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Situated Models and Metadata for Learning Management[1]

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Abstract: This paper depicts the interrelation between situated learning and learning management from an organizational and personal perspective. Based on this introduction we show how educational metadata can be used for approaches of situated learning and how we can take care of contexts using context specific role-based metadata.

Keywords: eLearning, Metadata, Situated Learning
Category: K.3.0

1 Situated Approaches in Educational Management

In an environment that is flexible and changes rapidly, knowledge management and educational management, form an integral part of strategic planning. This holds for the educational manager within an organization as well as for a self-organized life long learner. Educational management not only has to deliver knowledge-assets, but also to enable learners to create, communicate, and share knowledge, to develop competences, meta-cognitive skills, and capabilities to support the co-construction of shared innovative knowledge. Furthermore, educational management can be based on a large repertoire of pedagogical concepts ranging from models of instructional design to situated and humanistic approaches. In the following we will refer to pedagogical approaches which are based on information processing theory as *instructional design (ID)* (e.g. instruction, well-structured problem solving), and to pedagogical approaches which are based on theories of situated cognition as *situated approaches* (e.g. ill-structured problem solving, Communities of Practice). Educational management faces diverse goals and needs. Learning on demand which concentrates on *just in time access to information* is only one aspect within a more comprehensive vision. Education within an organizational context has to facilitate procedural and

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pragmatic knowledge in addition to domain specific and predominantly declarative knowledge. Members of an organization are engaged in transformation processes and complex processes of change by creating innovative and strategic knowledge.

Current standards and concepts for educational metadata focus on content-centered approaches and models of instructional design rather than situated approaches. Situated approaches engage learners in processes of creating and (co-) constructing knowledge. These processes are dynamic and ill-structured. Metadata for situated approaches could broaden the view and add visions which are closer to the ideas of the semantic web outlined in a scenario by Tim Berners-Lee et al. [Berners-Lee et al. 2001]. Actors in a scenario about learning services on the semantic web will be self-organized learners and educational managers [Allert et al. 2002].

We draft a metadata-concept which is relevant for situated approaches as well as instructional design and which will facilitate learners and teachers to organize learning processes. It is also relevant for exchanging and comparing units-of-studies.

2 Valuable Diversity

There are diverse models, theories, principles and paradigms of learning and teaching. There is common agreement that this diversity is of great value and that standardization in the field of learning has to address all of these models. IMS Learning Design is based on EML, which forms a pedagogical meta-model. LOM aims at being neutral with regard to learning theories and models. Often different models and theories of learning are referred to as cognitivist, constructivist or behaviorist view of learning.

Here we distinguish different metaphors of learning and knowledge as this gives a more vivid view on different epistemological foundations of learning. [Sfard 1998] distinguishes the *acquisition metaphor* from the *participation metaphor* of learning. The acquisition metaphor refers to learning which is "a matter of individual construction, acquisition, and such outcomes, which are realized in the process of transfer; it consists in a person's capability to use and apply knowledge in new situations. Knowledge is a property and possession of an individual mind" [Paavola 2002]. The participation metaphor of learning refers to learning as a process of participation in shared learning activities and social processes of knowledge construction. "Cognition and knowing are distributed over both individuals and their environments, and learning is 'located' in these relations ad networks of distributed activities of participation." [Paavola 2002]. This view is based on the concept of situated learning [Lave and Wenger 1991] and on [Vygotsky 1978]. Paavola extends the participation metaphor of learning and refers to it as *knowledge-creation metaphor* of learning, which means that "learning is seen as analogous to processes of inquiry, especially to innovative processes of inquiry where something new is created and the initial knowledge is either substantially enriched or significantly transformed during the process" [Paavola 2003]. The knowledge-creation metaphor of learning is seen as epistemological foundation of CSCL and knowledge communities. Stahl refers to learning as *meaning making* and grounds its collaborative character in the philosophical tradition of Heidegger and in Vygotsky's concept of mediated cognition which show how meaning is socially produced and situationally interpreted [Stahl 2003].

