Meta-Level Category ‚Role' in Metadata Standards for Learning: Instructional Roles and Instructional Qualities of Learning Objects

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ABSTRACT

The meta-level category '*role'* is originated in the field of semantics. Integrating the concept of *roles* to object oriented modelling as well as to the meta-model of the Standard for Learning Objects Metadata (LOM) can solve the problem of annotating different epistemologies, paradigms, theories, and instructional principles in learning and instructional design. In order to reuse and exchange learning objects we need information about these learning objects. The LOM draft standard defines a set of more than 70 attributes, which specify learning objects (titel, author, subject e.g.). However, even though the LOM draft includes a category educational, no information is included in the standard to specify the instructional quality of a learning object, nor to specify which instructional roles are filled by a learning object within a learning process. In this paper, we show how to include this important instructional information using the concept of instructional roles in a way, which is extensible and flexible enough to specify criteria prescribed by different instructional theories.

General Terms

Standardization, Theory.

Keywords

Meta-level Category '*Role'*, Metadata, Instructional Design, E-Learning, Standard for Learning Objects Metadata LOM

First published at COSIGN-2002,
02 – 04 September 2002, University of Augsburg,
Lehrstuhl für Multimedia-Konzepte und Anwendungen,
Germany

1. BACKGROUND AND CONTEXT

1.1 : The Meta Level Categories 'Type' and 'Role'

In this first chapter we expound a basic comprehension of the formal term "role" based on the work of Steimann (also citations are taken from Steimann) [22]. In the following chapters we will apply the concept of roles to the Meta-model of Metadata Standards for Learning (LOM e.g.).

According to Steimann, the term 'role' as well as modelling itself is originated in the philosophy of language. Eco in this context calls Lodwick (1619 – 1694) the first progenitor of lexical semantics. Lodwick does not start from the substantives (from nouns or names of individuals and genera, which was usual in aristotelic tradition) but from actions. Actions then are populated with actors and characters: with abstract roles, that can be connected to person's names, things, or places acting, re-acting and being acted. [5]

Lodwick distinguishes "appellative nouns" from "proper nouns". This differentiation is based on two qualities, which are established by Husserl (1859 – 1938) and Guarino. These qualities will in fact distinguish natural types and classes from roles in object-oriented modelling: Husserl introduced "Fundierung" (en: funding), Guarino [6] specifies semantical or ontological rigidity. Guarino [6] gives an formal definition of the term role and distinguishes the concept *role* from the concept *natural type.* A concept is funded if none of its instances can exist alone. Each instance has to be related to an other. A concept is semantically or ontologically rigid if an instance can not join and leave the extension of the concept without loosing its identity.

If x has the property of being an apple , it cannot lose this proporty without losing ist identity (...). This observation goes back to Aristotelian essentialism (…). [7]

Roles are those concepts which are funded but not semantically rigid. Natural types are those concepts which are semantically rigid but not funded. Linguistics has worked out an common theory of formal languages:

In der Theorie der Sprachen, formaler wie natürlicher, taucht ein Begriff immer wieder auf: der der Rolle. Rollen komplettieren die für die Sprachtheorie so wichtigen Konzepte Prädikat (als Träger der Aussage eines Satzes) und Objekt (als Ergänzung des Prädikats) um die Beschreibung der Funktion, die das Objekt in die Aussage ausfüllt. Rollen sollten damit, genau wie Prädikate und Objekte, fundamentaler Bestandteil jeder Sprachtheorie sein. Doch während die Formalisierung von Prädikaten und Objekten heute eine Selbstverständlichkeit ist, tut man sich mit der Einordnung des Rollenbegriffs in formale (Modellierungs-)Sprachen vergleichsweise schwer. [22]

While the concept of roles does not play any role in formal languages, including the logics (cp. modeling and the formal grounding of maths by FREGE (1848 – 1925)), it plays a major role in linguistics (cp. [3]). Standardisation of the term "role" in modeling complements the categories type and relation. Individuals of types can play roles. Types fill roles. Different from natural types, the character of roles is dynamic. Roles are dependent from relations and context. Roles specify the interactions of individuals. Individuals are classified dynamically by the roles they play. Each individual of one type can play different roles (polymorphism).

