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Managing & re-using didactical expertise: The Didactical Object Model

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ABSTRACT
The DIN Didactical Object Model extends the approaches of existing Educational Modeling Languages introducing specifications for contexts and experiences. In this paper, we show how the Didactical Object Model can be used for sharing didactical expertise. Educational Modeling Languages change the design paradigm from content orientation towards process-/ activity orientation. Especially in the community of teachers and didactical designers, this development has gained attention. However, reusing learning scenarios requires applying knowledge management concepts to this issue. To adequately reuse learning scenarios, information about context and experiences must become available. Furthermore, supporting human-oriented knowledge management instruments are needed to facilitate the exchange and reuse process. The DIN Didactical Object Model, developed by the German Standards Body (Deutsches Institut für Normung, DIN e.V.), provides specifications for this. Additionally, an integrative concept for knowledge sharing and reuse is presented: the solution integrates business, learning, and knowledge processes into a common architecture using the Didactical Object Model to exchange scenarios. The presented modeling language will enhance the use of Educational Modeling Languages towards knowledge-based exchange of learning scenarios and experience sharing.

Keywords
Didactical Object Model, Educational Modeling Languages, Learning Design, Integrated Knowledge and Learning Management, Didactical Expertise

Introduction

The efficiency of the development of learning scenarios highly depends on the ability to reuse existing materials and expertise. The reuse of didactical concepts and methods is enabled through the use of formal specifications, such as IMS Learning Design (Koper et al., 2002; Koper & Olivier, 2004). The ability to model didactical concepts has changed the development paradigm from content orientation towards activity-/process-orientation.

However, there are certain requirements to successfully reuse didactical scenarios and expertise. The most important factors for the reuse process are 1) contextualization and 2) experience sharing (see next section). Therefore, we apply a holistic knowledge management approach to the reuse process in order to fulfill the requirements for successful reuse.

Based on these concepts, the paper identifies useful extensions to IMS Learning Design and ways to improve the exchange of didactical expertise. First of all, we will present a review of research on reuse of expertise from a knowledge management perspective. After a review of Educational Modeling Languages, the Didactical Object Model (Deutsches Institut für Normung, 2004) from the German Standardization Body is presented. It extends IMS Learning Design, adding the categories of Context and Experience, leading to a specification which enables the exchange of didactical knowledge and to manage this knowledge in repositories and platforms. The article closes showing a concept for an integrated system for business, knowledge, and learning processes based on the Didactical Object Model and Knowledge Management principles. However, even though this concept is not yet broadly adopted, first results in a comprehensive evaluation-process approved corresponding benefits to our theoretical work (see the section describing the Evaluation of the Model).

Reuse from a Knowledge Management Perspective

One of the most important goals of standards is reuse (Littlejohn & Buckingham Shum, 2003; Pawlowski, 2001). The IEEE Glossary (1990) defines reusability as “the degree to which a software module or other work product can be used in more than one computing program or software system". Extending this definition to the field of learning, education, and training, we consider reusability as the degree to which a component, object, or activity can be used in more than one learning scenario.

Reuse has been discussed in particular in the field of software engineering (Jacobson et al., 1997), especially for software components through different methods, such as patterns (Buschmann et al., 1996; Gamma et al., 1995). Reuse is discussed for different abstraction levels, such as systems, applications, components, or documents (Firesmith & Henderson-Sellers, 2001). In the educational context, the discussion focuses on learning objects (Wiley, 2000; Sicilia & García, 2003) and learning activities (Brusilovsky & Nijhawan, 2002; Koper & Manderveld, 2004; Karampiperis & Sampson, 2005; Reusable Learning, 2004). The broad variety of aspects of reuse is discussed in Littlejohn & Buckingham Shum (2003).

A result which is common in the field of reuse is that it is not sufficient to just provide codified knowledge as data (Snowden, 2002; Swan, 2003). This knowledge might not be understood or used (Szulanski, 1996; Lugger & Kraus, 2001). Therefore, the issue of reuse is a core knowledge management problem (Sridharan & Kinshuk, 2002; Benmahamed et al., 2005): to facilitate e.g., knowledge identification, knowledge acquisition, knowledge development, knowledge distribution/sharing, knowledge preservation, and knowledge use (Probst & Romhardt, 2000).

Consequently, we will show how experiences from knowledge management research can improve reuse. In particular, we focus on the improvement of reuse through scenarios. We show how general knowledge management concepts apply to E-Learning development processes and indicate how the process of knowledge sharing can be improved.

