Describing Learning Objects for Situation-Oriented Knowledge Management Applications

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Abstract: From a knowledge management (KM) perspective, demand for learning is triggered directly from business processes and requires presentation of learning objects customized to the specific situation. Standardized descriptions of learning objects so far have not been designed with this aim in mind. This paper studies current meta-data specifications for learning objects with respect to their relationships to context dimensions describing situations in business processes in which employees switch to learning activities described in the concept of knowledge stance. Finally, the paper gives an outlook to an approach for on-demand course composition.

1. Introduction

The fields of e-learning (EL) and knowledge management (KM) have been around for more than a decade and despite numerous attempts to bridge the gap between the two intuitively strongly related fields, they are still quite separated in research and practice [LM+06]. In large organizations, EL and KM are institutionalized in different organizational units, information systems as well as attitudes towards handling knowledge. A more formal training approach with pre-defined courses contrasts a more informal approach “harvesting” knowledge in projects and directly handing it on to an unspecified target group without much effort put into validating it, didactically refining it or examining success of the learning processes. Although learning objects (LOs) or Web-based trainings (WBTs) typically used in EL and lessons learned or best practices typically used in KM are knowledge elements of varying stages of maturity, it supposedly can be treated similarly. Approaches for designing more user- or situation-centric KM applications seem to be equally useful for handling LOs.
WBTs can be characterized either as monolithic, static courses or as more or less pre-defined compositions of LOs. The result is in both cases a static WBT that should fit all learners in all situations, irrespective of their personal attributes and that of their current context. If the learner’s context and needs are not considered, motivation, success and acceptance may decline [DWC05]. In order to solve this problem, it is necessary to consider the learner’s concrete situation and to compose LOs during run-time into adaptive WBTs. Therefore, a detailed and processable description of the situation must be available. Building on the theory of task-technology fit [GTI95], a better fit between the learner’s situation (task) and the proposed WBT (technology) should improve learner’s performance.

EL research and practice have successfully developed and adopted numerous meta-data specifications and some widely used standards for the description of LOs. However, due to their complex and technical nature, it is difficult for a user to understand them. Thus, they do not adequately support the search for useful LOs. Consequently, an automatic (push) delivery of composed LOs dependent on the current situation seems to be a suitable solution. This requires revisiting meta-data specifications for LOs which is described in the following.

2. Modelling Situation-Oriented Applications

In the last years, many organizations have applied concepts of business process reengineering. Numerous methods and techniques to support business process modeling have been proposed. Recently, a number of authors have suggested extensions to business process modeling techniques that model (some of the) specifics of KM. Examples are extensions to ARIS [Ali98], GPO-WM [Hei02], KMDL [Gro03] and PROMOTE [HKT02], [KWo03] as well as the design of tools for flexible workflow management [GHe01]. Main extensions are additional object types, e.g., knowledge object or skill, and additional model types, e.g., knowledge structure diagram or communication diagram (see [Mai05] for a detailed analysis).

Even though the added concepts describe a portion of the context of knowledge work, there remain challenges (1) to overcome the product- or push-oriented metaphor inherently part of many applications and embrace the user-centric metaphor typically part of newer learning approaches, (2) to move towards on-demand presentation of learning material according to the situation in which the user currently is in and (3) to link the resulting learning activities to business processes. However, none of the methods clearly focuses designing typical situations in which employees encounter an opportunity to learn which is at the center of just-in-time KM [DGl02],
workplace learning [Ell02], [Ill03] or on-demand KM [SK+02]. On-demand KM means here that knowledge services are triggered by a situation in which the user switches to a learning-oriented action, in this case LOs are selected, composed and delivered considering as much context as possible.

A knowledge stance is a recurring situation in knowledge work in which an employee can, should or must switch from a business function to a knowledge action [HMa04], [Mai04]. This concept connects the process-oriented perspective and its focus on implementation, exploitation, and accumulation of knowledge in the context of business processes [Dav93], [HCh93] with activity theory and its focus on unstructured problems, creative, dynamic, and communication-intensive tasks, membership in communities, self-organizing teams and demand for learning. [Eng87], [Bla95]. A knowledge stance is defined by (1) occasion, i.e. opportunity or need that occurs in a business function requiring knowledge actions, (2) context, i.e. all dimensions describing the employee’s actual work environment, (3) mode, described by the four informing practices monitoring, translating, expressing and networking [Sch00] and (4) actions offered depending on occasion, context and mode. Categories for actions are developed e.g., from information quality tasks [Epp03].

