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Panning for Gold: Designing Pedagogically-inspired Learning Nuggets

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ABSTRACT

Tools to support teachers and learning technologists in the creation of effective learning designs are currently in their infancy. This paper describes a metadata model, devised to assist in the conception and design of new learning activities, that has been developed, used and evaluated over a period of three years. The online tool that embodies this model was not originally intended to produce runtime executable code such as IMS-LD, but rather focussed on assisting teachers in the thought processes involved in selecting appropriate methods, tools, student activities and assessments to suit the required learning objectives. Subsequently, we have modified the RELOAD editor such that the output from our tool can be translated into IMS-LD. The contribution of this paper is the comparison of our data model with that of IMS-LD, and the analysis of how each can inform the other.

Keywords

DialogPLUS, Learning Design, IMS, Learning Activities, Nugget Model

Introduction

There has been mounting interest over recent years in mechanisms for facilitating the uptake, repurposing and effective use of existing digital resources to support learning and teaching in higher education (Littlejohn, 2003). Indeed, teachers are increasingly expected to create or adapt online learning activities, with or without specialist technical support. Potentially interesting resources, available from a range of in-house or external sources, can be used to enrich learning environments and student experiences. However, finding, or creating, suitable materials and embedding them in well designed-learning activities can be both challenging and time consuming.

The work reported here has been undertaken during the DialogPLUS project, under the auspices of the JISC/NSF funded 'Digital Libraries in the Classroom' programme. For DialogPLUS, teaching colleagues in Geography departments in two UK and two US universities (Southampton, Leeds, Penn State, UC Santa Barbara) are creating and sharing online learning activities that draw on a wide range of available resources. The academics involved have varying experience of using digital media within their current teaching practice. This paper presents the model we have developed to support them in the process of creating pedagogically-informed learning activities. It uses underlying taxonomies of sound learning and teaching approaches as a basis for both guiding, and subsequently describing, effective designs.

The model is presented to users via an online editor which supports and guides them in the specification of all the elements of a learning activity, including intended outcomes, related tasks, embedded resources and appropriate tools. The explicit purpose of this editor is to assist teachers in designing successful learning activities, both for their own use and in a way that facilitates sharing and adaptation. It thus encourages practitioners to emulate and reuse examples of established good practice.

During the three years of designing, developing, implementing and testing our model and online editor, we have monitored and become increasingly involved with the wider world of learning design and metadata standards. Perhaps most importantly, we have examined our approach relative to the IMS-LD specification. The analysis presented here compares and contrasts our model with IMS-LD, and proceeds to demonstrate how the two models are complementary. Most recently, we have been able to take a teacher-created learning activity described in our format and convert it automatically into an IMS-LD manifest. This offers the exciting possibility of a user friendly front end to existing or emerging tools that create machine independent, runnable learning activities. The paper concludes with reflections on how this work informs both the design of our own model and that of IMS-LD.

Learning Nuggets

At the heart of our model is the notion of a learning nugget. This term was adopted early in the project, at a time when there was heated debate in the learning technology community about what constituted a 'learning object' (Polsani, 2003). Rather than impose any particular view or definition, when we engaged at our early meetings with the Geography teachers we allowed their vocabulary and definitions to emerge. They proposed the idea of a 'nugget' to represent stand-alone learning activities that would vary in size and scope. It was endorsed by team members from both countries and all three disciplines, Geography, Education and Computer Science.

Nuggets are primarily comprised of tasks that learners will undertake in a particular *context* in order to attain specific *learning outcomes*. Contextual elements include subject area, level of difficulty, prerequisite skills or knowledge, and the environment within which the activity takes place. Declared aims and learning outcomes are addressed by a sequence of tasks, each of which may involve particular techniques, various roles and interactions, plus access to specified resources and associated tools. A task will take a prescribed length of time and may, or may not be assessed. Nuggets are, or should be, designed with a particular approach to learning and teaching in mind (Conole & Fill, 2005). Our editor therefore prompts the user to specify or select an appropriate theoretical approach. This enables appropriate guidance to be given as the details of a nugget are fleshed out and should be helpful to those who subsequently discover and seek to re-use or re-purpose them.