Knowledge Management in the Context of Reuse

During the past decade, knowledge management has emerged as one of the most important and widespread management issues. Knowledge management finds its origins in a desire to learn from mistakes and to hinder the "reinvention of the wheel" in organizations (Reeves & Raven, 2001). In the past decade, the importance of knowledge as a key resource has become well established (Drucker, 1994; Maier, 2002). However, exchange within the design of learning processes is usually limited to exchanging content. This means that without the context, the exchange is limited to information sharing rather than knowledge sharing. Therefore, context should be in the focus (Levy, 2003).

We use a definition of knowledge management by Maier (2002) which is on the one hand general enough to support all kinds of different knowledge areas and on the other hand regards management in a functional sense: "Knowledge management is defined as the management function responsible for the regular selection, implementation, and evaluation of goal-oriented knowledge strategies that aim at improving an organization's way of handling knowledge internal and external to the organization in order to improve organizational performance. The implementation of knowledge strategies comprises all person-oriented, organizational, and technological instruments suitable to dynamically optimize the organization-wide level of competencies, education, and ability to learn of the members of the organization as well as to develop collective intelligence" (Maier, 2002).

Although this definition has a slightly technocratic notion and it could be debated whether it is possible at all to stimulate individual competency development through external strategies, we still want to stress the above mentioned distinction. According to Maier's definition, two approaches to knowledge management exist: human-oriented (personalization) and technology-oriented (codification strategy) (Hansen et al., 1999; Lehner, 2000; Swan, 2003). These two approaches pose a different view on knowledge management and thus on reuse (*Table 1*):

- *Human-oriented/personalization strategy*: Knowledge is closely tied to the person who constructed it. Knowledge is mainly shared through direct person-to-person contacts. Information and communication technology (ICT) just supports people to communicate knowledge, not to store it. One example in our context is experience sharing within a community or within an organizational context in which activity patterns change and people share their experiences concerning learning scenarios. This means that didactical knowledge and expertise can never be separated from the context of its present or past use. Furthermore, it can also not be separated from the person who was responsible for a certain scenario.
- *Technology-oriented/codification strategy*: This strategy addresses computer technology and ICT: Information is (carefully) codified and stored in 'databases' where it can be accessed and used easily

(Hansen et al., 1999). The formal model of experiences is an example which could be used in the frame of such a strategy to supply people with a standardized set of information. Typically, a specification like Learning Design or Educational Modeling Languages would be used to codify knowledge about didactical activities and store it in an interoperable format.

Table 1 outlines the two above mentioned approaches and defines its basic assumptions by means of *strategy*, *comprehension of knowledge*, involved *parties* as well as corresponding *knowledge management system functions*, and enabling *ICT components*.

Table 1: Classification of Knowledge Management Approaches based on Maier & Hädrich (2001)

	human-oriented	**technology-oriented**
knowledge management strategy	personalization	codification
comprehension of knowledge	knowledge is contained in people's heads	knowledge is rather understood as stored, documented information, detached from employees
actors/roles	knowledge worker, networks, and communities of interest	authors, experts, information broker
important knowledge management system functions	communication and cooperation, allocation of experts, community-support, human capital management	publication, structuring and integration, search, presentation and visualization of information elements
relevant ICT components	community, expert network, experience sharing	formal experiences, analysis model

More recent knowledge management approaches suggest a *holistic* approach to knowledge management, bridging the gap between human-oriented and technology-oriented knowledge management (Lehner, 2000). Likewise, Hansen et al. (1999) identified certain strategy-mixes to implement a holistic knowledge management: A company pursues one strategy predominantly, e.g., personalization, and uses the second strategy, i.e., codification, to support the first. As outlined in *Table 1*, experience sharing is a main task for human-oriented approaches, supported by specific ICT functions. Therefore, we suggest a holistic approach, focusing on the human-oriented aspects and using technology-oriented specifications as supporting instruments.

As already mentioned, there are various barriers affecting knowledge management activities and thereby affecting the acceptance of knowledge management solutions. Contrary to various studies, Szulanski (1996) elaborates knowledge-related factors such as the recipients' lack of absorptive capacity, casual ambiguity, and arduous relationships between the actors. To overcome these barriers, it is important to understand that a fundamental purpose of managing knowledge is to create shared context (Fahey & Prusak, 1998). Furthermore, with a holistic, integrated, and standardized approach supporting redundant channels for knowledge sharing, reuse will increase *acceptance* (Maier, 2002).

