E-Learning for Spatial Information Systems with personalized functionality

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Abstract: *E-Learning should be dynamically personalized to both groups and individuals. Only than e-Learning benefits will be heightened. The same courses will be presented with different content variations to different virtual groups. As learners move through the content, the course content and flow will alter. For course designers, the idea of learning objects requires an immense change in thinking. Instead of looking at learning as a fixed linear progression, they should now look at learning as clusters of independent, stand-alone objects of knowledge. These learning objects should be dynamically selected and sequenced by computer agents to form an individually tailored course.*

For e-Learning, learning objects and XML not only present advanced technologies, but also promise an approach to create online instruction quickly and economically. Although it is unlikely that a global library of learning objects will be formed in near future, developing a campus-wide instructional system based on learning objects for courseware design and delivery is still possible. In this paper, a set of XML schemas is introduced, that can be used as basic templates to wrap and tag reusable learning objects.

Keywords: *e-Learning, reusable learning objects, courseware authoring, personalization, cognitive styles.*

I. Literature review

E-Learning is increasingly being integrated into organisations and universities as a new means of teaching and supporting learners. In most cases e-Learning is used to support instruction, led classes in a blended learning environment; however, e-Learning is also sometimes used as the sole method of instruction [Nichols, 2003]. Moving from a classroom-training environment to an e-Learning environment is a vast undertaking within an organization both for employees and managers alike. The transition involves migrating training functions or training components from a static, physical environment to a dynamic, virtual environment. A substantial change in the training function and in the technical infrastructure of the organization is caused by this. Therefore, this transition should be planned, controlled and coordinated, prior to, during and following its migration.

Today's requirements for cost reduction in learning resources for both industry and academic institutions are becoming increasingly high. Therefore ways of reducing cost of e-Learning systems development without sacrificing quality have become a popular area of interest [Urdan & Weggen, 2000]. A way that both cost and development time can be reduced is by improving reusability [Downes, 2001]. This can be accomplished by ensuring that all content created is formatted into small reusable pieces that are each responsible for teaching one core concept, and are in a form that is independent of any specific implementation. These pieces of content are referred to as learning objects.

When course content is being developed, the course provider is not always looking at how the content could be reused in future courses. There is more concern with producing the content as

quickly as possible even if this means imbedding the course content directly into the display of the course, i.e., placing all content directly into the HTML. A definition of a learning object needs to be established in order to start the organization of content into reusable learning objects. That includes the purpose it is being used for [Hamel & Ryan-Jones, 2002], as well as a schema or set of schemas in XML that need to be created before the content development stage [Walsh 1998].

II. Re-usable SIS/GIS Learning Objects

Before designing an e-Learning system based on XML, some fundamental concepts and ideas must be clarified. The idea of learning objects requires an immense change in thinking for course designers. Instead of looking at learning as a fixed linear progression, they should now look at learning as clusters of independent, stand-alone objects of knowledge. These learning objects should be dynamically selected and sequenced by computer agents to form an individually tailored course. The key problem here is how these learning objects should be handled. A way is needed to be find how to ensure that these objects can be more easily accessed, can be located by computer, can be easily updated, and can be seamlessly tied in with other objects to make a more complete learning package. It is also needed to make sure that the learning course built on learning objects can present clear objectives, integrated content, and carefully sequenced instructional activities.

One answer for this is the using of XML as metadata for describing the learning objects. In an e-Learning system, metadata is used to support resource discovery. Every learning object will have associated metadata that is written in XML and conforms to a particular XML Schema. The schema gives specific constraints on the structure of metadata, and also provides information about the interpretation of the metadata. A series of tags defined in the schema are combined together to describe the learning objects. A designer or a search engine will look at the metadata to decide how to find the necessary learning objects and reconstruct them again. However, metadata alone is not enough. To make it possible for computers to make sequencing or any other instructional design decisions, the computers must have access to instructional design information to support the decision-making process. Therefore, it is necessary to have some way to describe the organizational structure of the learning objects and to include enough instructional design and sequencing information. Moreover, to make the instructional design suitable for an individual user, background information about learners is also required.

The idea of getting course designers to organize their content into learning objects is theoretically good, but problems arise when the designer does not clearly understand what a learning object is. When developing learning objects, one difficult part is the decision how to break the content down into pieces that will be easy to reuse. A common mistake is making each learning object so large that it covers several concepts. This creates a learning object that cannot be easily inherited and used by another course. When creating material for online courses, one of the goals is to create each learning object so that it can easily be used in multiple courses. However, since most people do not understand what a learning object should and should not contain, this makes it difficult for developers to create reusable pieces of content.

