

Coherent Social Systems for Learning: An Approach for Contextualized and Community Centred Metadata

Heidrun Allert

Abstract:

The aim of this work is to outline a modelling approach for context specific educational metadata, which addresses the valuable diversity in the field of learning. It presents some foundational issues in the field of learning and states that contextualization is crucial in many concepts of learning.

Keywords:

Metadata, modelling, concepts of learning, semantics.

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1. Educational Semantic Web

The idea of an *Educational Semantic Web* is a new approach, open to be filled with meaning. Besides a conceptual definition there is need for scenarios which form the concept. The notion of an Educational Semantic Web evokes a wide range of associations and visions. Some of them go far beyond the idea of search, exchange, and re use of learning material.

Scenarios which reflect the concept of receptive learning and the acquisition metaphor of learning (Sfard 1998) are well addressed in the current discussion on educational metadata and standards. A typical scenario looks as follows: *Learning material is produced by an author, sampled to courses by a course designer, classified according to skill taxonomies, and finally distributed to a learner. A learner, who owns a learning passport which lists skills and prior knowledge, is offered specific courses based on his learning portfolio and preferred learning style. A learning flow management guides the learning process, samples personalized sequences based on learners action, coordinates tracking functionalities and presents the learning material.* Scenarios which are intended currently are mainly those of instruction, distinguishing a provider side (author and course designer) from a consumer side (learner). The IEEE Standard for Learning Metadata proposes a corresponding vision: *"To enable computer agents to automatically and dynamically compose personalized lessons for an individual learner"* (LTSC-LOM 2003).

But in modern knowledge societies, which are characterized by fundamental changes and continuous transformation, there is also need for scenarios which focus on collaborative processes of creating innovative knowledge. This concept of learning is referred to as innovative and knowledge-creation learning (Bereiter 1985; Engeström 1997; Paavola, Lipponen and Hakkarainen 2002). It comprises open, ill-structured, and long lasting processes of problem solving and organizational learning, focuses on communication and cooperation, and engages different forms of knowledge: tacit, procedural and declarative knowledge alike. *Metadata may support learners to find a relevant Community of Practice or a tandem partner to communicate with towards a shared goal, a group of learners might look for a coach who is experienced in coordinating processes of ill-structured problem solving, semantic web agents might support mature self-organized learners in life-long learning.*

The term Educational Semantic Web marks a junction of endeavours in the fields of education and the Semantic Web. The Semantic Web – in short – aims to bring structure to the web as the complexity and heterogeneity of information represen-

tation is increasingly problematic. Education is – among other issues - concerned with learning. It is crucial to answer the question as to what we talk about when we talk about learning. This becomes even more important when we bring to mind that learning is referred to as meaning making – and meaning again is the core subject of semantics. In section 2 we present different concepts of learning in order to start a discussion on the envisioned diversity addressed by the Educational Semantic Web. This may help to diversify rather than confine the ideas and visions.

Accordingly requirements arise from both fields: the Semantic Web, which probably is more likely concerned with organisational and technical issues, and education, which focuses on socio-cultural and contextual issues.

The aim of this work is to outline a modelling approach for context specific educational metadata which addresses the valuable diversity in the field of learning. This work mainly focuses on pedagogical attributes.

After contrasting divers concepts of learning (section 2) we discuss the relevance of valuable diversity for educational metadata (section 3) and current modelling approaches (section 4). These chapters work as fundament to the approach of Learning Roles (section 5). Finally some practical implications are discussed (section 6).

2. Concepts of Learning

Rob Koper (2001) illustrates the diversity of concepts of learning in his outline on the Educational Modelling Language (EML) pedagogical meta-model by a citation from Duffy and Cunningham (1996, p.171): „As the quote from Skinner suggests, everyone agrees that learning involves activity and a context, including the availability of information in some content domain. Traditionally, in instruction, we have focused on the information presented or available for learning and have seen the activity of the learner as a vehicle for moving that information into the head. Hence, the activity is a matter of processing the information. The constructivist, however, view the learning as the activity in context. The situation as a whole must be examined and understood in order to understand the learning. Rather than the content domain sitting as central, with activity and the ‘rest’ of the context serving a supporting role, the entire gestalt is integral to what is learned.”

Within the relevant standardization initiatives there is common agreement that the

diversity of theories, principles and paradigms of learning and instruction is of great value and that standardization in the field of learning has to address any concept of learning. This means that a specific learning theory does not become a standard but that reference models and metadata schemas must allow the description of any learning theory and instructional model.

Often different learning theories are referred to as cognitivistic, constructivistic or behaviouristic. While this typology reflects some of the most prominent research paradigms in psychology, which deal with investigation and explanation of human learning, this taxonomy is problematic when used to classify concrete learning designs. While behaviouristic, cognitivistic and constructivistic learning theories provide a framework for the investigation of human learning they don't lend themselves directly to a concrete pedagogy. Even so a range of theories and principles of learning and instruction have been derived from psychological learning theories, each learning scenario can be viewed and analysed from any of these positions.

In contrast to the afore mentioned classification according to psychological theories of learning this work draws on concepts of learning and knowledge which are rooted in different philosophical positions of epistemology and ontology. Each concept of learning incorporates a specific conceptualisation of learning and knowledge. The philosophic relationships among philosophers and learning theories have been discussed e.g. by Packer and Goicoechea (2000). Stahl (2003) visualizes the relationship in a diagram (figure 1). A history of philosophy which is relevant for the learning sciences can be viewed from different perspectives. Figure 1 focuses on the aspect of individualistic and social theories.

The different concepts of learning as well as the assumptions they are based on play a prominent role in the design of learning scenarios. Every concrete learning design, educational technology and research methodology explicitly or implicitly refers to a concept of learning and an epistemological foundation. *"Contemporary learning theories reflect implicit (often unacknowledged) philosophic commitments defined at different stages in the history of philosophy, representing different responses to this dualism."* (The mind-body dualism introduced by Descartes, Stahl 2003).

The next paragraphs will outline some prototypical concepts of learning and knowledge which constitute the epistemological and theoretical foundations of learning models and pedagogical approaches. The outline of different concepts of learning (which is far from exhaustive) illustrates the valuable diversity in the field of learning and is meant to envision the far-reaching impact of the underlying

conceptualisation. This seems important as learning often is understood as acquisition rather than knowledge-creation. This work states that the acquisition metaphor of learning is well addressed by current metadata approaches and visions for the Educational Semantic Web – therefore the outline mainly focuses on concepts which go beyond this metaphor.

