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EXTENDING THE SCOPE OF THE CURRENT DISCUSSION ON METADATA TOWARDS SITUATED MODELS

Abstract. The use of standardized metadata for describing educational resources is one of the ongoing issues in the field of computer-supported learning. While we face an extension from describing learning objects to the annotation of learning services current standards for educational metadata still focus on instructionalism at the cost of neglecting collaborative and cooperative aspects of learning. Therefore it becomes important to rethink the concepts underlying current standards of educational metadata. In this paper we propose a data model that allows to describe resources that might be used for learning purposes with respect to diverse learning theories including those which are relevant in the field of CSCL.

1. INTRODUCTION

Standards for metadata in the field of learning aim at being pedagogically neutral or unspecific in regard to pedagogical theories and models (LOM, 2002). They focus on search, exchange and re-use of learning material, often called content items, learning objects or training components. Accordingly, training concepts focus on "*just in time access to training and information*." (Cisco Systems Inc., 2000). Scenarios, which concentrate on how to structure and organize access to learning objects, are mirrored in concepts such as content packaging (SCORM, 2001). Therefore they risk to reduce instruction to the distribution of content, learning to the consumption of content, and learning arrangements to the sequencing of content. The vision is *to enable Computer agents to automatically and dynamically compose personalized lessons for an individual learner* (LOM, 2002). From this point of view there is demand for learning objects, which are decontextualized.

Now an important shift takes place: The shift from *learning objects* to *learning services*. The vision now is inspired by the evolution of the Semantic Web: Various scenarios illustrate new possibilities enabled by the evolution of the Semantic Web, which is based on the assumption that each object on the web can be described appropriately and in a machine readable form. *A new form of Web content that is meaningful to computers will unleash a revolution of new possibilities* (Berners-Lee, Hendler & Lassila, 2001). Now the vision may also comprise models, which do not only concentrate on learning content but also on learning communities e.g.. We proposed entities like tutors, peers, learning groups, experts, learning activities to form learning services (Allert, Richter & Nejdl, 2002b). But currently we realize that the notion of learning services do not reflect a wider range of learning models and theories but are driven by business models: courses are scheduled, produced and

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offered (Jung & Fischer, 2002; Simon et al., 2002). These courses again reflect models which concentrate on the sequencing of learning objects, content navigation and access. Furthermore learning services are inspired by Web Services such as 'to register', 'assign' and 'authorize'. We do not realize a change towards the recognition of valuable diversity in the field of learning: a diversity which does comprise instruction and distribution of content as well as the co-construction of knowledge within knowledge building communities. The discourse about learning objects often focusses on organizations, teachers and authors of learning material. In the context of learning services on the Semantic Web we also have to directly address the learner, who is a mature and selforganized life long learner.

In this paper we do not conentrate on technical nor on organizational but on educational aspects of metadata in the field of learning. Context specific metadata for learning focus on a context specific view on learning services. We will discuss how this view extends current efforts to model properties of learning resources suitable for different learning paradigms. The guiding principle is valuable diversity: Metadata needs to address situated, humanistic as well as instructionalistic models.

2. STRUCTURAL CHARACTERISTICS OF EDUCATIONAL METADATA

In the field of learning we face valuable diversity. The context of specifying metadata for learning services is well characterised by Lyotards comprehension of science which is explained by Beck as follows: There is need to emphasise in a postmodern manner the conflicting diversity of models, the competition of paradigms, and the impossibility of integrative and finally valid solutions. The failure of integrating theories is specified a characteristic of postmodernism (Beck, 1993). Valuable diversity is appointed an indicator of postmodernism by Welsch (1987). In the field of learning the coexistence of diverse paradigms, principles and pedagogical theories can be stated. They are based on different assumptions (implicit or explicit) on learning and views of cognition and require or create different learning and teaching cultures. Metadata specifications have to address different scenarios based on diverse requirements and assumptions on learning. It is important to note that diverse theories, paradigms and models coexist: When meaning is decoded within context, this means that learning per se cannot serve as an unequivocal context. The different requirements for metadata information based on different learning contexts accumulate in the following two notions on cognition and learning: (1) *Cognition is considered as a system of information structures and procedures, and learning as acquisition of cognitive structures and procedures* (Greeno & Goldman, 1998). (2) *Cognition is considered as activity that is fundamentally situated in social and physical contexts, and learning as strengthening of capabilities for situated activities* (Greeno & Goldman, 1998).