In order to support all types of knowledge stances, a comprehensive KM system ([ALe01], [Mai04], [MHP05]) seems the appropriate solution. In this paper, we concentrate on the informing practice of translating, i.e. adapting knowledge to the current situation and the actions that can be supported by a learning infrastructure. Table 1 presents the dimensions of context required for this type of applications.

<table>
<thead>
<tr>
<th>dimension</th>
<th>description</th>
<th>implication for LOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>process</td>
<td>sequence of tasks</td>
<td>determines learning intent and application of the acquired knowledge, i.e. the endpoint of the translation</td>
</tr>
<tr>
<td>person</td>
<td>individual that engages in the learning process</td>
<td>is identified with the help of the person’s roles as well as manually and automatically established profiles that include preferences on learning</td>
</tr>
<tr>
<td>group</td>
<td>teams, work groups, communities the learner is engaged in</td>
<td>represents the collective in which the individual learner performs learning tasks, provides the social context for understanding LOs and for collaborative learning</td>
</tr>
<tr>
<td>product</td>
<td>electronic resources which the learner use</td>
<td>is the content of electronic resources used in the process as well as whilst learning determining the knowledge domain(s)</td>
</tr>
<tr>
<td>location</td>
<td>geographic location</td>
<td>enables location-based contents and services as well as the adaptation of learning contents to cultural context</td>
</tr>
<tr>
<td>time</td>
<td>available time for learning, current time</td>
<td>determines number and currency of LOs, the appropriate level of detail and contemplation</td>
</tr>
<tr>
<td>technology</td>
<td>technical attributes of devices / applications</td>
<td>is used for adapting LO to applications and appliances and to get attention metadata from diverse applications</td>
</tr>
</tbody>
</table>
Table 1: Dimensions of context of a knowledge stance
Knowledge stances help to frame context dimensions needed to support selecting LOs, presenting and translating them for application in the business process that the learner is engaged in.

3. Standards for Describing Learning Objects

Resources, i.e. LOs and the context have to be matched in order to realise a system delivering LOs coordinated with the learner’s context. LO as the central concept to handle learning content in EL is defined as (non-) digital entity that may be used for learning, education or training [IEE02]. Thus, a LO can be a whole course, a graphic, a table, even in non-digital form. For EL applications, LOs are restricted to digital resources [Wil01] which can be (re-) used in defined contexts. Reusability demands a comprehensive description of LO characteristics, typically stored as meta-data to the LOs. Deciding the appropriate level of granularity of the meta-data descriptions involves a trade-off between costs for meta-data creation and benefits from reusing the LOs [Wil01].

Standards support defining what meta-data to create and exchanging meta-data between applications and organisations. Meta-data must be classified in a standardized way [PLR04] and several organizations, e.g., Dublin Core², Aviation Industry CBT Committee (AICC)³, Global Learning Consortium⁴ or IEEE Learning Technology Standards Committee⁵ have developed meta-data schemata with different focuses and priorities. Additionally, several organizations like CanCore⁶ or CELTS⁷ derive their own proposals from established meta-data schemata and in the end some companies like CISCO⁸ can also be added to the large and intransparent group of initiatives. However, IEEE Learning Object Metadata (LOM) [IEE02] seems to be the most prominent exponent in the bulk of standards and specifications for describing LOs [Duv04]. Therefore, LOM elements are considered in the following mapping to the context dimensions introduced in section 2.

As a framework for mapping context dimensions, the generic categorization developed by Gilliland-Swetland seems to be a good starting point with the five categories administration, description, preservation, technology and use

²http://www.dublincore.org
³http://www.e-teaching.org/glossar/aicc
⁴http://www.imsproject.org
⁵http://ltsc.ieee.org
⁶http://www.cancore.ca/
for classifying meta-data [Gil05]. From the perspective of this paper, the categories preservation and technology both describe technical details and thus are merged. The category education was added to this generic scheme in order to enable the description of didactic characteristics of LOs as are typically part of e-learning-oriented standards such as LOM.

