ICTA'07, April 12-14, Hammamet, Tunisia

Technology assisted improvement of learning objects quality

Ramzi FARHAT[1, 2], Mohamed JEMNI[1] and Bruno DEFUDE[2]

[1] *Research Unit of Technologies of Information and Communication (UTIC)*
Ecole Supérieure des Sciences et Techniques de Tunis
5 Avenue Taha Hussein, B.P. 56, Bab Menara, Tunis, Tunisia.
Ramzi.Farhat@esstt.rnu.tn, Mohamed.Jemni@fst.rnu.tn

[2] *Institut National de Télécommunication d'Evry*
GET/INT 9, rue Charles Fourier 91011 EVRY Cedex - France
Ramzi.Farhat@int-evry.fr, Bruno.Defude@int-evry.fr

Abstract

Nowadays e-learning is considered as a strategic choice to support training and learning. This trend can be explained in part by some interesting e-learning's characteristics. In fact, this learning mode offers more geographic and temporal flexibility. Furthermore, it is generally flexible, scalable and adaptable. Furthermore, with the adoption of the learning object paradigm it is possible to make a huge economy of time and money due to the possibilities of reuse and share. However, the quality aspect is not sufficiently considered. Thus, we propose an approach to evaluate content quality according to a set of criterions. In this paper we present the key elements necessary to make such as controls in a computable manner.

1. Introduction

In the last few years, many research works have been devoted especially to the enrichment of e-learning environments and plate-forms by diverse tools and features. In the same time, a considerable effort has been made to define specifications and standards to enhance interoperability like LOM [8] or SCORM [1]. Actually, with the maturity of e-learning, new problematic and needs are emerging, in particularly concerning quality. In fact, objectives of e-learning, like making learning more effective, attractive and accessible to the learners, are not totally reached. The problem does not consist on a lack of tools, but it is related to other factors. For instance, as Koper confirms in [9], if we want to accomplish the promises of e-learning we should concentrate on the quality of the instructional design and its relationship to the possibilities of the Internet. Other factors influencing quality of e-learning exist, like the personalization of the learning experience according to some parameters such as e-learner preferences (user interface preferences, learning style, etc.), abilities (knowledge level, physical handicaps, etc.) and cultural specificities (contextualisation of content, adaptation of case studies, etc.).

Furthermore, recent researches related to the quality in e-learning are focused mainly on the evaluation of the whole of the e-learning process. This evaluation covers usually too much elements like: tools, content, tutoring, etc. Actually, two main approaches are available: benchmarking and questionnaire. The benchmarking is defined by the European Benchmarking Code of Conducts as "the process of identifying and learning form Good Practices in other organizations" (European Federation of Quality Management 2004). However, the questionnaire approach, widely used, consists on a set of questions about the whole e-learning process to determine a score that reflects its quality. With those approaches we highline tow limits.

Firstly, those approaches are time consuming and need human operators. In consequence they are not really adapted to the authoring process. In fact, it is generally iterative and incremental thus an automatic evaluation of quality is necessary to save time and money. Secondly, since e-learning is a

multidisciplinary field and its environments are generally complex, it is more interesting to start by studying quality for each aspect separately. Moreover, it seems important to adapt any proposed approach to the conception and production phase when it is easier to make modifications and to fix problems during this early phase.

Therefore, we propose an innovative approach to improve quality by introducing a properties' assessment process, into the learning object's design phase, enabling automation. In the next section will introduce the learning object paradigm that will be considered in our work. Then, we will present the approach principles. After that, we will show a use case applied to an e-learning system called SIMBAD [2]. Finally we will conclude by on going works.

2. Learning Objects

The IEEE Learning Technology Standards Committee defines a learning object as "any entity, digital or non digital, that may be used for learning, education or training" [8]. This is not the only definition, as it is specified in [10]. Moreover, those definitions do not necessarily converge. The learning object paradigm was a response to economic and pragmatic needs expressed by the e-learning community and presented in [5].