1.2 Standardisation in Learning

In this section we discuss the context in which standardisation in Learning takes place. Standardization has to face a context of diversity: a wide variety of diverse instructional models, learning theories, instructional principles, and paradigms guide the design of learning environments both explicitly and implicitly. Standardisation has to address controversial goals and assumptions on learning. We will state some contrasts:

1.2.1 Effective teaching as well as theory of change

Several initiatives focus on effective learning as SCORM (ADL) does: *As new instructional technologies emerge, they provide opportunities for universally accessible and effective life-long learning* [1]. But Janneck states controversial trends in initiatives of improving teaching and learning: Whereas public and politics postulate more effective learning, discourses in educational science focus on qualitative change in learning culture [9]. Learner centered approaches exist in parallel to instructionalist and teacher centered approaches. Distribution and teaching of knowledge exist in parallel to facilitating collaborative co-construction of knowledge and peer-tutoring (in CSCL) e.g..

1.2.2 Learning objective: Knowledge as well as competences

Many computer based learning environments are restricted to the teaching of knowledge and concentrated on organising and structuring units of information (knowledge objects). They focus on the ‚right' curriculum and life-long learning of knowledge on demand. But developing new tools and learning environments also enables learners to acquire skills and social competences. [10]. Whereas some learning environments imply learners which are selforganised others aim at imparting the skill of selforganization.

1.2.3 Valuable diversity

Standardization has to address any scenario based on diverse requirements and assumptions on learning. Therefore the context for Standardisation in Learning is well characterised by Lyotards comprehension of science which is explained by Beck: 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 failture of integrating theories is specified a characteristics of postmodernism [4]. Standards that aim at instructional neutrality must fail from the point of view of the science of philosophy. They risk to address a narrowed perspective on learning. Also the formation of a pedagogical meta-model [15] is not what we intend. We want to open the view on learning in standardization and propose an approach of Instructional Roles in Learning Metadata Standards, which supports the idea of explicitly modelling and annotating different paradigms, models and principles in learning.

2. APPLICATION OF ROLE-CONCEPT TO STANDARDS FOR LEARNING OBJECTS

To allow the reuse of learning objects (LO), various standards have been developed to describe learning objects, their relationships, etc. The IEEE LOM draft standard for learning object metadata [16] specifies a variety of bibliographic and technical properties of learning objects, as well as different relationships between learning objects, and make exchange, reuse, and search of learning objects based on these metadata possible. However, even though the LOM draft includes a category educational, no information is included in the standard to specify, which instructional roles are or can be played by a learning object within a course. As curriculum programs do, LOM concentrates on what should be taught and when, rather than how to teach. Obviously, a standard for learning objects metadata should not tell how to teach, but it should definitively be able to provide information on how to specify pedagogical aspects of learning objects.

A recent paper by Schulmeister emphasizes this point: While potential students of distance learning courses can search for price, author or subject of courses, they cannot search for criteria which are as important as these more formal attributes: *What information is given on whether students of law at the Cyberversity of European Law are coached more intensively than students from Capella University, whether one can take part in collaborative learning activities at the Athabasca University which are not available at ESC Pau? All these questions remain unanswered up to now.* [21]. Schulmeister claims that students cannot choose courses or learning units in a meaningful way on the basis of standards like AICC, SCORM, and IMS, as instructional principles of online courses are not addressed so far in these standards [21]. We add some additional questions students might have: "Which learning processes are supported?", "Is communication among learners embedded in the program?", "Is computer supported collaboration included?", "Does the course unit meet my preferred learning style?".

This difficulty is caused by the fact, that LOM attributes specify properties only at a very basic abstraction level. LOM specifies annotations for content and activities (Learning Resource Type -

Vocabulary: e.g. Exercise, Simulation, Questionnaire, Figure, Table, Narrative Text). LOM does not support metadata about instructional models and instructional theory, even though authors are implicitly or explicitly using specific instructional theories, and LOM does not support information about the use of learning objects in learning processes, which are a central concern in instructional design.

Specifying author and title is of course easier than specifying instructional information, but the question, whether LOM can be extended to implement the specification of instructional metadata related to instructional models and instructional theory, is an urgent one for a standard defining metadata for learning objects.

