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Developing a learning object metadata application profile based on LOM suitable for the Australian higher education context

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This paper reports recent work in developing of structures and processes that support university teachers and instructional designers incorporating learning objects into higher education focused learning designs. The aim of the project is to develop a framework to guide the design and implementation of high quality learning experiences. This framework is premised on the proposition that learning objects are resources that can be incorporated within a learning design. The learning design serves as the pedagogical model that drives the development. The first phase of the project required an analysis of metadata schemas by which learning objects could be described, to facilitate discovery, retrieval and inclusion in a learning design. In particular, the pedagogical descriptors within the IEEE Learning Object Metadata (LOM) standard were examined to determine their suitability for use in this project. The findings indicated that enhancement of the educational descriptors was required. To address this, a learning object metadata application profile specific to Australian higher education has been developed. This paper describes the process by which the metadata application profile was developed within the context of the overall project.

Introduction

Considerable attention is being focused on the concept of 'learning objects' as a mechanism to facilitate reuse of learning materials amongst educational communities. The practice of reusing educational resources is not new – teachers and designers routinely create new learning experiences for their students by reusing ideas and resources previously developed by themselves or others. However, within an Internet mediated environment, it is the global scale at which this activity can be performed and the digital form of the entity being shared that has been extended by the learning object concept. The idea behind learning objects is that a person (being a teacher, instructional designer, or even a student) can find

appropriate learning materials to reuse within their own learning setting. For this to be possible, a learning object must exist in an appropriate form to allow its reuse (eg., in digital form); it must reside in a place from which it can be retrieved easily (eg., a learning object repository); and it must be accompanied by an appropriate annotation to facilitate its identification and retrieval (metadata). Although this idea seems relatively straightforward, it assumes that the definition for learning objects is firmly established, that there is a standard annotation methodology, and that teachers or designers know how to incorporate learning objects into their instructional context. These issues, however, are yet to be fully explored (Anderson, 2003; Bush, 2002; Collis & Strijker, 2001; Hodgins, 2002).

This paper describes a project that is investigating these issues by developing a framework to guide the retrieval and reuse of learning objects, in a pedagogically appropriate way. The project's premise is that learning objects are resources that can be incorporated within a learning design. A learning design provides a pedagogical model that can be used to guide the development process of a learning experience. A starting point for the project was to examine existing learning object annotation strategies (metadata schemas) to determine how the pedagogical descriptors could inform the retrieval and incorporation of learning objects into a learning design. The outcome was to devise an appropriate learning object metadata schema, suitable for use in this project. The process undertaken to achieve this outcome is the focus of this paper.

Learning objects and reusability

The definition of a learning object has resulted in much debate. Three themes surface in the literature about the characteristics that constitute a learning object: form, granularity, and purpose. Learning objects can be digital or non-digital in form. The Learning Technology Standards Committee (LTSC) within the Institute of Electrical and Electronics Engineers (IEEE) has adopted a broad definition, proposing that a learning object is "any entity, digital or non-digital, that may be used for learning, education or training" (IEEE, 2002, p. 3). Yet, definitions that exclude non-digital entities are becoming more prevalent. For example, Wiley (2002a) states a learning object is "any digital resource that can be reused to support learning" (p. 6). The scope of the digital resource can range from smaller type resources such as digital images, small pieces of text, etc, to larger resources such as "Web pages that combine text, images, and other media or applications to deliver complete experiences (a complete instructional event)" (Wiley, 2002a, p. 6). Hummel, Manderveld, Tattersall, & Koper (2004) have refined this definition by explicating that to be a learning object a digital resource must be reproducible, addressable (ie.

connected with a URL and has metadata), used to perform learning or support activities, and made available for others to use. The Le@rning Federation schools online curriculum content initiative (2002) takes a similar stance, stating that learning objects have educational integrity, that is, they can be "identified, tracked, referenced, used and reused for a variety of learning purposes" (p. 1). Thus, granularity has become an issue when defining learning objects. Furthermore, the purpose for which a learning object may be used has influenced how it is defined. By explicating the 'learning' aspect of the digital resource, a 'learning object' can be distinguished from a mere 'content object'. For example, Downes (2003) argues that for a digital resource to be classed as a learning object, it must have some instruction inherent in it:

> A mere picture is not a learning object because there is no instruction inherent in the picture…The presentation of a picture, therefore, must be accompanied with some context. The context would describe what is to be learned from the picture (p. 1).