Figure 1 arranges approaches of instruction and learning on a continuum of contextualization.

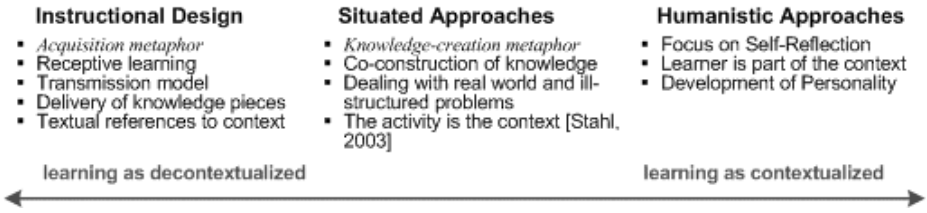

Figure 1: Views of learning on the continuum of contextualization

3 Metadata for Instructional Design and Situated Approaches

The vision underlying existing metadata approaches is well expressed by [LOM 2002]: *to enable Computer agents to automatically and dynamically compose personalized lessons for an individual learner.* Therefore a main goal is to compose consistency within a course or instructional unit. This is consistent with the guiding principle of instructional design. According to Reimann-Rothmann and Mandl [Reimann-Rothmeier and Mandl 2001], *goal and result of ID models are plans of instruction which tell instructors which strategy of instruction and method of teaching to choose according to given preconditions and prerequisites.* Therefore instruction can be formalized and automated. Learning objects are decontextualized.

Guiding principles and intended use of metadata for situated approaches are different: Learning processes of situated learning are ill-structured. Context plays a crucial role in situated learning. Metadata for situated approaches have to refer to the specific learning context and go beyond the mere creation of courses by authors etc. Metadata of situated approaches stress the aspect of interaction, communication and cooperation and have to support tasks like the following:

- A learner search for a Community of Practice with a specific strategic intent within the Educational Semantic Web.
- A Community of Practice creates a shared understanding by annotating knowledge-assets with “lessons learned” or “best practice”.
- Learners search for project presentations of peers.
- A learner searches for a peer to perform peer-tutoring with, a coach, etc.
- A mediating agent matches user profiles to support group formation.

The guiding principle is to enable interactive and cooperative processes. We assume that scenarios like these have not been intended by LOM, SCORM and other existing metadata approaches; but they are in the scope of many learning theories. We state that metadata should meet both visions, and thus situated approaches as well as models of instructional design should be addressed.

The context-specific use of learning resources requires context-specific metadata. General and objective annotation is obsolete in this concept. Two consequences become relevant: The types relevant in educational settings are not restricted to

knowledge-assets but also comprise persons, technology, activities, arrangements (figure 2).

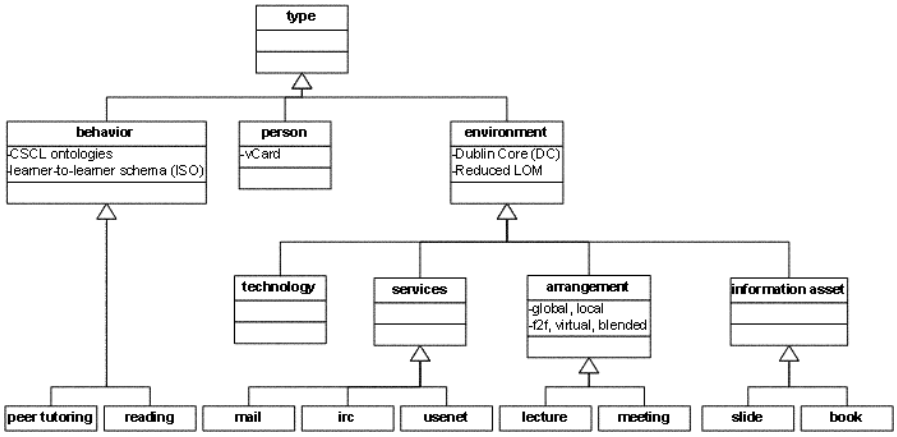

Figure 2: Types and subtypes relevant in learning (examples)