Requirements for Educational Modeling Languages

Reuse is not only limited to exchanging didactical scenarios as technical specifications. Moreover, it should be possible to exchange didactical expertise. This problem is a typical knowledge management problem aiming at exchanging expertise, originally mainly for working processes. Therefore, we apply knowledge management concepts to exchanging didactical information (Adelsberger et al., 2004).

Educational Modeling Languages provide a base for the technology-oriented knowledge management view using structured, formal, and interoperable specifications. It is the exchange format for different applications, e.g., through the use of repositories. The specification itself is a format to exchange scenarios between systems. As shown above, this should be supported by human-oriented instruments, e.g., Communities of Practice (Wenger, 1998). However, establishing Communities of Practice requires a common understanding and terminology on the domain (Wenger & Snyder, 2000; Friesen, 2002). To facilitate this process, different instruments are used, such as structured case studies (JISC, 2005) or templates for experiences (Bergmann, 2002). Secondly, knowledge needs to be contextualized to enable reuse (Allert, 2004). Therefore, instruments should be able to identify similar contexts and connect those to the object to be reused.

As a conclusion, the main requirements for reusability are the ability to contextualize knowledge and to facilitate experience sharing:

1. Context: A knowledge intensive process is strongly related to the context in which it occurs. In order to find similar contexts, this should be modeled to enable better search and retrieval procedures.
2. Experiences: Describing a didactical scenario in terms of activities does not describe its success or failure, nor does it describe constraints or personal views. These are crucial for successful reuse. Connecting experiences with scenarios leads to the personalization of learning environments. Introducing such a category to Educational Modeling Languages means that didactical knowledge sharing and reuse is possible from the technology- as well as the human-oriented view.
3. Acceptance: A shared context for users must be created to overcome the knowledge management barriers.

Applying a holistic knowledge management strategy to a knowledge intensive process means that specifications should support the technology-oriented view and links to actors should enable a human-oriented view. By applying these concepts, two main conclusions can be drawn:

1. Specification Level: Specifications should enable the modeling of contexts and experiences (see the section "Model description').
2. Systems Level: Systems using these specifications (such as repositories) should enable interactions between all stakeholders involved in the process (see the section 'Integrating knowledge management and learning using the Didactical Object Model').

Educational Modeling Languages

This section analyses Educational Modeling Languages, concerning their usefulness and appropriateness to fulfill the requirements of knowledge management for reuse.

In recent years, modeling of educational and didactical concepts has become a focus area of conceptual and standardization research in Europe. The lack of didactical conceptualization in content-oriented standards like LOM (IEEE Learning Technology Standards Committee, 2002) and SCORM (Dodds & Thropp, 2004) led to this trend: the current representation of metadata such as LOM does not provide an adequate representation of pedagogical concepts (Koper, 2001; Pawlowski, 2001). Furthermore, there is no adequate mapping of content-oriented representation to a pedagogy-oriented representation. A variety of models have been developed in order to close this gap (Pawlowski, 2002). Specifications to represent and reuse pedagogical and didactical concepts and methods are summarized within the concept of Educational Modeling Languages. We will briefly summarize the main specifications in this area to point out their strengths and weaknesses regarding reusability. The main aspects, as identified in the previous section, are:

- Contextualization: The semantics of the object are understandable in different contexts. This also means that the context needs to be represented in a specification.
- Experience Sharing: The object is linked with information on actors involved in its use to enable experience sharing.
- Acceptance: The object is represented in a widely accepted format using a transferable specification.

Additionally, it is necessary that the specification covers all aspects of learning scenarios. Koper & Olivier (2004) distinguish specific requirements (completeness, pedagogical expressiveness, personalization, and compatibility) and general requirements (reusability, formalization, and reproducibility). In this article, we focus on the aspect of reusability, for an in-depth analysis see (CEN/ISSS, 2002; Koper & Olivier, 2004).

PALO (Rodríguez-Artacho & Verdejo Maíllo, 2004) is a language to model educational content. It consists of five layers: management, sequencing, structure, activity, and content. A wide range of complete learning scenarios can be modeled using *PALO*. However, the exchange and reuse is limited because the context of the scenarios is not described.