Some of the innovative nuggets developed over the last three years have enhanced existing courses, whilst others have resulted in the creation of completely new courses. Examples of digital media embedded in the nuggets are interactive maps, Flash objects, census and environmental databases and modelling applications. Nuggets may also contain links to websites, online text, images, audio and video clips. Many incorporate formative or summative computer-based assessments, such as quizzes, drag and drop exercises, submission of written answers or the results of data modelling. Facilities for student reflection and communications with other students and teachers are often included, for example learning diaries, email and discussion boards.

In seeking to share nuggets, valuable lessons have been learned about repurposing them for different learning outcomes, institutional and technical contexts. For example, a nugget that fosters student understanding of academic integrity began life in one of the US universities and has been taken up enthusiastically by the two UK partners. Repurposing involved much more than technically enabling the nugget to run in different VLEs. Institutional documents had to be replaced with appropriate local ones, quiz questions framed differently, and feedback rewritten to serve the needs of specific student groups. In another instance, census information about Birmingham, England was replaced with that for Birmingham, Alabama within a nugget shared by two of the partners. It is manifestly apparent that teachers will enthusiastically adopt a good design but they usually want/need to swap the original content for their own.

Nugget Metadata

Based on our work with the teachers, plus observation and evaluation of student learning, a metadata model that facilitates this approach to re-use was developed and incorporated into an online editor for nugget designers. The metadata elements are pedagogically orientated, with the intention that these descriptive fields could eventually facilitate searching for and retrieval of, nuggets stored in a digital library or other online repository. They also enable the nugget structure to be maintained whilst content is substituted.

The sequence of tasks within a nugget has proved a somewhat controversial aspect of our model. In designing a learning activity a teacher usually has a specific sequence in mind but, especially in an online learning environment, learners will not necessarily follow it. Indeed, project evaluators have noted several instances of student aversion to explicitly restrictive navigation. Our approach, therefore, is to describe in the metadata the teacher's proposed sequence but to aim for an instantiation of the nugget that does not restrict a learner's access to the resources.

Figure 1 shows how we have modelled the entities described above, thereby defining a collection of objects and associated metadata.

At the root of Figure 1 is the Learning Activity object, described with metadata such as name, difficulty, subject, pre-requisites, approach to learning and teaching and environment. A '*(t)*' next to a metadata field on the diagram indicates the value is selected from our pre-defined, but extensible taxonomy for that element. As the diagram demonstrates, a Learning Activity addresses a set of Aims with ancillary Learning Outcomes. Each Aim object has a textual description. Each Learning Outcome is of a defined Type and contains a set of Tasks which will be presented in the order specified in the Sequence field.