The approach discussed in this paper extends previous work which has tried to extend LOM with didactic metadata. Meder establishes a detailed ontology for instructional design ("Didaktische Ontologie" [17]), but he only differentiates existing LOM categories and attributes and introduces additional types and corresponding vocabulary to specify the types of learning objects (detailed KnowledgeTypes, types of CommunicationsMedia, Transaction/Assigment, and CommunicativeContribution) and types of hierarchical and assoziative relations linking these learning objects (MatterOfFactRelations are subdivided into HierarchyRelations and RefersRelations). This additional vocabulary is highly structured. But authors must be familiar with the use of this vocabulary in different educational contexts, no support is given based on corresponding instructional theories or learning processes. The current paper extends this and similar approaches, by introducing an additional abstraction layer to the LOM specification which explicitly takes different instructional theories into account.

In this paper we investigate which additional specifications for learning object metadata related to instructional criteria are useful, and how these metadata can be specified and grouped, based on the corresponding instructional theories. We include an introduction to the current LOM standard, draft 6.1 (April 2001), discuss abstraction levels of pedagogical dimensions, and introduces a concept of instructional roles in modelling.

3. CURRENT LOM MODEL

The Learning Object Metadata Standard (LOM for short) [16] defines a structure for interoperable descriptions of learning objects. It aims at facilitating search, management and (re)use of learning objects by authors of online-courses, teachers and learners. A learning object is defined in the LOM specification as "*any entity, digital or non-digital, that may be used for learning, education or training*." [16]

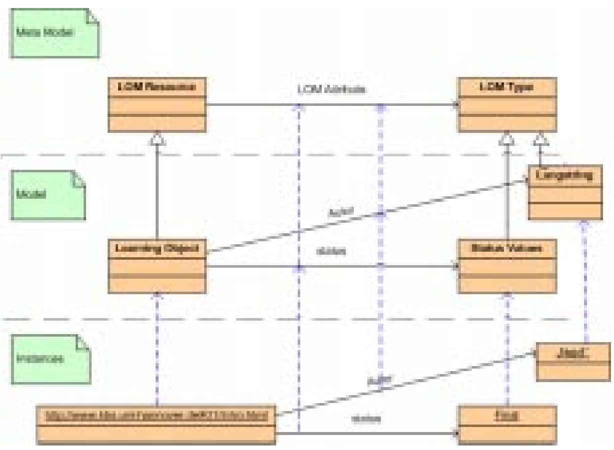

Figure 1. Current LOM Model.

The LOM basic schema consists of nine categories: the *General* category, the *Lifecycle* category, the *Meta-metadata* category, the *Technical* category, the *Educational* category, the *Rights* category, the *Relation* category, the *Annotation* category, and the *Classification* category. Each category is a grouping of data elements describing a learning object, for instance the General category groups general information about the learning objects such as title, description and keywords (Property, Attribute). This basic schema implicitly described in the specification is a rather simple one, but it is not explicity modelled by a common meta-model within the LOM specification. To make this meta-model more clear, we have modelled this LOM basic meta model using the Unified Modelling Language (UML) based on the LOM Draft Standard for Learning Object Metadata (Figure 1).

As shown in figure 1 the LOM Meta-Model consists simply of two types/classes: the LOM resource and the LOM type, linked by LOM attributes (LOM data elements). In the model layer we have only the learning object itself, the attributes describing the learning object and the datatypes for those attributes. In the LOM specification two types of data are defined:

- *Langstring*, which represents one or more character strings.
- The second type is just a set of values for a given LOM data elements (attributes), called *value space*. For instance the data element named *structure* in the category *General*, underlying the organizational structure of a given learning object has 8 values in its value space (*Collection*, *Mixed*, *Linear*, *Hierarchical*, *Networked*, *Branched*, *Parceled*, *Atomic*). This corresponds to the usual enumeration types present in many programming languages.

The descriptions of LOM are context-independent and static classifications. This is not appropriate for many didactic aspects: To characterize "collaborative learning" the type resp. the vocabulary "collaborative" can hardly be added to a single category, as "collaborative learning" is an instructional principle which affects and shifts the entire environment: the role of teacher and learner (Intended End User Role (LOM 5.5)), activities, interactivity type (LOM 5.1), Context (LOM 5.6), Typical Learning Time (LOM5.9), purpose, organizational framework, and many more. The current LOM model does neither provide concepts for modelling instructional models, instructional principles, nor to specify epistemological approaches.