The *Tutorial Markup Language (TML)* (Netquest, 2000) is a markup language for the development of tutorial systems. Only a limited range of didactical scenarios can be modeled, such as questioning and problem-solving scenarios.

The *Instructional Material Description Language (IMDL)* (Gaede, 2000) represents structure, content, assessments, metadata, and a learner profile. The approach strictly follows an instructional design approach. Therefore, it restricts the pedagogical design. It is not flexible enough to model any given pedagogical approach.

The *Essen Learning Model* (Pawlowski, 2001; Pawlowski, 2002) provides a metadata approach for modeling didactical concepts. It mainly consists of three categories, to model *Context, Content and Didactical Concepts/Methods.*

Further concepts focusing on didactical issues are *Instructional Roles* (Allert et al., 2002) and *Web Didactics* (Meder, 2001) which provide a promising approach to combine content and didactical expertise. However, these specifications are not widely used in the community.

A widely used concept for the representation of pedagogical concepts is the Educational Modeling Language (EML) (Koper, 2001) which served as a base for the IMS Learning Design Specification (Koper et al., 2002; Koper & Olivier, 2004). Learning Design is a specification for modeling activities in learning processes and for relating these to the content. It is integrated into the Content Packaging specification (Smythe & Jackl, 2004). The main categories are:

- *Activities* are tasks in the learning process – they are aggregated in an *Activity Structure*.
- Activities are related to each other through the concept of *Methods*. Individual structures are generated through *Conditions*.
- User adaptation is possible through the use of *Roles* (e.g., Learner, Staff). Individual scenarios can be generated based on attributes (*Properties*).
- Within activities, resources (*Environment*) and *services* (such as Mail, Conference, Search, and Monitoring) can be referenced.

Koper & Olivier (2004) show that this language enables developers and designers to model complete, adaptable, and reusable scenarios. This model fulfills the main aspects to enable reuse. It is a formal, widely accepted model. However, it does not provide a semantically rich representation of the context. Reuse is only possible in certain settings depending on the context: either the context must be similar or adaptation mechanisms must be provided to reuse scenarios. To provide a concept for measuring similarities or to provide adaptation mechanisms based on the context, a category *Context* should be added to describe information about intended or applied context. Additionally, it is not possible (and not intended) to attach *Experiences* (Klebl, 2005) to a scenario which is common to most of the above mentioned approaches.

As a conclusion, IMS Learning Design is the most promising approach concerning acceptance and reuse. It should therefore serve as a base for further developments and extensions.

Didactical Object Model

With regard to the two main conclusions drawn in the section 'Requirements for Educational Modeling Language', we will firstly discuss the DIN Didactical Object Model to show the concept, its relation to IMS LD and to elaborate the proposed extensions. Secondly, the requirements for systems using this model will be derived in order to enable efficient reuse and experience sharing from a knowledge management perspective.

Model description

The objective of the Didactical Object Model (DIN DOM) is to enable efficient exchange and reuse of didactical expertise (Deutsches Institut für Normung, 2004). The model was developed within the German Standardization Body (Deutsches Institut für Normung, DIN e.V.) by a large group of experts and users, initiated by the project "Virtual Education in Business Information Systems (VAWI)". In this project, a group of 17 universities in Germany formed a consortium to develop an Internet-based Master program in Business Information Systems. The requirement of exchanging content, concepts, and corresponding expertise in such a setting is obvious. Therefore, the project focused on the use and development of standards to provide solutions for a complex, distributed E-Learning solution (Adelsberger et al., 2001). Additionally, experts were represented from a variety of educational organizations, such as traditional training institutions, content providers, content evaluators, human resource managers, and universities. From the analysis of existing models (see previous section), specifically the Essen-Learning Model, EML, Instructional Roles, and IMS Learning Design, the following requirements were identified:

- to provide a formal description of didactical scenarios, concepts, and methods,
- to support the planning, design, and development of didactical concepts and methods,
- to support the identification and measurement of didactical scenarios,
- to support the sharing and reuse of course concepts,

- to support the search and selection of adequate courses and modules,
- to support the sharing of experiences,
- to be consistent with other specifications, specifically IMS Learning Design.

It should be noted that it is not the goal to compete with existing specifications, such as IMS Learning Design. The DIN DOM is intended to provide useful extensions which could either be included in future versions of IMS LD or serve as application profiles or as separate specifications used by Communities of Practice. The model is therefore intended to widen the future use of IMS LD and to reach new target groups.

