educational problem and (re-)present it by the usage of the simulation module.

The *Learning Process Simulator* integrates the *learning strategy* on the one hand and the availible *learning resources* on the other hand in order to simulate the expected learning effect when actually applying the strategy and material. Based on the comparison of the required competencies with those being learned when strategy and material is applied. This "rules engine" will automatically decide whether to execute the suggested learning strategy or to (re-)design the learning strategy and related learning resources and actions. Once the Simulation will result in an optimal proposal, the learning solution index will be handed over to the Learning Process Configuration (LPC) as well as to the Learning Process Execution (LPE), which consists of a combination of a Learning Management System (LMS), a Learning Content Management System (LCMS), a Skill respective Competency Management System, a Knowledge Management and a Collaboration System (KMS).

The result can be described as a convergent Learning Process Execution Platform which is responsible for managing and controlling the execution of the selected learning strategy and the configured learning path, also providing the interface with the LCMS, LMS, SMS and KMS in the sense of a user-centric workflow and enactment engine. When the learning process is executed the learner is expected to be able to fulfil the requirements and the execution of the complex situation. Based on the "Simple Query Interface (SQI)" [15] and "Open Knowledge Initiative Interface (OKI)" [16], access to available learning and knowledge resources stored in distributed repositories is realized, thus enabling a cost-effective reuse of existing learning material and information within the organization. As known from workflow-engines, the retrieved data could be delivered to a measurement tool, the so called learning process controlling cockpit.

2.4 Learning Performance Controlling

For controlling issues, the users 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.

Recently, the question of how to effectively control learning management has gained significant attention by both, practitioners and scientists. Scientists have focussed mostly on the issue of how to measure corporate learning success [17], but hardly on how to influence it. Instruments are often derived from related measures such as "service quality" [18] without proving the applicability. Furthermore, existing models don not provide a high explanatory power of training related effects [19]. 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 [20] – can be involved in controlling processes.

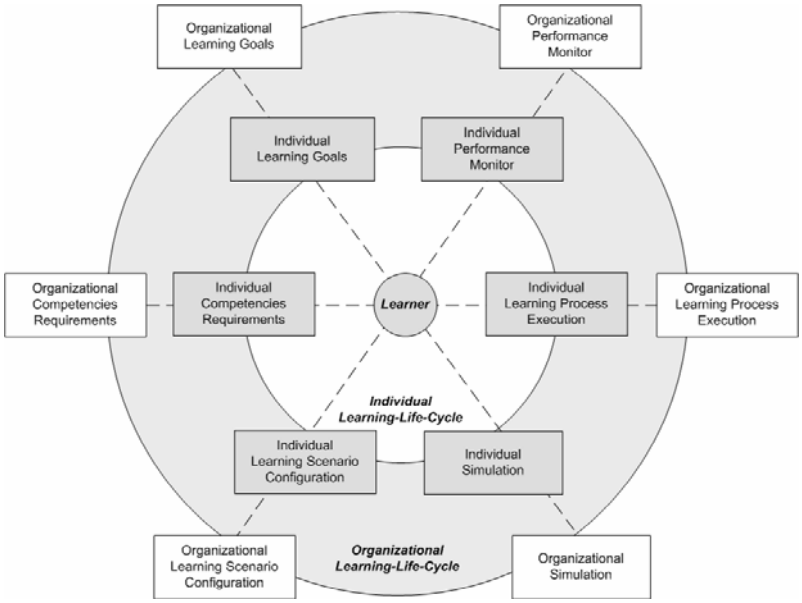

Figure 3: Aligned individual and organizational learning life cycle

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 the (business) process change. This measure and feedback process is carried out in the Performance Monitor, which supervises and evaluates the learner's execution of the complex situation. If the learner does not perform according to requirements then the cockpit initiates additional learning processes to improve the learner's ability to comply with the complex situation. 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 (see Figure 3.)

3 Convergent Knowledge environment and related work

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, an integrated reference architecture for process-oriented learning and information exchange that supports a complete learning process life cycle comprising:

1. *the analysis of complex business situations;*
2. *the identification of individual and organizational learning goals;*
3. *the analysis of competencies and their matching with individual skills;*
4. *the definition of appropriate learning strategies and the simulation of learning processes;*
5. *the execution of improved learning processes;*
6. *the monitoring of learners' performance according to the goals will be defined.*

Overall and seen from an organizational point of view, PROLIX will significantly contribute to the change management within companies that needs to develop into a holistic learning organization enabling the integration of learning into the daily working tasks. Corporate culture requires the provision of strategies, methods and concepts to satisfy heterogeneous learning needs. Mechanisms and concepts for the organizational introduction of TEL in corporations have to be co-ordinated with its philosophy and company 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 consist of a process- and competency driven framework for interlinking business process intelligence tools on the one hand with knowledge management and learning environments on the other. Learning is seen as a key enabler of business process change. Solving this complex task will open new segments of technology enhanced learning and by providing sustainable and transferable results, which contributes to the emergence of the information society as a whole.

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