4. BASIC INSTRUCTIONAL FRAME-WORK

4.1 Pedagogical dimensions – Abstraction Layers

As we claim that LOM does not integrate pedagogical dimensions we start by defining what we consider as pedagogical dimensions in this context. We choose a top-down-model in which pedagogical dimensions are imbedded in different layers of abstraction - according to educational and cognitive sciences. In this model, LOM only addresses the bottom layer which is the most basic.

4.1.1 Top-down-model

4.1.1.1 4th (highest) layer of abstraction: epistemology, paradigm

The highest level of abstraction addresses (whether implicitly or explicitly) broad orientation concerning epistemology resp. theory of cognition. This layer is often referred to as paradigm or as way of teaching, learning, thinking and designing. Behaviorism, cognitivism, constructivism are major approaches. Papert for example distinguishes between two main approaches, which contrast learning with teaching: he distinguishes constructionism from instructionism [19]. In practice instructional design often is a mixture of different paradigms.

4.1.1.2 3rd layer of abstraction: (instructional) principles.

From epistemology we can derive one or more instructional principles. Merrill refers to this layer as “set of underlying principles”. Examples are:

- Anchoring new concepts into the learner's already existing cognitive structure will make the new concepts recallable. [2]
- Problem solving will make knowledge transferable.

In the literature as well as in practice we often find fixed terms comprising some well-agreed principles:

- Problem Based Learning (PBL)
- Communities of Practice (CoP)
- Case Based Learning

4.1.1.3 2nd layer of abstraction: instructional models, learning theories.

According to Merrill, “principles are implemented by a program” and, “a program is based on principles” [18]. Instructional models and theories, as well as communication theories are guidelines or sets of strategies. Models often structure learning processes into several phases, make learning cycles explicit, and organize learning processes in a specific way.

4.1.1.4 1st (basic) layer of abstraction: content, practices, activities.

Content, practices, activities and sets of activities, scenarios and curriculum programs assembling content are located at this layer. This layer talks about what is done and to be learned as well as which resources are actually used. The current LOM Metadata Schema only addresses this layer.

4.1.2 Discussion of top-down-model

The domain of instructional design and educational science suffers from a lack of shared terminology. The term “theory” for example is used at different levels. Some learning theories are worked out as conceptual frameworks, constitute certain instructional principles, and are close to the highest level of abstraction (Ausubel 1960, Subsumption Theory. Klafki 1993, Bildungstheoretische Didaktik & Kritisch-konstruktive Didaktik e.g.), other theories are located almost exclusively at the most specific layer and therefore tend to be models (such as McCarthy

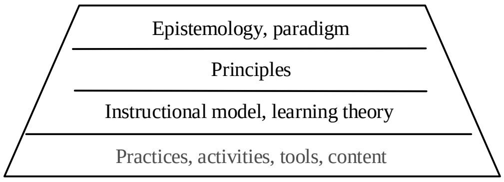

Figure 2. Top-Down-Model.

1996, 4-MAT [18]e.g.). Pedagogy as well as instructional design are ill-structured domains. Historic as well as cultural background is relevant in forming terminology as well.

The top-down-model makes clear that any decision which is made at a higher level of abstraction affects the more basic levels. Choosing the PBL principle results in shifting learning process, the role of teacher and learner, organizational structure and actual activities e.g.. Epistemological approach, instructional principles, learning processes and phases are not addressed by LOM. When including pedagogical dimensions we must provide for continuous change, trends, different cultural backgrounds,

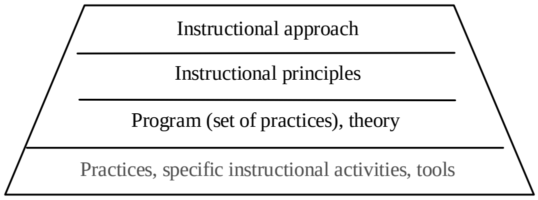

Figure 4. Top-Down-Model referring to Merrill.

ongoing social development, educational traditions, even individual beliefs in a specific approach. Hence, is it possible to fit pedagogical dimensions into standards? Our top–down approach basically reflects the German tradition of teaching as a reflective practice [25]. Klafki in 1985 re-innovates and reflects the term „Bildung“ which was central to Wilhelm von

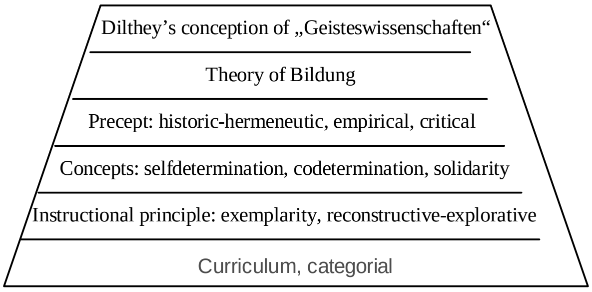

Figure 3. Top-Down-Model referring to Klafkis “Kritisch-konstruktive Didaktik”.

