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Learning Designs to Support Educationally Effective E-learning Using Learning Objects

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Abstract: This paper describes a design approach for integrating learning objects based on a strong pedagogical framework, the Smart Learning Design Framework (SLDF). The framework is based on the assumptions that good learning settings focus on pedagogically sound design and that reusable learning objects can be effectively located and incorporated into learning settings. This paper describes a tool developed to illustrate the framework through metadata tagging of learning objects using an application profile which incorporates a pedagogical vocabulary, and development of units of study based on high quality learning designs and the inclusion of learning objects.

Introduction

The drive for reusability in implementing online educational settings is not limited to a technical perspective, but must include a pedagogical context. Reusability and interoperability are being addressed technically through the introduction of a broad range of standards and tools, but emerging new knowledge about implementation of pedagogical principles and new theoretical understanding that are exposing the inadequacy of instructional design strategies that can take advantage of the affordances of online settings (Oliver, O'Donoghue & Harper, 2003, p. 107), are emerging to drive a significant investigation into the reusability of learning designs and the application of learning objects within these designs to create quality learning settings.

The concept of a learning object use and reuse is based on three assumptions:

- Teachers and instructional designers will want to and will be able to find appropriate learning materials to reuse within their own learning setting. For this to be facilitated a learning object must exist in an appropriate form to allow it to be shared easily (e.g., in digital form).
- Learning objects will reside in places from which they can be retrieved easily (e.g., a learning object repository) and they will be accompanied by an appropriate annotation to facilitate their identification and retrieval (metadata).
- Teachers and instructional designers will be able to create and implement learning experiences through learning settings that can be supported by learning objects.

Although these ideas seem relatively straightforward, they also assume that the definition for learning objects is firmly established, that there is a standard annotation methodology, and that instructors know how to incorporate learning objects into their instructional contexts. These issues, however, are yet to be fully explored (Anderson, 2003; Bush, 2002; Collis & Strijker, 2001; Agostinho, Bennett, Lockyer & Harper, 2004), but are now emerging as a crucial research agenda if reusability is to be achieved on more than an individual level. This paper explores an alternative learning object model, the Smart Learning Framework (SLDF) that makes use of generic learning designs, driven by pedagogically sound learner interactions within the context of reusability and learning object technologies.
The Smart Learning Design Framework

The Smart Learning Design Framework presented in this paper extends the framework presented in Lukasiak, Agostinho, Burnett, Drury, Goodes, Bennett, Lockyer, & Harper (2004). The cornerstone of the SLDF is the seamless integration of a technical data structure with a well-supported process for developing pedagogically sound e-learning materials.

The technical data structure is based on the MPEG-21 multimedia framework (Bormans & Hill, 2002), which employs a broader, universal technical specification, as opposed to more specific learning technology specification, such as IMS LD (IMS Global Learning Consortium, 2003). The SLDF authoring process is based on the notion that a learning design can provide guidance for authors to create pedagogically sound learning material. A learning design refers to the way in which activities, resources and support mechanisms are planned and sequenced for students (Oliver & Herrington, 2001). When described in a generic way, a learning design can serve as a framework or template into which learning objects and context-specific information can be incorporated (Bennett, Agostinho & Lockyer, 2004). Thus the learning design provides the pedagogical ‘glue’ to aggregate learning objects.

The outcome of the authoring process is referred to, in the SLDF, as a ‘unit of study’. A unit of study may comprise a single activity, multiple activities, a lesson or module, or an entire subject or course. Thus, from a conceptual viewpoint, the SLDF would support authors by:

- Offering guidance in the selection and adaptation of a learning design suitable to the author’s (teacher’s) educational context.
- Assisting with the selection and aggregation of suitable learning objects based on the chosen learning design.
- Packaging the unit of study for delivery to the learner(s).

The aggregation of learning objects into a unit of study is represented by a hierarchical structure in which learning objects are represented at the lowest level of the hierarchy. In the SLDF hierarchy a learning object is defined as a digital resource that represents the smallest autonomous pedagogical unit that can be reused to support learning related to a specific purpose or intention (Agostinho et al. 2004; Lukasiak et al. 2004).

Each learning object is represented as an MPEG-21 digital item (DI). This allows learning objects to have individual metadata and digital rights protection and also facilitates the sharing and storage of the learning objects in large educational repositories that support the broader MPEG-21 format. At the next level in the hierarchy, multiple learning objects can be aggregated to support a learning design and form a unit of study. The unit of study is also represented as an MPEG-21 digital item, which embeds the learning objects (themselves individual digital items) as resources in a learning design. A unit of study can also embed in another unit of study and so on. This format permits each unit of study to have unique metadata and rights embedded, whilst retaining the rights and metadata of the included learning objects and units of study. This hierarchical structure is represented in Stages 1 and 2 of Figure 1, where the multiple MPEG-21 learning objects generated in Stage 1 are combined with a generic learning design and embedded in the MPEG-21 unit of study of Stage 2.