At least, we can identify some common aspects between the different definitions. Firstly, learning objects must be accessible through descriptive metadata. Secondly, they must be reusable in others contexts than that for which it is created.

A learning object acquires its characteristics when it is conceived by designers. In fact it is a crucial moment to make suitable actions to make it better in term of quality and to make it more profitable for use. That is why our approach is design phase oriented. Now the question is what the term "quality" means when we talk about learning objects?

2.1. Quality

We mean by quality the requested properties that a learning object must have to accomplish effectively and efficiently its role. Therefore, it is necessary to study the entire life cycle of a learning object to identify the best way to enhance its quality. Figure 1 introduces the different phases of a learning object life cycle.

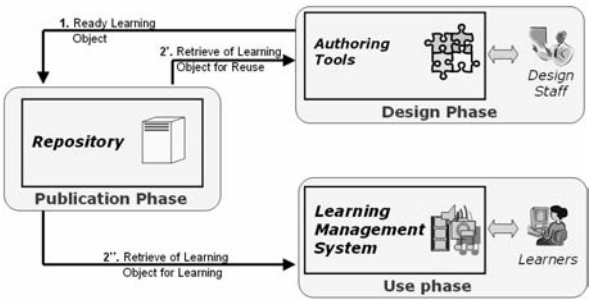

Fig. 1. Learning Object life phases

Following affirmations are presented as outcomes of our precedent works [4] and [7]. The design phase represents the entry point to the learning object life cycle and it is generally done in an iterative and incremental way. The wanted properties in this phase are related to the conformance to a given "technical" and "instructional" aspects.

Concerning the publication phase, it consists on storing the produced learning objects into repositories. Those repositories contain features for search and retrieve of learning objects. The successes of this phase of the life cycle depend on the conformance of learning objects to properties related to the descriptive "metadata" and "technical" requirements.

The use phase consists on the exploitation of retrieved learning objects for learning purpose. To make it possible for the Learning Management Systems (LMS) to make suitable learning object adaptation of form and content, with accordance to learners profiles, it is necessary that some properties be owned. Those properties are related to the "technical" and "instructional" aspects.

The different phases of the life cycle of a learning object, shown in Figure 1, requires some beneficial properties that can be classified on three categories: "technical", "instructional", and "metadata"

To be pragmatic and to define a flexible approach, we admit that there is not a unique set of properties that reflect a "good" learning object. Each community, experts group, organization can define its vision of quality by choosing its own set of properties.

3. Quality improvement process

The first step of the process consists on fixing the mining of the quality. This task must be done by education experts. A set of wished properties (or profile), which must be owned by learning objects, will be provided. The Figure 2 shows an example of a set of wished properties provided in natural language.

// Instructional related properties

P1. The number of concepts treated by a learning object must be lower than 5.

P2. The "introduction", "exercise" and "example" roles must be present in the learning object.

P3. The learning object must begin by an "introduction".

// Metadata related properties

P4. The "general" and "educational" metadata categories must be filled.

// Technical related properties

P5. Content must be in one of the following formats: "HTML", "JSP", "Java applet" or "flash animation".

Fig. 2. Example of Quality profile on a natural language

The second step is to transform the profile in a computable form. Then it must be shared and accessible to learning object designers. In the end of each iteration of the authoring phase, it is possible to evaluate the content compared to the profile. An automatic extraction of learning object's characteristics must be done by a software module. The result is a set of learning object's characteristics. They will be automatically compared with the profile. The output is a measurement of conformity with appropriate feedbacks. Thus the designers will take in consideration those remarks during the scheduling of the next iteration of the authoring phase.

Thanks to this approach, many anomalies and defects in learning objects will be discovered and recovered in an early phase. In the flowing we propose the main elements of the approach.