Within existing metadata approaches, learning objects are equal with the information object (e.g. a knowledge asset) itself. One of the major problems with this equation is that there is no significant and explicit distinction between an educational resource and a resource as any resource can be used in education (e.g. the poem "The Road Not Taken" by Robert Frost was not mainly intended to be an educational resource but can be used in educational settings). The concept of context specific metadata explicitly makes this distinction. A knowledge asset (e.g. person, technology, activity, arrangement) which can fill a role within a certain learning context is a learning resource. This notion is based on the concept of autopoietic social systems [Luhmann 2001]. Learning resources are characterized and constituted by context and relations.

4 Modeling Consistent Social Systems

The concept of Learning Roles explicitly models different views of learning. The underlying assumption is that mature life long learners not only know *what* they want to learn but also *how*. Therefore we do not model an integrative theory but focus on expressiveness and significance within the Educational Semantic web.

As LOM aims at consistent sequences, Learning Roles aim at coherent social systems. The concept refers to the theory of *Social Systems* (the functional-structural system theory) by [Luhmann 1995]. Systems reduce complexity - activities of persons are significantly related within a system. E.g. when a speaker speaks, the audience listens. According to Luhmann, persons do not belong to a *system* but to its *environment*. This means persons do only belong to a system filling a specific role. Within different systems they fill different roles.

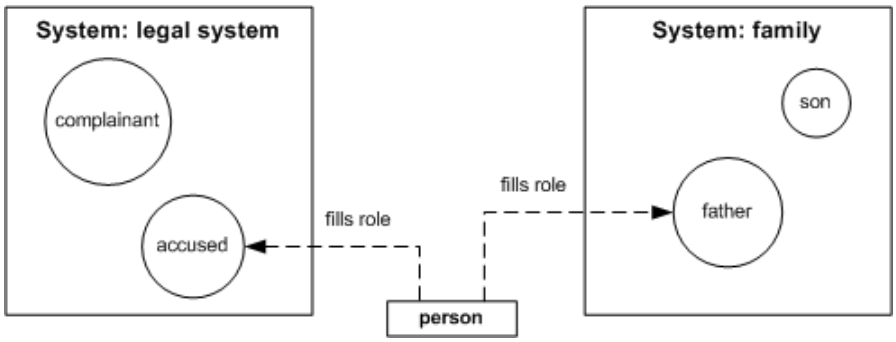

Figure 3: A person (type) filling roles within different systems

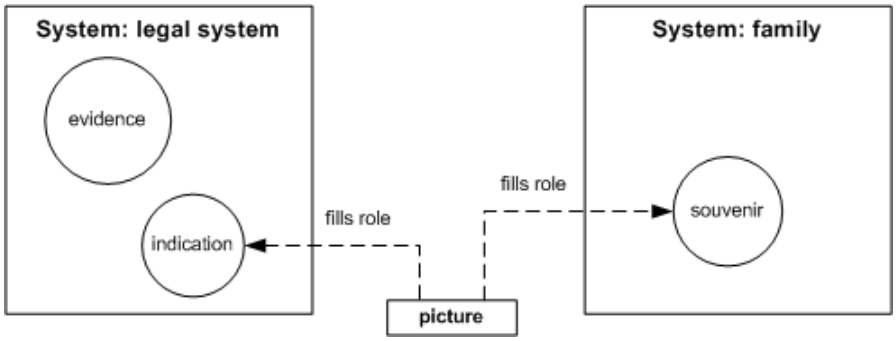

Figure 4: A picture (type) filling roles within different systems

The legal system serves as an example here. There is no legal system without a fundament. Legal systems are either based on *codified law* (e.g. the German legal system) or on *case law* (as in Anglo-Saxon countries). Here only the codified law is modeled. Roles within the system are related. E.g. person-roles: there is no accused without a complainant, no father without son (or daughter). Also the activities of the accused, complainant, attestor, and the judge are related. Within systems expectations are tied to roles.