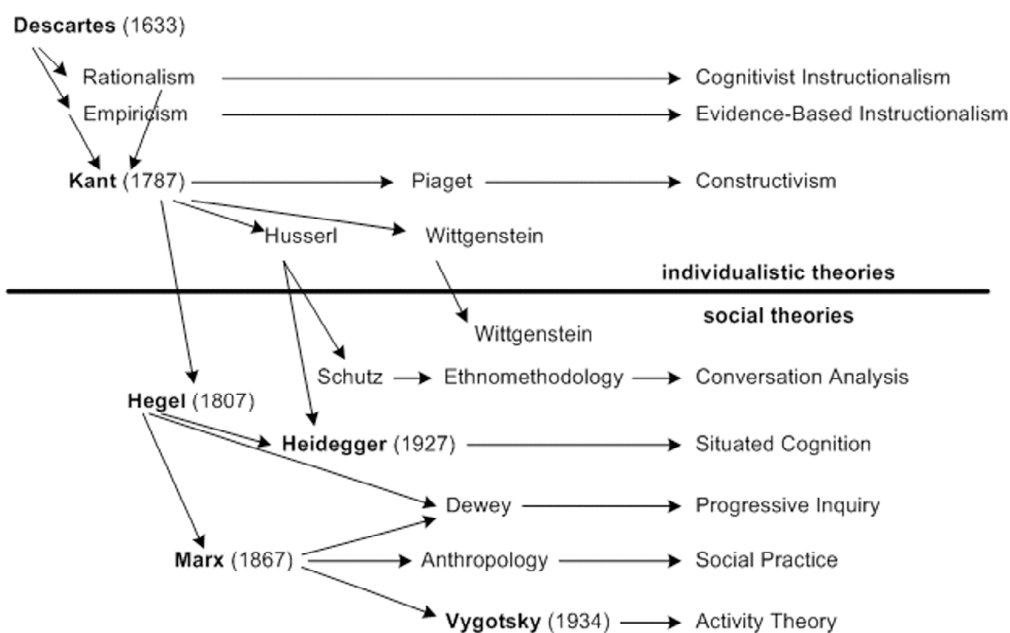


Figure 1: Philosophic influences on individual and social theories of learning (Stahl 2003)

2.1 Acquisition and participation metaphor of learning

Anna Sfard (1998) distinguishes the acquisition metaphor from the participation metaphor for learning.

The acquisition metaphor refers to learning which is a matter of individual construction and acquisition. The goal of learning is individual enrichment. Learners are consuming recipients and (re-)constructors. Teachers are providers, facilitators and mediators. Outcomes are realized in the process of transfer and means a person's capability to use and apply knowledge in new situations. Knowledge is seen as

property and possession of an individual mind and as public commodity. A typical acquisition scenario delivers information the learners are supposed to acquire or reconstruct. Exercises often include problem solving: solving well-structured problems which provide a clear problem statement and aim at a solution which can be assessed as right or wrong.

The participation metaphor of learning refers to learning as a process of participation in shared learning activities and social processes of knowledge construction. The goal of learning is community building. Cognition and knowing are distributed over both individuals and their environments, and learning is 'located' in these relations and networks of distributed activities of participation. The focus is on activities such as "knowing" and not so much on outcomes and products such as "knowledge". The participation metaphor of learning is based on Lave and Wenger's concept of situated learning (Lave and Wenger 1991). The term situated learning is an umbrella term many concepts refer to. It locates learning in the process of co-participation and in the field of social interaction, not in the head of individuals. Learning is referred to as meaning production. Learning means to move from peripheral participation to full membership within a knowledge community. Relevant roles are peripheral member, full member, and expert. Peripheral participants do not accumulate knowledge and skills but are introduced in processes, routines, networks, relevant issues, and approaches within the community. *"The individual learner is not gaining a discrete body of abstract knowledge which (s)he will then transport and reapply in later contexts. (...) There is no necessary implication that a learner acquires mental representations that remain fixed thereafter, not that the 'lesson' taught consists itself in a set of abstract representations"* (Hanks 1991, pp.14). According to this concept of learning students might not be taught how to conduct scientific work per se, but are introduced to scientific communities, to the procedures of how to publish on conferences which are relevant in this community, in which newsgroups members communicate controversially, and how to find current and promising issues of research within this community (Allert and Richter 2002).

2.2 Knowledge-creation metaphor and innovative learning

Paavola, Lipponen, and Hakkarainen (2002) extend Sfard's participation metaphor of learning and refer to it as *knowledge-creation* metaphor of learning. They extend the participation metaphor as it was originally used to characterize learning in traditional cultures which are relatively stable. The knowledge creation metaphor is used to characterize learning in modern knowledge societies and communities where

fundamental changes and transformations take place. Bereiter and Scardamalia (1993) argue that in innovative knowledge communities, which are emerging in knowledge society, there are no clear-cut roles for newcomers and old-timers as not only old-timers have access to the most valuable knowledge and skills and also newcomers develop competencies that are innovative and valuable.

The knowledge-creation metaphor of learning focuses on innovative learning and 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, Lipponen and Hakkarainen 2002, p.1). The knowledge-creation metaphor of learning is seen as the epistemological foundation of CSCL and knowledge communities. Models which are based on this concept of learning are developed and applied in knowledge management and education alike.

Paavola, Lipponen and Hakkarainen (2002) focus on the process of developing, advancing and creating knowledge. They develop the knowledge-creation metaphor of learning by analysing different models of innovative knowledge communities in order to better understand basic epistemological processes of knowledge advancement, i.e. Nonaka & Takeuchi's model of knowledge-creating organization (Nonaka and Takeuchi 1995), Engeström's model of expansive learning (Engeström 1999), and Bereiter's theory of knowledge building (Bereiter 1985).