3.1. Profile description language

Each profile has an identifier and a set of properties. Each property consists on a triple composed of a function, a comparator and a value. The value can be a simple value, an interval or a set of values. The Figure 3 shows the profile definition with a BNF like grammar:

profile := PROFILE_ID : property^{+}
property := function comparator (function | domain) ;
comparator := == | < | <= | >= | IN | NOT IN
domain := value | interval | set
interval := ([|]) value , value ([|])
set := { value, value^{+} *}*

Fig. 3. Quality Profile definition grammar

The profile definition is a set of properties based on functions. Two main categories of functions exist: core functions and supplementary functions. The first category groups the functions applicable in almost all contexts of use. Perhaps, the second category groups the functions tailored to some contexts of use. Thus, it is possible to define a special package of functions for SIMBAD [2], for PERSO [3] or for SCORM [1] compliant systems.

3.2. Core functions

Those functions must cover three aspects: "annotation", "technical" and "Instruction" aspects. The following notation will be used for functions:
<ReturnedValueType> <FunctionName> (<parameters>)

Metadata are very important to facilitate the search, the use and the reuse of learning objects. In practice they are often omitted by negligence or because authors consider that as a boring and a time consuming job. Therefore a core function allowing the definition of properties about learning objects metadata:
boolean categoriesAreFill(String[ ] categories)
Example of use in a profile:
this.Metadata.categoriesAreFill({"General", "Educati onal"}) == true;

The Instructional design aspect touches especially the structure of the learning object. In other terms, the arrangement of the content components with regards to their learning roles (introduction, exercise, example, etc.). Therefore a core function allowing the definition of properties about learning objects instructional aspect:
boolean existRoles (String[] roles)
Example of use in a profile:
this.Instruction.existRoles ("Introduction", "Example", "Exercise") == true;

The technical aspect is covered by some functions. For example:
boolean contentFormatIn(String [] format)
Example of use in a profile:
this.Technical.contentFormatIn("HTML", "JSP", "Java Applet", "SWF") == true;

The Figure below shows how the profile of the Figure 2 is described in conformance to profile grammar shown in the Figure 3.

```
PROFILE_01:
// Instructional related properties
    this.Instruction.countConcepts( ) < 5;
    this.Instruction.existRoles ("Introduction",
"Exercise", "Example") == true;
    this.Instruction.firstLORoleIn("introduction");
// Metadata related properties
    this.Metadata.categoriesAreFill({"General", "Educ
ational"}) == true;
// Technical related properties
    this.Technical.contentFormatIn("HTML", "JSP",
"Java Applet", "SWF") == true;
```

Fig. 4. Example of learning object quality profile

In addition to the core functions it is possible to add supplementary functions as additional packages. In the following we present how it is possible to use our approach during the authoring phase in the context of SIMBAD e-learning system.

4. SIMBAD case

The claim of SIMBDA system is that semantic metadata are required to allow a real reusing and assembling of learning objects. It is based on three models presented in details in [2]: the domain model which represents the concepts covered by the learning object, the learner model which keeps the profile of learners, and the learning object model which describes learning object content related to the domain model. Using this knowledge it is possible to propose sophisticated tools for searching and browsing into the learning object repository. Authors can reuse and compose existing learning objects using operators to produce new learning object. A learning object may be automatically adapted to a specific learner due to the use of operators. Finally, different learning strategies (learning object based or concept based) are proposed to learners. More details about SIMBAD vision of learning object adaptation and learning strategies are presented in [6].

In the following we present the learning object model, some views on composition graphs and some related specific functions.

4.1. Learning object model

In order to be found and re-used, a learning object must be described by a set of metadata. In the learning object model, we distinguish two types of metadata: the first one describes learning objects general characteristics (e.g. author, title, language, media) using LOM standard and the second one describes the semantic of the learning object. This semantic is structured in three parts and described in the same way than software components: prerequisites are the learning object inputs (what is required by the learning object) whereas content and acquisition function are its outputs (what is provided by the learning object).