Using the MPEG-21 DI allows the SLDF to provide simple and seamless customisation of the content delivery. This is represented by the Delivery Stage (Stage 3) in Figure 1, in which templates are used to customise the content presentation. Customisation is possible because MPEG-21 separates content from its presentation (Bormans & Hill, 2002) and the SLDF exploits this characteristic by using templates to extract the required content presentation from the UOS DI prior to final content delivery. A simple example application of the flexibility inherent in this system would be delivering similar learning content to students enrolled in the same subject at different locations. Employing the SLDF would allow an institution to generate a single SLDF Unit of Study and customize the templates to meet the requirements for the different locations. More sophisticated customisations are also possible, for example to students using different display devices or to suit different modes of teaching.
Authoring using the SLDF software system

The SLDF UOS Editor allows the author to specify learning objects and contextually specific information for a unit of study based on this framework. The author begins by choosing a generic learning design that will provide the basis for the unit being designed. For example, a unit of study might be constructed using the Predict-Observe-Explain (POE) learning design (Kearney with Wright, 2002), which is represented in Figure 2.

Predict, Observe, Explain Learning Design Sequence

Intended learning outcomes
- articulation and justification of ideas
- reflection on the ability of others' ideas
- critical reflection on own ideas
- construction and negotiation of new ideas

Figure 2: Predict-Observe-Explain Learning Design
The interface for the UOS editor is shown in Figure 3. When a generic learning design has been chosen, the author is provided with a form-based interface that will guide him/her through the major steps to develop the unit.

![Figure 3: Screen capture of POE Learning Design interface in UOS Editor](image)

When the unit is first created the UOS metadata record is established and some values are generated automatically. These generic values are used to support the authoring process. For example, the learning design detailed in Figure 2 requires that a multimedia representation of a scenario be included. Thus, when a learning object is selected for inclusion, the embedded learning object metadata is interrogated by the system. If the learning object is a digital item with metadata, the values associated with 5.2 Learning Resource Type are checked to see if they match the pedagogical requirements of the learning design. If there is a mismatch, the author is notified and can decide whether to include the learning object or select another.

If the learning object selected is not a digital item, the system converts it to one and gives the author the option to specify metadata for the object. The editing tool has been designed to simplify the process of adding metadata by automatically generating some values from the file(s) and author profile information. Use-specified data is then added using a combination of pull down menus containing the vocabulary items relevant to the application profile being used, and fields for free texts. Authors can obtain guidance by clicking on the question mark buttons throughout. The interface is represented in Figure 4.
The editor automatically generates fields such as resource location, MIME type and size from the technical specifications of the selected file(s). Automated completion of the title field is only treated as a suggestion and the author is free to replace the automated value with a more descriptive title. The author’s details can be stored as a user profile in the application preferences and are automatically included in the Contributors field, although this data can be altered if necessary. The majority of the remaining fields are specified by selecting the appropriate term from pull-down menus, with free text limited to fields such as Title, Description, Keywords and Educational Use, and to specify usage restriction details. The author can access guidance about how to complete each metadata field by clicking on the question mark icon associated with each field.

The SLDF structure presents a seamless mechanism whereby learning objects and other units of study may be grouped together into a single unit of study, while still retaining the rights, metadata and functionality of the individual objects. This retention of rights, metadata and functionality at each level creates a clear hierarchical structure within which the complexity of the objects/units of study increase as the level of the hierarchy increases. Also, the metadata becomes less objective (data-based) and more subjective (context-based) as one progresses up the hierarchy. The unit of study metadata describes the pedagogical approach and sequence in which the embedded content is to be presented while learning object metadata describes the specific content of the associated data.

**Delivery of Units of Study**

The SLDF supports explicit flexibility in content presentation via the application of templates to the unit of study at the point of delivery. Due to their versatility and universal format, XSLT style sheets have been chosen as the format for representing the SLDF templates. The process of flexibly presenting an SLDF unit of study, represented in stage 3 of Figure 1, shows the same unit of study being used to generate different presentation formats via the application of different templates. It is the vision of the SLDF design team that a range of templates for each learning design be available within the Unit of Study editor. These templates will support common standard formats, such as HTML and PDF. It is envisaged that authors will be able to customise the presentation of their content by editing the standard templates, producing their own templates or importing existing templates.
Figure 5 represents a possible scenario in which a unit of study for a higher education course can be presented in two distinct formats. The right-hand presentation represents a text-based handout, while the left-hand presentation constitutes a Web site that delivers course content such as images, video, and learner interaction via form fields. In this example, the SLDF uses the unit of study to produce both instances by using appropriate templates to extract the data into the required presentation format. The distinct advantage is that the author only produces a single unit of study. Traditionally, such an example would require the author to generate the two forms of learning content themselves.

![Figure 5: Example of adaptive content presentation](image)

**Conclusion**

The Smart Learning Design Framework design approach described here has allowed the research team to develop a working prototype that incorporates high quality researched learning designs and well-matched learning objects within an MPEG-21 framework. The researchers will now use the prototype to explore some of the basic assumptions underlying the learning object movement and make comparisons with other systems developing such as the IMS LD standard.

This paper describes a design approach for integrating learning objects based on a strong pedagogical framework, the Smart Learning Design Framework (SLDF). The framework is based on the assumptions that good learning settings focus on pedagogically sound design and that reusable learning objects can be effectively located and incorporated into learning settings. This paper describes a tool developed to illustrate the framework through metadata tagging of learning objects using an application profile which incorporates a pedagogical vocabulary, and development of units of study based on quality learning designs and learning objects.
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