Training Management System for Aircraft Engineering: indexing and retrieval of Corporate Learning Object

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Abstract. Training management in a company may benefit of a better integration with competence management outcomes. This paper is about an initial exploration of this proposal. It proposes a specific approach to support the indexing and retrieval of training courses with regard to the professions' target competences. This approach is grounded on Learning Object metadata, and semantic web (SW) technologies enabling advanced search and reasoning on Learning Object description. We intend to implement it using the KINOA prototype platform that contains an annotation editor and a semantic search server. The approach requires that a semantic Learning Object repository is built on several existing data sources. Standards from IEEE LOM and AICC are used as a starting point for the building of the semantic learning object repository and extended to fit with our needs and context.

Keywords: Training management, Learning Object, Semantic search technology.

1 Introduction

Training significantly contributes to the companies' ability to react on requirements of fast changes markets, customer needs and successful business process. Nowadays, industries have a high demand for well-trained teams and in the same time face continuous changes in their work processes and tools. Not only is continuous education an important process but it is managed on a contractual basis. Therefore, training management activity is a usual responsibility of Human Resources departments (HR). Actions and decisions about training are hold by HR according to the company objectives. The important requirement for training management is that it supports developing and maintaining the right range of skills and competences needed for the employees' jobs.

In order to support continuous education of engineers participating in an aircraft program, a training management process has been implemented within an Aeronautic company. This process is supported by a training management tools. It supports training courses management, each training course description is captured, referenced

and maintained, as well as employees' training history management; each training request is captured and traced, if validated, until the corresponding training session has been hold. These memorized data are intended to be reused when dealing with a new training request.
It is identified as a need that training retrieval and selection through this data be linked to the skill and competence development target. Yet, training offer/selection processes are not integrated with other existing company systems such as competence management, HRMS (Human Resource Management Systems), or CMS (Content Management Systems) systems.
This paper relates to a study that currently flows into an EU project called LUISA[1] aiming at search, interchange and delivery of Learning Objects (LO) in a service-oriented context. We restrict it to one subject raised by the definition of training services: the proposal of using competence gap analysis as a driver in the training selection process. In this framework, we first assimilate information about trainings to Learning Objects. Therefore we start by defining Learning Object and the main types of systems that make use of them in section 2. A prior problem we face is how to retrieve trainings in relation with skills and competences as needed to fit our needs and context. We propose an approach that relies on semantic modeling of training and competence management concepts, and indexing technology by means of metadata. The third section presents training selection use cases and necessary underlying conceptual model for search context expression. Then, we present our approach in the fourth section. It was built to illustrate possible indexing and retrieval of Learning Objects created on the basis of existing HR databases and materials. The approach includes the following major steps that are explained in more details in this paper:

- specify the set of metadata from available resources (that represent mostly unstructured knowledge) according to AICC definition
- model the learner's context along several dimensions (personal, organizational, topical, …) and their knowledge requirements
- based on this model, contextualize the training elements (viewed as Learning Object according to IEEE definition)

2 State of the art

Learning objects (LO) can be defined as instructional components or "objects" that can be reused in various contexts for technology supported instruction. They were first introduced in the object-oriented paradigm of computer science. These objects are thus intended to be retrieved and reassembled by instructional designers. They include in first place instructional materials and contents: a LO is "an independent and self-standing unit of learning content that is predisposed to reuse in multiple instructional contexts" (Polsani [1]). Learning resource, on line material or instructional component are all terms that are used to mean much the same as "learning object" in this acceptation. But needs related to computer-based instruction

[1]LUISA is an acronym for Learning Content Management System Using Innovative Semantic Web Service Architecture.

demanded enlarging LO acceptation to cover many kinds of other knowledge elements. For Barritt and Alderman [2] not only is a LO "an independent collection of content and media elements" but also "a learning approach (interactivity, learning architecture, context) …"
In addition to reusability, second fundamental idea is that LO digital entities deliverable over the Internet. This leads to ground LO indexing and retrieval implementation in semantic web technologies, defining metadata schema for their description. The term metadata refers to a collection of keywords, attributes and descriptive information. The search, retrieve and reuse of LO thus rely on their previous description by use of metadata.
To facilitate the adoption of this approach the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) promotes a popular metadata schema in the domain: "Learning Objects Metadata Standards" (LOM) [4]. According to IEEE a LO is "any entity, digital, or non digital, which can be used, reused, or referenced during technology supported learning" [3]. Each one can be described using a set of more than 70 attributes divided into 9 categories responsible for general, technical, or educational aspects of the resource.
The Aviation Industry CBT (Computer Based Training) Committee (AICC) is currently working on an IEEE LOM compatible metadata collection adapted to aviation industry training [5]. The AICC schema specifies a distribution of attributes into 11 categories and includes additional vocabulary compared to LOM.
Different kinds of systems can make use of LO in company context. Learning Management Systems (LMS) are software to support the management and monitoring of company training management activities. Current LMS enable organizations to manage learners (students, employees) keeping track of their progress and performance across various types of training activities. They usually include a catalogue of available and/or relevant courses, materials, and training events, all entities that can be represented in the form of LO. Learning Content Management System (LCMS) are software to support the management of instructional materials and contents. LCMS main target users are authors of training materials and instructional designers. The business problem they aim at solving is the storage and sharing of reusable contents to support the creation and delivery of new learning materials throughout the company.

