Current and future usages of E-learning metadata and ontologies.

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Summary

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Abstract

The purpose of this report is to provide an overview on current and future usages of annotations, metadata and ontologies in the e-learning projects of the JEIRP partners. The first section of this article defines a methodology based on user roles which allows for a structured presentation of the usages. The methodology is used for the description of several current usage scenarios in Section 2. Additionally, this methodology allows identifying open research questions. These are described in detail in Section 3 which provides an outlook on future work and describes the open research questions in more detail.

1 Methodology

1.1 User Role

The potential role of a user plays a central part in the methodology. Therefore, in a first step, we will define the roles which are of interest with respect to the JEIRP. The focus lies on learning and teaching, not on administrative matters, hence roles such as “technical administrator” are disregarded. Most roles can be played by humans as well as software agents. Hence, in the following the term agent refers to human and artificial agents, except where specified explicitly.

Each of these roles potentially works with metadata. Most of the time, they add metadata to a learning resource and use previously added metadata, with a manual, semi-automated or automated method. The roles are the following:

- Learner: A learner is a person interacting with the learning resources with the goal of achieving an educational objective that changes his mental state, e.g., increasing the knowledge about a specific concept.
- Teacher: A teacher is an agent interacting with learners with the goal of achieving an educational objective that changes the mental state of students, e.g., increasing students' knowledge about a specific concept.
- Instructional Designer: An instructional designer is an agent creating learning resources with the goal of achieving an educational objective, e.g., increasing learners' knowledge about a specific concept.
- Pedagogical Administrator: A pedagogical administrator is an agent concerned with the effectiveness of learning and with quality assessment.

1.2 Use Scenario Table

In order to explore the various use scenarios in a given context, we set up for each context a table expressing which role uses a metadata/annotation (columns) previously created by another role (rows). A letter in a cell of this table expresses that there exists an interaction between the row role and the column role. This interaction is materialized into a use scenario for the “column” role with metadata created by the “row” role. It implies also that there exists a scenario for creating the metadata. If the role is performed by a human, this fact is indicated by letter ‘H’, and if it is done by a computer, we write ‘C’. Such a table expresses the range of current scenarios in a given context and enables us to study future scenarios for the empty cells.

We chose to focus on the contexts the JEIRP partners are involved in. For each of these contexts, the methodology is the following:

- Defining the cells of the table corresponding to a current use of metadata.
- For each selected cell, specifying two scenarios: the metadata creation scenario and the metadata use scenario.

For example, in the context of course authoring, in the table below, the cell *Instructional Designer x Teacher* is selected. HH indicates that the instructional designer and teacher are humans. This means that metadata created by an instructional designer can be used by a teacher, leading to the two following scenarios:

- An instructional designer annotates a resource to describe its content and explain its rationale, for example using the LOM format.
- A teacher searches for a resource having specific content.

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner				
Teacher				
Instructional Designer		HH		
Pedagogical Administrator				

2 Current Usages/Scenarios

Five scenarios/usages are described: Course generation, exercises assessment, suggestion of learning material, data analysis, and external memorization. Some scenarios use metadata, some annotations and others ontologies.

2.1 Course generation

A course generator assembles learning resources to a curriculum that takes into account the knowledge state of the leaner, his preferences, learning goals, and capabilities. Moreover, the automatic course generator should take into account possible pedagogical dependencies among the learning resources (e.g., prerequisite or ordering relationships) as well as possible pedagogical strategies suitably formalized by an instructional designer.

In this scenario, in addition to metadata such as LOM [IEEE LOM] that describes individual learning resources, metadata encompasses the order of learning objects in a course (such as IMS CP) and pedagogical strategies that describe how learning objects are ordered with respect to the learners individual capabilities.

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner				
Teacher	HH/CH	HH/CH		
Instructional Designer	HH	HH/HC	HH	
Pedagogical Administrator				

Teacher to Learner

Creation (H): A teacher generates a sequence of learning objects (a course) for her learners.