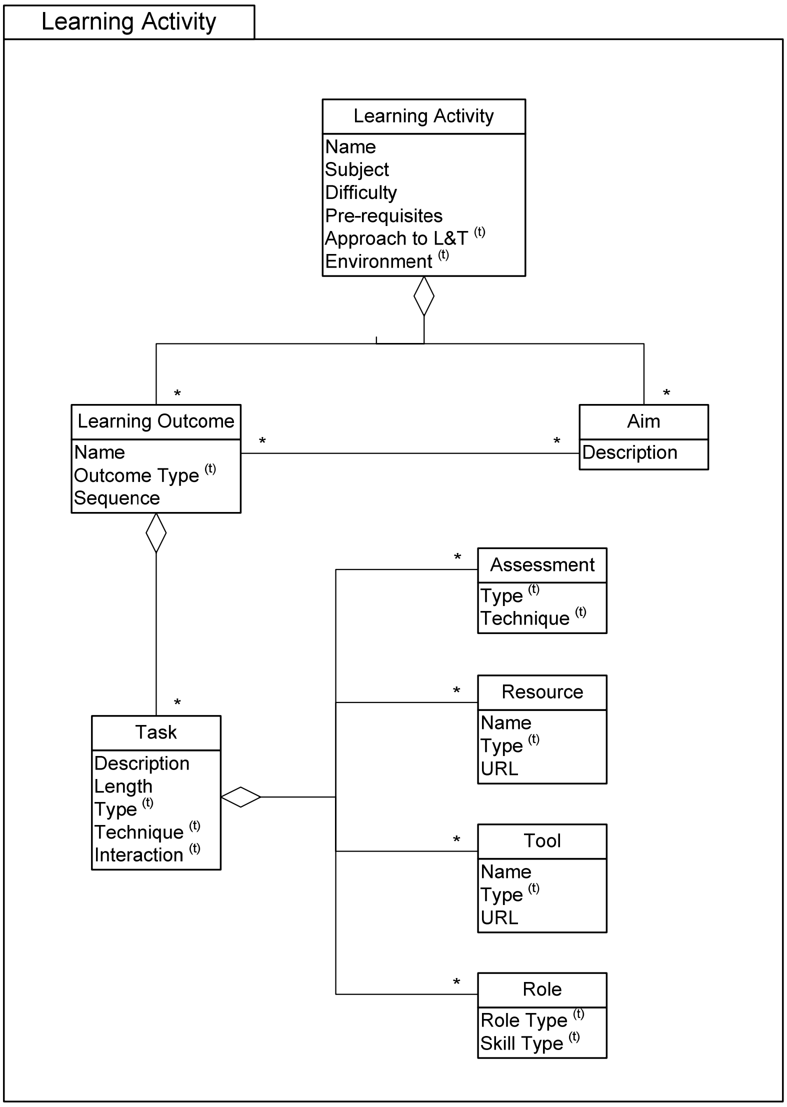

Figure 1: Conceptual UML Model of the Learning Activity Nugget Structure

Each Task is described by metadata covering Type, Technique, Interaction and Length of Time to complete. Further, to undertake a task, learners may need specific tools and resources. For example, if the first task is to read some introductory material, the tool in this instance would be the text viewer (MS Word, a web browser, Adobe Acrobat reader, etc.) while the resource would be the web page or text file the learner reads. The type of interaction for the task (one-to-one, one-to-many etc.) is selected from our taxonomy. As some tasks may be assessed, an assessment component can be attached to indicate what Type of summative, formative or diagnostic method is involved and the Technique used (multiple choice questionnaire, essay, exercise etc.). The final element in a task describes the associated Roles and Skill.

Together a sequence of Tasks, each with its own Tools, Resources, Roles and Assessments, comprise a Learning Outcome and these Outcomes help achieve one or more Aims. Aims and Outcomes make up a single Learning Activity.

The Wider Context

The increasing availability and use of online, digital resources to support teaching and learning is stimulating a convergence between the fields of learning design and learning object technologies. Indeed, in some quarters, the reusability debate has moved on from how to label digital objects using metadata so that other people, or systems, can find and use them, to how to describe "a whole learning experience" so that it can be "tweaked" for use elsewhere (Kraan, 2003).

This is consonant with the approach we had already adopted, so in our development of the nugget model, we have been able to draw on the growing body of work on standards for describing the various aspects of e-learning in international educational, governmental and commercial systems. These include the early days of SCORM, the evolving Learning Object Metadata (LOM) standards, IMS Learning Design and the many and various spin-offs.

The work in e-learning has its roots back in the early intelligent tutoring systems that arose from work spun out of the old AI research communities. During the 1980's these researchers focussed on representing the student's knowledge in explicit user models, and attempted to adapt the presentation of materials to this knowledge. In these early systems the instructional material and sequencing rules were generally locked into the specific system and not easily transferable. It wasn't until the late 1990's that work started on defining open standards to describe learning materials.