2.1. Diverse Epistemologies

An important aspect of any learning situation is its character of not being unspecific with regard to learning theories, cognitive theories (such as behaviourism, cognitivism, constructivism) and learning principles (such as situated, expository etc.). Standardization in the field of learning faces diversity. To deal with this different approaches have been proposed. Initiatives like LOM (2002) aim at forming standards which are instructionally unspecific while the Educational Modelling Language (Koper, 2001) forms a pedagogical meta-model. We think it is better to explicitely model different pedagogical theories and paradigms in order to form context-specific sets of metadata – for two reasons:

1. From different approaches within the philosophy of science and the logic of science (Luhmann, 2001; Lakoff, 1990; Popper, 1966) we conclude that being unspecific in specifying categories is impossible. Therefore sets of metadata always reflect specific learning paradigms, theories, and principles as well as assumptions on learning. We state that current approaches only address a narrowed perspective on learning and teaching.
2. A user within the (semantic) web will want to find learning services which actually face his needs. Not only with regard to learning content but also regarding different learning strategies, learning models, and organizational forms of learning and teaching.

Therefore we rate a surplus to model differences instead of similarities. The basic principle of the Semantic Web is to bring structure to meaningful content as well as the ability to process semantics by automated means (Berners-Lee et al., 2001). Meaning of information is decoded within context and communities (Wenger, McDermott & Snyder, 2002; Friesen, 2002). But the learning sciences per se cannot provide an unequivocal context, as we have argued previously. Only specific models / theories / paradigms can serve as centres of reference and as context for expressing and decoding meaning. Let us illustrate this on a few examples:

- In modelling educational settings, people usually model the role *learner* and *teacher* (LOM 5.5 - Intended End User Role, Value Space). But there are learning models which do not know these roles - but roles such as *community coordinator* and *core member* (Communities of Practice, (Wenger et al., 2002)). These roles have different characteristics, qualities, tasks to perform (different from *learner* and *teacher* – we can not simply map them). To set up roles like *learner* and *teacher* and to draw a difference between these roles reflects specific learning paradigms and (implicit or explicit) assumptions on learning. To map roles we must identify comparable similarities. In doing this we will come to a very general understanding and would reduce expressiveness, significance, and relevant educational characteristics. Friesen (2002) states that further formalization and abstraction is not the appropriate strategy in order to achieve increased interoperability.
- Effect Studies within the science of communication ask the question: *What do the media do to the individual?* LOM categories 5.3 *Interactivity Level* and 5.4 *Semantic Density* reflect this position: The level of interaction is determinable by the characteristics of the resource. We state that this position is associated with the transmission model. In contrast to this Audio Research within the science of communcation ask: *What does the individual do with the media?* As a result semantic density and the level of interactivity is constructed by the user according to former experience, interests, individual relevance, and the users

actual ‘handlungsleitende Themen’ (Charlton & Neumann-Braun, 1992) and can not be assigned to the resource. The Uses and Gratification Approach (Blumler & Katz, 1974; Swanson, 1987) for example reflects this view which is comparable to constructivist approaches within the learning sciences.

- Whereas some models focus on learning which takes place in interaction with learning content (a simulation within a CBT e.g.) other models focus on interaction within groups of learners (peer assessment, collaboration). To illustrate this: the conceptual idea of WASP (Fors, 2002) – ‘a generic web-based, interactive, student activating patient simulation system’ is that of collaborative learning and peer tutoring. Learning does not take place in interaction between the learner and the system (learning object), but within a group of peers which communicate, collaborate and interact while sitting in front of the computer. The system is just a vehicle to activate interaction among learners and does not determine the level of interaction [Fors, personal communication].
- The scope of the IEEE standard which specifies a high level architecture for information technology-supported learning, education and training systems explains that this standard is *pedagogically neutral, content-neutral, culturally neutral, and platform-neutral* (IEEE, 2001). But from an educational perspective systems have restrictive affects: there is no system, which supports models of CSCL as well as CBT to the same degree currently. Schulmeister (2001) states: the choice of a specific teaching model/learning method entails according forms of navigation and interaction. In most cases system designers have decided this already. Therefore users freedom to decide and design is restricted.