The knowledge-creation metaphor goes beyond the acquisition metaphor of learning where knowledge is taken more or less as such. *“We have argued that in these models learning and knowledge advancement is understood through a knowledge-creation metaphor that emphasizes the importance of going beyond the information given. All of them are trying to answer to the challenge of the ‘learning paradox’ by focussing on processes of innovation. The learning paradox (or the ‘Meno paradox’) is the classical problem of explaining how something more complex is created using existing knowledge (see Bereiter 1985). These three models of innovation take the learning paradox to be a basic epistemological question by highlighting the importance of explaining how something new is created”* (Paavola et al. 2002, p. 11). These models, which are referred to as models of innovative learning, avoid mentalism and an exclusively individualistic approach by criticizing the classical conception of knowledge as conceptual, declarative, and propositional knowledge only. The *“models of innovative learning criticize the traditional view according to which human cognition is a symbolic system that mainly relies on explicit propositional knowledge and functions according to explicit formed production rules”* (ibid. p. 6). Understanding the process of innovation

as externalization of declarative knowledge, which already resides in an individual's head, is a simplistic view.

Innovative learning is seen as dialectical interaction between different forms of knowledge: tacit, procedural and declarative knowledge. *Procedural knowledge* (know-how) is based on the idea that activities and skills are not guided by explicit rules and propositional knowledge. Rather, rule-like behaviour emerges as an outcome of knowledgeable action (ibid. p.6). *Tacit knowledge* is based on the idea that creative experts have experience of solving problems in their field. Based on tacit knowledge they have some sort of sense what is promising in their field, how to solve new problems and trying to find out new and more promising ways of doing things in their field.

Knowledge creation is seen as a fundamentally social process as people collectively improve their understanding through social interaction. "*New ideas and innovations emerge among rather than within people*" (ibid, p.8). This means that knowledge is not considered to reside in, or created within, an individual's mind. The assumption that knowledge consists of objects, which can be systematically produced, developed and accumulated is referred to as the mentalistic concept of knowledge.

Shared conceptualization and shared construction of conceptual artefacts arise from dialectical interaction of tacit, procedural and declarative knowledge within processes of solving problems, questioning objectives and existing problem solutions, originating new thoughts and advancing communal knowledge. In collaborative knowledge advancement ideas, practices and conceptual artefacts are transformed.

These models of innovative learning are not only relevant in scientific research communities but also in knowledge management (Nonaka and Takeuchi 1995) and school education (Bereiter 1985 and Engeström 1999).

2.3 Learning as shared meaning making

Stahl (2003) strengthens the collaborative character of learning and refers to learning as shared meaning making. Meaning making is not understood as a psychological process which takes place in individuals' minds but as an "essentially social activity that is conducted jointly – collaboratively – by a community, rather than by individuals who happen to be co-located" (ibid, p. 523). Stahl grounds the collaborative character of meaning making in the philosophical tradition of Heidegger, Hegel, and in Vygotsky's concept of mediated cognition which shows how meaning

is socially produced and situationally interpreted. His conception of meaning making goes beyond the exclusive focus on the individual as thinker. *“That is to say, the meaning-making practices do not merely take place within a ‘context of joint activity’, as actions might take place within the four walls of a room. Rather, the context of joint activity is those practices – the practices form the context. Similarly, the meaning is not merely transferred from mind to mind by the activities, but the meaning is constructed by and exists as those activities. Similarly, artefacts are not simply instruments for conveying independent meanings, but are themselves embodiments of meaning”* (ibid. p.524).

Stahl integrates the idea of a dynamic relationship: He assumes a dynamic relationship between shared meanings and individual interpretations.

This perspective refers to knowledge as acculturated and situated knowledge and cognition as situated and mediated cognition: meaning is created in the intersubjective world and only then incorporated (internalized) in a person’s own sense-making repertoire. Meanings persist in physical and semantic artefacts within a culture. People interpret these meanings from their own perspectives. There is a dynamic relationship between embodied meaning and interpretation. This relationship overcomes the body-mind dualism which was introduced by Descartes *“where meaning, as something purely mental, is ontologically distinguished from and epistemologically divorced from the physical world”* (Stahl 2003). Kant and Hegel worked to overcome this dualism (ibid., p. 523; Kant 1868/1990), Hegel shows how consciousness emerges through activity in the social and physical world (Hegel 1807/1967), and Vygotsky (1930/1978) worked out the collaborative character of meaning making. Stahl refers to Kant and Hegel as relevant for socio-cultural and constructivist learning sciences.

The dialectical dynamic relationship means: Comparable to Bereiter’s concept of conceptual artefacts, meaning is collaboratively produced in a cultural context, embodied in a physical or semantic artefact, and situationally interpreted within a community (or social system). Meaning is both: incorporated in a conceptual artefact as well as intersubjectively interpreted and shared. (Stahl 2003, p. 524, referring to Vygotsky 1930/1978).

This position holds that meaning is neither purely deducible from the object itself nor exclusively constructed by the audience (by consensus), but that there is a dynamic relationship. From this point of view, describing an artefact a priori (per se) is not possible. It is only possible to interpret the meaning situationally.

The different positions and concepts of learning reflect fundamental issues of epistemology and ontology. Beyond the differences outlined here, we assume a basic communality: Irrespective of the concept of learning chosen, learning environments are conceptualized as coherent social systems. This means, within a learning scenario corresponding concepts of learning, knowledge and person's roles work together. For example: When learning is assumed to be acquisition, the teacher will understand himself as a provider of knowledge and the learner as consumer or re-constructor, otherwise the system wouldn't work well.

As semantics is concerned with meaning, the field of learning may work as an example for modelling within the Semantic Web. The next chapter is mainly based on this outline.

3. Valuable Diversity and Educational Metadata

This section discusses the relevance of valuable diversity for educational metadata. Within the relevant initiatives there is common agreement that this diversity is of great value and that standardization in the field of learning has to address any concept of learning. But they propose different strategies of how to achieve this:

- IMS Learning Design is based on EML, which forms a pedagogical meta-model, modelling what is in common with all theories and models (IMS LD 2003, Koper 2001).
- LOM aims at being neutral with regard to learning theories (IEEE LOM 2002).
- The approach of Learning Roles explicitly models diverse concepts of learning.

3.1 Reflecting current standards and specifications

Organizing different approaches of learning and instruction on a continuum of contextualization illustrates that context is more crucial in some models than in others. The notion of "de-contextualized learning objects", which is a core assumption of many approaches to educational metadata, perfectly addresses models of Instructional Design, rather than Situated Approaches.