Use (H): A learner reads a course in a learning environment.

Creation (C): A software agent automatically generates a course for a learner.

Use (H): A learner reads the course.

Teacher to Teacher
Creation (H): Teacher A generates a course which is used by a different teacher B.

Use (H): Teacher B teaches the course to his pupils.

Creation (C): A software agent automatically generates a course for a teacher.

Use (H): A teacher refines the course in order to teach it to his pupils.

Instructional Designer to Learner
Creation: An instructional designer formalizes pedagogical strategies which are used by the learner for course generation.

Use: A learner uses the pedagogical strategies to generate a course.

Instructional Designer to Teacher
Creation (H): An instructional designer formalizes pedagogical strategies which are used by the teacher for course generation.

Use (H): A teacher generates a course for his pupils.

Creation (H): An instructional designer creates pedagogical strategies.

Use (C): A software agent uses the pedagogical strategies for course generation.

Instructional Designer to Instructional Designer
Creation: An instructional designer formalizes pedagogical strategies and exchanges them with other instructional designers.

Use: An instructional designer reuses pedagogical strategies.

The described scenarios use different kinds of metadata:

- Learning object metadata, e.g., LOM.
- An ontology of instructional objects: An ontology that describes a learning resource from an instructional perspective. Such ontology does not describe the content taught by the learning material, e.g., concepts in physic and their structure. Instead, each class of the ontology stands for a particular instructional role a learning resource can play, for instance a paragraph in a text-book.

System/Approaches by JEIRP partners:

- ActiveMath [Melis et Al. 2001]
- UniGe [Adorni 2003]

2.2 Exercises assessment

There are 2 ways of understanding exercises assessment. One way is 'asses the exercise statement', the second one is to asses solutions given by students. Here we take the second point of view.

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner	HH	HH	HH	
Teacher	HH	HH	HH	

Use: / Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
	CH	CH	CH	
Instructional Designer	HH/CH	HH/CH	HH/CH	
Pedagogical Administrator				

Learner to Learner

Creation: A learner creates an annotation, (for example difficulties encountered or essential step of the solution) on an exercise and sends it to other learners.

Use: Learners read annotations made by another learner and take action (like helping a student with difficulty or solve the exercise).

Learner to Teacher/Instructional Designer

Creation: A learner creates an annotation for examples difficulties encountered while attempting/solving an exercise.

Use: Teachers/instructional designers read annotations made by learners and take proper pedagogical action (like further explanation, redesign the exercise etc).

Teacher/Instructional Designer to Learner

Creation: A teacher/instructional designer, could be a software agent, creates an annotation, (for example a difficulty level, a hint, the first steps of the solution or a pitfall to avoid) on an exercise that learners have to do.

Use: Learners read annotations made by a teacher/instructional designer before solving the exercise.

(Note: the Logic-ITA, a web-based tutoring tool in Logic used at Sydney University, allows teachers to annotate exercises with hints or first steps of the solution; a software agent could extract pitfall to avoid from the database of mistakes made by students.)

Teacher/Instructional Designer to Teacher/Instructional Designer

Creation: A teacher/instructional designer, could be a software agent, creates an annotation, (for example most common mistakes or difficulties encountered by students while solving an exercise) on exercises.

Use: Teachers/instructional designers read annotations made by teachers/instructional designers before proposing exercises to students, or to present their course material differently, or to provide students with further explanations.

System/Approaches by JEIRP partners:

- Logic-ITA [Abraham et al. 2001]

2.3 Suggesting learning materials

In this scenario, learning materials are annotated based on an explicit semantic. These annotations are used to select and suggest learning materials to learners. Domain metadata are described with XTM (TopicMap standard).

Use: / Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner				
Teacher	HH/CH	HH/CH	HH/CH	
Instructional Designer		HH/CH	HH/CH	
Pedagogical Administrator				

Teacher to Learner

Creation: Teachers, as well as software agents, annotate the learning material and present the related learning materials to learners.

