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Article abstract

Reusable learning objects are an approach that is receiving a significant amount of attention in distance-based and online education (see Reports # 11, 40, and 46 in this series). They have the potential to provide cost-effective, personalised instruction with a short development time. Instructional design principles, however, must play an important part in any such development effort, within a design process that occurs on two levels. At the higher level, instruction must be designed to deliver material efficiently to students at the modular/ course/ programme level. Design principles should be applied at the secondary level, at which the unique characteristics of learning objects are determined. Various instructional design (ID) methodologies are capable of dealing with these issues. The current report discusses a sle of these methodologies, and compares the ID adequacy of objects in four major learning object repositories: Merlot, CLOE, EOE, and Wisconsin Online. At the time of writing, each of these repositories contains objects that are inadequate from the ID point of view.

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49. Learning Objects and Instructional Design

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Abstract

Reusable learning objects are an approach that is receiving a significant amount of attention in distance-based and online education (see Reports # 11, 40, and 46 in this series). They have the potential to provide cost-effective, personalised instruction with a short development time. Instructional design principles, however, must play an important part in any such development effort, within a design process that occurs on two levels. At the higher level, instruction must be designed to deliver material efficiently to students at the modular/ course/ programme level. Design principles should be applied at the secondary level, at which the unique characteristics of learning objects are determined. Various instructional design (ID) methodologies are capable of dealing with these issues. The current report discusses a sle of these methodologies, and compares the ID adequacy of objects in four major learning object repositories: *Merlot*, *CLOE*, *EOE*, and *Wisconsin Online*. At the time of writing, each of these repositories contains objects that are inadequate from the ID point of view.

Instructional Design Requirements of Learning Objects

For a learning object (LO) to have instructional impact, it must embody explicit planning for learning, intentional instructional design (ID). Solid ID is a critical part of reusable LO design (Longmire, 2000; Wiley, 2000; Douglas, 2001; and Sosteric and Hesemeier, 2002). For the purposes of the current review, it will be assumed that the term LO refers to a digital entity intended to further the achievement of a specific learning objective. This working definition discounts those LOs that generate learning serendipitously, and could restrict the review to LOs in computer-based environments. Digital entities, whose primary purpose in a given context are to provide information, will be referred to as content objects (CO). Depending upon the context, a CO may become a LO or may serve as a LO component.

LOs typically comprise two different major components that may, or may not be, co-resident on the same computer – the learning content and the metadata. Both of these LO aspects must be considered during the ID process for the object to be effective. The metadata provide the learning context for the LO, and are the key to its *reusability*. The prime requirement of a LO is that it is reusable in different contexts (Sicilia and Garcia, 2003), and specifically in each of its target contexts as defined in the metadata. The *granularity* of an LO is defined as its instructional size, a characteristic hotly debated among LO advocates (Wiley, 2000). As learning objectives may be

needed at different levels of a course or programme, each combining different lower-level enabling objectives, so too a LO can be defined as material capable of assisting a higher-level learning objective, comprising lower-level LOs defined to achieve enabling objectives. From the ID perspective, it is the scope of the learning objective that is important in the definition of LO granularity. The smaller the granularity, and the finer the objective the LO is designed to achieve, the greater the LO's reusability, for the object will be applicable across a greater number of learning contexts and adaptable to different learner characteristics. Lesser granularity permits the LO's use in an environment where LOs can be moved in and out of the learning system in response to changes in learner type. Reduced granularity, however, increases cost and management difficulty (Herridge Group, 2002).

For a LO to be reusable across multiple learning contexts, it must also be able to stand on its own. For the LO to serve different objectives in different instructional contexts, it must be independent of the position in which it is placed in the larger learning environment. If a LO is dependent upon other objects that appear before or after it in the learning sequence, it cannot achieve a learning objective in its own right. It is therefore not an LO at all, but is – at best – an asset in the structure of a larger LO, perhaps involving other LOs that are necessary to the achievement of the learning objective. The LO's ability to be used in different technological environments enhances its reusability; efforts must be made during the LO's development to maintain its independence of any particular hardware or software environment, including the use of specialised plug-ins. Such technological dependencies should be recorded in the LO's metadata. To accomplish all of these objectives, it may be necessary to adjust the ID methodology used.

Instructional Design Overview

Instructional design (ID) is "the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation" (Smith and Ragan, 1999). Instruction is normally regarded as a system of interdependent elements that facilitate intentional learning (Gagné, Wager, Golas, and Keller, 2005; Reiser and Dempsey, 2002). ID methodologies can be applied at many levels, from the development of entire curricula, to that of the activities for a single lesson. It can represent the work of an individual or of a team of specialists. ID models are usually represented as a sequence of iterative processes, often requiring a number of cycles, before the product is fully refined. Depending upon the complexity of the instruction, however, ID may be better represented as a tightly interwoven knot than as a linear sequence of processes. This interwoven nature is particularly evident in those designs produced by rapid prototyping techniques (Smith and Ragan, 1999). In such cases, care must be taken to ensure the adequate completion of each stage before the start of the next; otherwise critical information may be missing from the material, resulting in learning errors.