Based on the requirements specified above, the following levels and components were identified (see *Figure 1*):
1. *Context* describes the environment in which a scenario is intended to be used or has been used. The main aspect is the description of organizational aspects of the context. This representation describes for example, what kind of organization the scenario was used in or the educational objectives of the organization. Additionally, it describes aspects outside the organization, such as cultural issues or trends within a society which might be taken into consideration.
2. *Actors* denote the individuals, agents, or groups involved in the learning scenario. It consists of the description of actors themselves, but also their experiences concerning the learning scenario.
3. *Activities* are, based on Learning Design, the main aspect of the model, describing didactical concepts within an activity structure.
4. *Resources* describe materials and services to be potentially used in a learning scenario.

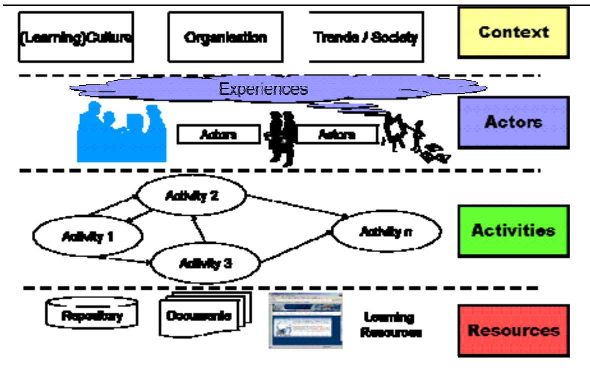

Figure 1: Levels of DIN DOM

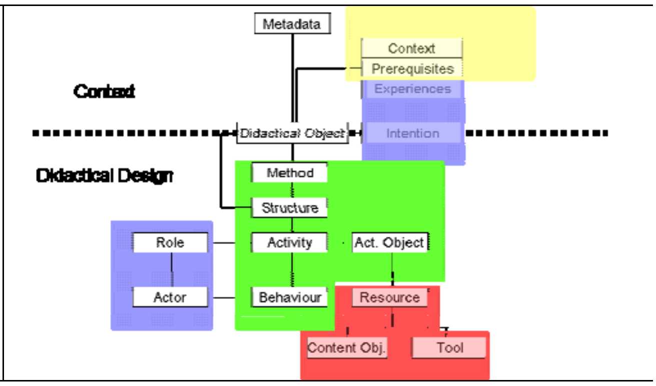

Figure 2: Structure of DIN DOM

The main concept in DIN DOM is the Didactical Object (see *Figure 2*). The *Didactical Design* describes the didactical, structural, and content aspects of a learning process/scenario. Methods contain the main information on the didactical concept, including structures, resources, and roles. The Didactical Design contains all elements and relations to describe a complete learning scenario. This part of the model is consistent to IMS Learning Design.

Through the concept of Didactical Objects the Didactical Design is related to the context and experiences. The context describes specific aspects, such as its situated embedding and relations to the Didactical Design. Actors play an important role in the model. On the one hand, actors are described concerning their preferences or competencies; on the other hand, they are directly connected with the Didactical Design modeling their intentions (ex-ante) and experiences (ex-post). The main components are summarized in the table below (*Table 2*).

Table 2: Categories of DIN DOM

Category	Description	Sample Attributes
Didactical Object	Node	
Metadata	Metadata record to describe the object according to Learning Object Metadata	General, Lifecycle, Rights
Context	Context of a Didactical Object describing the intended or current environment of usage	Name, ID, Kind (e.g., cultural, institutional, economic, location, technical), Type (e.g., planning, application)
Experience	Experiences made using a Didactical Object	Context reference, entity (e.g., actor X, organization Y), description
Prerequisites	Prerequisites for the use of a Didactical	Kind (e.g., technical, location, organizational),

	Object	description
Intention	Intention of developers how an object should/might be used	Kind, description
Method	Description of the didactical concept and its activities, based on IMS Learning Design	Name, kind, description, reference, task structure, task, role, resource
Global elements	Elements used by the Didactical Object	Actor, behavior, resource (e.g., content, service, tool)

The DIN DOM is an extension and therefore compatible with IMS Learning Design. The main extensions are the specifications of the context and experiences. It is possible to use DIN DOM as an application profile of IMS LD and vice versa. However, the main difference is the intention of usage: DIN DOM intends to facilitate knowledge sharing processes. The specification itself recommends practices for reuse. The use of each Didactical Object (e.g., in repositories) in a certain period should be related to the object, containing the context of a particular use scenario and the experiences with this context.