Use: Learners read annotations made by teachers/software agents and the suggested learning materials in the learning environment.

Teacher/Instructional Designer to Teacher/Instructional Designer

Creation: Teachers/Instructional designers, as well as software agents, annotate the learning material. Because the annotations were made based on an explicit semantic, they can be shared by other teachers/instructional designers.

Use: Teachers/instructional designers, as well as software agents, read annotations made by other teachers/instructional designers or software agents and present them to their own students in combination with their own annotations.

2.4 Quality Assessment through Data Analysis

In this usage context, both the metadata included with the Learning Object (e.g. LOM) and the metadata generated in the learning process (e.g. SCORM RTE) are stored in a data warehouse for further analysis.

The data warehouse allows powerful multidimensional analysis, both by expert users and by software agents (e.g. data mining), over massive amounts of historic data, in scenarios like: ROI analysis, trend detection, alarm monitoring and pedagogic reasoning.

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner				HH
Teacher				
Instructional Designer				HH
Pedagogical Administrator				

Learner to Pedagogical Administrator

Creation: A learner generates metadata related with Learning Object usage and interaction in a Learning Management System (SCORM RTE and other LMS statistics).

Use: A pedagogical administrator performs multidimensional analysis on the usage data of Learning Objects (time to complete, assessment scores, etc.) in order to evaluate the effectiveness and quality of learning.

Instructional Designer to Pedagogical Administrator

Creation: An instructional designer annotates Learning Objects.

Use: A pedagogical administrator performs multidimensional analysis on the existing pool of Learning Objects (less covered areas, content types, etc.) in order to make investment or content management decisions.

System/Approaches by JEIRP partners:

- [Oliveira and Domingues, 2004]

2.5 External memorization

Electronic document are currently the main object handled by the various actors of an e-learning system for various purpose: the teacher prepare its teaching, the learner work on the document, the instructional designer author it.

External memorization is the activity where the user of an electronic document memorizes notes of events and knowledge while reading the document. This set of annotation is called “external training memory” because it is complementary to the user’s one.

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner	HH		HH	
Teacher		HH	HH	
Instructional Designer				
Pedagogical Administrator				

Learner to Learner

Creation: A learner creates an annotation on a pedagogical material and sends it to other learners.

Use: A learner reads annotation on a pedagogical material made by other learners.

Learner to Instructional Designer

Creation: A learner adds a remark on a pedagogical material concerning difficulties with this material and sends it to the Instructional Designer.

Use: An instructional designer studies remarks made by learners on a pedagogical material in order to modify this material.

Teacher to Teacher

Creation: A teacher creates annotations on a pedagogical material and shares them within his pedagogical team.

Use: A teacher reads annotations made by its colleague on a pedagogical material.

Teacher to Instructional Designer

Creation: A teacher adds a remark on a pedagogical material concerning difficulties with this material and sends it to the Instructional Designer.

Use: An instructional designer studies remarks made by teachers on a pedagogical material in order to modify this material.

System/Approaches by JEIRP partners:

- [Azouaou et al., 2003]
- [Desmoulins and Mille, 2002]

3 Future Usages

In this section, we will describe those combinations of roles and metadata annotation creation and usage which can be identified using our methodology but where not yet scientifically investigated. For the first scenario, course generation, we will point at additional considerations which arise in a completely distributed context (P2P) and provide detailed descriptions of application scenarios in higher education and course composition.

3.1 Course generation

Use: / Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner	HH	HH	HC	
Teacher			HH/HC	
Instructional Designer			CC	
Pedagogical Administrator				

Learner to Learner
A learner creates a course for a fellow learner, for instance as an exercise. This kind of exercise forces the student to articulate knowledge *about* the content, hence trains meta-cognitive capabilities, e.g., “If I want Anton to understand the concept of 'monoids', I must first present him a motivating example.” Additionally, a learner can send any course he particularly likes to a fellow student.