Sosteric and Hesemeier (2002) concur by stating: "what would make the… image a 'learning object,' would be additional information that would allow an instructor or instructional designer (or perhaps even an automated program) to know how to use the object in an educational setting" (p. 3). Other definitions offer further refinement. For example, Mohan and Greer (2003) argue that a learning object "facilitates a single learning objective" and "may be reused in a different context" (p. 258). Hummel et al. (2004) suggest that activities and courses are not learning objects, instead learning objects and learning activities comprise courses. From this brief survey of learning object definitions it is evident that a clear definition of a learning object is still under development.

The ambiguity associated with defining learning objects has implications for how learning objects can be reused. The concept of reuse on which the notion of learning objects is based is underpinned by three assumptions, which require further investigation. They are elaborated as follows.

Assumption 1: Teachers/instructional designers are willing to use other people's learning objects.

Teachers regularly share and reuse resources and ideas amongst colleagues, but there is little evidence that teachers are becoming active learning object 'reusers', as much of the current work on learning objects has focused on the technical aspects of the storage and retrieval process (Bannan-Ritland, Dabbagh & Murphy, 2002) rather than the implications for instructional use.

Assumption 2: Learning objects are accompanied by a standard annotation to allow them to be found easily.

Due to the vast volume of information available on the Internet, it is becoming increasingly difficult to find relevant material. Metadata, that is, information about the information, would enable users to efficiently search for, select, and retrieve learning objects, just as a record in a library catalogue enables borrowers to find a book. There are several metadata initiatives underway, two main ones being *The Dublin Core Metadata Initiative* (http://dublincore.org/) and the IEEE LTSC *Standard for Learning Object Metadata* (IEEE, 2002). These learning object metadata schemas are being adapted and customised to meet the specific needs of communities (Duval, Hodgins, Sutton, & Weibel, 2002; Kraan, 2003).

Examples of metadata customisation include school education initiatives, such as *CanCore* in Canada (Friesen, Mason & Ward, 2002), *The Le@rning Federation* in Australia (Ward, 2003) and the *Hawaii Networked Learning Communities* project in the United States (Suthers, Johnson, and Tillinghast, 2001); and higher education initiatives such as the *EdNA Metadata Standard* (Education Network Australia, 2002). These examples illustrate that there is no one, all encompassing metadata standard to facilitate learning object search and retrieval.

Assumption 3: When retrieved, teachers know how to make effective use of learning objects within their instructional setting.

There are no standard procedures or processes that enable teachers and instructional designers to "design, develop, and deliver computer based instruction created with learning objects in predictable, interoperable, and reusable ways" (Anderson, 2003, p. 19). Wiley (2002b) argues that the learning object research agenda must begin to investigate how learning objects can be sequenced to create a high quality instructional experience, or "we will find ourselves with digital libraries full of easy to find learning objects we don't know how to use" (p. 2).

Teachers and instructional designers need support to incorporate selected learning objects within the pedagogical approaches best suited to their context. They need access to appropriate strategies and tools that make the process of implementing learning objects as flexible and seamless as possible. Whilst there is research being conducted to investigate these issues (eg., Collis & Strijker, 2001; Kang, Lim & Kim, 2003), more research is necessary to investigate the instructional design implications of reusing learning objects. Particularly, there are calls for research to identify and investigate pedagogical models that effectively utilise learning objects to further the development of models for "best practice" (Griffith, 2003).

The Smart Learning Design Framework Project

The project discussed in this paper aims to address this gap in research by developing a framework to guide the retrieval and reuse of learning objects, in a pedagogically appropriate way. The framework, called the *Smart Learning Design Framework* (SLDF), is premised on the proposition that learning objects are resources that, if effectively annotated with metadata, can be retrieved and incorporated into a learning experience. The project uses the following definition for a learning object: *a digital resource that represents the smallest autonomous pedagogical unit that can be reused to support learning related to a specific purpose or intention*. According to this definition, a learning object must have an inherent instructional or learning purpose and cannot be broken down into sub-units. Examples in accord with this definition include: a digital image accompanied by explanatory text, a set of quiz questions and answers, and a sequence of lecture slides. A learning design refers to the way in which activities, content resources and support mechanisms are planned and sequenced for students (Oliver & Herrington, 2001). The idea of a learning design is similar to the concept of a generic learning activity as proposed by Laurillard and McAndrew (2003). The learning design serves as the pedagogical scaffold to support teachers and instructional designers in developing high quality learning experiences for their students. The implementation or instantiation of a learning design is referred to as a 'unit of study' (Koper, 2001). A unit of study may comprise a single activity, multiple activities, a lesson or module, or an entire subject or course.