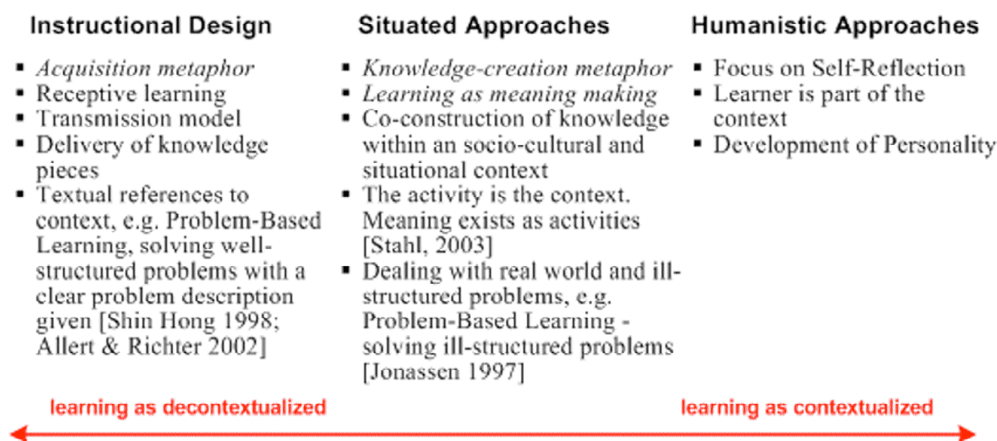


Figure 2: Approaches of learning and instruction on a continuum of contextualization¹

Many current approaches and models for metadata are content-centred and implicitly address the acquisition metaphor of learning. Learning and instruction is seen as the process of transferring information. The learning objective is predefined and the learner works towards it. The learner is assumed to be a passive recipient, which means that meaning is enclosed in the learning object and acquired by the learner. LOM (IEEE LOM 2002) reflects this concept by specifying attributes such as *Typical Learning Time* and *Semantic Density* within its category *Educational*. It assumes that the semantic density is determined by the characteristics of the resource: enclosed in the learning object and transferred to the user, but not constructed by the user. Effect studies within the science of communication refer to this position as transmission model, which asks: *What do the media do to the individual?* In contrast to this the Uses and Gratification Approach within the science of communication asks: *What does the individual do with the media?* This approach reflects a shift of paradigms which took place in the science of communication in the 70s.² As a result semantic density and the level of interactivity is constructed by the user according to former experience, individual relevance, and the user's actual interests (Charlton and Neumann-Braun 1992) and can not be assigned to the resource.

¹ This work refers to models which are based on information processing theory as models of *instructional design* and to models which are based on situated cognition as *situated approaches*.

² This is also a guiding element in the slogan of Sony which has changed from "It's a Sony" to "You make it a Sony". <<http://www.sony.de>>, Retrieved: October 27th, 2003.

Current standards within the field of learning mainly reflect a naturalistic position. Their intention is well-described by LOM: *“This standard will specify the syntax and semantics of Learning Object Metadata, defined as the attributes required to fully/adequately describe a Learning Object”* (IEEE LOM 2003b). It aims at an absolute description of an object and assumes de-contextualization. Meaning is completely deduced from the object itself, which means that the entire meaning lies within the object. LOM’s concept of semantics is based on epistemological and ontological assumptions comparable to those of the acquisition metaphor of learning.

The modelling approach of IMS LD (2003) describes how an object is used within a unit-of-study. Therefore the approach seems to be different as an object is not described per se, but in its relations to other structural elements within a unit-of-study. But in principle the approach of modelling is the same - only the root element is different: While LOM’s root element is a learning object, the root element in IMS LD is a unit-of-study. The unit-of-study again is assumed to be completely and fully described, according to requirement R1: “Completeness: The specification must be able to fully describe the teaching-learning process in a unit of learning, including references to the digital and non-digital learning objects and services needed during the process.” (IMS LD 2003). As a consequence a unit-of-study is a closed unit. IMS LD can’t describe an open system (the notion of *open systems* refers to Willke 2000): a unit-of-study in its context, e.g. in its relation to organizational change and organizational learning (which is not a simple *“is part of”* relation). But this is crucial e.g. in Engeström’s model of expansive learning or Bereiter’s model of innovative learning. We state a conflict between the aspects of contextualization in some concepts of learning and the notion of de-contextualization in the current discussion on metadata.

The outline of different positions in epistemology and ontology shows that this position is only one among others. Stahl’s approach of learning as meaning making e.g. neither assign the attributes exclusively to the object nor exclusively to the user but assume a dynamic relationship as well as contextualization within culture and situation.

The notion of “being pedagogical neutral” and “non-prescriptive”, proposed by standards such as EML (2001), IMS LD (2003), IEEE LOM (2002) assumes that learning theories are not pedagogical neutral, but reference models and standards for metadata are, as they are integrative meta-theories. Not that these standards and

specifications failed in being neutral. But there is no chance being neutral as referring to an epistemological and ontological position is unavoidable. Defining the structure of metadata and specifying a conceptual data schema inevitably reflects a specific concept of knowledge and meaning.

We would like to strengthen the argument that categories, which are set up to describe an object, and reference models inevitably refer to an epistemology and are not neutral by Kant's concept of 'a priori' and 'a posteriori': Kant in the *Critique of Practical Reason* overcomes the dualism of rationalists and empiricists as he proposes the categories of space and time as the only categories which are a *priori* and thus preconditions for any experience. Any other category is a *posteriori*: it presupposes sensory experience and is not independent from space and time as epistemological categories. Only the categories time and space are independent of epistemological terms (Kant 1868/1990).

3.2 Explicitly modelling diversity

This reveals a conflict: on the one hand a modelling approach has to be able to describe divers concepts of learning, which refer to different epistemological and ontological positions, on the other hand the modelling approach itself reflects a specific epistemological and ontological position. How can an approach which reflects a certain position describe learning concepts which reflect another?

We replace the construct of neutrality by that of viability. This does not aim at neutrality as current approaches and models do. This view is based on *Lyotard's Report on Knowledge* (1984), which was first published in 1979, and which investigates the condition of knowledge in post-industrial societies and postmodern cultures. Lyotard gives up the criteria of truth to legitimate knowledge. The question is not, whether knowledge is true or false, but whether it has the ability to explain and whether it allows for connectivity. Glasersfeld refers to this as the concept of *viability* (Glasersfeld 1980). Viability originally means practicability. Concepts, models, and operations are viable as soon as they address the needs and descriptions we use them for (Glasersfeld 1995).