4. Mapping of Standards to Context Dimensions

The meta-data standard LOM and several specifications representative for numerous approaches listed in section 3 have been mapped to the context dimensions presented in Table 1. The authors have studied the relationships between meta-data elements and appropriate context dimensions with the help of examples for purposeful selections of LOs on the basis of descriptions of situations and LOs (see Table 2). Categories, mappings and some examples of relationships will be discussed in the following.

<table>
<thead>
<tr>
<th>meta-data categories and elements</th>
<th>elements and cites</th>
<th>LOM</th>
<th>matched context dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>administration</td>
<td>primary for handling and organising LOs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>identification</td>
<td>• identifier</td>
<td>• identifier</td>
<td>-</td>
</tr>
<tr>
<td>storage</td>
<td>• location information</td>
<td>• location, catalogue &amp; entry</td>
<td>product</td>
</tr>
<tr>
<td>versioning</td>
<td>• version control</td>
<td>• version, status &amp; contribute</td>
<td>-</td>
</tr>
<tr>
<td>meta description</td>
<td>• meta-metadata</td>
<td></td>
<td>product</td>
</tr>
<tr>
<td>description</td>
<td>for describing and classifying the content of the LO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>key words</td>
<td>• finding aids</td>
<td>• keywords</td>
<td>process, product</td>
</tr>
<tr>
<td>summary</td>
<td>• exhibit records</td>
<td>• description</td>
<td>-</td>
</tr>
<tr>
<td>title</td>
<td>• title</td>
<td>• title</td>
<td>-</td>
</tr>
<tr>
<td>annotations</td>
<td>• annotations</td>
<td>• annotations</td>
<td>group, person</td>
</tr>
<tr>
<td>creation process</td>
<td>• cataloguing records</td>
<td>• contribute</td>
<td>-</td>
</tr>
<tr>
<td>relationships</td>
<td>• relationships</td>
<td>• taxon path &amp; relations</td>
<td>product</td>
</tr>
<tr>
<td></td>
<td>• has alternative</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• has component</td>
<td></td>
<td></td>
</tr>
<tr>
<td>language settings</td>
<td>• language</td>
<td>• language</td>
<td>person</td>
</tr>
<tr>
<td>duration</td>
<td>• duration</td>
<td>• duration</td>
<td>time</td>
</tr>
<tr>
<td>granularity</td>
<td>• aggregation level &amp; semantic density</td>
<td>• aggregation level &amp; semantic density</td>
<td>product</td>
</tr>
<tr>
<td>structure</td>
<td>• structure</td>
<td>• structure</td>
<td>-</td>
</tr>
<tr>
<td>sector classification</td>
<td>• coverage</td>
<td>• coverage</td>
<td>process,</td>
</tr>
<tr>
<td>technology</td>
<td>for describing the LO’s embedding in a technical infrastructure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| requirements | - hard & software documentation \(^A\)  
- control flexibility \(^C\)  
- requirements & platform requirements \(^D\)  
- technology |
| backup | - metadata for recordkeeping systems \(^A\)  
- -  
- control flexibility \(^C\)  
- technology |
| file information | - digitization information \(^A\)  
- hazard \(^C\)  
- format \(^A\)  
- size \(^A\)  
- technology |
| configuration | - display transformability \(^C\)  
- installation remarks \(^A\)  
- technology |
| education | for educational requirements and characteristics |
| instructional design | - instructional domain, context & strategy \(^B\)  
- learning outcome type \(^B\)  
- learning objective \(^B\)  
- learning objective \(^D\)  
- interactivity type & interactivity level \(^B\)  
- interactivity type & interactivity level \(^D\)  
- person, group, technology |
| outcome | - typical learning time \(^D\)  
- typical learning time \(^D\)  
- time |
| handling time | -  
- purpose \(^B\)  
- process |
| level of difficulty | - difficulty \(^B\)  
- difficulty \(^B\)  
- person, group |
| learning material | - environment \(^D\)  
- learning resource type \(^D\)  
- person, technology |
| target group | - role \(^D\)  
- end user role, typical age & context \(^B\)  
- group |
| adaptability | - educational adaptability \(^B\)  
- property object \(^B\)  
- person |
| requirements | - required training resources \(^B\)  
- person |
| evaluation | - assessment type \(^B\)  
- process |
| use | for describing terms and conditions of application |
| legal terms of use | - legal access requirements \(^A\)  
- copyright \(^B\)  
- process, person, group |
| costs | - cost \(^B\)  
- process |
| usage | - user tracking & audit trails \(^A\)  
- person |
| access requirements | - access mode \(^B\)  
- person, technology |
| re-use | - content re-use \(^A\)  
- - |
| security | - authentication and security data \(^A\)  
- person, technology |