Before any discussion begins about creating an XML schema for a learning object, a basic understanding should be gained of what a learning object is and what research is currently happening in this area. Several definitions of learning objects devised by well-known researchers in this field will be examined to help get a better understanding of learning objects. The most widely discussed definition of a learning object comes from the IEEE Learning Technology Standards Committee. The IEEE has developed the 1484.12.1-2002 Draft Standard for Learning Object Metadata in which they state their definition of a learning object [IEEE, 2002]. The IEEE defines a learning object as:

"Learning Objects are defined here as any entity, digital or non-digital, that can be used, re-used or referenced during technology-supported learning." [IEEE, 2002]

This definition has been criticized by researches in the learning object field. The main problem with this definition is that it is too broad. The statement of a non-digital entity allows for almost any person, place, or event to be considered a learning object [Wiley, 2000]. This definition does not exclude anything from being a learning object and this makes this definition in its current form problematic to work with. Defining learning object in too broad a way, causes any useful meaning about learning object to be loosed. Although reuse is the core of the learning object notion, as flexibility, adaptivity, and interoperability are all facilitated by the property of reuse, there is still a trade-off between the benefit of reuse and the cost of combination and re-sequencing. It is unclear in most definitions of a learning object what the content of a learning object should be. There are specifications available defining what the metadata used in a learning object should be, such as the specification defined by IEEE, but little discussion about the structure and design of learning object content. In this research, a much narrower definition is preferred, which makes the automatic construction of individually tailored courses possible.

In its most basic form, a learning object is made up of two components: metadata and content [Downes, 2001]. It is important to understand that every learning object consists of these two components, especially when it comes to writing a schema to represent a learning object.

Metadata is data about data. It allows for information in some digital resource to be described and classified as well as providing other useful information. Learning object metadata allows developers to provide identifying information about content they have developed, as well as use metadata to search other learning objects that they may be able to use. Some examples of typical types of learning object metadata are: author, organization, creation date, version, title, subject, description, keywords, preconditions etc.

Content in a learning object is some group of material combined together to teach one concept. Content material for online courses can be any of the following: explanations, instructions, definitions, images, animations, programs, quizzes, etc. For example, a possible set of content for a learning object could consist of an instruction, definitions, facts, interactions, examples, summary, assessment, and additional resources. This is just a basic example of the types of material that could be used to create the content for a (GIS) learning object [Fig. 1].

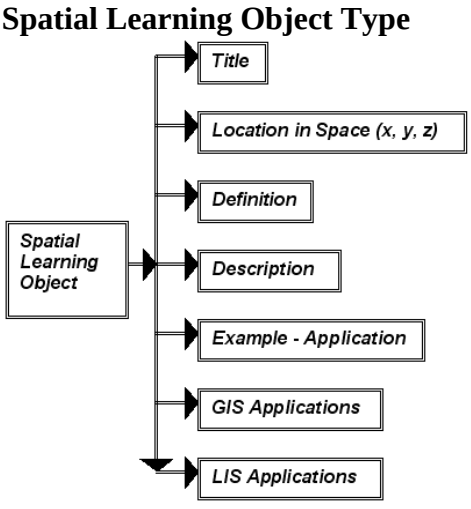

Fig. 1: The Structure of a GIS e-Learning Element (Object)

Therefore, a redefinition of a learning object may be expressed as follows:

A learning object is an integrated knowledge object, focusing on a core concept, not just a piece or a chunk of information.

Learning objects are often used as components to assemble larger learning modules or complete courses, depending on different educational needs. Normally, a learning object is smaller

than a course, a module, or a lesson. However, in order to describe or explain a single core concept clearly, a learning object may still include some integrated knowledge bits, which may be in different formats, such as text, pictures, video clips, maps or simulations. All materials in a learning object will be organized to surround and describe a core concept.

III. aN e-LEARNING GIS Schemas

With these in mind, a basic framework for an e-Learning system becomes clear. The basis of the system is formed by a library of learning objects with metadata. In order to construct personalized courses for learners, a data model of a learner is needed to provide background information to describe the learner's needs. The Learning Management System, including a search engine, uses the learner's interests to select appropriate learning objects and then pieces together courses based on the organizational structure and instructional design information [Wiley, 2000].

