LEARNING OBJECT METADATA MANAGEMENT FOR ADAPTIVE CONTENT DELIVERY

1. Introduction

E-Learning is identified as one of the emerging areas in the last few years[1]. Educational content in electronic form is constantly produced and become available through Internet. Learning Objects (L.O.) are "reusable chunks of information, used as a modular building blocks of e-learning content"[2]. Existing learning objects can be reused and so they make custom assembled courses possible, while copyright status remain clear. Information about LO developers, description of its meaning and its possible role are the main body of LO metadata. In order to serve interoperability, metadata follow international standards. Learning Object Metadata (LOM) by IEEE Learning Technology Standards are in wide use. [3]

On the other hand adaptive hypermedia techniques have been used over the last years[4] to make possible for an e-learning environment to provide personalization through adaptive content delivery as the main adaptivity aspect is the deliverance of the content tailored to learner's needs. The purpose of this paper is to discuss how standardized IEEE LOM METADATA can be exploited and extended in order to serve adaptivity. To this end, we refer to cognitive learner's characteristics which are significant to the appropriate educational content selection. Moreover, we identify the content properties which are compatible to any given learner's characteristics. We also propose three new metadata subfields to the existing IEEE LOM metadata standard,

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[1] Eklund, J., Kay M., Lynch H.,(2003), E-learning: emerging issues and key trends (A discussion paper),Last visit 2005-09-12,URL: www.flexible**elearning**.net.au/research/2003/**elearning**250903final.pdf

[2] [*ADL-SCORM (2001).Sharable Content Object Reference Model version 1.2 reference model , Retrieved October 29, 2003 from: http://www.adlnet.org*].

[3] [*IEEE1484.12.1-(2002). Learning Object Metadata Final Draft Standard Retrieved October 29, 2003 from http://ltsc.ieee.org/wg12/index.html*].

[4] Dolog P., Henze N., Sintek , (2004) *The Personal Reader: Personalizing and Enriching Learning Resources using Semantic Web Technologies*

which serve adaptivity to learner's profile while we discuss the exploitation of the metadata which are in use so far.

2. Adaptivity in Terms of Learners Characteristics

Some characteristics of learners should be recorded in a user profile database to be used for adaptation purposes. These characteristics could be the background knowledge (language skills, familiarity to computers e.t.c), the domain specific knowledge, cognitive and affective abilities (user's intellect, learning speed spatial cognition, ability to concentrate or motivation to learn) constitutional attributes (physical properties, body like disabilities, age and so forth), preferences (include learner style definitions), interests and learning targets (Brusilovsky 1996[5]). As far as learner style is concerned in literature one can find a number of learning styles classifications. Among them Kolb classified learning style in a two-dimensional space according to which conception and elaboration of information are the two dimensions of learning process. He also said that *each dimension of the learning process presents us with a choice*. For example, since it is practically impossible to drive a car (Concrete Experience) and analyze a driver's manual about the car's functioning (Abstract Conceptualization) at the same time, one resolves the conflict by choosing."[19]. Hence, in order to conceive information one has to choose between Concrete Experience (C. E.) and Abstract Conceptualization (A. C.) As a matter of information processing one has to choose among Reflective Observation (R. O.) or Active Experimentation (A. E.). Such choices determine the learning style. Other approaches also exist as for example the one given by Pask according to whom, cognitive style is referred to the «serialists/holists» classification. As he wrote «Holists use a global thematic approach on learning, while serialists concentrate more on details." [20].

3. Adaptivity in terms of Content Characteristics

Elaborateness (i.e. detail level) is one of the content characteristics that can be exploited for adaptivity purposes. Content presented in different levels of detail should benefit adaptivity according to learner:

- Domain specific knowledge (which defines the pieces of information i.e the content domain, which a learner has to learn).
- Differences in learning rates.

[5] Brusilovsky , P. Methods and techniques of adaptive Hypermeida, Journal of User Modelling and User Adapted Interaction., vol 6, pp 87-129,1996.

- Learners personal intentions (just to pass a lesson or to learn in depth.)