Learner to Teacher
A learner creates a course which is evaluated by the teacher.

Learner to Instructional Designer
A learner sends an existing course he particularly likes to a software agent that acts as an instructional designer. The agent determines the underlying pedagogical strategy and adds it to the preferred strategies of the learner for future usages.

Teacher to Instructional Designer
A teacher sends courses together with an evaluation about how well they were suited for his pupils to an instructional designer. The designer can use the feedback in order to adapt her pedagogical strategies. The instructional designer can also be a software agent, in which case it determines the pedagogical strategy of an existing course that worked well and adds it to the preferred strategies of the teacher for future usages.

Instructional Designer to Instructional Designer
Software agents that act as instructional designer can exchange courses and instructional strategies.

3.2 Course generation in a P2Pcontext

In most of the current usages, annotations, metadata and ontologies are (1) sometimes used by a single isolated user (role) for memorization or better organization and structuring purposes, (2) more often as a means of interaction, exchange and sharing between different roles as illustrated in each current usage table. However it is implicitly understood in most cases that users (roles) share the same site.

In this future usage, we address the problem of pedagogical resources sharing between separate sites (each site is a peer). Sites are not only physically distributed but more important have different usages. Even in the case they run the same scenario, significant heterogeneity in the pedagogical resources and description is expected. In this distributed context, metadata, annotations and ontologies are a first important step toward describing the semantics of pedagogical resources of a given site available for other sites. The sharing of pedagogical resources strongly depends not only on the usage or scenario but on the choice of metadata, annotations and ontologies. In the case of metadata such as those described by means of LOM or Dublin Score, sharing of resources between separate sites is structured and easier to implement. In the presence of domain dependent metadata and ontologies, sharing becomes harder. In the presence of a mixture of say metadata and ontologies, the problem is even harder.

To illustrate Peer-to-peer (P2P) usage of metadata, annotations and ontologies, let us focus on a course generation usage in this distributed context. We assume a scenario where a teacher wants to create a new course. Course, as pedagogical resources are instances of topics, each topic being described in the peer by an isa hierarchy or ontology. Then the teacher either finds the resources he needs locally in his/her peer, or he/she looks for resources in other peers. If all peers share the same ontology, the problem becomes querying neighbor peers for resources under a given topic. Unfortunately, ontologies are not the same in different peers. Similar terms of different ontologies have to be connected. A simple known model consists in connecting two similar terms from different ontologies by an isa link. Then, if term t in peer 1 is connected to term t' in peer P2, all resources under t become resources under t'.

We intend to choose a more specific course generation scenario and experiment various models of description by means of metadata, annotations and ontologies, various models of connection between peers. We call the association of the two models a P2P model of description. Given a P2P description model, the problem becomes then how to discover required pedagogical resources in neighbor peers and to find the best strategies for this distributed query processing.

3.3 Other scenarios for future usages of course generation

3.3.1 Perform European Higher Educational System (called 3-5-8)

The objective is to help building of common curriculum like European Masters and exchanging of students and scholars by using materials and metadata built by several universities

With reference to the European Higher Educational System, called 3-5-8, degrees and formations of the several countries of European Community has been harmonized. In this framework, each university has to describe:

- The list of courses which it offers, annotated with data such as evaluation types, ECTS, teaching semester, course level, prerequisite courses, equivalent courses, concepts learned, disciplinary area, trades and competences acquired,
- Professors which are teaching these formations and who can store their teaching materials on their personal web site or on a platform specific of his/her university.

According to this new European Higher Educational System, information available on university websites, could be used to help building of common curriculum like European Masters, exchanging of students and scholars. A student, a teacher or a scholar should be able to consult metadata, curriculum, and courses contents offered by others universities with which he/she wants contract some exchange or build a degree program. For example, he could access a learning course stored on the web site of another teacher, and access to some data like those listed above.

For example, a learner will consult the material

- to choose a specific course unit at a given level ;
- to decide if it will take this unit in his university or in another university in a context of exchange of students;
- to look at the competences taught by this course.