A: [Gil05]  
B: [AIC06] with selective extensions to IEEE LOM  
C: [Can06] with selective extensions to IEEE LOM  
D: [Kop01] with selective extensions to IEEE LOM, part general meta-data

**Table 2: Mapping of learning objects to situations**
The meta-data elements of the category *administration* are primarily used to manage LOs and therefore the relevance for the mapping of context dimensions is marginal. Nevertheless, there are some mappings with context dimension *product* for corresponding meta-data entries.

In the category *descriptive*, elements can be assigned to nearly all context dimensions except *technology* and *location*. Matching meta-data entries from documents currently used in a situation in which LOs are required (product) to meta-data elements of LOs permits many opportunities, especially in matching the elements *keywords*, *relationships*, *sector classifications* or *granularities*. For example, keywords from documents in use can be applied to search for LOs with corresponding *keyword* entries.

Technical context parameters match exclusively to *technical* meta-data elements, because the requirements and descriptions of technical devices are reflecting those meta-data elements.

Meta-data elements from category *education* are typically associated with personal characteristics, so these elements predominantly match the dimensions *person* and *group*. For instance, information about completed LOs are stored in a learner profile and can be matched to the *requirements* when selecting LOs.

Elements from category *use* can not be exclusively assigned to a single context dimension. Terms of use and costs are directly influenced by process parameters like process priority. Other meta-data elements like *access requirements* or *security* are assigned to technical or personal context dimensions. For example, a cost limit specified in a process description can be matched with the *cost* information from the meta-data of LOs, especially when using a distributed repository or multiple content providers.

Except for context dimension *location*, all dimensions can be assigned to meta-data elements, because LO descriptions typically do not contain geographical information. However, location information can be derived from other meta-data, e.g., by relating *keywords* to geographical coordinates (points of interest).

Figure 1 shows the process of using context descriptions of a situation for the on-demand presentation of learning material that is described in the following.
Figure 1: Using context of a situation for composing courses

Starting point for on-demand learning systems is the business process. More specifically, the learning activities would be triggered by an opportunity in a business process in which an employee with a certain learning profile can, should or must de-routinise and learn in order to be able to complete the present task properly. A learning system realising the delivery of LOs according to the worker’s situation described by the context dimensions has to perform the following steps:

Firstly, context data needs to be collected which can be implemented by sensor services that provide context from basic systems such as repositories, ERP or HR systems. This raw data must be filtered, aggregated and related in a separate consolidation process. After preparing the input data, it is necessary to select LOs with the help of automatic query generation. LOs are selected from the return set and composed into courses. The size of courses can vary from atomic LOs over dyads to entire WBTs. The decision is placed by a personal software agent or by a rule-based approach based on a fitness function as benchmark for evaluation [GH95]. The last step in the process is to transfer the LO identifiers to the delivery component which retrieves LOs from the repository and presents them to the learner.

The endpoint of a so-defined learning activity would not be passing a test, but completing the original task in the business process and possibly a reflection step, i.e. documenting learning experiences and experiences gained from applying the knowledge to overcome this hurdle. This is a scenario that is not typical for EL which rather concentrates on contemplative, general, long-lasting courses that end with an exam and thus poses a number of changed requirements towards designing such solutions.

5. Conclusion

In order to support demand for learning triggered directly from business processes, this paper has presented one potential solution for on-demand KM combined with EL. Most modelling approaches do not explicitly consider the requirements from on-demand KM. Based on activity theory, the concept
of knowledge stance seems to be a sufficient solution. Corresponding context dimensions can be mapped to current meta-data standards and specifications for LOs. The approach handles LOs in a similar way as other knowledge elements, such as lessons learned, good or best practices as well as orientation services for locating experts or communities of practice. This provides the potential for bridging current gaps between EL and KM applications. As next step, the concept will be implemented as automatic on-demand course delivery system using descriptions of the situation in business processes based on the concept of knowledge stance.

Literature