The Sharable Content Object Reference Model (SCORM) defines a Web-based model for combining learning objects and executing them within a run-time environment. ADL, the US initiative behind SCORM, was tasked with providing "access to the highest quality education and training, tailored to individual needs, delivered cost-effectively anywhere and anytime" (Dodds, 2005). To this end, SCORM has at its core, an inbuilt sequencing engine based on the earlier Simple Sequencing specification. Simple Sequencing (SS) is an IMS specification which defines a language to express an order or path through a collection of learning activities. The inclusion of SS within SCORM enforces a primarily didactic model of learning, and although pre-defined rules, branches and decisions can be made within the sequenced components, there is a lack of user model which limits the amount of personal adaptability that a SCORM lesson can provide on its own (Abdullah & Davis, 2005).

At the same time as SCORM was being developed in America, a group at the Open University of the Netherlands (OUNL) were also designing a model for describing learning units. Basing their model on wide ranging surveys of what other pedagogical experts and practitioners have been doing over the past century, Learning Design (LD) was created as a means of specifying the operation and delivery of educational material. LD was originally developed under the title Educational Modelling Language (EML) before being adopted by the IMS working group (Olivier & Tattersall, 2005). LD aims to provide a rich, varied and flexible language for building structured learning units that tries not to restrict pedagogical approaches, although it could be argued that it does take a more instructional design-orientated approach (Downes, 2003).

A learning 'unit' in this context can be anything from an atomic Learning Object to a module or course. Indeed IMS-LD is aimed at functioning at the level above that of LOM, and can be used in conjunction with the standard by referencing LOM objects when referring to environments. The specification defines a collection of reusable components which can be broken down or aggregated to form new learning units. LD uses a top level 'Components' object which contains all the Roles, Activities and Environments in a learning design. To bring these components together in a sequence, LD uses the analogy of a theatrical production with Methods consisting of Plays, and Plays consisting of Acts. The Acts specify the learning activities which are undertaken by a single role by referencing the Role and Activities objects from within the Components hierarchy.

Because a LD specification for a learning unit is designed to be independent of any delivery environment, services that are to be used by the learner (for example, an email, conference or announcement service) can be specified generically and subsequently resolved at run-time when required.

While these features are all to be found in IMS-LD level A, further levels (B and C) within the LD specification allow for more complex designs with personalisation based on user preferences, adaptability of learning material, dynamic (conditional) work flows through learning materials, role-play and event-driven simulations.

In recent months, editors have started to appear that allow designers to create a LD from scratch and attach metadata and resources to the unit. It can then be packaged into a single file to form a complete self-contained learning unit which can be imported into any 'IMS LD compatible' learning environment for presentation to users. Editors currently fall into two categories; specification editors such as RELOAD (Reload, 2005) and CopperAuthor (CopperAuthor, 2005) which provide a forms-based means of inputting the metadata for learning design with little or no guidance to support the user, and higher-level editors such as ASK (Sampson et al., 2005) and MOT Plus (Paquette et al., 2005) which provide a graphical medium in which designers can plan out the structure of learning units visually but still need the services of a form-based editor to finalise the production of the learning design. The next generation of graphical learning design applications aspires to eliminate forms entirely. An early example, the Learning Activity Management System (LAMS), uses a drag-and drop interface (Dalziel, 2003). This was inspired by learning design but, at the time of writing, does not support the IMS-LD standard.

To aid the adoption of IMS-LD, the OUNL have focussed their efforts on providing a free and open sourced set of middleware components that form a runtime environment for playing out IMS-LD designs, called CopperCore (OSTG, 2005). The idea is to provide developers of Virtual Learning Environments with an engine to manage the basic business logic of learning design execution. This business logic covers tasks such as learner synchronisation, constraint checking and learning unit personalisation for all levels of Learning Design (A, B and C).

The CopperCore system provides the missing link between development and execution for units of learning that have been modelled in LD with tools such as RELOAD. The adoption of LD is currently in its infancy and unlikely to become mainstream until existing VLEs support the import and execution of LD units with tools such as those provided by CopperCore.