According to Luhmann's concept of difference, the relevant difference which makes sense in science is not true/false, but viable/non-viable. We state that the relevant difference which makes sense for models and metadata schemes within the Educational Semantic Web is not 'neutral/not-neutral', but: 'viable/non-viable' referring to divers paradigms of learning. In order to precisely reflect the needs of

semantics the difference may be: expressive/non-expressive.

Within different concepts of learning different attributes and categories used to describe different structural elements are viable (or: expressive). It is almost impossible to annotate relevant structural elements of situated learning and innovative learning with attributes and categories defined in LOM (IEEE LOM 2002), which is more likely to reflect the acquisition metaphor of learning. A schema of metadata must be viable, which means, it must fit into a learning culture.

Within different communities different concepts of learning are seen as a core or foundation³. Therefore we propose the concept of community-oriented metadata, based on Wenger's statement on learning: "Meaning within communities" (Wenger 1998), which adapts the often stated notion on semantics "Meaning within context" to a community-oriented view. The community-oriented metadata approach refers to Stahl's approach of learning as meaning making which proposes the dynamic relationship between meaning created in the intersubjective world and incorporated in an conceptual (physical, semantic, or linguistic) artefact and meaning interpreted by individuals - both meaning making processes are contextualized in culture and situation.

There is not a single or definite, generally accepted and universally valid meaning of metadata, but metadata which fits to the needs of different communities. According to Wenger's notion of "meaning within communities" consistent use of metadata is more likely to be ensured within communities.

The approach of Learning Roles presented in section 5 proposes the concept of roles, which allows us to explicitly model diversity and ensure semantic interoperability.

4. Activity-Centred Models

The use of metadata (data about data) is an approach to bring structure to the web. But metadata becomes data if there is no consistent use: "open to be written, read and interpreted as each person sees fit" (Chalmers 1999). Therefore there is need for agreement on metadata schemes. These metadata schemes are based on models intended to describe key aspects of a certain domain. "*A model is a representation in a certain medium of something in the same or another medium. The models captures the important aspects of the thing being modeled from a certain point of view and simplifies or omits the rest.*" (Rumbaugh, Jacobson, and Booch 1999, p.13). Modelling means to

³ Within the CSCL community for example, conceptual and foundational issues are discussed in special sessions on their core conferences (e.g. CSCL 2003, Designing for Change, Bergen – Norway).

specify relevant structural elements and relations, to specify relevant categories and attributes. Standardization means to agree on these models, categories, and metadata schemes within relevant communities and organisations such as IEEE, IMS, and ISO. The field of education metadata schemes and models aims at describing structural elements and functional relationships within learning and instructional settings. Of course there is common agreement not to set up an prescriptive model, which is only based on specific or a limited number of concepts of learning, but a meta-model, which is able to integrate any concept, and which allows us to integrate any new concept (Klebl 2002). Koper (2001; IMS LD 2003) embarks on this strategy and specifies an integrative meta-model, called “pedagogical metamodel”, which is pedagogically neutral as it models what is in common with any pedagogical model. IMS LD is based on this pedagogical metamodel.

There is a long tradition of instructional meta-models in the German and European learning sciences (Peterßen 1994; Blankertz 1969; Scheunpflug 2001). These instructional meta-models were supposed to provide teachers with a meta-model which enables them to generate new models which are adequate to the specific educational situation the teacher is confronted with, rather than to teach them a limited number of specific models (Heimann 1962).

All these instructional meta-models, including IMS LD, have a lot in common as they all are *activity-centred models*. Activity-centred models describe activities based on means-end relations. According to Scheunpflug (2001) activity-centred theories describe activities comprising elements such as subject, object, objectives, resources, methods, and functional relations. They work on the premises of linear causality and the relation of objectives and resources⁴. They provide categories to describe situations in which teaching and learning take place and serve as models for planning and describing educational settings. Activity-centred models are based on activities as a core element. As activities are defined as goal-oriented an activity-centred model enforces the pre-description of the relation of means and objectives.

Scheunpflug (ibid.) states that these models undergo a crisis as teachers claim that instruction on the one hand requires planning, on the other hand planning is not sufficient to ensure learning. Problems indicate that learning is not completely predeterminable and plannable. Teaching and learning are structurally complex -

⁴ The notion of activity-centred theories is not equal with *activity theory* according to e.g. Miller, Gallanter, & Pribram; Vygotsky, and others (Miller, G.A.; Gallanter, E.; Pribram, K.H. (1973). *Strategien des Handelns. Pläne und Strukturen des Verhaltens*. Stuttgart: Klett). Scheunpflug (2001) refers to them in German as ‘*Handlungstheorien*’, which is translated to *activity-centred theories* here.

they are different processes which are related, but the learning process is not adequately described by intentional instruction. Learning does not directly result from planned instruction. The unity of learning and instruction was only hypothetically assumed, learning seemed to be determinable only as long as the society was relatively homogeneous. As the knowledge society is characterized by continuous change, transformation, and heterogeneity, Scheunpflug questions whether existing models are able to adequately address increasing complexity caused by continuous change and diverging processes of learning and instruction (ibid. p.11). Activity-oriented models are based on the assumption that planned instruction results in learning. Complex structures and divers interacting variables work as source of irritation and disturbing factors. Facing complex phenomena in learning it is not possible to make a prescriptive plan which assures that a pre-determined objective will be reached. Even though all stakeholders within the learning process have intentions, the appointed means do not inevitably lead to the envisioned goal. Planning is not sufficient to reach an objective.

Often innovative learning takes place in the context of organizational change: e.g. *workflow embedded innovative learning* is often integrated in and intertwined with processes of *organizational learning*, as it allows people to question and criticize accepted practices. A relevant question is, whether and how the organization, in which the workflow embedded learning takes places, changes and learns. If the organization does not change, workflow embedded learning might work as a source of irritation – which means, the complexity within the system increases. The dynamic relationship between different learning processes and complex processes of change is inadequately addressed by models that almost exclusively focus on programmatic actions and objectives and are closed to their environment. According to Scheunpflug (2001) a blind spot of activity-centred models is their missing ability to describe the relation between the program (a learning design) and its context. The notion of de-contextualization coincides with the blind-spot of activity-centred models. But innovative learning processes are contextualized, generative, ill-structured, and long lasting processes, which do not directly lead to a predetermined objective. Learning is referred to as drifting (Kösel 1993). A sufficient model therefore must be able to describe open systems, ill-structured non-deterministic processes of change.