The conceptual process of the SLDF involves the following steps:

- Guide teachers and designers in the selection and adaptation of appropriate learning designs for their educational context;
- Assist teachers and designers to select and aggregate suitable learning objects based on the chosen learning design; and
- Package the contextualised learning design into a 'unit of study' for delivery to the student.

The Smart Learning Design Framework builds on the work of the *Learning Designs* web site - an Australian government funded project that collected 32 exemplars of learning designs demonstrating innovative use of information and communication technologies, and developed six of these into generic forms (see http://learningdesigns.uow.edu.au/). The SLDF project will explore the potential for learning designs such as these to serve as a framework for designing with learning objects. The focus of the project is to facilitate the use of learning objects within constructivist based

learning designs suitable for tertiary education; however, this work also has implications for other education sectors.

The first phase of the project involved examining the standardisation efforts for learning object metadata, to determine the most suitable metadata approach that can inform the retrieval and incorporation of learning objects into a learning design.

Development of a Learning Object Metadata Application Profile

The starting point: A literature review of learning object metadata

The last decade has seen significant effort devoted to the development of learning object metadata standards for the purpose of achieving interoperability, that is, learning objects using the same metadata schema can be used by any tool or system that complies to that schema. Thus the learning objects are said to be interoperable.

The researchers began their investigation of the use of metadata for the storage and retrieval of learning objects by examining the first IEEE LTSC accredited standard – the *1484.12.1 Learning Object Metadata* (LOM) data model standard (IEEE, 2002). An initial research task involved reviewing critiques of LOM by various education communities, to gain an understanding about how LOM was being implemented, and to determine its strengths and potential limitations. This involved discussions with several members of the IEEE LTSC 1484.12.1 LOM working group via email, and a search of relevant literature that included:

- Web sites and conference proceedings hosted by standards bodies, such as The Centre for Educational Technology Interoperability Standards (CETIS) (http://www.cetis.ac.uk/), IEEE LTSC (http://ltsc.ieee.org/), The Dublin Core Initiative, and CanCore (http://www.cancore.ca/);
- Conference proceedings, mainly the IEEE International Conferences and the Dublin Core Annual conferences; and
- Journals, in particular special issues about learning objects or metadata.

The review found that recent applications and critiques of LOM had revealed several limitations of the educational descriptors (Allert, Dhraief, & Nejdl, 2002; Friesen, Roberts, & Fisher, 2002; Suthers, 2001). A significant issue is the lack of fully explicated definitions of the educational category. As a result, researchers and developers are using a variety of approaches in implementing the LOM pedagogical descriptors. The literature also

highlights that in addition to applications that use LOM in its published form, there are three alternative approaches in applying metadata:

- *Using a subset of LOM:* The CanCore project (Friesen, Roberts, & Fisher, 2002) has adopted a streamlined approach by recommending that a subset of LOM elements (60 of the 77 LOM elements) be used and provides in depth guidelines about how each element should be applied. CanCore offers a more pragmatic approach to the use of metadata by offering a middle way between the complex LOM and the minimalist Dublin Core approaches (Friesen, Fisher & Roberts, 2003). Such strategies indicate that while there is interest in applying the LOM standard, changes are being made to develop a metadata approach that is appropriately customised to the particular context.

- *Extending LOM:* The Le@rning Federation (a five-year Australian initiative aimed at developing a repository of high quality online content for Australian schools) has developed its own metadata schema that incorporates elements from LOM, Dublin Core and the Education Network Australia (EdNA), plus defining some new elements (The Le@rning Federation Schools Online Curriculum Content Initiative, 2002).

- *Using a different metadata approach:* Carey, Swallow and Oldfield (2002) suggest an alternative set of descriptors that characterise the 'educational rationale'. This is wholly outside the LOM standard and is an attempt to capture the process oriented information about the instructional approaches that underpin learning objects.

These activities have lead particular educational communities to adapt existing metadata schemas to suit their own needs (Friesen, Mason & Ward, 2002). The implications for reuse of learning objects coded under such customised schemes are yet to be fully explored.