The generic form of ID, found at the core of most current models, is the ADDIE model – Analysis, Design, Development, Implementation, and Evaluation (Gagné, Wager, Golas, and Keller, 2005; Reiser and Dempsey, 2002). This model focuses on learner performance relating to real-world tasks, and makes no assumption that a live teacher is necessary (Reiser and Dempsey, 2002). These characteristics make the ADDIE model appropriate as a starting point for the development of online learning and, specifically, LOs. Other methodologies have been proposed for the development and use of LOs, though have not differed essentially from the basic ID model (Martinez, 2000; Herridge Group, 2002; IMS, 2003; Downes, 2003; Johnson, 2003). LO design and development has two stages: the development of the LOs themselves, and their organisation into large aggregations, whether larger objects, modules, or courses. Most writers deal with the

aggregation of existing LOs rather than with the development of original LOs. ID principles can apply to either level. Johnson (2003) suggests that LOs should be developed according to approaches that ensure the appropriate application of sound ID strategies, enforcing clearly defined quality standards. A clear learning intent must be associated with a LO, and such intent cannot be made consistently evident in the absence of a comprehensive and systematic ID process. Martinez (2000) suggests that ID principles that result in better instruction have been avoided by LO designers, largely because of lack of familiarity with them. She questions the instructional value of LOs developed without due attention to major ID concepts. As metadata standards evolve, it is to be hoped they will become capable of including more ID information.

A Comparison of LO Requirements

The design considerations of a LO first arise at the initial analysis stage, at which the characteristics of the learners are determined, and the contexts in which they will learn. Analysis must consider the students' ability to learn effectively using online education, and the extent to which they will be able to endure visual and design differences among LOs brought together from disparate sources. Learner characteristics should be clearly indicated in the LO's metadata, since this will affect the appropriate reuse of the LO. In designing a monolithic course or module, learning objectives are defined in terms of "the skills to be learned, the conditions under which the skills must be performed, and the criteria for successful performance" (Dick, Carey, and Carey, 2001). To make these objectives appropriate for the development of LOs, they must be broken down into more detailed enabling objectives facilitating the development of information LOs and lower-level LOs. During the development of the instructional strategy, the specific design of the LO must be addressed. The manner in which learners will be presented with the instruction is determined (the delivery media and learning activities), and the sequencing and aggregation of objectives. These tasks must be completed whether the designer is developing an entire course or individual LOs. The size of each LO must be decided and its reusability weighed against the applicability of the LO in the instructional context. Smaller LOs can be aggregated into larger granularity LOs, though this may involve greater management costs. Wiley (2000) and Dick, Carey, and Carey (2001) have each recommended consideration of Gagné's nine events of instruction during the development of an instructional strategy.

A further consideration when developing an instructional strategy appropriate to the use of LOs is that multiple approaches to the instruction may be necessary to account for an LO's use in multiple contexts with multiple learning styles. For exle, an LO may include video, audio, and textual treatments of certain material to assist those students who learn best from one or another of these media. During the development of instructional materials for traditional classroom delivery, both student and instructor materials may be developed. Student materials will contain a summary of the knowledge to be acquired, and instructor materials will provide elaborative information. In developing online learning materials, however, such a division of information may not be appropriate. In the development of LOs specifically, the developer may have no knowledge of their ultimate usage, and must therefore make the information contained within the object as complete and context-free as possible, without sacrificing effectiveness. Such broad applicability implies a strong organisation of information, and the likely use of multiple media to ensure that the LO is independent of external requirements.

In order to enhance its transferability to multiple contexts, development of an effective LO also involves serious consideration of human-computer interface issues (Cassarino, 2003). Formative and summative evaluation of LOs and their aggregation can be carried out as in traditional teaching contexts. While traditional course materials can be evaluated in the context for which

they were originally designed, LOs need to be evaluated in multiple contexts. Since the original designer cannot anticipate all of the contexts in which an LO will be used, evaluative data may need to be obtained from designers who have included the LO in other learning situations. General metadata standards do not include fields for feedback of this type, though some LO repositories (e.g., Merlot, *see below*) have added this feature to their structure.