Within this legal system a picture does not exist but only a picture which fills the role *indication*. This means: as soon as someone hands in a picture the judge will bring it into the system as indication – or eventually refuses to do so. Only filling the role indication the picture is part of the system.

What does system-oriented modeling mean for metadata in the field of learning? Two examples will demonstrate this view:

- A Community of Practice (CoP) or a knowledge building community comprises the roles *core member*, *active member*, *peripheral member*, *coordinator*, *expert* [Wenger 2002], but not the roles learner and teacher. Information assets fill roles such as *innovative knowledge*, *best practice*, *lessons learned*. Persons filling roles within a CoP-meeting have specific expectations concerning learning process, learning culture etc.

- A session of instruction (expository learning and teaching, receptive learning) comprises the roles learner and teacher. Information assets have a function within the learning process and can fill the role *orientation*, *progressive differentiation*, *practice*, or *integration* [cp. Ausubel 1968]. A person filling the role learner within this session will have specific expectations.

Peter is a person and might fill the role coordinator in the CoP arctic biologists and at the same time he fills the role learner in an instructional (expository) scenario. An information asset also may fill different roles within different concepts of learning.

4.1 The Concept Role

To model social systems a corresponding concept taken from formal languages is needed. The concept of *Roles* we use is taken from the field of semantics and formal languages, see [Steimann 2000a, b]. Steimann recommends introducing the concept of Roles into object-oriented modeling in order to make possible dynamic modeling approaches. He distinguishes natural types and class-types from roles-types (table 1). Roles are not semantically rigid but founded [Guarino 1992]. Instances of natural types can fill, adopt and leave a role without loosing their identity. Roles are defined by context and relation (interaction).

Natural-Type/Class-Type	Role-Type
•Static	•Dynamic (Dynamic classifying)
•An instance of a class once and forever belongs to that class. It cannot change it without loosing its identity	•Founded (has context and relations) •Not semantically rigid – does not lose its identity when leaving the role [Guarino 1992]

Table 1: Distinguishing natural-types and class-types from role-types.

5 Role-based Metadata

It is necessary to distinguish between static attributes (such as DC and vCard attributes) which are based on the type of a learning object or learning resource, and context- or role-dependent attributes which are based on the roles a learning resource can fill. Every educational resource can have one or more associated roles. Learning objects, persons, and other educational resources have some context-independent attributes; in the case of information-assets, these are mainly the attributes from Dublin Core and some further LOM attributes, like dc:title, dc:creator, etc.. Persons are annotated with vCard attributes like vcard:FN (full name) and vcard:EMAIL. Furthermore, context-specific, role-based attributes are attached to educational resources.

5.1 Learning Roles

To model diversity we introduce the concept of *Learning Roles.* We call roles in the context of learning *Learning Roles*. Learning Roles are meta-roles (meta-types in M2 in figure 5) which specify roles, interaction between roles, and qualities/properties of roles.

Each Learning Role reflects a specific concept of learning, learning theory or pedagogical approach (both instructional design and situated approaches). Learning resources can fill roles temporarily which are specified by Learning Roles and therefore dynamically adopt properties from diverse Learning Roles. In a previous paper we proposed the concept of Learning Roles to specify educational attributes [Allert et al. 2003]: a learning service may fill different roles in different instructional/learning contexts. Similarly to how ontologies are often agreed on by a community of knowledge such as ACM or IEEE we suggest deciding on relevant roles within communities (such as scientists, practitioners, consultants on educational management). Comparable with ontologies Learning Roles can be seen as shared conceptualization: Communities (e.g. the community of *CoP*) have to agree on a shared understanding of learning (concept of learning) and on relevant characteristics of specific models and specify appropriate metadata.