Because LOM has become an IEEE accredited metadata standard, although research studies have revealed some limitations with its pedagogical descriptors, the research team thought it appropriate to further examine LOM to gain first hand experience by applying it to several learning objects.

Applying LOM to a number of learning objects: Examination of the LOM pedagogical descriptors

This research activity involved directly applying the educational category descriptors to a number of learning objects to identify strengths and limitations of the LOM standard in describing pedagogical characteristics

of learning objects. Twelve learning objects (created by students in a postgraduate program on Information Technology in Education and Training) were selected. Examples included an animation of the water cycle, an interactive package showing the parts of the human heart, and a multimedia presentation describing a lunar eclipse. These learning objects were chosen based on the following characteristics:

- They were self contained modules that focused on a single concept or small number of related concepts.
- Documentation describing the target learners and learning context was available to the researchers.
- The set included learning objects developed for early childhood, primary school, secondary school and adult learners across a range of discipline areas, such as art, business, drama, literary, science, and information technology.
- The set incorporated a variety of instructional strategies, including exploratory packages and prescriptive tutorials.
- The set included a range of multimedia combinations (eg., text, graphics, audio, and animation compiled as either a web site, *PowerPoint* presentation, *HyperStudio* stack or *MediaBuilder* package).

The research adopted a two stage approach, similar to that used by Suthers (2001), to explore the issues arising from the application of LOM educational descriptors. In Stage 1, three researchers each reviewed three learning objects to which they applied the LOM educational elements and documented their findings. The researchers also recorded notes about their deliberations during this process against each educational element.

In Stage 2, each researcher worked with the remaining learning objects and recorded responses to the following questions:

- For what purpose would I use this learning object (LO)?
- For what age group or learning stage would it be applicable?
- What are the objectives the designers were trying to achieve?
- What type of learning experience does the LO provide?
- Does the LO support active participation by the learner?
- What is the scope of the learning experience (time to use it, amount of work involved)?
- Does the LO include high quality media elements?

These questions were devised to capture information that the researchers deemed useful to designers or teachers when reviewing a learning object for potential inclusion in their learning environment. The responses to these questions allowed the researchers to develop rich descriptions of the sample learning objects, but also served to highlight issues about providing such information within the metadata.

The outcomes of both stages were collated and compared. Overall, the team found that the LOM documentation did not provide sufficient guidance for the researchers to apply the descriptors consistently, and thus there were significant differences in the interpretations of what values should be applied. Furthermore, the elements in category *5: Educational* are structured in a single level with each being of equal importance. This is unlike other categories, such as *9. Classification,* that possess multiple levels of descriptors to express inter-relations between the elements. This poses some difficulties in applying LOM to learning objects for which the intended audience is not uniform or for which there are multiple intended uses. An example is when there are multiple audiences for which a learning object might be used differently, ie., a learning object might have a different educational application for different grade levels. The existing flat structure of the educational descriptors cannot represent these relationships. Also, for some elements the values provided by LOM could not be used to accurately describe a learning object, because they were ambiguous or limited. For example, values available for *5.2 Learning Resource Type* included options describing both format, such as narrative text, and potential use, such as problem statement.

These findings suggest that LOM could be enhanced by further developing definitions for the educational descriptors to improve guidance offered about their application. Also, refinement of some of the educational category elements may be needed to reflect interdependencies and provide meaningful detail.

This research activity, in conjunction with the findings from the literature review, provided the team with the following insight about the way forward for the project.

The learning object literature highlights that whilst there are metadata standards such as LOM and Dublin Core, communities of practice are incorporating their own specific vocabularies for certain metadata elements. The use of metadata application profiles is becoming prevalent as communities look for more specific ways of annotating their learning objects whilst adhering to a metadata standard's overall structure. Duval et al. (2002) support the 'application profile' concept:

> The main goal of application profiles is to increase the 'semantic interoperability' of the resulting metadata instances within a community of practice, by going beyond the universal consensus of a single standard, without compromising the basic interoperability that the standard enables across the boundaries of these communities (p. 6).

It was thus deemed appropriate that a subsequent research task should be the investigation of the use of application profiles to determine how they are being applied by the learning object community. Specifically, the CanCore approach (Friesen, Fisher & Roberts, 2003) seemed a feasible metadata application profile to further explore in terms of investigating its suitability for this project. CanCore has evolved over almost a decade and is a well-researched metadata application profile (Friesen, Fisher & Roberts, 2003). An analysis of the CanCore Educational category elements would be required to determine whether the recommended values (vocabularies) for the pedagogical descriptors are suitable for the Australian higher education context or whether this project would need to devise its own metadata application profile that includes appropriate vocabularies.