2.2. Explicitly Modelling Diverse Learning Theories, Paradigms and Principles

In the following we distiguish between class-type and role-type. For better readability we refer to role-type as *role* and to class-type as *natural type*.

2.2.1 Learning Roles and Role-Based Attributes

To model diversity we introduce the concept of Learning Roles. The concept of *Roles* we use is taken from the field of semantics and formal languages (Steimann, 2000). Steimann recommends to introduce the concept of roles into object-oriented modelling in order to make dynamic modelling approaches possible. He distinguishes natural types from roles: Natural Types are static, which means that an instance of a class once and forever belongs to that class; it cannot change it without loosing its identity. Roles are dynamic and allow dynamic classifying; according to Guarino (1992) roles are funded (they have context and relations) but not semantically rigid (an entity does not loose its identity when leaving a role).

We call roles in the context of learning Learning Roles. Learning Roles are meta-roles (meta-types in M2 in figure 1 and 2), which specify roles, interaction between roles, and qualities/proporties of roles. An entity must have certain qualities to be able to fill a specific role. A natural type can fill, adopt and leave a role without loosing its identity. Roles are defined by context and relation (interaction). Each Learning Role (meta-role) reflects a specific theory, paradigm, or learning principle.

Entities such as persons, knowledge assets, technologies can fill roles temporarily which are specified by Learning Roles and therefore dynamically adopt properties from diverse Learning Roles. Learning Roles can be used to specify educational attributes (Allert, Dhraief & Nejdl, 2000a): An entity may fill different roles in different instructional/learning contexts. To illustrate this in more detail:

- There is not a single concept of tutorial support, but diverse concepts, diverse roles and tasks of a tutor, depending on the design of the learning situation. The term “tutor” therefore does not yet imply a specific task or a specific mode of support.
- A videoconferencing session is not yet a learning activity. It does neither constitute, characterise nor induce a learning activity. The appropriate learning activity is a session of collaborative co-construction of knowledge in discourse using a videoconference, or a session of expository teaching transmitted by videoconference.

Similarily to how ontologies are often agreed on by a community of knowledge such as ACM or IEEE we suggest to decide on relevant roles within educational communities (such as learning scientists, practitioners, consultants on learning and knowledge management).

2.2.2 Procedure

Here we outline the procedure of how Learning Roles can be modelled. Comparable with ontologies, Learning Roles can be seen as shared conceptualization. A community which has expertise in a specific learning or teaching concept sets up an Learning Role. The members of the community have to agree on relevant characteristics and elements (such as actor-roles, interaction and activities) of the specific concept and specify appropiate metadata. Here we roughly sketch relevant characteristics and data-models of two potential Learning Roles.

Step 1: Identify relevant characteristics: e.g. actor-roles, intentions or activities.

Table 1: Relevant characteristics of concept ‘Communities of Practice, CoP’ (preliminary)

Characteristics for *LR* ‘Communities of Practice (CoP)’	
Person	Community Coordinator (Local)
	Community Coordinator (Global)
	Community Leader/Expert
	Core Member
	Active Member
	Peripheral Participant
Technology	Community Platform
	Knowledge Base
Learning Arrangement	Meetings (local, distributed, (a) synchronous)
Strategic Intent	Helping Community
	Best-practice Community
	Knowledge-stewarding Community
	Innovative Communities
Knowledge Asset	Best Practices
	Innovative Knowledge
	Lesson Learned

Table 2: Concept 'PBL, solving ill-structured problems' (preliminary)

Characteristics for *LR* 'PBL, ill-structured'	
Person	Problem Solver
	Project Coordinator
Components	Problem Situation
	Case
	Problem Domain
	Problem Constraint
Support	Support for Argument Construction
	Support for Generating Strategies
	Support for Reflection
	Knowledge Base Made Available to Learners
	Construction Kit

Step 2: Identifying relevant natural types and roles: From this characteristic elements one can identify relevant types and roles.