One concern that may deter widespread uptake of the standards is that LD is too technical, and possibly too prescriptive, for creative teachers who have imaginative ideas but are unable to express them within the specification. What might be termed the 'SCORM effect' places emphasis on CBT-type, single-user, instructional designs. This has led us to reflect on how people think about constructing their learning designs, and specifically to consider how to merge our flexible and pedagogically sound approach to supporting nugget design with IMS-LD. While working on this aspect, we have become aware of others taking different approaches to resolving similar challenges with respect to teacher involvement. Broadly, these draw on exemplars of good practice or suggest particular models of teaching and learning processes to define patterns or templates that teachers can rework. Critical comparison of these schemes and our own is beyond the scope of this paper but interested readers are referred to Griffiths & Blat (2005).

In the next section we comment on the similarities and differences between our model and IMS-LD.

Comparing the Nugget Model with IMS-LD

While a large effort has been invested by bodies such as the IMS, ADL, LTSN and OUNL into defining standards for both learning object metadata and pedagogical structuring of materials (e.g. Simple Sequencing or IMS-LD), the initial aims and requirements for supporting our nugget design required a different approach. However it has been interesting to observe that the resulting learning activity model we produced has much in common with the IMS-LD specification.

We chose our own design metadata for a number of reasons. The collaborative standards efforts described earlier have provided a highly structured set of fields that can be machine processed. While this approach is essential if learning objects are to be automatically indexed in repositories and then searched and retrieved automatically via components such as software agents or learning environments, our objectives were slightly different. Our aim is to provide a set of metadata fields that would be most appropriate to teachers to understand and use when describing and searching for other nugget objects. In this respect the useful flexibility and expressive nature of IMS-LD is less important. This means the fields and data in our model have been chosen to represent a middle ground between being machine processable and being easily understood by the authors themselves.

The second consideration in choosing our own set of metadata tags was the desire for brevity. It is acknowledged that the standardisation effort aims to produce languages that are flexible enough to be used in a wide range of situations and this has led to large feature-rich models. Nevertheless, there is a general consensus that getting users to enter any sort of descriptive data is difficult; especially when the benefit of such work is not immediately obvious to users (Currier et al, 2004; Cardinaels, Meire & Duval, 2004). Adopting an external specification brings the added difficulty of being forced to use alien terminology that might deter teachers. In order to reduce the obstacles towards the adoption of our model we have chosen a reduced number of metadata items using terms and structures that are familiar to our specific users. However, as our aims for the model do extend beyond the small user group, the metadata have been chosen to be subject-neutral. It is intended that these fields will be descriptive enough for our requirements while also being useful to teachers outside our initial domain of Geography.

The decision to continue with our model also acknowledges that IMS-LD was developed with different set of objectives in mind. Our nugget specification represents, at a high, abstract level, the description of a learning unit with metadata that is primarily human understandable. This is in contrast to IMS-LD which, as an interoperability specification, is intended for machine use and in addition the editors currently developed for it are intended to be used by specialised learning designers whose role differs from that of the content providers (Olivier & Tattersall, 2005).

However, in spite of these differences in the approaches adopted, the resulting models have much in common. While their internal structures and how they organise learning activities differ, they can both be used to define the same units of learning. LD defines elements in separate groups (e.g. Environments, Roles and Services) and then uses identifiers to reference instances of these objects from within the organisational structure of the learning unit. In contrast, the Nugget model contains all of its components within a single hierarchy and uses longer, free-form text strings to describe each item. The absence of references in the Nugget model means that items need to be repeated if they are to be used more then once in a single learning activity. This means what we loose in conciseness we gain in more human understandable metadata.

When a simplified version of both models are shown side by side in Figure 2, it can be seen that the basic objects of the learning activity nugget model clearly map to corresponding objects within IMS-LD.