Therefore learning object metadata become the fundamental element for both LCMS and LMS complementary technologies. The grounding of Learning Object indexing and retrieval implementation in semantic web technologies fits well with our objective (using competence gap analysis as a driver for training's selection). The main interest relies in the innovative features of SW architecture allowing linking of metadata elements with the ontological representation required for search context consideration.

3 Use case description

As underlined above, our goal is that trainings' selection can be based on the opportunity they offer to bridge the gap with the profession target competences. In this section, we present the existing information sources, use cases to illustrate their use, and requirement to provide contextual description for training search.

3.1 Training related information sources

In our current context, training related information and materials (final learners, training modules, sessions, etc.) are stored and managed in several data sources, mainly:

- SAP database allow the management of the training course descriptions and of the employees' training history. In this database Human Resources capitalize the information about the available training courses: each training course is referenced and described by means of a label, a summary, source organism, etc. and keep track of requested, planned, rejected, accepted or completed training sessions for every employee.
- An intranet Catalogue is published based on the training database. It corresponds to a selection of the core offer, build on the more usual and recurrent trainings.
- Independent repositories contain some training programs and training materials. These materials are edited and managed independently in form of MS PowerPoint or Word charts.

3.2 Competence related information source

As regards the description of competences (abilities to perform some activities), skills and knowledge (knowledge and know-how that must be demonstrated for a given competence), a profession's competence and skill index has been defined. It is structured by main fields (families of activities) in the company, such as Engineering, Information System or Architecture. A competence and skill combination builds a profession profile. To illustrate this description, we take the example of the 'Application Architect' profession in Figure 1.

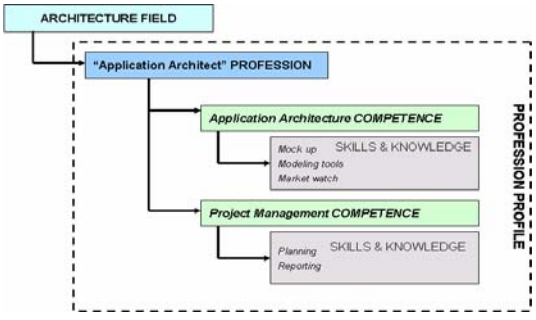


Figure 1- Profession competence index (excerpt)

The reference competence index supports the deploying of competence management throughout the company. Any job or position in the company (meaning a position hold by an employee) can in its turn being defined in terms of target "proficiency levels" defined on the basis of the competences associated to each profession: we call it position profile. Requirements for the target profession profiles are provided by operational managers. They are used afterwards as input for comparison with actual employees' profiles, leading to identifying possible competence gap. Human Resources capture and maintain these competence grids in a dedicated database, for subsequent competence management actions among which training activities.

3.3 Training selection use cases

Two use cases have been identified where training selection involves competence gap analysis.

- Engineers express individual training needs and requests. Then, training managers study each request and accept it or not according to criteria such as budget compatibility and availability of a training course relevant to the expressed needs, but also an assessment of the well-found nature of the request.
- Employees have annual interviews with their direct manager; these interviews aim at allowing comparing their skills and competences with their profession profile. At this occasion, competence gaps are stated which lead to expression for training needs and eventually to selection of trainings.

We comment the first case 'As Is' procedure illustrated in Figure 2. The employee doesn't access the entire training database but may browse the intranet core catalogue. He addresses his request to Training Manager (by phone call, e-mail, etc.). The Training Manager analyses the expressed needs using available resources (the training history and database, profession's competences and skills index) and finally proposes (or not) a training course referenced in the database. He has no access to the actual employee profile. Finally, the selection relies on the Training manager's experience, his knowledge of training prerequisites and goals, and his ability to recall fitness to a particular Profession.