As a conclusion, the model facilitates design and development processes for the following purposes:

- Activities as the central modeling paradigm: like Learning Design, activities should be in the focus of design and development processes instead of content. Especially in the community of teachers and trainers, this can lead to more acceptance than content-oriented development since the development process is more similar to the typical development process teachers are used to (e.g., designing lesson plans).
- Reuse of scenarios: DIN DOM improves the processes of searching, retrieving, and reusing scenarios between systems and organizations.
- Knowledge Management and Experience Sharing: This focus issue was solved by introducing a structured representation of experiences for learning scenarios. Each Didactical Object will have a history of experiences attached. This history can then be used as a start for experience exchange and a basis for choosing adequate objects.
- Tools: One main aspect to increase acceptance is the provision of easy-to-use tools and templates to improve development processes. The specification is a basis for template and tool development.

Finally, it should be noted that the specification itself only covers the technology-oriented perspective of knowledge management. Therefore, it is important to utilize the possibilities of the specification by adding human-oriented knowledge management instruments. In the next section, we will therefore show a concept for integrating technology-oriented and human-oriented aspects.

Integrating knowledge management and learning using the Didactical Object Model

The Didactical Object Model is only a starting point to enable the reuse of scenarios. It is of vital importance to embed the usage of the model into an integrated architecture and process of knowledge sharing in all phases.

The integrated system should include systems which support processes in different situations. Such an integrated system should support processes directly related to the production and use of learning scenarios and to the core business processes of an organization. Additionally, an integrated knowledge management system should support problem solving processes and the exchange of expertise. Finally, corresponding learning systems support processes to develop competencies necessary for the business process. A single entry point should integrate these systems. As an example, an Electronic Performance Support System (EPSS) could provide access to all systems involved (Grey 1991; Raybould, 1995; Adelsberger et al., 2004). It should provide personalized, adapted information which is derived from the related systems (see *Figure 3*).

From a technological point of view, the Didactical Object Model is the main exchange format for such a system: It serves as representation for didactical scenarios (planning system, learning system), context (planning system and knowledge management system), and experience (knowledge management system). The personalization is based on context and actor information from DIN DOM.
From a human-oriented point of view, the specification is the starting point for interaction. Users will contact other users, based on intentions and experiences. However, the cooperation and communication environment must be part of an integrated system.

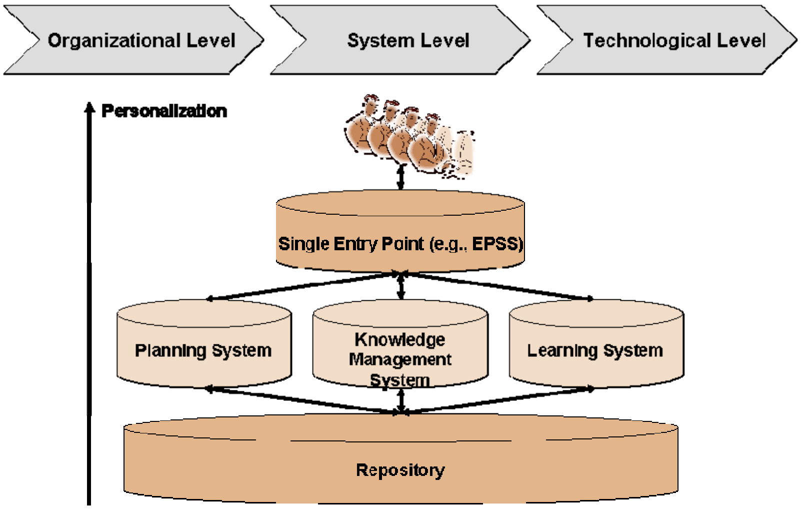

Figure 3: Integrated Architecture

Consequently, the processes of usage must be integrated: In a workplace environment, various process classes can be distinguished: e.g., Production Processes, Knowledge Processes, and Learning Processes (see *Figure 4*).