From our comparison of these two models, we have been able to map metadata from the nugget description into that of Learning Design. The nugget 'Tasks' are essentially the same objects as 'Learning-Activities' within IMS-LD. This in turn makes 'Learning Objectives' object equivalent to 'Activity-Structures', which are collections of 'Learning-Activities'. The top level 'Nugget' object in our model, whilst containing some metadata that is stored in different parts of the IMS-LD model, most aptly fits in at the 'Component' level, as this top level object contains the roles, activities and environment elements. A complete analysis of each metadata mapping is out of the scope of this paper, so instead the more important technical issues of converting between the two are discussed in the next section.

Converting Nugget Description to IMS-LD

To further explore the relationship between the Nugget description model and IMS-LD, we modified RELOAD to perform an automatic translation from a Nugget description (described in our XML schema) into an IMS-LD manifest file.

As previously shown, the metadata in our nugget model is mostly descriptive and can be easily mapped to corresponding LD elements that describe the components related to a learning activity; however these fail to address the elements of LD related to execution. The challenge is to make an executable LD from a nugget, albeit a simple runnable Level-A LD. Part of the difficulty is due to the nature of the nugget approach and its primary purpose of promoting appropriate teaching methodologies. As a result, some of the fields deemed to be mandatory for the execution of a LD are not mandatory in the nugget model.

Another problem is the lack of an adequate formal mechanism for specifying the workflow or how it should be delivered. Although a sequence element does exist in a nugget, it is an unformatted, human-readable text string and so sequences which may have been specified by the nugget author cannot be understood by an automated conversion utility.

To address the above issues, several assumptions have to be made. The first assumption is that all the relevant fields in the Nugget have been entered appropriately. Another is that the tasks in the nugget should be executed in the order they are appear in the nugget document. With this assumption, the generated LD will present all the tasks of a learning outcome as a linear sequence of learning activities within an activity-structure. There will be no specific time limits for the completion of activities unless specified in the task length field of the nugget model. If authors require more flexibility, they can restructure the sequence of activities, change the completion conditions on activities or add new activities and resources using a LD editor such as RELOAD.

If multiple roles exist in the nugget, it brings a further complexity in generating a runnable LD. If only a single role exists, all the tasks in the nugget will be learning activities within a single activity structure, which in turn will be a reference in a role part, within an act, within a play. However if multiple roles are specified in the nugget, the mapping to LD is not straightforward and there are several possible solutions to the problem. One way is to give *each role its own act* within a play. The advantage of this solution is the roles can be synchronised with each other before entering another act related to other roles. However, this might not be the intended outcome of the nugget author and it is difficult to keep track of each role and their synchronisation points.