To go on with the second case: interviews are clearly situations where training needs are defined. Yet, available resources to support possible gaps and trainings needs identifying with regard to expected position profile being not linked:

- Position Competence Assessment Grid driving comparison between a target position profile and an employee's one
- Web Training Catalogue (an online view over the training database that comprehends core training offer, not competence indexed).

Although this use case typically involves the knowledge of the competences related to a given profession and proficiency level required, this knowledge can not be exploited to query the training catalogue. This second case finally results in addressing a request to training manager as described in first case.

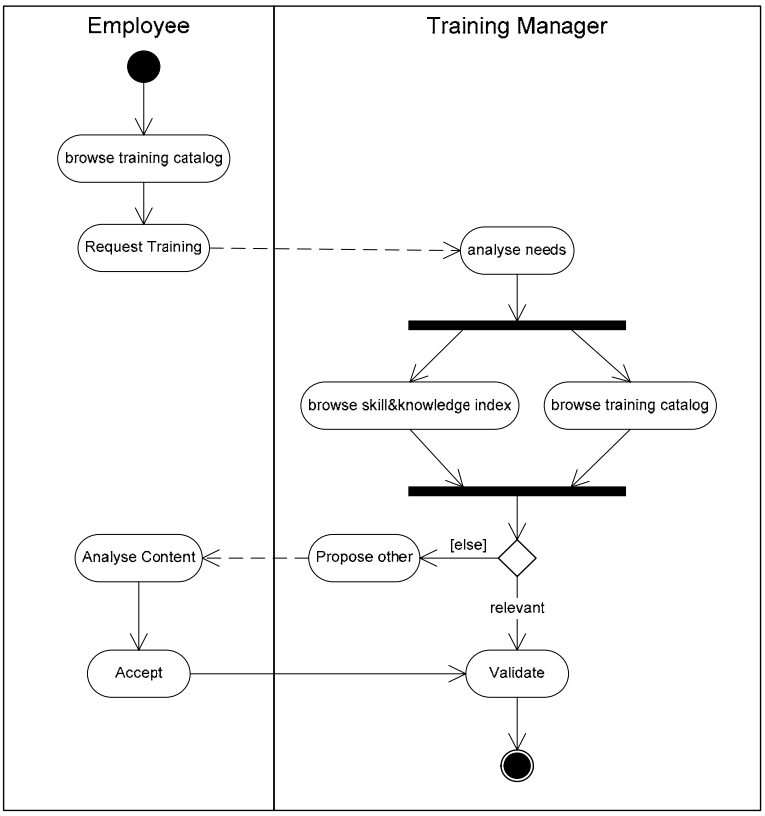


Figure 2 - As Is training request procedure

As a conclusion, we shall underline that actual solution cannot address the need for linking the competences related to a given profession and training courses or programs: this would mean very costly evolutions or modifications of static models coded in databases structure. But semantic web technologies tackle with this type of problems: advanced search functionalities using a global ontology allow combining and even deducing new knowledge from existing resources.

3.4 Requirement for a context aware search

Requirements are cascaded as follows:

1. Training selection service should contribute reducing competence gap,
2. Training search function to support selection should take competence gap description as a criteria,
3. Training description (in form of annotated LO) should include the competence term.

No metadata are currently intended to support description of Learning Object associated competences. Consequently we need to refine LO description to enable retrieval of trainings that fit with profession profiles. To do so, training goals are assimilated to the Learning Object target competences; prerequisites are the required competences that condition request validation and registering to a session.
The key point towards context-aware learning object delivery in our context is that both trainings goals and prerequisites must be described in terms of competences. This is where we face a different kind of problem related to the cost of manual annotation in time and resources, especially when training database is continuously evolving to mirror update offer.
This raises a secondary requirement: the possibility of supporting LO annotation.

4 Towards semantic search and annotation support

With regard to the requirements, we propose implementing a semantic search function over a repository built on the several data sources available. The primary advantage we see in this approach is the possibility of crossing information currently independent. In a second stage, we intend to make use of the allowed advance search to support new annotations.
The actual implementation of the model is not reached yet. Thus this section provides an initial exploration of the approach, which in our view includes:

- define the needed set of metadata to annotate LO,
- create an ontology as a unifying model for existing information,
- export and transform data from existing sources,
- define search involving mapping over the annotation files and the ontology that provide cross views over the resource, and inference support for annotating the LO.

