Learning Objects, Instructional Design, and Online Learning

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ABSTRACT

This paper provides a conceptual and technical overview of learning objects, which are defined as "any digital resource that can be reused to support learning" (Wiley, 2000, p. 7). The paper argues that effectively deploying learning objects, whether through the Scalable Content Object Reference Model (SCORM) in a traditional learning management system, or as part of Training and Learning Architecture (TLA) through content brokering, not only requires compliance with technical specifications but also instructional design principles. The paper concludes by presenting instructional design strategies for using learning objects in online learning.

INTRODUCTION

This paper will discuss the use of learning objects, also referred to as content objects, in instructional design. In particular, it will review the current literature on learning objects and explore applications for designing online learning. The literature review will in part examine the relationship of learning objects to object-oriented computer programming. It will also examine both the instructional design concerns and the technical requirements for learning objects related to the Shareable Content Object Reference Model (SCORM) and Training and Learning Architecture (TLA). Finally, the paper will suggest strategies for implementing a learning objects approach when designing online instruction.

LITERATURE REVIEW

Conceptual Overview of Learning Objects

As David Wiley observes, the concept of learning objects in large part originated from the world of object-oriented computer programming (Wiley, 2000, p. 3). In object-oriented computing, each "object" in the code represents a real world object (Cheon, 2009, slide 24). A group of like objects form what is called a "class"; an object is a particular instance of a class (for example, particular televisions are objects, while the concept of a television is a class). If an engineer creates a program to manage savings accounts, for example, he or she might create a class that corresponded to a savings account, and the account would have certain properties, such as the account owner, the account balance, and the account number (Derek, 2006). A particular savings account (my savings account) would be an object within the general class of savings accounts.

Because objects in programming correspond to real world objects, and classes in programming correspond to real world categories, the code is easy to read. More importantly, it can be reused. If someone else has already written a computer module for savings accounts that works well and has been debugged, why not incorporate that into a new coding project, rather than build the savings account module a second time? Object-oriented programming thus allows programmers to reuse existing modules, already created by others to speed development time and minimize duplicative work. The practice of reuse is built directly into the development process, and developers can access existing components from online repositories. (Douglas, 2001, p. 2)

Wiley's Taxonomy of Learning Objects

Learning objects build fundamentally on the concept of reuse. Wiley defines learning objects as "any digital resource that can be reused to support learning" (Wiley, 2000, p. 7). Wiley identifies three types of learning objects in his taxonomy: 1) content objects; 2) strategy objects; and 3) discourse objects. In addition, he identifies three criteria that should be applied to each type of learning object: specification, scope, and sequence. Specification concerns the "number of criteria a digital resource must meet to be considered a learning object." (Wiley, 2009, p. 353). Scope concerns the size of a learning object, and sequence concerns the sequencing of both learning objects and activities and information within a given learning object.

Wiley defines content objects as “self-contained chunks of information.” (Wiley, 2009, p. 353). They can be presented in a variety of formats, including text, visual, audio, or video. Practitioners vary considerably in how they define the specification of a content object on a scale, ranging from virtually no specification or structure, where anything and everything can be a learning object, to a high degree of specification and structure with respect to content, organization, format, and metadata indexing. Similarly, depending on the particular practitioner, the scope or size of a content object is defined in a variety of ways: the time it takes to complete the instruction, how many objectives are covered, the number of screens or steps a user interacts with, and even the digital size of the file. Sequencing of a content object, by contrast, tends to track established learning theories, such as those set forth by Reigeluth (simple to complex) and Gagne (prerequisites, subordinate skills, and terminal objective).

In contrast to content objects, strategy objects have no content. They represent “procedures, processes, and patterns of instruction.” (Wiley, 2009, p. 357) Wiley analogizes content objects to data and strategy objects to algorithms: just as an algorithm processes data, so a strategy object “operates” on a content object to process the content, structure feedback, or generate practice or assessments. A discourse object is a special kind of strategy object that “scaffold[s] interactions among learners.” (Wiley, 2009, p. 360) While content objects and strategy objects are selected by instructional designers or automated systems, discourse objects are created and inserted in content by learners. Specification of discourse objects also takes place on a continuum, from unstructured wikis on one end of the spectrum to more structured collaborative tools on the other end.

SCORM Taxonomy

Just as reuse is key to Wiley’s understanding of learning objects, so, too, is reuse a key part of the Sharable Content Object Reference Model (SCORM) and its taxonomy. SCORM grew out of the Advanced Distributed Learning (ADL) initiative, whose mission was to standardize training management and delivery so that "the Department of Defense (DoD) [could] have access to the highest-quality learning and performance support."[1] SCORM does this by integrating a set of specifications and technical standards that allow what it refers to as content objects to be accessible, interoperable, durable, and reusable. (*SCORM Users Guide for Instructional Designers*, 2011, page 16).

As stated in the Run-Time Environment book of SCORM 2004 published by ADL (2009): ". . . there must be a common way to launch and manage content objects, a common mechanism for content objects to communicate with an LMS and a predefined language or vocabulary forming the basis of the communication."[2] As a practical matter, this means that a learner can view any course that is SCORM-compliant in any Learning Management System (LMS) that is also SCORM-compliant.

For the 2004 4th Edition of SCORM, ADL released three overlapping, yet distinct, "books" (extended PDFs), each with a distinct area of focus: the Content Aggregation Model (CAM), the Run-Time Environment (RTE), and Sequencing and Navigation (SN). This paper will focus primarily on the SCORM Content Aggregation Model as it relates to learning objects. (Citations for all three SCORM 2004 books are provided in the bibliography for those wishing to explore the other SCORM topics.)