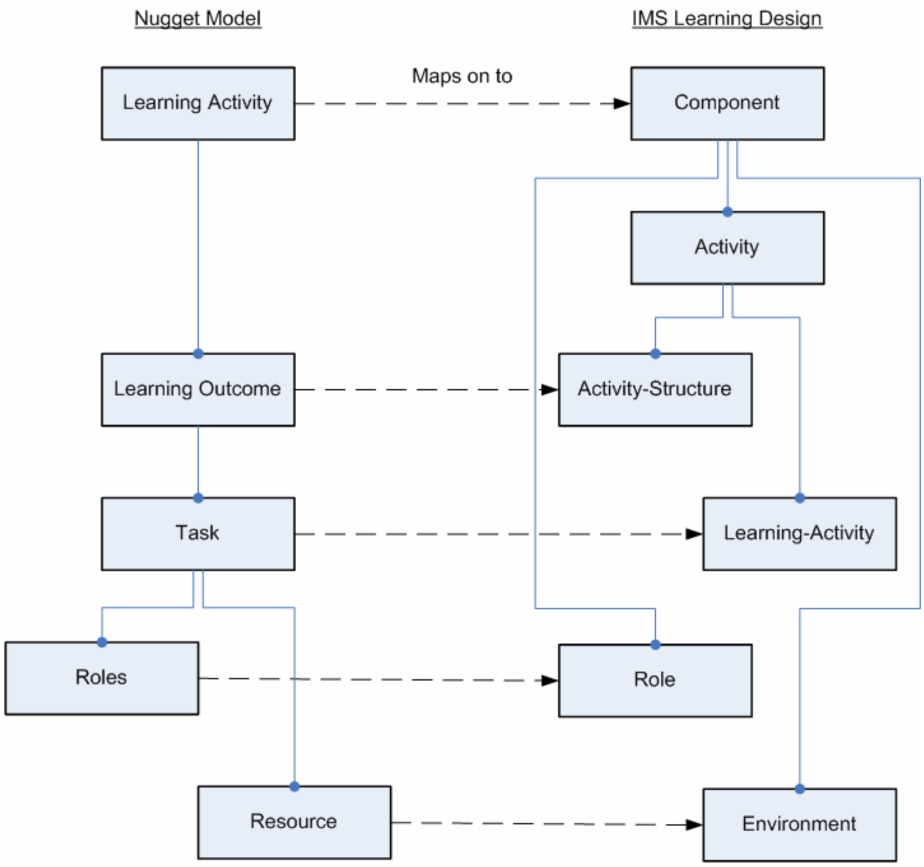

Figure 2. Mapping the major components of the Nugget Model onto IMS-LD

A second solution is to assign *all roles to the same act* so that the final LD has a single method, consisting of a single play with one act containing all the roles from the nugget. This would make the LD conceptually very simple to manage, however you then loose the ability to sequence events as all roles in an act happen concurrently. In addition, this approach also deviates from the way roles were designed to be used as sub-components of tasks in the nugget model.

The third solution, and the one chosen for our conversion routine, is to assign *each role to a play*, where the play has a single act containing the learning activities needed to be performed by a single role. Although this is not the intended use of the play mechanism in IMS-LD, this method has been chosen because it results in a less complex LD than the first solution by making it easier to keep track of which roles are associated with each activity, and is more flexible then the second solution, as the editing of activities from a single role does not cause interference to the flow of activities in other roles in the method.

This work shows that while the nugget model isn't sufficient to completely map onto all aspects of IMS-LD, by applying the modifications mentioned above and mapping the available fields of the nugget model to that of Learning Design, is it possible to automatically generate a 'basic' LD. The nugget is primarily mapped to Learning Design's Learning-Activities and Activity-Structure objects but has no support for higher organisational structures that appear in Levels B&C of LD, so the converted design will consist of a single Method, containing one or more Plays, each containing a single Act. However the design can only be deployed if all the necessary fields in the nugget have already been filled. If any of the mandatory LD metadata is missing from the nugget model the authors will still need to use the features of a LD editor such as RELOAD to flesh out the design. An LD editor also allows authors to attach digital resources, specify services or provide finer grain control over the order of activities and the rules for completion of those activities.

Analysis

Having achieved the conversion of our nugget model into the IMS-LD specification, we are now able to look further at the similarities and differences between the two approaches and comment on what might contribute to the improved functionality and usability of both.

Reflection on the Nugget Model

In analysing the relationship between the two approaches to modelling leaning, it becomes clear that for the nugget model to be used to describe more generic learning activities such as courses and modules, it would require higher levels of organisational structure above that of the current tasks, outcomes and nuggets. This would reflect the higher levels of sequence composition that IMS-LD employs with its Plays and Acts.

As previously described, there are concerns about specifying the sequence of tasks within a nugget. Our method is more flexible, but less precise, than the content manifest and organisation approach adopted in the Reload tool. However, one of the drawbacks of Reload is that it presupposes and enforces linearity which may not serve the learners very well.

As a tool for creating deployable LD modules, our conversion utility cannot guarantee that all nuggets can be converted to executable IMS-LD. However, we see possibilities for our approach to be used as a planning tool for LD within the design phase of learning unit development, before a tool such as RELOAD becomes useful. Our nugget toolkit can be used to guide practitioners in this planning phase as they initially elaborate their aims, objectives and tasks, all based on sound pedagogical principles. A completed nugget could then be converted into a skeletal LD template and authors, using a LD editor, could fill in the missing metadata, attach physical resources and package up the content ready for delivery.