An additional idea that surfaced is that the metadata of a learning object in terms of the pedagogical information can only describe its intended original use, not the myriad of ways a teacher may use a learning object in a learning setting. This infers that learning objects are essentially educational resources and it is the teacher or instructional designer who decides how they ought to be used within a learning environment. Thus, what may be required is another level or layer of metadata that guides the teacher and designer in selecting and using particular learning objects to construct a high quality learning environment. This could result in a two-tiered metadata approach where one layer (referred to as 'Learning Object Metadata') focuses on the characteristics of the learning object itself and the second layer (referred to as 'Unit of Study Metadata') specifies how the learning object could be used within a particular learning context. Unit of Study metadata is to be further explored in the next phase of the project, once the learning object metadata approach for this project is finalised.

Applying a LOM-based Application Profile to a number of learning objects: Examination of the CanCore educational descriptors

The CanCore metadata application profile was selected for examination to determine its applicability for the project's Learning Object Metadata because of the following reasons:

- It aims to provide a more usable metadata schema;
- It has been well documented and argued in the literature;
- It supports interoperability as it complies with LOM by adopting a subset of the LOM descriptors; and
- It suggests the use of several vocabularies to extend meaning beyond the LOM descriptor values.

A new set of learning objects was compiled for this research task so that the team could further 'test' its definition of learning objects. The strategy to compile the sample of learning objects involved identifying learning objects within three subjects/courses (offered within a postgraduate information technology in education and training program) and two CD interactive multimedia packages (which are professional development resources: *Dual Diagnosis* for general medical practitioners and *123 Count With Me* for primary school teachers). These five technology based learning resources were selected on the basis of different pedagogical and delivery approaches.

To help identify learning objects within the five technology based learning environments, the following question was posed: "Based on the intended use of this technology based learning package/setting, what could be considered as reusable?" Examples of learning objects included: digital video clips accompanied by summary text, templates to assist students in completing a task (eg., research proposal plan, design statement), readings, cases, annotated bibliographies, reference lists, technical manuals, and web sites focused on a particular topic.

Each learning object was then examined according to the CanCore Educational Category guidelines (documented in the CanCore Metadata Guidelines Version 1.1, the CanCore Educational Guidelines 1.8.9, and CanCore Appendix A, Version 1.8.9, retrieved from the CanCore website (http://www.cancore.ca/). The strategy for determining the values for each of the five educational descriptors (*5.2 Learning Resource Type*, *5.5 Intended End User Role*, *5.6 Context*, *5.7 Typical Age Range*, and *5.11 Language*) was to firstly select the most appropriate LOM provided value; secondly, examine the CanCore recommended values to determine if the provided vocabulary or vocabularies sufficed; and thirdly, if the CanCore recommended values were not appropriate for the learning object, an alternative value was suggested.

The research team discussed their individual findings to identify commonalities and anomalies. The findings are summarised below.

5.2 Learning Resource Type:

- Some educational 'features' are not well catered for by the values provided by LOM. Examples include learning objects that serve as curriculum or course outlines, and learning objects that are to be used as 'tools' to support students in completing a task or assist the 'thinking' process such as templates. Some media types such as audio are also not catered for by LOM.

- The vocabularies most useful to describe the learning objects beyond the LOM values were

  i. DLESE - Digital Library for Earth System Education, http://www.dlese.org/Metadata/
  ii. GEM - Gateway to Educational Materials, http://www.geminfo.org/Workbench/Metadata/Vocab_Type.html

  Yet, these too do not capture some educational uses well. For example, whilst DLESE provides a 'Tool' category, it does not include a subcategory 'template' to represent a 'thinking' aid for students when completing a task. There is also no value for a 'reading' as a type of educational use provided in both vocabularies. DLESE does cater for 'Text' resources such as books and journal articles but there are no values for part of a book, such as book chapter, or a conference paper. It is thus suggested that DLESE and GEM be included as vocabularies in the project's learning object metadata application profile but that a project specific vocabulary be compiled also.

- The provision of values that represent format or genre and educational use evident in LOM, DLESE and GEM, but with no clear distinction between the two, makes it confusing to apply. It is suggested that a new vocabulary be devised that attempts to categorise these two characteristics.