A teacher can access to the material

- to compose a curriculum with others European partners, for example to constitute a master program for an Erasmus Mundus project;
- to compose a course and consider third-party material as a part of his course;
- to have a look on the course of one of his colleagues.

A group of teachers who wish build a common curriculum, like a European Master, have to compare the content of the several teaching units proposed on a given theme at the same level, the evaluation types, languages, etc.

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner	F	F		
Teacher	F	F		
Instructional Designer				
Pedagogical Administrator				

In this context, metadata are often created by the university which defines content of formations and curriculums. Therefore, when a teacher constructs a course or a material, he inherits this metadata. This inheritance could be realized by a software agent. In this context, there is also the scholar role, and it would be possible to define: Teacher to scholar, and scholar to scholar.

Learner to learner

Creation: A learner who assisted a course in a foreign university, annotate a course or a material to inform others students of his own university about the quality of this course/material or about the prerequisites expressed in modules of his own university.

Use: A student is choosing a module and consult annotations about the quality and the level, indicated by others students of his own university who took this unit in the past.

Learner to teacher

Creation: A learner annotates a course/material to indicate the level of difficulties, quality and prerequisites relative to the curriculum of his origin university.

Use: A teacher reads these annotations to adapt the content of prerequisite units for future potential students who will do exchanges.

Teacher to Learner

Creation: A teacher creates a course or a learning material and deposits it on his personal website. He creates some metadata on the integration in his university, such as level, course units where this course/material is taught, level, prerequisites, etc. There are also links between units concerned and equivalent units in foreign universities.

Use: A learner who wishes to learn a part of his curriculum in a foreign university, consult units which are equivalent to those existing at this university, compare contents, forms, languages, etc.

Teacher to teacher

Creation: A teacher creates a course or a learning material and deposit it on its personal website; links with his university to some metadata like level, course units where this course/material is taught, language, etc.; links between units concerned and equivalent units in some foreign universities; annotations related to others units proposed in partners universities to converge to a common degree program.

Use: Teachers of several European countries wish constitute an European master or another common degree between these countries, by composition of units picked up in the nationals degrees. Each teacher consult and compare the equivalent units existent between these universities, compare contents, forms, languages, prerequisites, etc., and complementary units. They can also consult content of material to compare different courses / materials.

System/Approaches by JEIRP partners:

- [Herin & al., 2004]

3.3.2 Building a course by composing several educational materials available on the web

We focus our attention on the problem of re-using existent on-line educational materials developed according to different instructional paradigms and of composing “the best parts” of them in order to obtain high-level courses which combine all best characteristics of different approaches. We propose a methodology, some tools and an architecture which constitute a support for teachers in building educational courses using “the best parts“ of heterogeneous educational materials available on the WWW. Our approach to compose a course is based on techniques used by teachers when they are composing and improving their courses, using some textbooks on the subject. The goal is to help the teacher to construct his course until to obtain a “stable” course.

The teacher is helped in detecting which parts of existing educational materials are the best to use for composing teaching courses and in checking that different parts composing the built course hold semantic coherence even if they come from heterogeneous sources. This is done by proposing each composed course to students and by evaluating its effectiveness on the basis of comprehension the students have of contents of the course.

Starting from such evaluation, learning is made on the quality of the course and feedback is provided for revising and improving it. In particular, the evaluation of students’ reaction to the proposed course gives advice on both the quality of single parts composing it and on effectiveness of the whole course, i.e. it reveals if the order of the parts of the course (curriculum) is a good one and if semantic coherence holds among them. Learning, in our approach, relies on a pragmatic methodology of evaluation and revision of built courses, which reproduces the real way according to which teachers compose and improve traditional classroom courses.

Our approach relies on observations coming from real-life teaching experiences where teachers build progressively teaching courses by iteration on different steps: composition of the course, teaching session, evaluation of different parts of the course by testing students.