Content's technicality serves adaptivity to context specific knowledge of user. This characterization turns to be an advantage in interdisciplinary knowledge fields, referring to technical or theoretical knowledge background correspondingly. Content's technicality indicators in a passage are for example the equations (chemical or mathematical ones).

Interactivity of content should also be pronounced. Learning Objects that directly induces learner's action e.g a simulation, should benefit those who prefer active experimentation in Kolb's information processing axis of learning, while learning objects that are for passive learning , should be the proper ones for those who prefer reflective observation.

Educational material should also be characterized as example or as theory. Those who choose Concrete experience in information conceiving take advantages of given examples, while those who choose Abstract Conceptualization in information conceiving benefits more from theoretical presentations.

As a matter of LO content difficulty which is rated from very low to very high the learner is expected to choose according to his/her abilities.

Let us now call LO's appropriateness to learner's current learning state, as LO's Comprehensiveness. This should not be considered as static content property. Thus, it cannot be attached to LO's metadata. Instead, it is inferred dynamically as the learner proceeds through an e-Learning Course. To this purpose, an appropriate log file is kept .

4. Exploiting and Extending IEEE LOM Metadata Fields

IEEE LOM Metadata standard is consists of nine categories. Educational category in this standard consists of the following fields: Interactivity type , Learning resource type , Interactivity level , Semantic density , Intended end user role ,Context ,Typical age range , Difficulty , Typical learning time, Description , and Language

Interactivity type is among the metadata fields which are useful to adaptive content delivery. Its value can be active, expositive, or mixed. Learning by doing is supported by LO characterized as active while passive learning is supported by LO which are characterized as expositive. Using "Interactivity Level" field values, which extend from very low to very high, more fine grained adaptivity is reached.

"Description" field stands for "comments on how these learning objects are to be used" This field according to IEEE LOM standardization has multiple occurrences up to 10 times. So, this field is expected to be exploited for content annotation according to elaborateness, technicality and example/theory discrimination. The described metadata schema has been included in the following source code.

```
<?xml version="1.0" encoding="ISO-8859-7" ?>
- <lom>
  - <general>  </general>
  - <lifecycle>  </lifecycle>
  - <metametadata>  </metametadata>
  - <technical>  </technical>
  - <rights>  </rights>
  - <educational>
    - <interactivitytype>
        <source>LOM v1.0</source>
        <value>Active</value>
      </interactivitytype>
    - <interactivitylevel>
        <source />
        <value /> Low </value>
      </interactivitylevel>
    - <semanticdensity>  </semanticdensity>
    - <difficulty>
        <source>LOM v1.0</source>
        <value>Medium</value>
      </difficulty>
    - <typicallearningtime>  </typicallearningtime>
    - <learningresourcetype>
        <source>LOM v1.0</source>
        <value>Simulation</value>
      </learningresourcetype>
    - <intendedenduserrole>  </intendedenduserrole>
    - <context>  </context>
    - <typicalagerange>  </typicalagerange>
    - <description>
    - <subject>
        <value>Technicality</value>
      </purpose>
    - <determinant>
      - <value>
          <langstring xml:lang="x-
            none">Low</langstring>
        </value>
      - </determinant>
  -</description >
  - <description>
    - <subject>
        <value>Elaborateness</value>
      </purpose>
    - <determinant>
```

```
      - <value>
          <langstring xml:lang="x-
            none">High</langstring>
        </value>
      - </determinant>
  -</description >

  - <description>
    - <subject>
        <value> </value>
      </purpose>
    - <determinant>
      - <value>
          <langstring xml:lang="x-
            none">Example</langstring>
        </value>
      - </determinant>
        -</description >
    </description>
  </educational>
  - <relation>  </relation>
  - <classification>  </classification>
 </lom>
```

Comprehensiveness can be inferred as the log file consisting of data about which LO user has already studied is matched against Educational metadata "Relation" field of the kind "is part of" or "requires"

5. Conclusion and Further Work

Exploiting and extending the IEEE LO Metadata fields in order to be usable in Adaptive Hypermedia Educational Systems one expects to allow the wider use of the LO databases which are reachable through the web. It expected also that this contributes from this point of view to the LOs interoperability. In [ ] we introduce a domain knowledge concept map construction based on the proposed LOM standard.

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