4.1 Semantic search platform architecture

The implementation relies on the KINOA platform [6] first developed to support shared ontology-based annotations on documents. It allowed similar implementations in other application domains. The main reason for this choice is that KINOA integrates Corese Semantic Search Engine [7], which we would experiment to retrieve corporate learning objects. The architecture is shown in
Figure 3. It contains:

- Digital repository with resources expressed in RDF language: training courses, sessions, but also, employees' profiles and professions. It is built with information exported from Training, Training History and Competence (Interview) databases and transformed according to training ontology,
- The ontology expressed in RDFS language
- Semantic Search Server (Corese) that will index these RDF resources files and uses the ontology and inference rules to support search functionalities.
- Search and visualization interfaces (based on the ontology).

Training resources can be enriched and modified by an annotation editor (not represented on the figure).

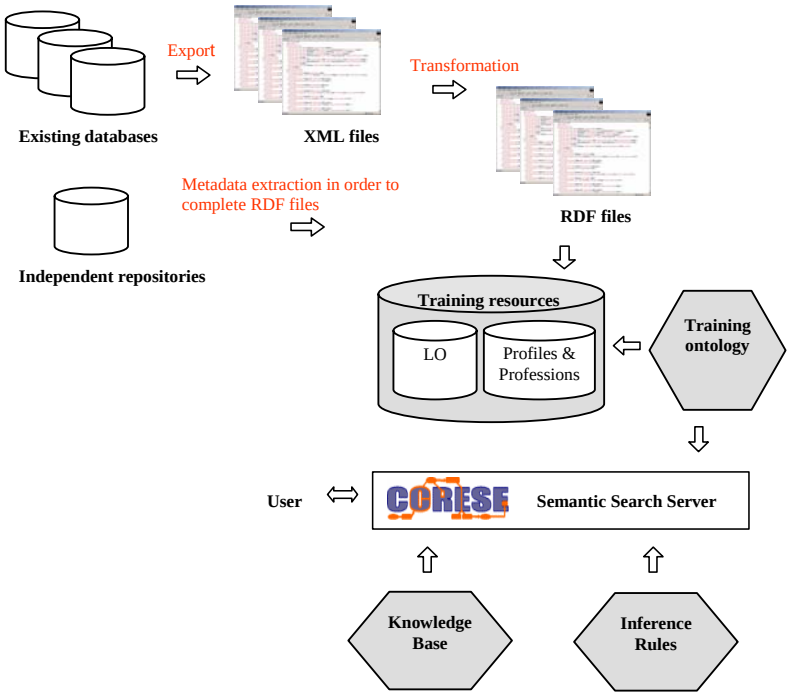


Figure 3 - KINOA search platform architecture

4.2 LO metadata definition

The existing training resources will have to be described before their integration into LO digital repository. We refer to the AICC schema to define three types of corporate learning objects in our context.

- Assignable Unit: Training materials used in training sessions (mainly documents)
- Structured training Package: Training courses descriptions (Training database)
- Training Program: Description of some logical linking between the training courses, often in form of graphical representations in MS PowerPoint format

This structuring conforms to the typology of LO granularity levels defined in AICC standard (Figure 4). Each component type comes with a specific set of (standardized) metadata, not represented in the figure.

Level	Term	Description
1	Asset	pieces of content or assessments that usually can't be used by

		themselves, such as images, animations, text, video, questions.
2	Launchable resource	a grouping of one or more assets bundled together for a single launchable resource, such as a web page.
3	Assignable unit	a self-contained "chunk" of data consisting of one or more assets or launchable resources. An assignable unit is the first level of aggregated objects where assets are combined for a particular stand-alone purpose. An assignable unit is the lowest level that can communicate with an LMS.
4	Structured training package	a digital description of Assignable Units, Launchable Resources, and Assets, including off-line activities (simulator sessions, classroom sessions, etc.). Sequencing information and the structure may be hierarchical with many levels, or flat.
5	Training program	a collection of structured training packages related to a specific syllabus, or curriculum. It includes a digital description of the structured training packages, as well as sequencing information for the structured training packages.

Figure 4 - AICC Learning Objects granularity levels

The definition of the metadata depends of the foreseen application (and ontology) and new metadata may be proposed in the process. For example, Training course database contains attributes that either match with the LOM or AICC standardized schemata (label, identifier, summary, source organism, etc.) or require the developing of a local metadata (target profession, concerned subsidiary company).
Related to the session object stored in Training history come other existing LO metadata such as cost or duration. But more interesting in our context, it provides the link between Training and Competence management database. This will be further explained.

4.3 The ontology

The domain application ontology is needed to semantically describe the metadata and relations between concepts related to the several data sources. It aims at provide the appropriate model of manipulated concepts and help establishing cross data sources relationships.