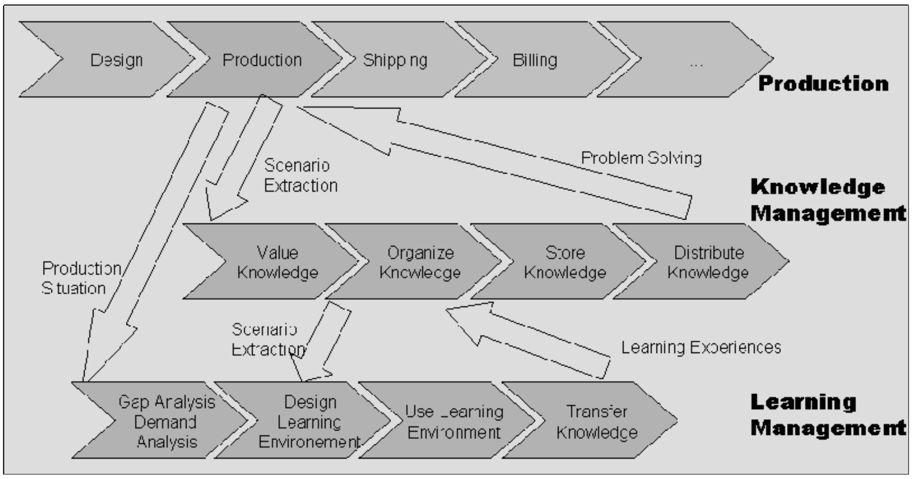

Figure 4: Knowledge-supported processes

Synergy can occur in various situations, e.g., within production, learning, and knowledge processes respectively in the corresponding systems, i.e., planning system, knowledge management system, and learning system (see *Figure 3*). With regard to DIN DOM, we focus on the exchange of information concerning (learning) scenarios and experiences.

- *Production Process and Knowledge Management Process:* In the production process, the user only uses directly related information systems, such as shop-floor information systems. In case of problems (e.g., delays, machine breakdown), the knowledge management system is used. The problem scenario represented using DIN DOM is transferred to the knowledge management system. If there are solutions, the production process is continued. If not, a new problem scenario is generated, providing solutions for future problems after the problem is finally solved.
- *Production Processes and Learning Processes:* The production situation should be continuously monitored by external and internal evaluations. The results should be the basis for a continuous gap analysis, identifying competencies and skills to improve the production process. The situation can be modeled (e.g., as the base for a case study) using DIN DOM. The learning process will be started and performed, leading to an improved production situation.
- *Knowledge Processes and Learning Processes:* Developing real life scenarios usually requires enormous resources. Combining learning and knowledge processes, real scenarios can be derived from the knowledge management system if both systems use DIN DOM as the representation format. Learning experiences can

also provide suggestions for problems arising in the future and should therefore be stored in the knowledge management system.

Integrating the above mentioned system classes on the *specification level* as well as on the *systems level* (see the section describing the Requirements for Educational Modeling Languages) allows a flexible organization of a knowledge-oriented workplace. Problems can be solved directly, whereas workplace-oriented learning is also facilitated. Particularly, the direct relation of business process, problem solving, and learning allows the usage of real scenarios, experiences, and resources between the systems. For such an integrated architecture and process scheme, DIN DOM as the core exchange format provides scenarios and related information. The above mentioned scenarios show how even a loose coupling of the systems can improve knowledge support for the workforce. However, the transfer of scenarios, situations, competencies, and adaptation functions requires semi-automatic adaptations. Next generation systems should provide automatic detection, adaptation, and contextualization functions.

Evaluation of the Model

The process of standardization in the German Standards Body (DIN e.V.) included several steps of evaluation. In the first stage, the requirements of different user groups were collected. As stated previously, several user groups were involved in this process, in total 65 participants from all educational areas. In parallel, existing approaches were analyzed and related to the requirements of the user groups. This resulted in the requirements and assumptions shown in the section describing the Educational Modeling Languages. The main goal of the process was then to evaluate whether the requirements of different user groups (as described in 4.1) were met and if the model is suitable for developing new integrative solutions. Therefore, the specification development process was done using several feedback loops. At each stage of specification development, structured feedback (requirement analysis and refinement, specification verification and validation, improvement suggestions) was collected in interviews and questionnaires. The results were discussed, leading to consensus. Therefore, the standardization process itself is a validation process. Additionally, prototypes were used in the participants' organizations, the experiences were shared and went into the specification process. Therefore, the model was carefully evaluated in several stages over a period of three years.