5.5 Intended End User Role:

- LOM values were deemed sufficient.

5.6 Context and 5.7:Typical Age Range:

- The LOM values do not seem well-tailored to the Australian educational context. The research team conducted a brainstorm session to devise a more suitable vocabulary for each element. The suggested additional vocabulary for *5.6 Context* is: Adult and community education; Vocational Education and Training; University undergraduate; University postgraduate; and Professional formation. The suggested additional vocabulary for 5.*7 Typical Age Range* is: First year undergraduate, Second year undergraduate, Third year undergraduate, Fourth year undergraduate, and Postgraduate.

5.11 Language:

- LOM values were deemed sufficient.

The outcomes from this research task confirmed that whilst the additional vocabularies suggested by the CanCore application profile are helpful, the project needs to devise its own learning object metadata application profile, one that incorporates vocabularies suitable for the Australian higher education sector and can be applied to constructivist learning settings. Whilst additional vocabularies for LOM elements *5.6 Context* and *5.7 Typical Age Range* have been devised by the research team, further investigation is required to develop a project specific vocabulary for LOM element *5.2 Learning Resource Type*.

Developing a vocabulary suitable for the Australian higher education context

To devise an additional vocabulary for LOM element *5.2 Learning Resource Type*, an analysis of the resources used in the 32 technology based learning projects documented in the *Learning Designs* web site was conducted. The web site provides a rich description of each ICT based learning environment, by outlining the tasks students are required to perform, the resources accessible by the students to help in completing tasks, and the support mechanisms for assisting students in their 'learning'. Also, many of the exemplars represent constructivist learning environments. Thus, it was deemed appropriate that an examination of these projects take place, to help inform the research team about the values for its proposed additional vocabulary.

One researcher and two research assistants individually examined the descriptions of the 32 exemplars and each produced a list of key words that summarised the resources implemented. Another researcher then reviewed the three lists for themes and collated the findings. Overall, the key words referred to either the format/genre of the resource or the function/educational use of the resource (eg., lecture, demonstration, quiz). The format/genre of a resource was further categorised as follows:

- Text based resources or readings (eg., literature, textbook, hard copy printouts, library resources)
- Multimedia resources (eg., animations, web sites, CD packages)
- Physical (eg., laboratory, computer hardware, equipment)

The categorised list was reviewed to ensure singular terms were applied (for example, Cases was changed to Case, Library resources was changed to Library resource) and each key word was defined. Definitions were based on knowledge of the context of the resource used in the particular learning design exemplar. Where possible, definitions were also based on similar elements in other vocabularies included in CanCore and/or Oxford English dictionary definitions.

The result of this research task has been the development of an additional controlled vocabulary for LOM element *5.2 Learning Resource Type*. This is documented in the SLDF Learning Object Metadata Application Profile Version 1 [http://www.digitalmedia.uow.edu.au/projects.html]

Discussion

Further work is needed to refine the SLDF Learning Object Metadata Application Profile. A range of issues was identified when devising an additional vocabulary for *5.2: Learning Resource Type* which focused mostly on the function/educational use values. Ideas that require exploration are:

- The vocabulary provides insight about the function the resource serves within a learning experience in order of dominance. This could be used in conjunction with LOM element *8.3: Annotation. Description* to provide a summary.
- How a learning object is implemented is dependent on its context of use. For example, a learning object that is a simulation could be used as a demonstration or an example, or for self assessment. Thus, whilst the original educational use could be provided at the Learning Object metadata level, a more contextualised educational use may be provided at the project's proposed Unit of Study metadata level.
- The provided values for function/educational use are not exhaustive and require revision and expansion, to include other functions such as: formative assessment: eg., mock exam; and reading: eg., required or optional.

A prototype tool that will allow the research team to apply its learning object metadata application profile against a range of learning objects is under development. It is envisaged that the use of this tool will facilitate the refinement of the application profile. Keeping abreast of other controlled vocabularies implemented by other LOM application profiles is also an ongoing research activity.

Conclusion

This paper has described the work conducted by a project focused on developing a framework to guide the retrieval and reuse of learning objects in a pedagogically appropriate way. The framework is underpinned by the notion that a learning design serves as the pedagogical model, that guides the development of a learning experience, and thus can provide guidance about suitable learning objects to incorporate into the learning setting. The first phase of the project involved examining the IEEE LOM standard, to determine how the pedagogical

descriptors could inform the retrieval and incorporation of learning objects into a learning design. The outcome was the development of the project's own learning object metadata application profile.