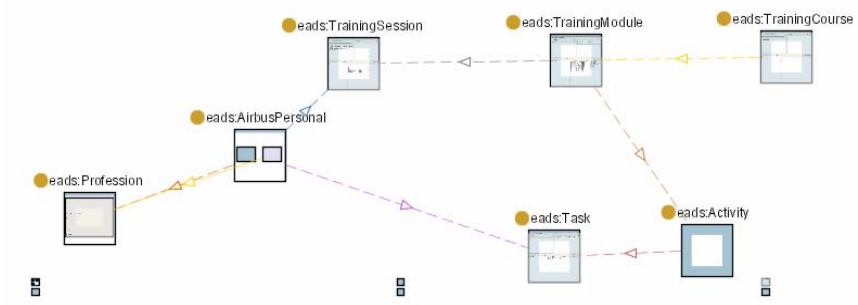


Figure 5 - Training selection ontology (extract)

We are currently developing this model. It will evolve during validation and experimentations with HR training managers. Main concepts are Field, Function, Profession, Competence, Skill, Knowledge, Proficiency Level, Employee, Training Course, Training Session, Training program... An analysis of information sources allows identifying naming conventions to express the modelling concepts, especially to extract some semantics (relation between data). Schema in Figure 6 shows an abstract of some data related entities and established relations. The modelling notation is UML entity-relationship-diagram.

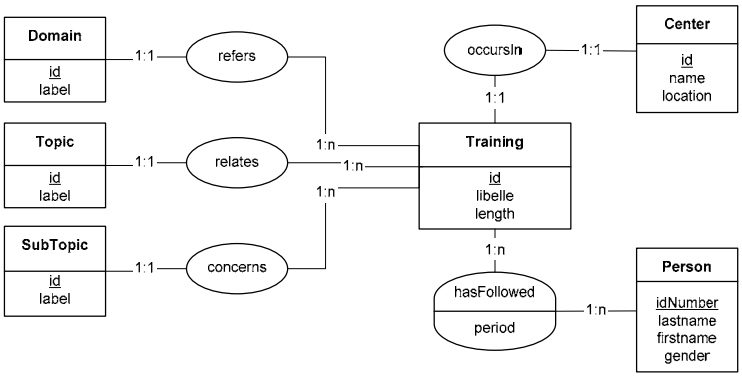


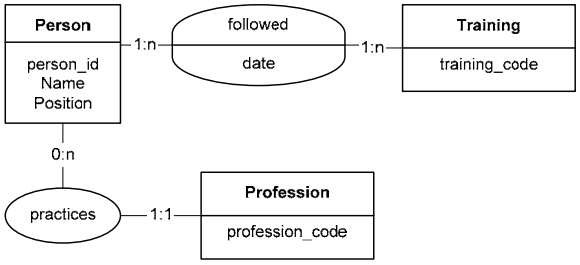
Figure 6 - Training History Database Schema

4.4 Data transformation

Based on the export from the databases, annotations files are built in accordance to the metadata schema and the ontology. A transformation of these initial data results in RDF files as input to the KINOA platform presented (see
Figure 3).
The transformation step specifies for every metadata describing the LO what is to be created from available databases.

4.5 Search description

The core feature of Corese Search Server [7] is the ontology based search and inference rules processing. Following our idea a search for Training must involve a description of profession profile's competences. The model of the domain shoes linking concepts, Session and Person, between respectively Profession profiles and Training Course (a session being a particular implementation of a training course).



It can be used to search and filter training courses adaptively to the employee. For instance, based on the employee's competences (already acquired) and his profession profile (competences required), we can deduct the training modules of interest.
As said above, another objective is to complete missing information by using inferences rules. Existing Training course description (metadata) do not usually contain information about target competence or profession. Reasoning on the employee's profession and its linked competences enables to propose some missing metadata (list of possible 'target' competences to be related to a given training module). The definition of rules will be done in collaboration with HR actors.

5 Conclusion and Perspectives

The use of competence related information is a way to improve the efficiency of training management. We propose an approach to support the indexing and retrieval of training courses with regard to the professions' target competences. This approach is grounded on Learning Object metadata standards and semantic web technologies. We intend to implement it using the KINOA prototype platform that contains an annotation editor and a semantic search server. Ontology base search enables search by type of concept and by relations between concepts. Moreover, specific knowledge of a domain can be added to the data of the repository by using inference rules.
So far, conceptual models and implementation steps have been defined. The next steps, besides actual implementation, will be to work with Training Managers to assess the relevance of searches and to define inference rules that will allow complementing the annotations.

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