Based on this line of reasoning, there is need for a meta-model which goes beyond the constraints of activity-centred approaches and is able to describe concepts of learning which assume learning to be situated and inherently self-referential.

5. Learning Roles – Modelling Coherent Social Systems

In this section we outline a modelling approach for context specific educational metadata which addresses the valuable diversity in the field of learning.

The modelling approach is based on the Theory of Social Systems (Luhmann, 1995), which represents a system-centred view and is a non-deterministic and non-prescriptive theory. The Theory of Social Systems is a variant of General System Theory. It works as a meta-theory which focuses on the relation of social systems and their environments. System theory aims to describe social systems including their structures, relations, foundational principles and goals. According to Scheunpflug (2001) it is able to integrate and describe activity-centred models. Willke characterizes this theory as universal regarding domains and disciplines. Many disciplines are confronted with similar problems, e.g. the problem of increasing complexity, which can not be reduced to simple categories and principles (Willke 2000). The Theory of Social Systems is not explicated here, except for aspects which are required to understand the modelling approach of Learning Roles. A comprehensive introduction into the theory of social systems is given by Willke (2000) and Krieger (1998). The foundational work is: Social Systems by Luhmann (1995).

The approach of Learning Roles faces diverse requirements deduced from semantics and education.

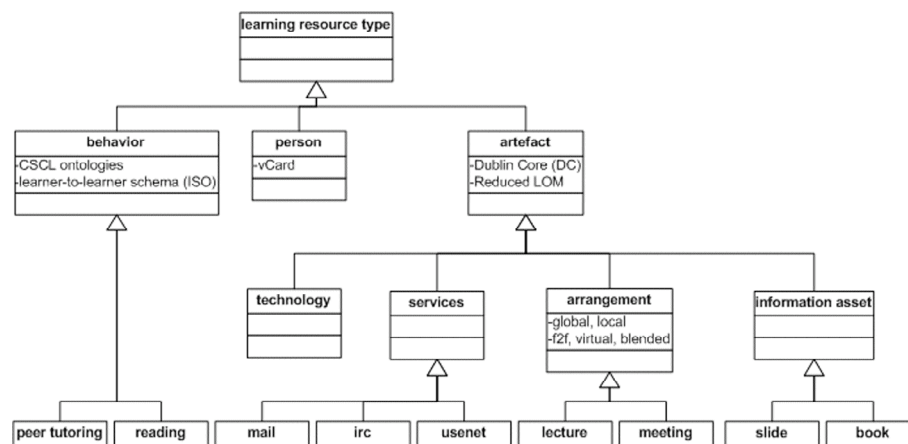
5.1 Diverse Types

Modelling courses, consistent sequences containing learning material and social interaction alike, requires describing diverse types of resources. Guiding principle is to support a wide range of scenarios in the Educational Semantic Web:

- A learner searches for a Community of Practice with a specific strategic intent.
- 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 types relevant in educational settings are not restricted to knowledge-assets but also



comprise persons, technology, activities, processes, arrangements (figure 3).

Figure 3: Types and subtypes relevant in learning (examples)

Within existing metadata approaches, learning objects are equated to 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. An information asset (resp. person, technology, activity, arrangement) which can fill a role within a certain learning context is a learning resource as soon as it actually fills that role (metadata of use). Learning resources are characterized and constituted by context and relations.

5.2 Modelling Coherent Social Systems

The concept of Learning Roles explicitly models diverse views and concepts of learning. The underlying assumption is: Mature life-long learners do not only reflect *what* they want to learn, but also *how*. They choose from formal and informal learning opportunities. Therefore we do not model an integrative theory but focus on expressiveness and significance within the Educational Semantic Web.

5.2.1 Social Systems

As LOM aims at modelling consistent sequences, Learning Roles aim at modelling coherent social systems. Systems reduce complexity - activities of persons are significantly related within a system. E.g. when a speaker speaks, the audience listens. According to Luhmann (1995), people do not belong to a *system* but to its *environment*. This means a person does not belong to a *system* for all intents and purposes but only in some respects and filling a specific role. Within different systems a person fills different roles.

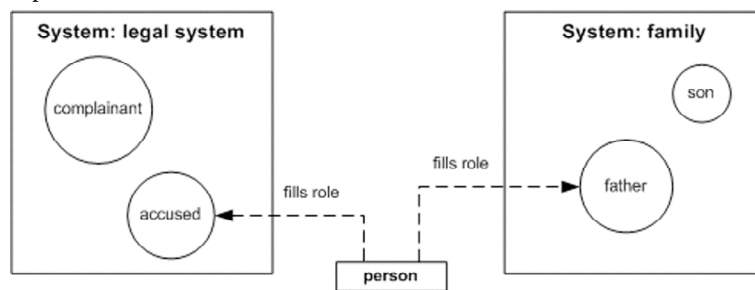


Figure 4: A person (type) filling roles within different systems

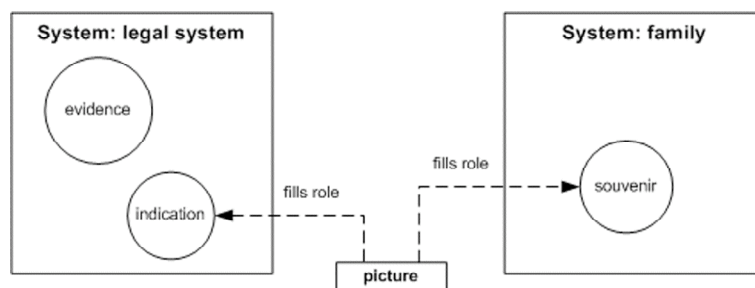


Figure 5: A picture (type) filling roles within different systems

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

Within the legal system a picture does not exist. But 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 modelling mean for metadata in the field of learning? Two examples will demonstrate this view:

- A knowledge-creation community comprises the roles *core member*, *active member*, *peripheral member*, *coordinator*, and *expert* (Wenger 2002), which can not directly be related to roles such as learner and teacher. Information assets fill roles such as *innovative knowledge*, *best practice*, *lessons learned*. Persons filling roles within a knowledge-creation scenario have certain expectations concerning learning process, learning culture etc.
- A session of instruction and acquisition knows the roles learner, facilitator and teacher. Information assets have a specific function within the learning process. A person filling the role of learner within this session has certain expectations.

Peter is a person and might fill the role coordinator in the knowledge-creating community 'Arctic Biologists' and the role of learner in an instructional scenario. An information asset also fills different roles within different concepts of learning.