Humboldt's Theory of Bildung in the epoch 1770 to 1830, the late Enlightenment („’Bildung’ als Zentralbegriff pädagogischer Reflexion“ [12] - Kritisch-konstruktive Didaktik). Klafki emphasizes the significance of classical theories of Bildung for a contemporary concept of Allgemeinbildung [13]. Drawing a top-down-model from his concept might look like shown in figure 3.

Hence, the top-down-model presented in this paper is derived from German tradition of education. But there is obviously an urgent need for implementing a model in LOM that reflects both, American as well as European thought, and hopefully also other tradition in the field of pedagogy and instructional design. American education is influenced by curriculum theory and curriculum traditions and starts from a different cultural backgroud (Starting a Dialogue: A Beginning Conversation Between Didaktik and the Curriculum Traditions [8]). Curriculum theory concentrates on understanding the overall educational significance of the curriculum.

Analogies between these different traditions can be stated: Merrill in “First Principles of Instruction” presents various instructional theories and underlying principles. His approach seems to be comparable to our perspective which is presented by German authors [12][14]:

A practice is a specific instructional activity. A program is an approach consisting of a set of prescribed practices. A principle is a relationship that is always true under appropriate conditions regardless of program or practice. Practices always implement or fail to implement underlying principles whether they are specified or not. Instructional approaches may facilitate the implementation of one or more instructional principles. [18].

The meta-model we present does take into account not only the most basic level but also higher levels of the presented top-down-model. In order to solve the need for dynamic classification, the meta-model includes the additional concept of *roles*.

5. INSTRUCTIONAL ROLE AND INSTRUCTIONAL APTITUDE

Using LOM metadata we cannot specify the instructional aptitude of a learning object. Is a learning object suitable to be used in a scenario of collaborative learning or in a scenario enabling problem solving? Metadata should be useable to specify instructional aptitude at any level of abstraction as explained in the previous chapter: models, theories, principles, even epistemology. We will demonstrate and substantiate this by two use-cases, elaborating the level of instructional models and learning theories in the following.

5.1 Learning Sequences – Learning Processes

In separating content from structure, learning objects are decontextualized. In order to advice the recontextualization of content for learning, learning objects should be integrated in learning strategies, learning processes or sequences (such as case studies). We already stated that learning processes are not addressed by LOM. In our meta-model, learning objects are integrated into different learning cycles supporting processes which are derived from different

instructional models. In the role-concept of our meta-model learning theories and instructional models represent context. Instructional models define instructional phases within a learning cycle.

Merrill stresses the importance of phases in learning cycles and states common instructional phases in PBL:

Many instructional models design environments which involve students in distinct phases of learning. Each model determines a set of specific phases. Each phase is part of a learning cycle and involves important, often implicit components of effective instruction (…) Many current instructional models suggest that the most effective learning environments are those that are problem-based and involve the students in four distinct phases of learning: (1) activation of prior experience, (2) demonstration of skills, (3) application of skills, and (4) integration of these skills into realworld activities. [18]

We present two examples in order to illustrate the conceptual model. In these examples we focus on two different epistemological approaches: cognitivism and constructivism. Principles are Expository Teaching (according to Ausubel [2]) and PBL.

In our meta-model any phase of learning represents a specific instructional role. Learning objects (types) fill different instructional roles within learning processes or learning cycles set up by different learning theories or instructional models. One and the same learning object may fill different instructional roles defined by different instructional models and learning theories or derived from various instructional principles.