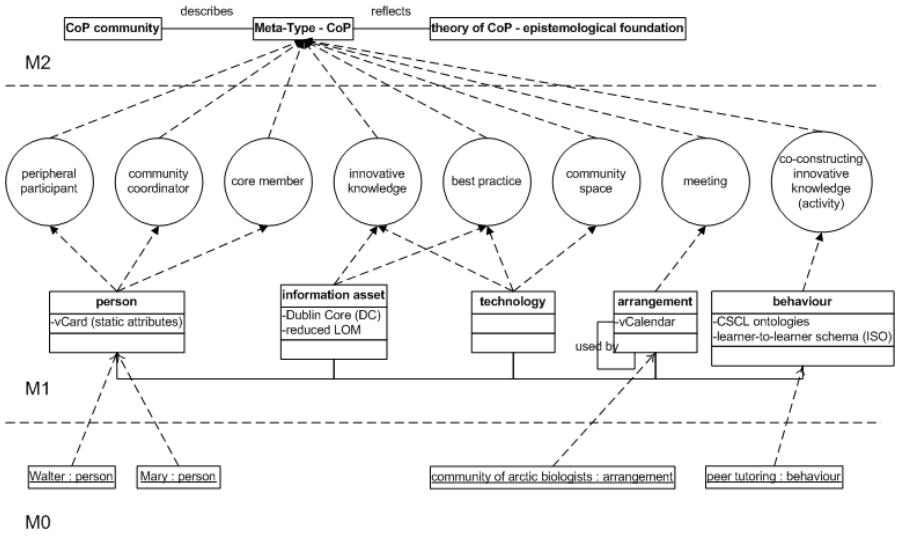

Figure 5: Model Community of Practice (CoP) – examples of types and roles

5.2 Identifying Relevant Types and Roles

Each learning theory is constituted by characteristic elements and is based on an epistemological foundation. From these characteristic elements one can identify relevant types and roles. Relevant learning services can be identified by asking: What is useful to be provided and offered on the (semantic) web. What do users search for in the context of learning? Then we infer conceptual models. Here we outline two models. The model *Communities of Practice* and the model *Problem-Based Learning (solving ill-structured problems*). Within the diagram a rectangle indicates a *natural-type* and a cycle indicates a *role-type*. (Fig. 5, 6)

Whatever entity is to be annotated one can ask which type it is (person, knowledge-asset, technology, activity, and arrangement) and can annotate this type with suitable metadata (vCard for persons, Dublin Core or reduced LOM for knowledge assets e.g.). Then we can ask what role it fills or can fill. Additional

educational metadata is then derived from different Learning Roles. Any entity will be annotated with static attributes and context-specific role-based (dynamic) attributes.