The learning object prerequisites are a set of triples (concept, role, level); the content is described with a set of couples (concept, role); the acquisition function indicates which triple (concept, role, level) will be added to the user model if a condition of validation is satisfied.

A learning object is a unit accessible via an URI. This unit can be used independently or for composition by third parties. Composition operators (SEQ for sequence, ALT for alternative and PAR for parallel) are defined in order to recursively compose learning objects. A composed learning object is an acyclic oriented graph where nodes are learning objects, or operators.

The following class diagram resume the learning object (LO) architecture in the SIMBAD case.

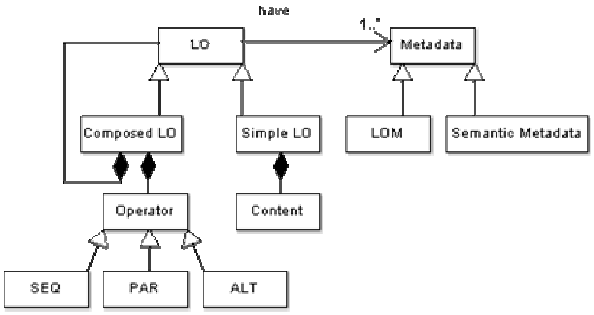

Fig. 5. Learning objects in SIMBAD

4.2. Different points of view on composition graphs

A "composition graph" can be viewed at different levels of abstraction corresponding to the number of nested learning objects (if any). At the upper level (or abstract level), we have the composition graph as defined by an author and at the lower level (or concrete level) we have the composition graph where all complex learning objects have been replaced by their composition graph (and recursively if necessary).

For example, for a learning object identified by LO_400 with the following composition graph (denoted by a binary expression) at abstract level:
LO_400 = LO_12 ALT (LO_350, LO_26)

Where LO_12 and LO_26 are atomic learning objects and LO_350 is a composed learning object with the following composition graph at abstract level:
LO_350 = LO_29 SEQ LO_271
And LO_271 is a composed learning object having the following composition graph at abstract level:
LO_271 = LO_254 PAR (LO_219, LO_210)
Thus LO_400 have the following definition at the low level, called concrete Graph:
LO_400 = LO_12 ALT (LO_29 SEQ LO_254 PAR (LO_219, LO_210), LO_26)
And the depth of the composition graph is three, as mentioned by the following Figure:

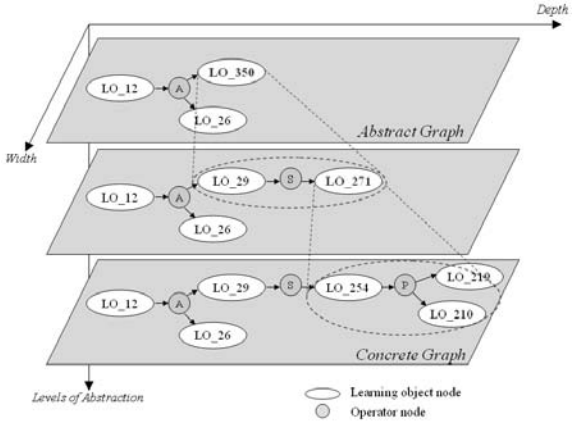

Fig. 6. Different points of view on LO_400 composition graphs

A composition graph can also be viewed as a set of "delivering graphs". A delivering graph is a composition graph without ALT and PAR operators. It corresponds to a possible delivering of the LO. For example, the associated set of delivering graphs for LO_400 is:
SDG (LO_400) = {
LO_12, LO_26;
LO_12, LO_29, LO_254, LO_219, LO_210;
LO_12, LO_29, LO_254, LO_210, LO_219;
}

The SIMBAD system is an example where we have a rich e-learning environment paid in term of complexity especially concerning learning objects design. In fact, with levels of abstract the author can not easily deduct from the abstract graph what a learner will have. Indeed, learner may have at the delivering level something there are not correspond to author goals. So we have big risks about the quality of learning objects. In consequence it is important to introduce a quality control in such as systems.