Our concept of roles stringently and clearly distinguishes the natural types of learning objects (media type, tools e.g.) from their instructional role/purpose [6][23]. The Teachware-specific Meta-Model in Learning Material Markup Language LMML [24] defines Motivation as well as Example, Exercise, Question, Table, List, Multimedia and others as instances of ContentObject. But from the perspective of instructional design Table, List and Multimedia elements are media types or different types of illustration which are contained in the curriculum. These types fill, for instance, the role *Example* or *Motivation*. Categories of LOM do not address a main task of instructional design: the support of learning processes respectively cycles of learning. There are different ways for modelling learning sequences. The selection of a learning sequence is based on instructional principles and is epistemology focused. Learning theories and instructional models suggest to involve the students in distinct phases of learning.

The top-down-model can be mapped to the concept of types (class) and roles as shown in figure 5.

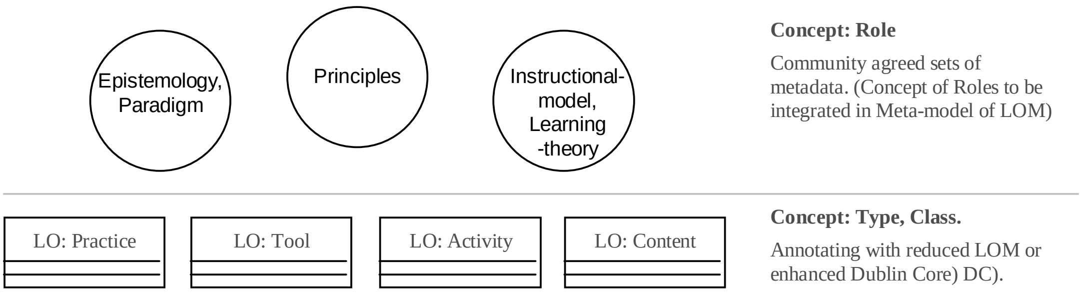

Figure 5. The model distinguishes roles from types/classes.

5.2 Roles for Modelling

There is a wide choice and diversity of definitions of the role concept in literature. In this paper we will not examine more closely the different meanings and uses of the role concept which has been elaborated in [22]. Here we will focus on the definitions relevant for our purpose. Steimann distinguishes definition of chareceristics from the player itself: *A role is a kind of protocol specifification specifying behaviour and characteristics, but not the role player itself* [23]

As opposed to natural types or classes, roles have strong dynamic aspects. Types/classes, which are the fundamental concepts in the object oriented modelling are inherently static: an instance of a class once and forever belongs to that class – it cannot change it without loosing its identity. An HTML-page for instance will always remain an HTML-page; removing its tags makes it a degenerated HTML-page, but an HTML-page nonetheless. On the other hand, the same HTML-page may fill different roles in the same instructional model or in two different instructional models. Let us map these definitions to the educational terminology. A learning object may play different roles within different instructional models and within the same instructional model.

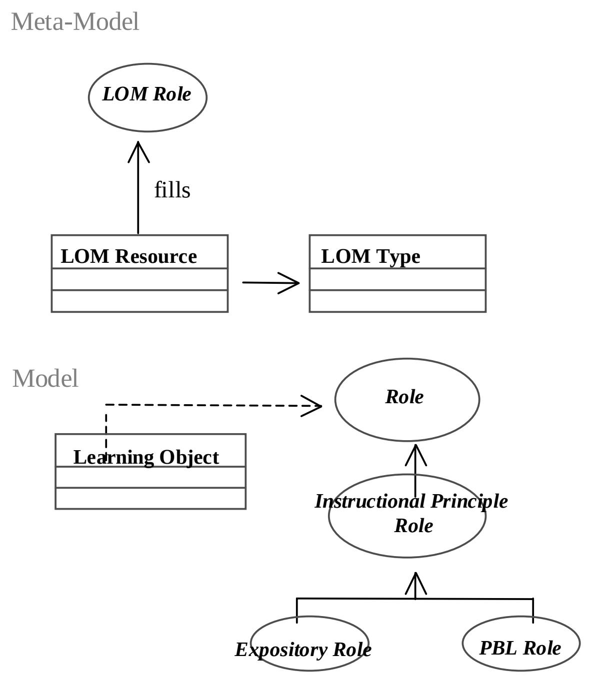

Figure 5. The extended LOM Meta-Model.