In this project, the following aspects are defined in XML schema:

- The Learning Object
- The Metadata for retrieval and reuse

Spending time researching metadata is avoided since there are existing detailed standards or specifications for learning object metadata, the content packaging specification and the learner information specification that have been developed by IEEE, IMS, CanCore [CanCore, 2002] and Dublin Core [Dublin Core, 2005]. However, it should be noted that some modifications are needed, to make the schemas more suitable for a reusable and adaptive e-Learning system. Moreover, the concept of learning object and develop a schema for it is redefined according to the new features that have been summarized. All of these four schemas and a learning management system form the foundation of the whole e-Learning system.

III.(i) The Design of a Schema for GIS Learning Object

In this schema for learning objects, the root element is "learning Object". Other elements are organized into eight different categories:

- title – The title of the learning object
- definition – The definition of the core concept on which the learning object focuses
- description – Some detailed descriptions of the core concept
- example – Some examples about the core concept
- application – Simulation or demonstration used to explain the core concept
- conclusion – The conclusion about the core concept
- exercise – The exercise used to improve the study of learner
- test – The test used to evaluate the result of study

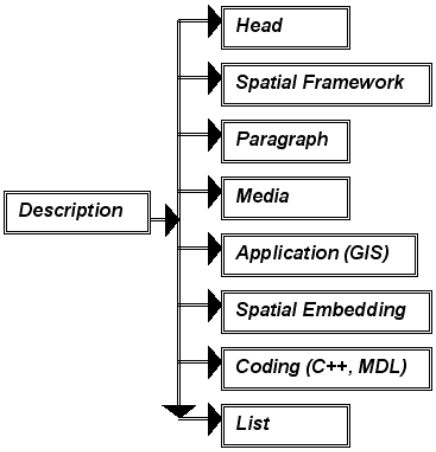

Fig 2: The Proposed Structure of a "Description" Spatial Element

For each sub-elements of the root element, a unique ID is assigned, which can be used as a reference to this element. Each element may also have "reference" attribute and "status" attribute. If the learning object inherits content from a parent learning object, the "reference" attribute indicates one specific element in the parent, and the "status" attribute indicates what kind of action will be taken [Fig. 2], [Table 1].

Name	Use	Facets
id	*required*	*connection*
reference	*required*	*integration, focal*
status	*optional*	*zonal, substitution*

Table 1: *The Attribute Functionality*

The following lists the available actions:

- If the status is "zonal", it means that the content in the current element should aggregates values of a field over each of a set of zones.
- If the status is "substitution", it means that the content in the current element should replace the content in the parent element, which is indicated by the "reference" attribute.
- If the status is "integration", it means that the content in the current element should integrate with the content in the parent element, and then combine together to form a single content.
- If the status is "connection", it means that the current element and its content should be inserted behind the parent element.
- If the status is "focal", it means that the attribute of the current element should derive, at a location x, of a neighbourhood function n(x) of x.

Since a learning object may contain text content, some elements are still needed to support such textual formats as paragraph, table, list, and head. In addition to text elements, the "media" element is used to indicate what kinds of multimedia are used in this learning object, so the proper tools can be invoked to display the multimedia files. This element includes three attributes, "type", "mimeType" and "uri", which present the type of the multimedia file and the reference to the file. Moreover, the "code" element may be used to tag some special texts, such as formulas or algorithms. However, for the "test" element and "exercise" element, it is possible to adopt an existing specification to develop test items. In this schema, QTI Lite specification from IMS is imported [IMS, 2002]. This specification is based upon the IMS QTI specification and is the realization of a subset of that model. It is presented as the entry-level specification to the full QTI specification, just supporting the question styles of true/false and multiple choices with single answer. By adopting the specification from IMS, the test items developed for learning objects may be easily reused by other e-Learning systems.

