

Educational Topic Maps^{*}

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Abstract

To address the critical issues of findability, shareability and reusability of learning resources, we propose an authoring environment for building, maintaining, and using standards-based, ontology-aware e-learning repositories. The proposed environment, TM4L (Topic Maps for Learning), is based on the new ISO standard XML Topic Maps (XTM).

1 Introduction

A crucial issue in e-learning is how to efficiently organize and classify learning content. This paper deals with developing concept-based courseware that provides information support for performing learning tasks in web-assisted courses. Finding relevant information is a recognized difficulty in web-based task performance. For example, a study of undergraduates in twenty two courses [Bailey, 1997] shows that when asked at which stage of the research they needed help, students overwhelmingly (80.9%) chose “finding relevant information”. We propose an ontology-aware e-learning environment aimed at assisting students in retrieving information necessary to perform course tasks (assignments, projects, etc.) in an intuitive, meaningful, and efficient way.

In science disciplines, the subject domain structure can be represented by the domain concepts (agreed upon common vocabulary) and their interrelationships. This representation vocabulary, or *ontology*, not only presents the deep conceptual knowledge in the specific domain but if used for annotating learning resources can enhance their *findability*, *shareability*, and *reusability*. Thus an ontological representation of a subject domain can support, from one side, efficient *context-based* access, search, and retrieval of online learning materials, and from another, a deeper overall understanding of the subject domain. Another advantage of such representation is that the concept-based content can be used across different sub-fields and courses. Topic Maps (TM) [Park and Hunting, 2002] are suited to representing ontologies. The ability of TM to link resources anywhere on the web and to organize them

ontologically makes TM an attractive technology for the new wave of e-learning systems. By offering semantic structure, TM can guide students in their browsing and search of learning materials. In addition, the growing repertoire of techniques for simplifying, merging and interrelating ontologies can be used to combine TM created by different authors/applications. However, a central bottleneck for spreading TM as an e-learning platform is the lack of specialized educational TM authoring tools [Dichev *et al.* 2004].

2 TM4L

Ontology-aware e-learning applications must provide extensive support for both ontology development and ontology usage. In the last decade, a number of tools for ontology construction have emerged; however, they are not appropriate for use in a TM-based environment. Although some currently available ontology editors such as Protégé-2000 [McGuinness, 2002] have plug-ins allowing export of ontologies to Topic Maps, they do not support essential TM features, which are of significant importance for interoperability of e-learning applications. Thus our goal was to develop an authoring environment guided by two considerations: conformance to the TM standard coupled with facilitating the task of e-learning content authoring. Taking into account these considerations, we have designed an environment, TM4L, which enables the creation, maintenance, and use of ontology-aware courseware based on the ISO standard – Topic Maps. As an alternative to conventional authoring systems TM4L is aimed at facilitating the integration of already existing learning resources on the web.

To ensure sharability, exchangeability, reusability, and interoperability of learning content, TM4L steps on two key properties of Topic Maps:

- merge of topics (to support individual or collaborative authoring)
- published subjects (as a platform for interoperability).

Published subjects are a method of establishing semantic identity of subjects. They are intended to provide non-ambiguous identifiers for subjects. TM4L supports published subjects: for each topic (representing in TM a subject), authors can specify the URI that is to be used as its

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Published Subject Identifier (PSI). This TM4L feature is intended to promote interoperability of e-learning applications. It reflects our vision that subject ontologies in specific domains will emerge stepwise, by creating, augmenting and interrelating ‘private’ ontologies to achieve completeness and consensus. This process will be only possible if semantic identity of modeled subjects is established.

Another important TM feature supported by TM4L is the concept of scope. A scope indicates the context within which a characteristic of a topic may be considered to be true. One common use of scope is to provide localized names for topics. For instance, to distinguish between a pointer interpreted as a memory address and a screen pointer used by speakers, scopes of “Programming” and “Presentation” may be assigned to the “Pointer” topic. TM4L uses scopes to define contexts. A simple application of scope is to separate “beginner” resources from “intermediate” or “advanced” resources, thus enabling different information to be presented to learners of different levels.

TM4L also allows a topic to have one or more names associated with it (e.g. two authors may express the same topic in different ways). Giving more than one name to a topic means that all the names refer to the same subject, i.e. the names are all synonyms. In addition, TM4L allows different topics to have the same name thus enabling distinction of terms with different meaning. It is possible to use variant names - alternative forms of base names that may be more suitable for certain computational purposes than the primary names.

The TM4L environment consists of a TM Editor and a TM Viewer. We have currently completed the TM4L Editor, which allows the user to build ontology-driven learning repositories. It provides ontology and metadata engineering facilities coupled with basic document management capabilities. The learning content created by the editor is compliant with the XML Topic Maps (XTM) standard and thus interchangeable and interoperable with any standard-based TM tools. TM4L is designed to hide the details of the XTM syntax and presents the author with a friendly view of TM. A screenshot of the TM4L Editor interface is shown on Fig. 1.

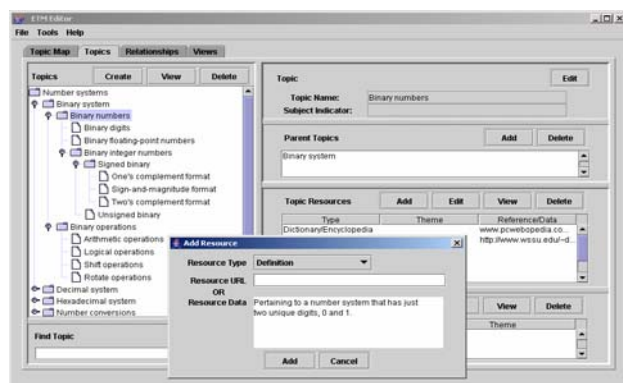


Figure 1. A screenshot from the TM4L Editor interface

Authors without specific technical knowledge of TM and XTM are able to create and edit learning material. Since TM4L is TM-based, the main objects that it ma-

nipulates are topics (representing domain concepts), relationships, resources, and views (implementing the TM scoping feature). Resources can be internal and external. Internal resources are short pieces of information about a concept, such as definition, short description, etc., stored locally. External resources can be any addressable objects on the web referenced by their URI. In the TM4L terminology a view (scope) is defined in terms of themes.

The TM4L Editor’s functionality includes the following capabilities:

- Creating and maintaining concepts.
- Creating and maintaining relationships between concepts: adding/deleting relationship types, member roles, and relationship instances. (Pre-defined relationship types such as type-subtype are available for use.)
- Creating resources (learning objects): defining resource types, adding/deleting/modifying resources.
- Creating contexts (defining different views on a TM).
- Storing Topic Maps persistently either in standard XTM files or in an Ozone database.
- Merging Topic Maps.
- Checking for broken links to external web resources.
- Importing/exporting Topic Maps.
- External searches on the web (through Google).

The TM4L Editor is implemented as a client-server application developed in Java and using the TM4J Topic Map Engine (<http://tm4j.org/dg-d0e35.html>). The Editor has open modular architecture that allows easy extension of its functionality.

3 Conclusion

In this paper we present work in progress that is aimed at contributing to the development of efficiently searchable, reusable, and interchangeable discipline-specific repositories of learning objects on the Web. We propose an authoring environment for supporting the development of standards-based ontology-aware online learning materials.

References

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