- *Natural Types*: Person, Technology, Knowledge Assets, etc.
- *Roles*: Community Coordinator, Community Platform, Best Practices etc.

In the following the community can identify relevant learning services: What is useful to be provided and offered on the web (semantic web). What do users search for in the context of learning? They could search for: Persons who offer services: an experienced Community Coordinator. A community within a specific domain. Technology that is useful to realize a specific scenario etc.

Step 3: Constructing models in UML. Here we draft two exemplary models (fig. 1,2). Within the diagram a rectangle indicates a natural type, a cycle indicates a role.

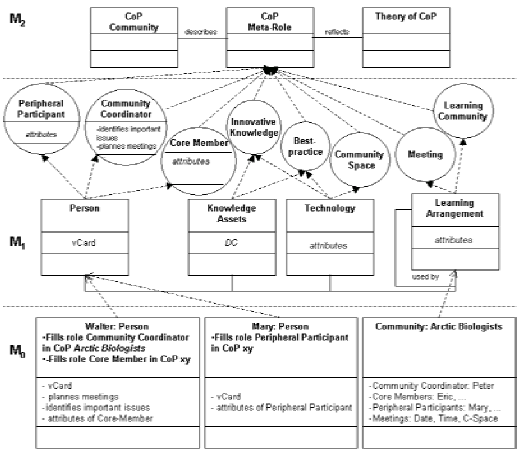

Figure 1: Model 'CoP' (preliminary)

The dominance of roles which can be filled by persons in the CoP-model reflects the characteristics of this learning concept: Communication among participants.

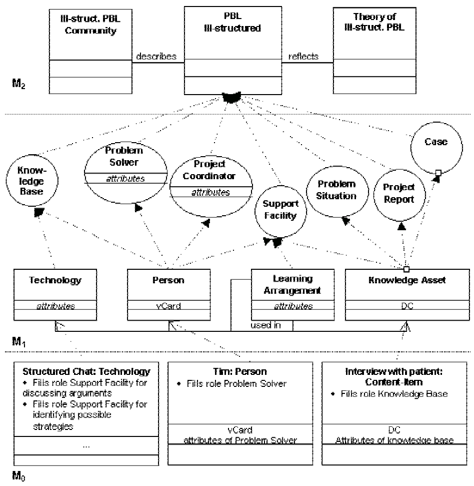

Figure 2: Model 'PBL-ill-structured' (preliminary)

Whatever entity is to be annotated one can ask, which type it is (person, knowledge-asset or technology) and can annotate this type with suitable metadata (vCard for persons, DublinCore or reduced LOM for knowledge assets e.g.). To annotate educational metadata, the Learning Role has to be referenced and the particular role within this Learning Role has to be named.

3. METADATA FOR LEARNING SERVICES

As stated, many aspects which are relevant in learning arrangements can not be assigned to learning objects, but to learning services. The vision of the semantic web requires metadata as meaning (cp. Friesen, 2002). Metadata which allows to annotate learning services significantly, specifically, and expressively. Berners-Lee et al. (2001) proposed visions of the semantic web in a scenario. Allert et al. (2002b) presented a scenario which applies the proposed ideas to the field of learning: Users such as learners and human resource managers set up their semantic web agents in order to find various learning services on the web, e.g.: Best practices in the field of learning; learning concepts; learning management systems; collaborative technology; community oriented platforms which support the concept of Communities of Practice (CoP); an experienced Community Coordinator; a consultant who is familiar with the idea of CoP; a course which does not only deliver learning content but enables cooperative learning.