The overall process is characterized by the following steps:

- Consensual contents of the course: contents of a teaching course generally constitute a consensus for what concerns the main concepts to teach in the course. For example, a teaching course on programming languages is accepted to be composed of two main parts: data structures and algorithmic structures. In many cases, a concept constitutes a prerequisite for another concept: in this case, we say that the two concepts are related.
- Use of different textbooks: when a teacher builds a course, he consults different books or articles treating the subject of the course. In general, a teaching course is built by composing pieces of knowledge selected from different textbooks.
- Content planning: each teacher has his own teaching method according to which he decides about relevant concepts to teach in the course and their teaching order. We call curriculum of a teaching course the ordered sequence of concepts taught in a course. Each teacher sequences his own curriculum.
- Composition of the course: once a curriculum has been sequenced, associating each concept in it with pieces of knowledge selected from different textbooks substantiates it.
- Teaching session: the composed course is presented to students.

Course evaluation by testing students: teacher evaluates effectiveness of his course by examining how students perform on quizzes and tests on all concepts composing the teaching course. In particular, the teacher detects which typical errors are made by students on the different parts of the course.

We propose an approach based on an analogy with observations listed above:

- A Global Ontology (GO) describes consensual contents of the course: we dispose of a consensual conceptual structure, GO, which represents the consensual knowledge about a given teaching course. It contains all concepts composing the course as well as prerequisites holding among them. Concepts in GO are called Learning Units (LUs). Prerequisites among EUs are represented by precedence constraints.
- A Local Ontology (LO) is a conceptual structure which describes an on-line learning material which replace a traditional (or a part of a textbook). The teacher disposes of a great deal of learning material available on the Web treating the same subject of a given teaching course. A learning material teaches a set of LUs. So, each learning material is described by a conceptual structure called LO containing all LUs taught by it.
- A curriculum planner helps the teacher in sequencing the curriculum: the teacher sequences his own curriculum and the Curriculum Planner checks its consistency with respect to GO. A consistent curriculum is a sequence of LUs present in GO respecting all precedence constraints.
- A course composer composes the course by associating curriculum LUs with the parts of learning material able to teach them. This is done by instantiating each LU in the curriculum with one of the corresponding ELUs contained in LO.
- Teaching Session during which the course is taught to students.
- Evaluation methodology: the teacher makes the evaluation of the effectiveness of a teaching course by testing students on all LUs composing the curriculum. For each tested LU he gives a teaching coefficient indicating how well the EU has been “learned“ by students and detects errors made on it. The evaluated course is stored in a Curricula Database.

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner				
Teacher	X	X		
Instructional Designer				
Pedagogical Administrator				

Teacher to teacher
Creation: A teacher creates a course and or a material.

Use: A teacher composes a course by sequencing some materials and he assesses a sequence of materials.

Teacher to learner
Creation: A Teacher composes a course by sequencing some materials.

Use: A learner learns a course using the sequencing proposed by his teacher.

System/Approaches by JEIRP partners:

- [Herin & al., 2002]

3.4 Exercises assessment

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner				
Teacher				HH CH
Instructional Designer				HH CH
Pedagogical Administrator				

Teacher/Instructional Designer to Pedagogical Administrator
Creation: A teacher/instructional designer, could be a software agent, creates an annotation, (for example exercise never attempted, too difficult).

Use: A pedagogical administrator reads the annotations and takes proper action (for example, decide to delete the exercise from the pool of learning resources).

3.5 Quality Assessment through Data Analysis

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner				
Teacher			HH	HH HC
Instructional Designer				HH
Pedagogical Administrator				

Teacher to Instructional Designer
Creation: A teacher sequences Learning Objects to create a course.

Use: An instructional designer performs multidimensional analysis on the sequences followed by users (learning paths, learning styles, etc.) in order to improve course sequencing or to detect new Learning Object needs.

Instructional Designer to Pedagogical Administrator
Creation: An instructional designer defines a pedagogic methodology (using IMS Learning Design).