The next phase of this project focuses on investigating the processes by which a generic learning design can be customised to a particular context or setting; and how appropriate learning objects can be identified, and once identified, incorporated into the adapted learning design. The development of a LOM based application profile tailored to the Australian Higher Education context serves as the basis on which learning objects can be annotated appropriately to facilitate their selection for use in a generic learning design. The challenge faced by the project team is to determine how to link the learning object metadata with the proposed unit of study metadata, that is, the additional metadata level that can guide the teacher or instructional design (or even perhaps an automated system) on how to select suitable learning objects and aggregate them to construct a high quality learning environment. The unit of study metadata seems analogous to what Duval and Hodgins (2003) refer to as the 'glue' required to aggregate learning objects in order to make explicit a learning path. They argue that better support is required for authoring of learning objects by aggregation (Duval & Hodgins, 2003). It is hoped that this project can make a significant contribution to this issue.

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References

Allert, H., Dhraief, H. & Nejdl, W. (2002). Meta-level category "role" in metadata standards for learning: Instructional roles and instructional qualities of learning objects. *Paper presented at COSIGN-2002: The 2nd International Conference on Computational Semiotics for Games and New Media*, University of Augsburg, Germany, 2-4 Sep. [viewed 9 May 2003, verified 29 May 2004] http://www.cosignconference.org/cosign2002/papers/Allert.pdf

Anderson, T. A. (2003). I Object! Moving beyond learning objects to learning components. *Educational Technology*, July-August, 19-24.

Bannan-Ritland, B., Dabbagh, N. & Murphy, K. (2002). Learning object systems as constructivist learning environments: Related assumptions, theories, and

applications. In D. A. Wiley (Ed.), *The Instructional Use of Learning Objects* (pp. 61-98). Bloomington, Indiana: AIT/AECT.

Bush, M. D. (2002). Connecting instructional design to international standards for content reusability. *Educational Technology*, 42(6), 5-13.

Carey, T., Swallow, J. & Oldfield, W. (2002). Educational rationale metadata for learning objects. *Canadian Journal of Learning and Technology*, 28(3). [viewed 2 Apr 2003, verified 29 May 2004] http://www.cjlt.ca/content/vol28.3/carey_etal.html

Collis, B., & Strijker, A. (2001). New pedagogies and re-usable learning objects: Toward a new economy in education. *Journal of Educational Technology Systems,* 30(2), 137-157.

Downes, S. (2003, July 31). *Design, Standards and Reusability*. [viewed Jan 2004, verified 29 may 2004] http://www.downes.ca/cgi-bin/website/view.cgi?dbs=Article&key=1059622263&format=full

Duval, E. & Hodgins, H. W. (2003,). A LOM Research Agenda. *Paper presented at The Twelfth International World Wide Web Conference*, Budapest, Hungary, 20-24 May. [viewed 28 Jan 2004, verified 29 May 2004] http://www2003.org/cdrom/papers/alternate/P659/p659-duval.html.html

Duval, E., Hodgins, W., Sutton, S. A. & Weibel, S. L. (2002). Metadata principles and practicalities. *D-Lib Magazine*, 8(4). [viewed 3 June 2003, verified 29 May 2004] http://www.dlib.org/dlib/april02/weibel/04weibel.html

Education Network Australia (2002). *EdNA Metadata Standard Version 1.1*. [obtainable from http://www.edna.edu.au/metadata/, viewed Jan 2004, verified 29 May 2004]

Friesen, N., Mason, J., & Ward, N. (2002, 13-17 October). Building educational metadata application profiles. *Proceedings of DC-2002: Metadata for E-Communities: Supporting Diversity and Convergence 2002*, Florence, Italy, pp. 63-69. Frienze University Press.