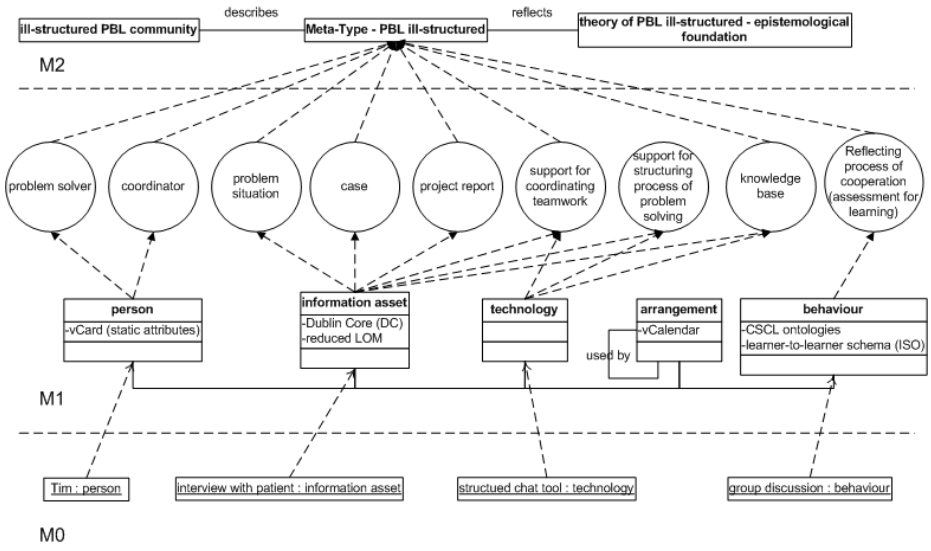

Figure 6: *Model PBL ill-structured – examples of types and roles*

A system is referred to as a type. This means: if an instructional-unit is integrated in a session of Problem-Based Learning, the instructional unit is a type, filling a role within the learning process of PBL (integrating a unit-of-study in unit-of-study).

Another example: there might be the Meta-Type "*Brainstorming*", comprising specific roles. In a CSCL session Brainstorming is a type (behaviour), which fills the role "knowledge externalization" (activity).

Activity roles represent the function behaviour (type) has within a learning process. An activity is defined as "goal-directed". Behaviour (such as "group discussion", "brainstorming" etc.) has a goal within a learning process. Therefore behaviour represents an activity in a learning process. Someone who plans a learning process asks: what function does the "group discussion" have within the learning process. Or vice versa: how can we induce "knowledge externalization"? Then the type "group discussion" fills the role "knowledge externalization" within the CSCL session.

6 Practical Implications

Human activity is predominantly shaped by schemata and scripts. These schemata and scripts are relevant only within specific contexts. The script about behaving in a first class restaurant is quite different from a fast-food restaurant script. The script comprises expectations about activity sequences, the behaviour within the assigned roles, etc. Similarly different learning theories demand for activating different scripts and schemata. Activating inappropriate schemata or scripts causes problems within educational settings. The following scenario illustrates this:

Dr. Holm is a well known expert and consultant in the field of strategic management. This morning she starts a new course within an Executive MBA program. She is quite motivated as she prepared something special: She plans to present problem situations. Students are supposed to solve these problems cooperatively. All problems she selected are ill-structured: There is no one-best solution but any solution will have pros and cons: 'Like in real businesses. Learning does take place in cooperative construction of arguments, in correcting wrong conclusions, as well as in reflecting the learning processes in the end. She never prepared something like this before – it was hard work and took much more time than she expected. Normally she is giving a lecture telling about her experiences. But as she herself is motivated she expects her students to be motivated as well.
But when she finished presenting the problem situations students only expressed their dissatisfaction. They expected her to present her knowledge in which they are so interested in. Why should novices solve problems when all the knowledge they need is missing and when experts already have well-prepared solutions? This situation rather quickly was somehow deadlocked and Dr. Holm was only able to cope with this unexpected situation in giving a fairly unprepared lecture.

Role-based modeling facilitates the orientation within a given context and allows comparing contexts instead of generalizing and homogenizing across divers contexts [Allert et al. 2003]. Additionally a common activity model can describe interactivity within an educational setting. The concept of context-specific metadata shares a system-centered view to describe complex interaction processes [cp. System Theory Luhmann 2001]. To reduce complexity in modeling the context, we model specific learning theories. Each learning theory is based on an epistemologically founded term of learning, specific actor roles, perspectives and so on.

An object potentially fills different Learning Roles. For example a person can hold the role *Community Coordinator* within a specific Community of Practice while he fills the role *Problem Solver* in a problem solving team. The attributes and tasks assigned to this person vary with respect to the role. In the same way a knowledge asset might fill the role *Best Practice* in a CoP while it is used as an *Example-Integrating Knowledge* in an instructional learning arrangement.

7 Further Work

In a first step we will propose a complete set of metadata (including types and roles) for a specific Learning Role. We then test the implications towards *CSCL user and group profiles* to facilitate cooperative learning. Based on this we will elaborate the requirements for the design of mediating agents which support group formation e.g.

Metadata in the field of learning often address technical and organizational requirements. In this work we focus on the educational aspects and on the learner.

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