4.3. SIMBAD specific functions

Firstly, concerning the metadata aspect with SIMBAD we have semantic metadata: prerequisites, content and acquisition. Thus specific functions must be defined. For example, the following one returns the number of the prerequisites:
number countPrerequisites ( )
Example of use:
this.Metadata.countPrerequisites() <5;

The instructional aspect can be controlled by controlling the compositions graphs at their different levels. Therefore some related specific functions.
The following function returns the number of ALT operators used in the composition graph. We mention here that through the controlling of the number of operators we control too the adaptability of the learning objects.
number countALT ( )
Example of use:
this.AbstractGraph.countALT ( ) > 1;
Thus, defined functions cover three aspects: structure, semantic and mixed properties of the composition graph. Therefore a function concerning structural aspects, applicable for different composition graphs of a learning object:
The following function returns the number of learning objects node reused at the given graph level.
number countLO( )
Example of use:
this.AbstractGraph.countLO ( ) < 10;

Moreover with extensions it is possible to have more detailed range to functions application. In the case of SIMBAD it is possible to specify that a function must be applied to the abstract, concrete or delivery graph. This is some examples:
The "existRoles" function returns true if the required roles exists. It is possible to specify the composition graph level for which it must be applied. Example of use:
this.ConcreteGraph.existRoles ({"Introduction", "Definition", "Example"}) = = True;
The "firstLORoleIn" function returns true if the first node has one of the given roles. It is possible to specify the composition graph level for which it must be applied. Example of use:
this.ConcreteGraph.firstLORoleIn ({"Introduction"}) = = True;

5. Conclusion and ongoing works

In this paper we have presented a technology assisted approach for the improvement of learning

objects quality. It provides a computable, flexible and extensible language to describe quality. This language is based on core and specific functions.

Actually we are working on the refining of the core functions. Moreover we are investigating the adequate support to extract information about the properties on a learning object that will be compared to quality profiles.

References

[1] ADLNET. ADVANCED DISTRIBUTED LEARNING INITIATIVE, *"Sharable Content Object Reference Model: The SCORM Content Aggregation Model Version 1.2."*, available from: http://www.adlnet.org/, 2001.

[2] Bouzeghoub A., Carpentier C., Defude B., and Duitama J.F., *"A Model of Reusable Educational Components for the Generation of Adaptive Courses"*, Proceeding of the First International Workshop on Semantic Web for Web-Based Learning in conjunction with CAISE'03 Conference, 2003.

[3] Chorfi H., and Jemni M., *"PERSO: Towards an adaptive e-learning system"*. Journal of Interactive Learning Research, Volume 15, Issue 4, pp 433-447, 2004.

[4] Defude B., and Fahrat R.. *"A Framework to define Quality-Based Learning Object"*, Proceeding of IEEE ICALT Conference, pp 23-27. 2005.

[5] Downes S., *"Learning Objects: Resources for distance education Worldwide"*, International Review of Research in Open and Distance Learning, ISSN:1492-3831, 2001.

[6] Duitama J.F., Defude B., Bouzeghoub A., and Lecocq C., *"A Framework for the Generation of Adaptive Courses based on Semantic Metadata"*, Multimedia Tools and Applications, pp 25-27, 2005.

[7] Farhat R., Jemni M., and Defude B, "Indicateurs de qualité dans les objets d'apprentissage", Proceeding of 4th International Conference JTEA, 2006.

[8] IEEE Computer Society, Learning Technology Standard Committee, *"IEEE Standard for Learning Object Metadata, IEEE Std 1484.12.1."*. 2002.

[9] Koper R., *"Modeling units of study from a pedagogical perspective: the pedagogical metamodel behind MEML"*, Open university of the Netherlands, 2002.

[10] Pithamber R. Polsani, *"Use and abuse of reusable learning objects"*, Journal of Digital Information, Volume 3 Issue 4, Article No. 164, 2003.