In the following section we will use the Unified Modelling Language (UML) to model two instructional models or learning theories. Figure 5 shows the LOM Meta-Model extended by the role concept. We defined a new concept “Instructional Role” as a subclass of the general class “Role”. In this chapter we will focus on two instructional principles: Expository Teaching and PBL [26]. Thus we define two subclasses “Role of Instructional Principle – Expository Role” and “Role of Instructional Principle – PBL Role”. For each further instructional model, principle or paradigm we can define new subclasses of the concept “*Instructional Role*”. Learning Models, instructional principles and paradigms are used as context of roles and may determine relationships between entities.

In fact metadata sets according to specific roles are to be set up and agreed upon by communities of practice and scientific communities in regarding fields. Standardization initiatives may moderate these processes. These processes will not be easy as standardization itself is hard work. But in advance, LOM could be reduced to less attributes. We suggest to remove the Category ‘Eductional’ and some others and address instructional and educational information at the level of specific roles.

Models carefully describe the instructional function of each phase within a learning process. We refer to phase plus specified function as instructional role. Used in such a way, the instructional role is compatible with the idea of the role concept: a type must have certain characterising predicates [7], qualities, attribute, or requirements in order to be able to fill a certain role. Characterising predicates, attributes and requirements are matchable with the concept of instructional aptitude explained in the beginning of this chapter. We suggest to name instructional aptitutes ‘instructional qualities’.

Here we only present two use cases for better understanding of the concept of Instructional Roles. These use-cases do implement the instructional principle Expository Teaching as well as PBL by specific models.

5.2.1 Learning Sequence and Phases according to Ausubel’s Expository Teaching

5.2.1.1 Learning Theory

Ausubel's theory is a cognitive learning theory. "The model of cognitive organization proposed for the learning and retention of meaningful materials assumes the existence of a cognitive structure that is hierarchically organized." [2]. Ausubel’s theory deals with how learners learn large amounts of meaningful material from textual presentations. According to Ausubel, learning is well organized by superordinational, representational, and combinatorial processes that occur during the reception of information. “A primary process in learning is subsumption in which new material is related to relevant ideas in the existing cognitive structure on a substantive, non-verbatim basis. Cognitive structures represent the residue of all learning experiences; forgetting occurs because certain details get integrated and lose their individual identity.” [11]

According to Ausubel a learning sequence consists of four learning phases: (1) advance organizer, (2) progressive differentiation, (3) practice and (4) integrating (Ausubel’s Expository Teaching).

5.2.1.2 Roles according to Ausubel’s Expository Teaching

A given learning object (type) fills a precise role within a learning phase. A learning object can play different roles within a given learning sequence. For instance a text or video-file presenting a case can be used in the first phase called “advance organizer" as motivation for the learner but can also be used in the phase "practice" as an "apply practice element" in another course.

Table 1. Phases of Expository Teaching according to Ausubel

Phase	Instructiuonal purpose
Advance Organizer	Prepare for integration of new knowledge. Subsuming bridge between new learning material and existing related ideas. Present introductory material that helps students relate new information to existing knowledge schemes. New ideas and concepts must be "potentially meaningful" to the learner. Help to relate new ideas to existing scheme. Ask questions like: What do you want to find out? What operations do you need to perform to get there? What do you already know?
Progressive Differentiation	The most general ideas of a subject should be presented first and them progressively differentiated in terms of detail and specifics. Organize new material by subordination, superordination and coordination.
Practice	Practice and apply
IIntegrating and Connecting	Integrate and link new knowledge to other fields of knowledge and context areas as well as to the advance organizer. Instructional materials should attempt to integrate new material with previously presented information through comparisons and cross-referencing of new and old ideas

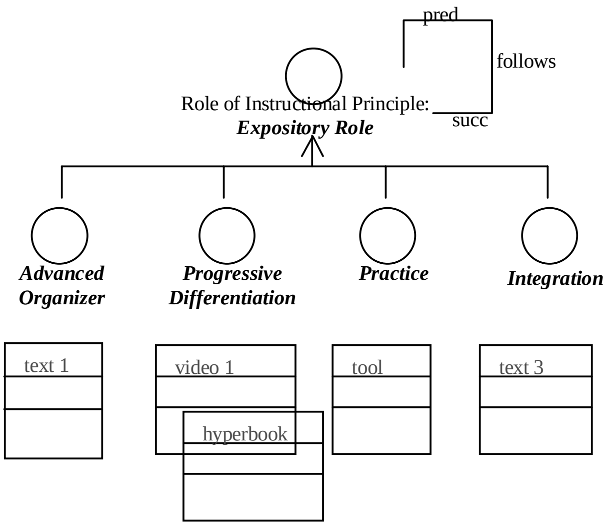

Figure 6. Typical Scenario according to Ausubel's Expository Teachning.