Reflection on IMS-LD

While there are things to learn which impact on the nugget model, we can also reflect on issues raised by our work that concern IMS-LD. One important question that was highlighted relates to the positioning of learning objective information. The IMS specification allows learning objective resources to be placed only at the Method and Learning-Activity levels of Learning Design, however in our nugget model, learning objectives are stored as Learning Outcomes objects and these objects map best to the Activity-Structure component of LD. This is problematic because Activity-Structures cannot have certain metadata such as pre-requisite information, structure descriptions or learning objective metadata associated with them (IMS LD, 2005). In our conversion process we can circumvent this issue by replicating learning objective data and placing it at each of the atomic Activity objects, however this raises a question about the apparent limitation in LD. This restriction on the placement of metadata has been raised in other work with learning design (Paquette & Rosca, 2004). If we were able to suggest an area where IMS-LD could be improved, it would seem sensible to allow designers to attach learning objective metadata at all stages of a Learning Design not just at the highest or lowest levels.

Reusability is a central concern in the LD community and there have been many debates on the subject of just how reusable components of a design for learning really are (Kraan, 2003; Feldstein, 2002; Welsch, 2002; Jacobsen, 2001). This is in part because of the related question about how reusable a single resource is when taken out of the situated context in which it was originally used (Downes, 2003). In LD, that context is made explicit such that, in order to reuse a component, designers would be required to re-author much of the surrounding contextual metadata. In our project, we have found that the most desirable aspect of our nugget model is not principally to identify *what* resources are used, but rather *how* a specific subject is being taught by others. We believe that while the debate on long-term reusability of LD is still undecided, a tool such as ours can greatly increase the perceived reusability of learning design templates by providing a mechanism for abstracting the 'design' of learning activities separately from the business of making executable units of learning.

Another important issue when building descriptions based on strong pedagogical foundations is the need to identify and label the types of assessments being used. In the nugget model, Assessments are a form of Tasks with additional metadata describing the type and form of the assessment. Converting this model into IMS-LD revealed a difficulty in that LD does not handle assessments itself, but instead relies on an external specification for modelling questions and tests called QTI (IMS QTI, 2005). This could be problematic as the general design of learning activities by practitioners is so closely tied with that of their assessment. The separation of the two, while useful for implementation and specification reasons, might cause problems in the transfer of design approaches. By excluding assessment information from LD, a single specification is not available to fully describe a unit of learning. Furthermore, authors should not need to be aware of the existence of the two different specifications. This is really an issue for the design and development of editors and as such these future tools will not only have to support both standards, but also need to be user friendly to foster the long term adoption of learning design.

Conclusions

This paper describes the underlying model of an online tool that supports teachers, and other learning activity creators, as they create nugget descriptions and store them alongside others contributed by a growing community of practice. It incorporates a set of pedagogically driven metadata that can be used to describe learning nuggets and as a basis for discovery and retrieval from digital repositories. The metadata items are selected from carefully defined, but extensible, taxonomies.

Analysis of, and comparison with, the IMS-LD specification revealed that our framework supports teachers in the earliest stages of planning online learning, whereas IMS-LD concentrates on representing interoperable and runnable learning designs. Thus, our work has potential as a pre-editor for IMS-LD to promote good pedagogical design. Our nugget model focuses on describing individual learning activities, rather than programmes of educational teaching, and has highlighted the need for IMS-LD to provide more opportunity to specify metadata at each of its hierarchical levels. It also indicates a requirement for more extensive metadata explicitly describing the approach to learning and teaching.

Our conversion utility, integrated into the RELOAD editor, provides a mapping between our fields and the metadata fields of IMS-LD. While the majority of fields have equivalents in both models, it is not possible to guarantee that all nuggets can be converted into executable IMS-LDs. Our analysis reveals critical changes that could be made to both models such that they better support the needs of practitioners in describing real learning activities.

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