Secondly, we performed an evaluation in the following setting which was selected as a representative scenario for the use of DIN DOM to facilitate knowledge sharing within an organization. The prototyping setting was chosen to test an environment where a) business and learning processes can be connected, b) knowledge sharing is not facilitated yet, and c) the communication between different actors (of different perspectives) can be improved. This setting is suitable for evaluating the appropriateness of the specification for the technology-oriented view and to analyze the connection of business and learning processes. The organizational units involved were the software development and human resources/training departments of a large refinery. Within its software development department test scenarios are written for specific software, in our case the steering software for filling and shipping processes. The main connection between business and learning processes was the generation of training scenarios from corresponding test scenarios. This means that software testers and evaluators developed E-Learning scenarios directly from test cases. The specification was used as the technical exchange format for both scenarios. The category *Experience* was used to exchange experiences between different departments (specifically, software testing and human resources/training). After six months, expert interviews (N=10) were taken. The main conclusions were:

- The Didactical Object Model is useful for the exchange of scenarios and the general description of training cases. Specifically, DIN DOM was used to transfer cases from software testing to the developers of product training.
- The didactical object model is helpful to structure experience exchange. It might be useful to apply ontologies to the subject in order to improve communication between experts from different disciplines.
- Both perspectives found the structured exchange very helpful to improve communication. However, for the use of the exchange format, support was necessary to find a common terminology and create a common understanding.
- The exchange of experiences might not work in a different environment, e.g., when barriers and competition between departments or organizations occur.

The use of simple XML-editors to develop and edit the DIN DOM is not sufficient for all users. Graphical user interfaces were widely requested and recommended.

The main conclusion was that DIN DOM can be used to model complex scenarios (such as workplace oriented scenarios, generated from test scenarios). However, tools and applications are urgently needed to involve all users, not limiting the use to users with a high technological competence. The experience exchange was initiated and worked well in the environment which means that the use of the specification in connection with human-oriented knowledge management instruments can work as an enabler.

Two additional evaluation steps will follow the evaluation-process steps which have already been performed; in the German Standards Body and the above described experiment. The main goal of these additional evaluations is to demonstrate that the model can be efficiently used in various contexts, especially in the connection of knowledge management and learning processes, and to reach new target groups.

First of all, the model will be submitted to the standardization bodies, specifically to ISO/IEC JTC1 SC36. This next step will evaluate the suitability on the global level and will enhance the discussion on the specification. The main issue in this process is the relation of DIN DOM to existing specifications, specifically IMS Learning Design (as mentioned above as e.g., application profile, extension). This standardization process will include global experts to extend the requirements for use on a global level.

Besides, evaluation will be within the project Quality Initiative E-Learning in Germany (QED) (Pawlowski, 2005). In this project, innovative solutions for Small and Medium Enterprises (SMEs) are developed. Specifically, a repository for Mobile Learning Scenarios is developed to enable trainers and training developers in SMEs to design new training solutions. The main objective of this second part of further evaluation is to determine the suitability of DIN DOM to represent mobile scenarios, to develop workplace-oriented scenarios, and thus to relate knowledge management and learning systems in SMEs. The evaluation will be done over a period of 2 years to see the long-term effects of the use of mobile learning and knowledge management.

However, the first results from the evaluation-process; the standardization process and the prototypes were very promising. They have shown that the exchange of scenarios between departments and organizations can be facilitated. Nevertheless, support is still necessary to create a common understanding. For future development, this implies that tools should be developed easing the use of such a specification for different user groups.

Conclusion

Exchanging didactical expertise is a complex task. It must take into account concepts from various disciplines, such as Educational Modeling Languages and supporting Knowledge Management approaches. In this paper, we have shown the concepts of the DIN DOM which extends IMS LD by two main categories: *Context* and *Experience*.

By the use of these categories, the reuse of didactical scenarios can be improved by providing the technological base to enable structured knowledge sharing. Didactical scenarios can be filtered, chosen, and adapted based on the context. Additionally, experiences are collected for each didactical object. However, it is necessary to support the use of the specification with human-oriented knowledge management instruments. The experience and context extensions to the original IMS LD specification are the base for an efficient technology-oriented and human-oriented exchange of didactical expertise.

The first experiences with this concept led to promising results. However, in the near future a critical mass of scenarios needs to be available. Additionally, easy-to-use tools are urgently needed to involve more stakeholders within the community.

The DIN DOM will be forwarded to different standardization groups to improve current specifications, either as application profiles, new separate specifications for experiences and context, or as an extension to IMS LD. In parallel, repositories and tools need to be developed to reach a critical mass of users sharing scenarios, expertise, and knowledge.

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