5.2.2 The Concept of Roles

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 the introduction of the concept of Roles into object-oriented modelling in order to make dynamic modelling approaches possible. He distinguishes natural-type and class-type from roles-type (table 1). Roles are not semantically rigid but founded (Guarino 1992). Instances of natural types can fill, adopt and leave a role without losing their identity. Roles are defined by context and relation (interaction).

Natural-Type/Class-Type	Role-Type
<ul style="list-style-type: none"> • Static 	<ul style="list-style-type: none"> • Dynamic (Dynamic classifying)
<ul style="list-style-type: none"> • An instance of a class once and forever belongs to that class. It cannot change class without losing its identity 	<ul style="list-style-type: none"> • Founded (has context and relations) • Not semantically rigid – an instance does not lose its identity when leaving the role (Guarino, 1992)

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

5.3 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 resource, and context- or role-dependent attributes which are based on the *roles* a learning resource can fill within learning processes (or: its function within a learning process). To illustrate this, we give an example: LOM's category *Learning Resource Type* (Nr 5.2) is often criticized, as it mixes up the types of objects and the function they may have within an instructional design (the vocabulary provided is: "*exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative text, exam, experiment, problem statement, self assessment, lecture*" (LOM, 2002)). The concept of role-based metadata would model a slide as a type, a problem statement as a role as a slide can fill the role problem statement (cp. fig. 6).

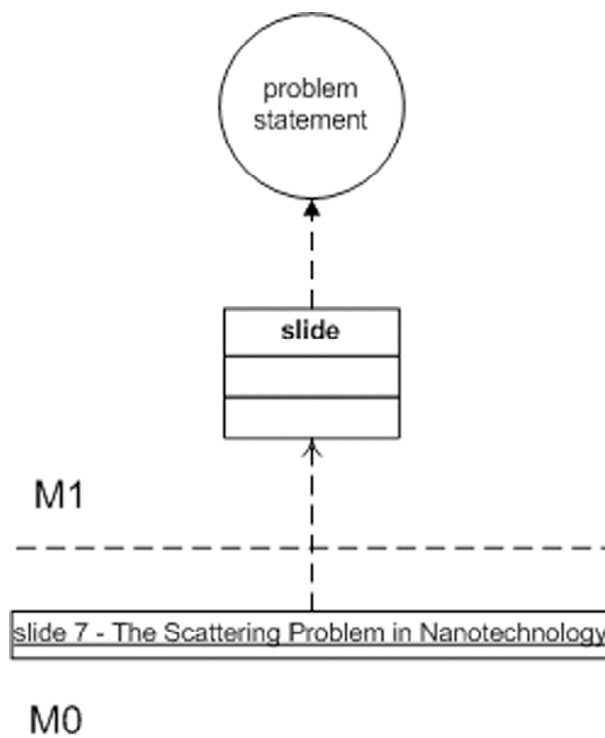


Figure 6: A slide filling the role problem statement in a learning design.

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.

5.3.1 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 7) which specify roles, interaction between roles, and qualities/properties a type must meet in order to be able to fill a role.

Each Learning Role reflects a specific concept of learning, learning theory or pedagogical approach (both instructional and situated approaches). Learning resources can fill roles 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, Richter, and Nejd 2003): A resource may fill different roles in different contexts of learning and instruction. Similarly 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 communities (such as learning scientists, practitioners, consultants on educational management). Comparable with ontologies Learning Roles can be seen as shared conceptualization: Communities have to agree on a shared understanding of learning (concept of learning) and on relevant characteristics of specific models and specify appropriate metadata. Annotating with metadata means to decide for one or more Learning Roles.

5.3.2 Identifying Relevant Types and Roles

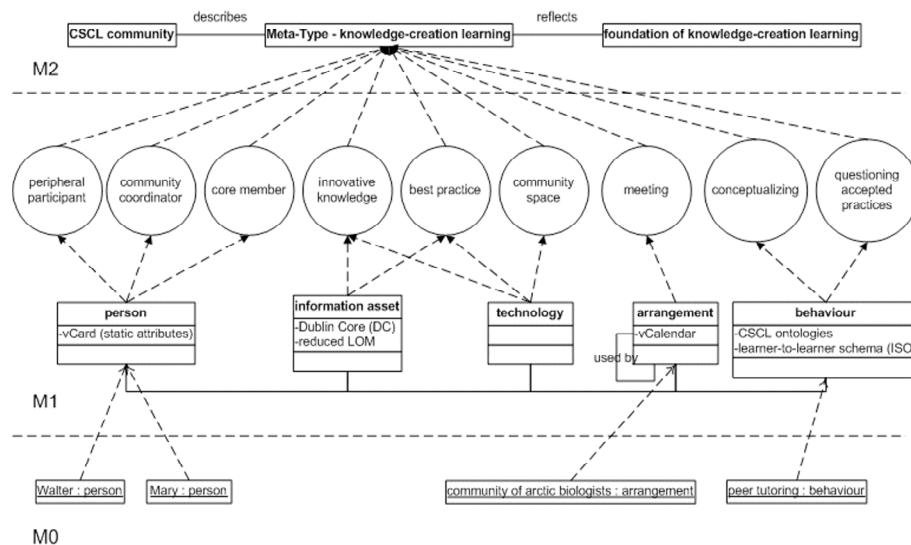


Figure 7: Model 'knowledge-creation learning' – examples of types and roles

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 resources 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? Here we outline two models: the model *knowledge-creation* learning and the model *acquisition learning*. Within the diagram a rectangle indicates a *natural-type*, a circle indicates a *role-type* (figure 7 and 8).

Whatever entity is to be annotated one can ask, which type it is (person, knowledge-asset, technology, activity, 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. Semantic interoperability can be attained through the provision of static type-based metadata.