Friesen, N., Fisher, S. & Roberts, A. (2003, September 10, 2003). *CanCore Learning Resource Metadata Application Profile: CanCore Guidelines for the implementation of Learning Object Metadata Version 1.9*. Athabasca University. [for Version 2.0 document availability, verified 29 May 2004, refer http://www.cancore.ca/documents.html]

Friesen, N., Roberts, A., & Fisher, S. (2002). CanCore: Metadata for Learning Objects. *Canadian Journal of Learning and Technology*, 28(3). [viewed Mar 2003, verified 29 May 2004] http://www.cjlt.ca/content/vol28.3/friesen_etal.html

Griffith, R. (2003, April). *Learning Objects in Higher Education*. Academic ADL Co-Lab with Sponsorship by WebCT. [viewed 7 May 2004] http://www.academiccolab.org/resources/webct_learningobjects.pdf

Hodgins, H. W. (2002). The future of learning objects. In D. A. Wiley (Ed.), *The Instructional Use of Learning Objects* (pp. 281-298). Bloomington, Indiana: AIT/AECT.

Hummel, H., Manderveld, J., Tattersall, C. & Koper, R. (2004). Educational modelling language and learning design: New opportunities for instructional reusability and personalised learning. *International Journal of Learning Technology*, 1(1), 111-126.

IEEE (2002). *1484.12.1 IEEE Standard for Learning Object Metadata*. [viewed Jan 2004, verified 29May 2004] http://ltsc.ieee.org/wg12/par1484-12-1.html

Kang, M., Lim, D. H. & Kim, M. (2003). Learning Designer™: An e-learning design and development tool generating SCORM learning objects. *Proceedings of the Learning Objects 2003 Symposium: Lessons Learned, Questions Asked.* Honolulu, Hawaii, pp. 32-38. Association for the Advancement of Computing in Education.

Koper, R. (2001). Modeling units of study from a pedagogical perspective meta-model behind EML. Educational Technology Expertise Centre, Open University of the Netherlands. [viewed 13 Mar 2003, verified 29 May 2004] http://eml.ou.nl/introduction/docs/ped-metamodel.pdf

Kraan, W. (2003, May 13). *No one standard will suit all*. The Centre for Educational Technology Interoperability Standards. [viewed Jan 2004, verified 29 May 2004] http://www.cetis.ac.uk/content/20030513175232

Laurillard, D. & McAndrew, P. (2003). Reusable educational software: A basis for generic learning activities. In A. Littlejohn (Ed.), *Reusing online resources: A sustainable approach to e-learning* (pp. 81-93). London and Sterling, VA; Kogan Page.

Mohan, P., & Greer, J. (2003). Reusable learning objects: Current status and future directions. In D. Lassner & C. McNaught (Eds.) *Proceedings of ED-MEDIA 2003 World Conference on Educational Multimedia, Hypermedia and Telecommunication*. Honolulu, Hawaii, pp. 257-264. AACE.

Oliver, R. & Herrington, J. (2001). *Teaching and learning online: A beginner's guide to e-learning and e-teaching in higher education*. Perth, Western Australia: Edith Cowan University.

Sosteric, M. & Hesemeier, S. (2002). When is a Learning Object not an Object: A first step towards a theory of learning objects. *International Review of Research in Open and Distance Learning*, 3(2). [viewed 11 Apr 2003, verified 29 May 2004] http://www.irrodl.org/content/v3.2/soc-hes.html

Suthers, D. D. (2001). Evaluating the learning object metadata for K-12 educational resources. *IEEE*, 371-374.

Suthers, D. D., Johnson, S. M. & Tillinghast, B. (2001). Learning object meta-data for a database of primary and secondary school resources. *Interactive Learning Environments,* 9(3), 273-289.

The Le@rning Federation Schools Online Curriculum Content Initiative. (2003). *Metadata Application Profile*: Version 1.3. Curriculum Corporation and education.au limited. [viewed Mar 2004, verified 29 May 2004] http://www.thelearningfederation.edu.au/repo/cms2/tlf/published/8519/Metadata_Application_Profile_1_3.pdf

Ward, N. (2003). Creating a metadata application profile: A case study of The Learning Federation experience. *Proceedings of the EDUCAUSE in Australasia 2003 Conference*, 6-9 May, Adelaide, Australia, pp. 662-668. University of Adelaide.

Wiley, D. A. (2002a). Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy. In D. A. Wiley (Ed.), *The Instructional Use of Learning Objects* (pp. 3-23). Bloomington, Indiana: AIT/AECT.

Wiley, D. A. (2002b). *Learning objects*. In A. Kovolchick & K. Dawson (Eds.) Educational Technology: An Encyclopedia. Santa Barbara: ABC-CLIO. [viewed 7 Apr 2003, verified 29 may 2004] http://wiley.ed.usu.edu/docs/encyc.pdf

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