LO Repositories and ID Principles

Though it is often difficult to determine if ID standards have been deliberately applied to a particular piece of instructional material, objects contained in content repositories can be assessed in terms of their adherence to specific ID principles. In particular, the following questions can be asked of the individual items in an object repository: Do they facilitate intentional achievement of specific instructional objectives? Or are they merely COs, supplying basic information only and needing to be combined with other objects to facilitate intentional learning? The object's ease of use, navigability, and reusability can be assessed by reviewing its interface and the extent to which it is tied to a particular learning context.

1. Merlot Multimedia Educational Resource for Learning and Online Teaching

Merlot Multimedia Educational Resource for Learning and Online Teaching (*http://www.merlot.org*) is a major international repository administered by a consortium of higher education institutions, and contains objects on a broad spectrum of disciplines. Objects added to the repository are open for peer review, which are made available to visitors along with the metadata that assist in assessing the applicability of an object for specific purposes. The objects are not actually contained within the repository, and it is often difficult to contact their source sites. This reviewer surveyed the first 20 objects presented in *Merlot*'s Business category, listed with reference to peer ratings. Of these, nine were content objects (COs) that would need to be combined with other instructionally specific objects in order to supply the learners with both context and intent. Only eight objects could be classified as actual LOs, four of which appeared to be widely reusable, though only as whole topics owing to their granularity. Many of the object sites were commercial, containing information provided primarily as a means to sell another product or service. A scan of objects listed further down the list in the Business category revealed many other commercial sites presenting COs with apparent limited reusability.

2. CLOE Cooperative Learning Object Exchange

CLOE Cooperative Learning Object Exchange (*http://cloe.on.ca*) is a repository at the University of Waterloo containing peer reviewed LOs. All objects in the repository undergo peer review before being posted. Their metadata are available, but the results of the peer reviews are not. This restricts the formative evaluation of an object by other than its original creators. *CLOE* is a small repository, so the current object review was cross-disciplinary. Of the 12 objects reviewed, seven were classifiable as COs, requiring other information in order to produce intended learning. Four were full-topic, stand alone LOs with definitions of objectives, content presentation, and assessment. One object was unavailable, an unexpected problem given that the objects are all housed within the repository database. None of the objects were simple graphic assets as with the image files found in some repositories. All were self-contained and would be highly reusable in appropriate contexts. Their metadata were not always complete, and a potential user would need

to review each object in turn to find adequate comparative information. Overall, the quality of materials in this repository appears to be higher than that found in *Merlot*.

3. EOE Electronic Object Economy

EOE Electronic Object Economy (http://www.eoe.org) is a LO repository containing Java-based objects. Objects in other repositories may be developed using this programming environment, and the repository is distinctive in that, except for the HTML shells surrounding the Java applets, no other technologies are used. The Business category of objects was again chosen for review, and eight objects were selected for assessment. Of these, two were inelegant, but functional and reusable objects incorporating simple Java applets for performing calculations. While attempting to navigate to one object that claimed to calculate amortisation schedules, the evaluator was redirected to a pornography site. The remaining sites were unavailable. The review was terminated at this point since the search was totally unproductive.

4. WORC Wisconsin Online Resource Center

WORC Wisconsin Online Resource Center (http://www.wisc-online.com) is a collection of Flash-based COs. Each is short and only occasionally provides complete topic coverage. Six objects were reviewed in the Business category. Each displayed a consistent interface that would assist their seamless integration into a comprehensive course. For most purposes, however, they are unlikely to stand on their own.

Conclusions

Reusable LOs can be effective in the delivery of cost-effective, timely, reusable instructional materials. Their effectiveness, however, is as much a product of efficient instructional design as any learning materials or process; and ID principles should addressed during the objects' design and development. The ID principles proposed for use in object-oriented situations are essentially the same as those used in the development of traditional instructional materials. They should be applied not only in the design and development of modules and courses using LOs, but also in the creation of the objects themselves.

A survey of objects contained in existing repositories, however, reveals that relatively few can strictly be defined as LOs at all, being of a basic CO type and not useable on a stand-alone basis to bring about intentional learning. These objects need to be aggregated with other materials in order to achieve specific objectives. Their quality also varies greatly, and in some cases calls into question the professionalism associated with the learning materials of which they are a part. The current review indicates that the effective development of LOs requires the clear definition of an instructional process addressing the unique characteristics of LO technologies, within the structured process stressed by ID principles. If such principles are not heeded, learning repositories will gain a reputation for amateurish content, rather than credibility as worthwhile educational resources.

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The next report in the series discusses techniques for optimizing conferencing freeware.

N.B. Owing to the speed with which Web addresses are changed, the online references cited in this report may be outdated. They can be checked at the Athabasca University software evaluation site: http://cde.athabascau.ca/softeval/. Italicised product names in this report can be assumed to be registered trademarks.

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