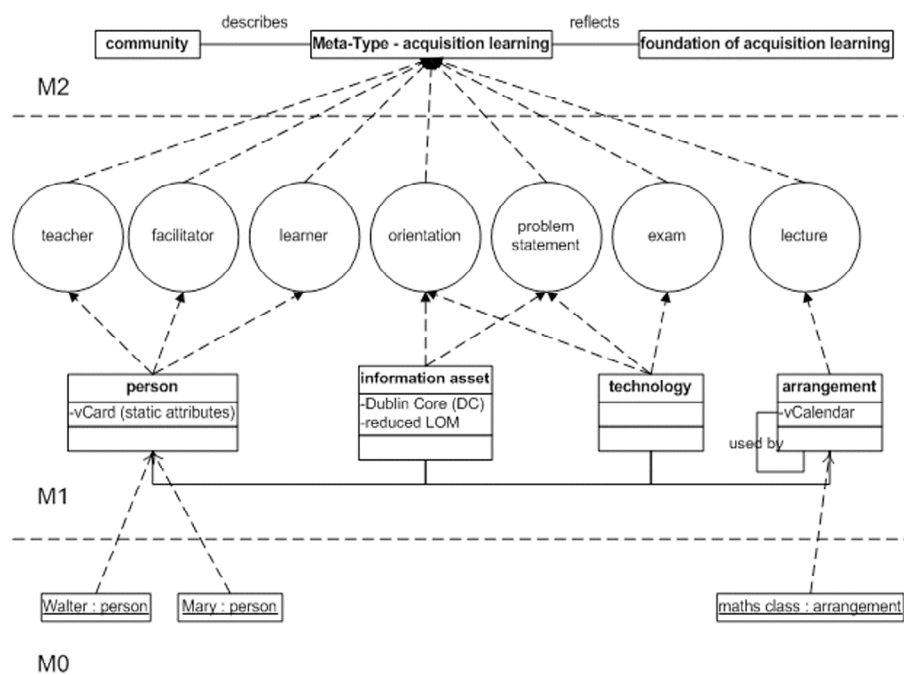


Figure 8: Model 'acquisition learning' – examples of types and roles

A system is referred to as a type. This means: if an instructional-unit is integrated in a session of knowledge-creation, the instructional unit is a type, filling a role within the learning process of knowledge-creation. This allows us to integrate a unit-of study within a unit-of-study.

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

Activity roles represent the function a *behaviour* (type) has within a learning process. An activity is defined as “intentional”. A behaviour (such as *group discussion*, *brainstorming*, etc.) fills a goal within a learning process. Therefore a behaviour represents an activity within 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 activate *questioning accepted practices*? Then the type *group discussion* fills the role *questioning accepted practices* within the knowledge-creation session.

5.3.3 Pattern and developmental pathways

In a very broad sense, learning processes are processes of change and development. Processes of change are meaningful and intentional but not directly influenceable and teleologically determinable. But whereas activity-centred positions describe learning processes by means-end relations, system-centred positions focus on the (underlying) mechanisms that link the components of a system. They identify mechanisms which are based on the assumption of self-referential systems.

We state a vision for the Semantic Web which is based on the recognition of patterns and developmental pathways. Identification, analyses, interpretation, and use of patterns and developmental pathways is due to different concepts and theories of learning and therefore role-specific. Theory-based pattern recognition and analyses means role-based description of patterns.

6. Practical Implications and Discussion

Human activity is predominantly geared to schemata and scripts. These schemata and scripts are viable within certain contexts. A script comprises expectations about relevant activities, the behaviour within assigned roles, etc.. Scripts and schemata are not rigid process models, which are strictly discharged. Learning rather means to develop and generate, to revise and change scripts and schemata (Allert, Richter, 2004). Different concepts of learning demand the activation of different scripts and schemata. Activating inappropriate schemata or scripts causes problems within educational settings. For example, criticizing one another might be highly appreciated within one concept and context, but inappropriate within another. A

learning design might fail when stakeholders don't share expectations – making them explicit is an important step to agree on them, modify or even change them. Role-based modelling facilitates the orientation within a given context and allows comparing contexts instead of generalizing and homogenizing across divers contexts (Allert et al. 2003).

An object potentially fills different Learning Roles. For example a person can fill the role *Community Coordinator* within a specific Community of Practice (CoP) while it 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.

Furthermore role-based modelling allows us to model different contexts which are related and intertwined, e.g. workflow embedded learning which is integrated in organizational learning (figure 9). Types such as persons, problem solutions, information assets may fill different roles within these contexts. The natural types provide the basis for semantic interoperability.

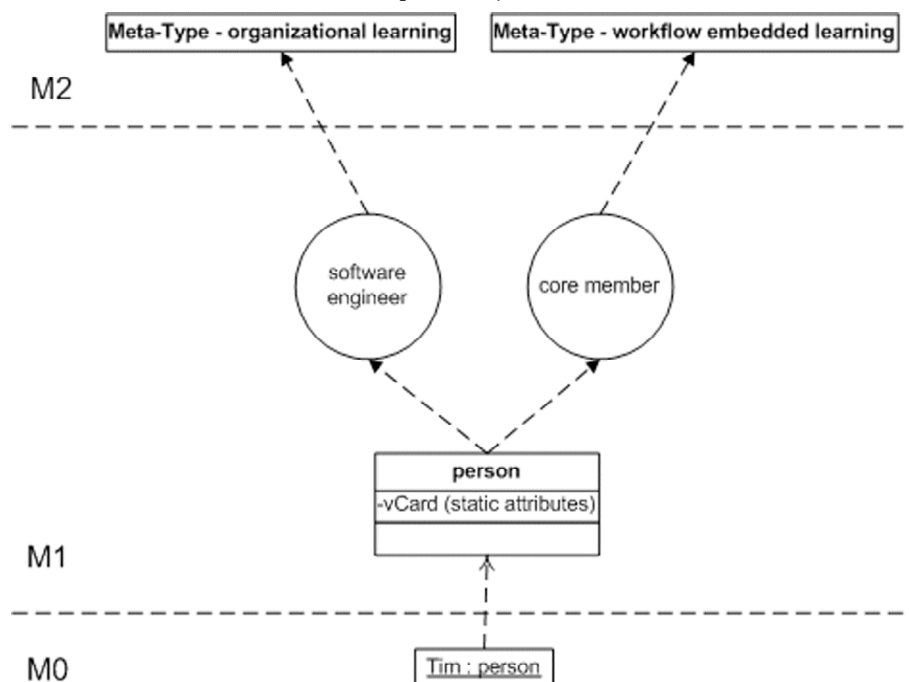


Figure 9: Related contexts: organizational learning and workflow embedded learning

The examples of Learning Roles presented in the paper are far from complete. They are intended to explain the approach. According to the idea of community-based metadata schemes, it depends on communities, practitioners and scientists, representatives and interested members in a community to set up a Learning Role.

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