5.2.2 *Problem Based Learning*

5.2.2.1 *Instructional Models for PBL*

Many instructional models are concerned with Problem Based Learning. Most of them refer to various approaches of constructivism. For standardization it may be useful to identify and model common phases which are existent in many models. Referring to Merrill these are "(…) (1) activation of prior experience, (2) demonstration of skills, (3) application of skills, and (4) integration of these skills into realworld activities." [18].

On the other hand use-cases can be derived from specific instructional models and do exactly fit into local instructional practice. Our use-case is derived from the "Konzept der mehrperspektivischen Technikdidaktik" (concept of multi-perspective instruction in the education of engineering) [20] and an instructional model based on this concept [26].

5.2.2.2 *Roles according to PBL*

A learning object can play different roles within different learning sequences modelled according to different instructional models. For instance a text presenting a theory can be used in the phase "advance organizer" (roles according to Ausubel) as well as in the phase "Generalize" (roles according to PBL).

Table 2. Phases within a scenario of PBL

Phase	Instructiuonal purpose
Goal Description	Present problem to be solved. Set ultimate Goal
Specify Criteria	Specify one or more criteria your solution should meet. What aspects do you want to focus on. How do you know you reached your goal?
Background Knowledge	Identify knowledge needed. Sample and share knowledge. Ask experts.
Generate Ideas	Generate ideas. Draft provisional hypothesis.
Implement Solution	Generate and develop solution. Implement. Compare different solutions
Reflect	Evaluate solution, reflect solution, reflect product, reflect process.
Generalize	Conceptualize, integrate, and generalize your knowledge. Exchange from example into theory.

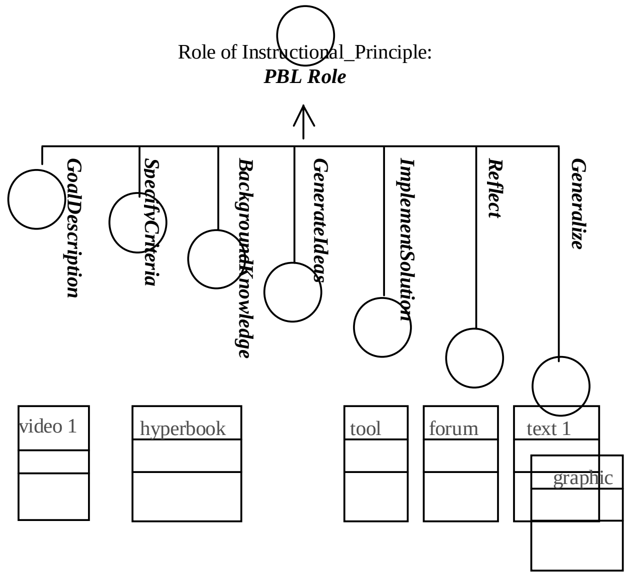

Figure 7. Typical Scenario of PBL.

6. SUMMARY – FURTHER WORK

Motivated by the lack of instructional information in the current LOM standard, this paper presented a short analysis of this deficiency and showed how the concept of didactic roles can be used to extend the current LOM standard to include this missing information. The important advantage of this approach is its ability to deal with dynamic modelling and instantiation, in contrast to a standard class-oriented approach which is suitable for the static attributes currently included in LOM. We presented two use-cases which take into account two different learning models and specified the corresponding Instructional Roles for these models. The presented use-cases are very specific. They explain the idea of integrating the role-concept in object-oriented modelling within learning environments.

Integrating Instructional Roles in standards must ground on broader and agreed sets of attributes addressing different instructional principles, learning theories and paradigms. We currently work on an exemplary set of metadata for an Instructional Role called 'Situated Learning'. And we will recommend an reduced set of categories within LOM.

We apply both to the Open Learning Repository (http://www.kbs.uni-hannover.de/~allert/olr/studie4/site/). Its design is guided along the idea of 'Communities of Practice' (CoP) as well as PBL.

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