3.2 Learning Objects

The Draft Standard for Learning Object Metadata (LOM, 2002), one of the most important initiatives to provide metadata schemas for annotating educational resources, defines learning objects as *any entity – digital or non-digital - that may be* *used for learning, education or training*. This very broad definition and scope of learning objects is narrowed down by the proposed attribute *Learning Resource Type* (5.2) and its Value Space: *Exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative text, exam, experiment, problem statement, self assessment, lecture*. Even though LOM includes the possibility to extent this list of learning resource types it clearly states that LOM mainly focuses on these content objects.

The broad definition of learning objects as suggested by LOM has been criticized as overarching and impractical (e.g. Polsani, 2002). Now there are two trends that try to solve the problem of describing educational resources. On the one hand there is a tendency to restrict and specify the concept of learning objects. Cisco Systems (2001) defines content item as: *A small piece of information that is stored in a database and is used to communicate skills or knowledge in support of a RIO. It can be in any media format including text, graphics, animation, video, audio, and HTML plugin. It is combined with practice items and assessment items to create a RIO*. Polsani (2002) defines learning object as *an independent and self-standing unit of learning content that is predisposed to reuse in multiple instructional contexts*. As we have already discussed in Allert et al. (2002b) and in the context of e.g. the ELENA project (ELENA, 2002) we think the better way is to broaden the scope and focus of learning resources instead, to learning services.

3.3 Learning Services

A learning service is constituted and characteriсed by the learning context in which it is or can be used. Learning services can be provided and offered on the web. Users such as learners, teachers, organisations may search and find learning services.

Definition of Learning: For our purposes we adopt the definition of learning proposed by Wittrock (1977, acc. to Gruber, Prenzel & Schiefele, 2001): Learning is the term we use to describe the processes involved in changing through experience. It is the process of acquiring relatively permanent change in understanding, attitude, knowledge, information, ability, and skill through experience. This definition covers incidential as well as intentional learning processes. Bereiter & Scardamalia (1989) use the term intentional learning to refer to cognitive processes that have learning as a goal rather an incidential outcome. We agree on these definitions on learning.

Definition of Learning Services: A learning service is any entity which is able to fill a role within a learning context. Here are some examples for learning services:

- An activity within a learning context.
- Persons filling a supportive role in a learning context (e.g. an expert with a specific area of expertise; peers to perform peer-tutoring; a coordinator; learning communities to carry out collaborative knowledge construction).
- Learning material.
- Instructional ideas (the community of teachers of primary education do not only effectually exchange learning and teaching material but also ideas of how to use them – how to teach and support learning).

- Learning arrangements: e.g. as soon as arrangements such as MUDs and MOOs (cp. Remmele et al., 2002) are transported into the context of learning, they constitute learning arrangements.
- In the concept of *context-specific metadata for learning services* context and relation are key concepts: learning services are characterized and constituted by their context and relations (interactions with other learning services). Characteristics of a learning context are defined by existing and potential Learning Roles. Each Learning Role reflects a specific learning concept.

4. PRACTICAL IMPLICATIONS AND FURTHER WORK

Learning Roles implicate that each learning object or learning service can fill different Learning Roles. Peter is a person. Therefore his type is ‘person’ and the static attributes conform to the vCard standard. Peter is member of a problem solving team. Here he fills the role *Problem Solver*. Peter also is member of a domain specific Community of Practice. Here his role is *Community Coordinator*. Therefore the role-based dynamic attributes are derived from *Problem Solver* in the context of solving an ill-structured problem and *Community Coordinator* in the context CoP. A knowledge asset may fill the role *Best Practice* in a CoP context and the role *Example – Integrating Knowledge* at the end of a textbook chapter in an instructional learning arrangement. Prof. Pretorius may fill the role *teacher* in an instructional scenario and the role *Expert* in a CoP.

Learning in practice often combines instructional and situated learning. For example: Within a process of ill-structured problem solving often units of instruction are necessary and reasonable. Therefore learning arrangements can be annotated from the perspective of different Learning Roles.

A role-based approach is as modular as the field of learning theories and enables us to easily model different kinds of educational settings using appropriate vocabularies. In our further work we will draw into account existing ontologies on collaborative learning.

5. AFFILIATIONS

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