III.(ii) The Design of a Schema for GIS Metadata

There are currently several metadata XML schemas focusing on e-Learning. However, though those schemas may be used, a specific metadata XML schema should still be created in this research for the following reasons:

a) The purpose of most standard schemas having the goal of interoperability is to allow everyone throughout the world to be able to successfully find and use learning objects. Therefore these schemas are complex, often with about one hundred element tags. An alternative is to choose some necessary elements from them and to build a new schema, which will provide a good enough description for the learning objects in this specific project

b) A designer wants to be able to search for the specific topics within the library of learning objects. To do this effectively, the schema must have a controlled vocabulary, only allowing certain words to be entered between tags. While this makes the searches fast and accurate, it is not possible to do this without creating a unique schema. In fact, more constraints were needed to be add in this XML schema and make the metadata document more meaningful [Fig. 3].

```
< XS: schema xml: XS = http://www.GIS.com/XMLSchema
  elementFormDefault = "qualified"
  ----------------------------------------
        < XS: import schemaLocation = "ATEI-1.xsd"
              import schemaLocation = "boundary"
              import schemaLocation = "interior"
              import schemaLocation = "closure"
           ----------------------------------------------------
                        < /XS: sequence >
                  < /XS: complexType >
        < /XS: element >
```

Fig. 3: A GIS e-Learning Schema

However, using a unique XML schema will not significantly harm the interoperability of the e-Learning system. The tags are choosed from the standard schema, so every tag in this schema is still meaningful to others. A third-party search engine that can handle the XML metadata documents conforming to the standard schema could also handle this one. In practice, about 23 tags from the IMS Learning Resource Meta-data Specification were selected. Following are the first and second level elements in the tree structure of the GIS metadata schema [Fig. 4].

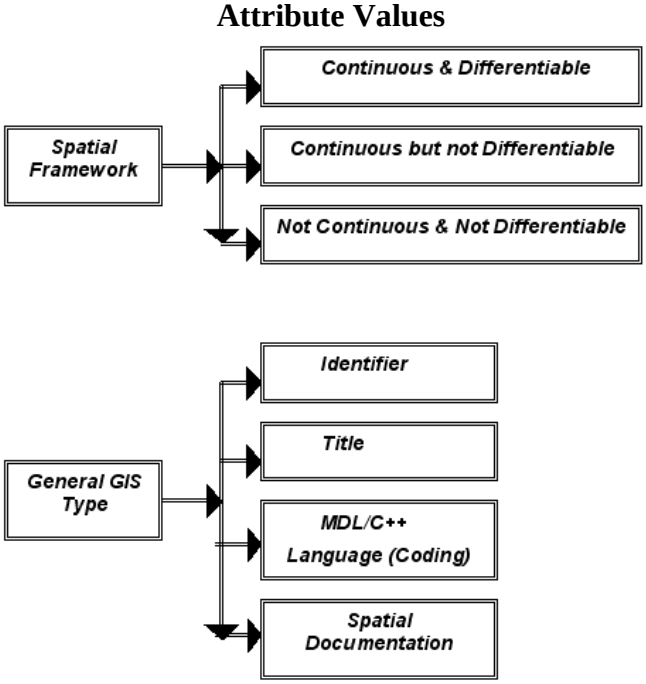

Fig. 4: The Structure of the GIS Metadata Schema

1. **General** – Context independent features of the resource
    - identifier – Globally unique label for learning objects
    - title – Name give to the resource
    - language – The human language used by the learning object
    - description – A textual description of the content of the learning object
    - keywords – Keywords describing the resource
2. **Technical** – Technical features of the learning object
    - format – Technical data type of the resource
    - location – A location or a method that resolves to a location of the resource
3. **Educational** – Educational or pedagogic features of the learning object
    - interactivitytype – the type of interactivity supported by the learning object
    - learningresourcetype – specific kind of resource, such as text or figure
    - context – the typical learning environment where use of learning object is intended to take place
    - semanticdensity – subjective measure of the learning object's usefulness as compared to its size
    - difficulty – how hard it is to work through the learning object for the typical target audience
4. **Relation** – Features of the resource in relationship to other learning objects
    - kind – Nature of the relationship between the resource being described and the one identified by <resource> element
    - resource – Resource the relationship holds for
5. **Classification** – Description of a characteristic of the resource by entries in classification
    - taxonpath – A taxonomic path in a specific classification

IV. Conclusions

The main issue in this project was to decide what the content of a learning object should be. Narrowing the definition of a learning object to refer to course design made the determination of what content types to use considerably easier. The purpose for designing the XML schemas was to create a set of schemas that would be directly useful to online course developers in the Computer Science field. It will be interesting to see how the design of this learning object and information object hold up when used to develop the content for a real online Computer Science course. We believe that these schemas will be useful, even if not as a finished product, but more as a work in progress. If a content developer has a set of schemas to use as a starting point, at the very least they can modify and improve these schemas as weaknesses in their designs are discovered. However, with these schemas the content developers will not have to start from scratch by performing their own research in this area and writing their own learning object and information object schemas.

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