Use: A pedagogical administrator performs multidimensional analysis on the pedagogical methodologies defined in the LMS (educational purpose, instructional concepts, examples and exercises, etc.) in order to detect the main trends and check for their consistency.

Teacher to Pedagogical Administrator
Creation: A teacher evaluates and annotates Learning Objects.

Use: An instructional designer performs multidimensional analysis on the existing pool of Learning Objects (most popular, instructional methodologies used, etc.) in order to rank the Learning Objects in terms of their usefulness and pedagogic value for a defined learning objective. This role can be partially or completely fulfilled by a computer if there are semantic annotations.

3.6 External memorization

Use: Create:	*Learner*	*Teacher*	*Instructional Designer*	*Pedagogical Administrator*
Learner	HM	HH		
Teacher	HH HM			
Instructional Designer	HH HM		HH	HH
Pedagogical Administrator		HH HM	HH	HH

Learner to Learner
Creation: A learner creates annotations he wants the system to remind him at a specific place and a specific moment or activity.

Use: The software reminds the learner such or such annotation depending on a specific place and a specific moment or activity.

Learner to Teacher
Creation: A learner annotates a pedagogical material following the teacher's instruction.

Use: A teacher assesses the learner work, including its annotations.

Teacher or Instructional Designer to Learner
Creation: A teacher or an instructional designer attaches annotations to a pedagogical material he provides to his learners. These annotations represent complementary information about the material and the activity.

Use: (H) The learner reads annotation on the pedagogical material.

(M) The software reminds annotations to the learner during its activity with the document depending on the stage he/she currently working on.

Pedagogical Administrator to Teacher
Creation: A pedagogical administrator adds a remark on a pedagogical material concerning specific issues to pay attention during the teaching activity and sends it to the Instructional Designer.

Use: (H) A teacher studies remarks made by pedagogical administrator on a pedagogical material in order to pay attention to some issues.

(M) The software reminds the teacher during the teaching activity to remind specific issues depending on the stage its learners are currently working on.

Pedagogical Administrator to Instructional Designer
Creation: A pedagogical administrator adds a remark on a pedagogical material concerning difficulties with this material and sends it to the Instructional Designer.

Use: An instructional designer studies remarks made by teachers on a pedagogical material in order to modify this material.

Instructional Designer to Pedagogical Administrator
Creation: An instructional designer attaches annotations to a pedagogical material representing complementary information about the material and the activity.

Use: The pedagogical administrator reads annotations on the pedagogical material.

Instructional Designer to Instructional Designer
Creation: An instructional designer creates an annotation on a pedagogical material and sends it to other instructional designers.

Use: An instructional designer reads annotation on a pedagogical material made by other instructional designers.

Pedagogical Administrator to Pedagogical Administrator
Creation: A pedagogical administrator creates an annotation on a pedagogical material and sends it to other pedagogical administrators.

Use: A pedagogical administrator reads annotation on a pedagogical material made by other pedagogical administrators.

4 Conclusion / Future Work

We developed a methodology to identify and describe usages of semantic annotation of learning content. A wide range of different usages was identified, supporting the general applicability of our methodology.

Even more important than describing existing approaches is the usage of the methodology to characterize possible future research areas, more specifically future usages which could be identified but were not yet the target of exploration. Hence, this work can serve as a basis for future collaboration among the Kaleidoscope partners.

One major future area of research identified was to extend the scope of existing roles. For instance, learners can take a more active part, as annotators of learning content (future usages of course generation) or by rating courses (European Higher Educational System scenario). Instruction that lets learners engage in a more active participation has become a focus of discussion, especially thanks to the recent PISA studies.

A second area focuses on the evolution of e-learning standards, mainly IMS and SCORM specifications. In

fact, the effective usage of learning objects in educational programs or in customized learner oriented Just-in-Time learning packages requires some higher level specifications. To what extent the use of ontologies can support the effective usage should be investigated in a following JEIRP.

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