The SCORM content model, or taxonomy, is made up of assets, sharable content objects (SCOs), activities, content organization, and content aggregations. (SCORM 2004 4th Edition, Content Aggregation Model, 2009). An asset is a basic building block of a learning resource, for example, a video, text, or an image; it is an electronic representation of some kind of media that can be rendered by a Web client and displayed to a learner. However, an asset cannot communicate with an LMS. A sharable

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[1] Advanced Distributed Learning (ADL), Sharable Content Object Reference Model (SCORM®) 2004 4th Edition, *SCORM Users Guide for Instructional Designers*, Version 8, 2011, page 15.

[2] Advanced Distributed Learning (ADL), Sharable Content Object Reference Model (SCORM®) 2004 4th Edition, *Run-Time Environment (RTE)*, Version 1.1, 2009.

content object (SCO), by contrast, can communication with an LMS; for example, an SCO can collect data on a user's performance. An SCO consists of one or more assets that, taken together, constitute a chunk of instruction, for example, a lesson, topic, or module. While SCORM does not prescribe the size of an SCO, as a practical matter, the smaller the size, the easier it is to reuse the SCO in multiple learning contexts. An activity is what a user does as she or he progresses through an SCO or related SCOs. An aggregation of content is typically a group of related SCOs, and the organization of content refers to the top-level aggregation of the content.

A SCORM-compliant course is placed within a content package to be delivered to the LMS. A course package has two major components: 1) an XML file called the manifest, which inventories the content structure and resources of the content package and which provides organization for the content, and 2) the content itself, that is, all the files that make up the content.

ADL has also published a SCORM Users Guide for Instructional Designers (2011), which addresses best practices for, among other things, finding and creating reusable content. The Guide provides a number of resources for locating existing content. The Guide also identifies four different categories of reuse: redeploying, rearranging, repurposing, and rewriting. When content is redeployed, the instructional designer uses the SCOs "as is" in a different LMS. When content is rearranged, the instructional designer reorders the SCOs or deletes one or more of the SCOs. When content is repurposed, the instructional designer may add SCOs (as well as reorder or delete SCOs). When content is rewritten, the instructional designer makes changes to the assets themselves, for example, changing the examples or imagery, or removing context specific textual references. Of course, as one progresses through those four categories of reuse, increasingly sophisticated instructional design is required.

When creating reusable content, the Guide advises creating granular SCOs, which make it easier to reuse a particular SCO for a variety of audiences. One way to keep SCOs granular and easily reusable is map each SCO to a learning objective. Of course, there may be exceptions to this; the size of the SCO depends not only on reuse but also on learner performance tracking requirements.

Learning Objects and Training and Learning Architecture (TLA)

ADL is now preparing for the next generation of SCORM, called Training and Learning Architecture (TLA). While SCORM has made content reusable, it has not succeeded as well in making content shareable. The development of TLA is in part a response to the open source movement, mobile technologies, wireless technologies, games, augmented reality, and cloud-based learning. (Please see www.adlnet.org/tla for a complete discussion; last retrieved April 21, 2013.) TLA will not replace SCROM, but it will supersede the present capabilities of SCORM.

TLA has four key components:

1. Experience Tracking (also known as Experience API, xAPI, and Tin Can API)
2. Content Brokering
3. Learner Profiles
4. Competency Networks

This paper will briefly discuss the first two components (experience tracking and content brokering) and refer the reader to www.adlnet.org/tla for more information about the second two (learner profiles and competency networks).

Experience Tracking

Experience Tracking, more commonly known as Tin Can API (Application Program Interface), will allow tracking of a range of learner experiences in a variety of contexts; in addition to tracking traditional records of scores and course completion, it will also record very granular learner activities, such as reading an article or watching a video, which may not necessarily occur within the confines of a Learning Management System (LMS). (Please see http://www.adlnet.org/tla/experience-api for a complete discussion; last retrieved April 21, 2013). Tin Can API recognizes that learning experiences occur in a variety of settings; the goal is to collect and record learning experiences that are quantifiable, sharable, and trackable. While Experience Tracking covers traditional SCORM learning, it also captures informal, more social learning. The key point is that this model allows the tracking of experiences, not just completion. The goal is to make activity data interchangeable.

Activity streams are the model for Experience API; they are supported by social media and technology industries. Activity streams follow a simple statement structure of **"Actor—Verb—Activity"** ("I—did—this"), in which actors, verbs and activities are broadly defined. A statement is essentially an assertion about a learner and his or her learning experience. The "I" portion of "I—did—this" is the actor or agent; while this still supports the single learner (and authentication), it also supports team learning and combined identities. The "did" portion of "I—did—this" defines verbs associated with experiences; while a core set of verbs still allows for formal learning, an extensible subset of verbs allows for a wider range of actions, such as those that involve gaming and social media. An open source verb registry is planned to ensure interoperability of verbs and actions among content developers. The "this" portion of the "I—did—this" statement permits a wide range of activities, such as video, audio, games, and social interactions, both real and virtual. Successful completion of an activity, in part or in whole, will be associated with a competency. The activity portion is also associated with a trusted authority who will confirm that the statement asserted (what a learner has done) is in fact true.

Activity streams will be delivered to and stored in a Learning Record Store, a tracking service that can be incorporated into a Learning Management System (LMS). While an LMS only stores data from LMS sessions, a Learning Record Store can collect learner data from many places, and different systems can pull from it, for example, to support semantic analysis, assessment services, reporting systems, and statistical services.

Content Brokering

Content brokering, the second component of the TLA, relates to the sequencing and navigation of content. In simplest terms, it seeks to identify the next logical piece of content that should be launched for a user to support just-in-time learning. Central to that effort is identifying what content is available; content brokering builds on the practice of "federation of content," meaning that while there may be multiple repositories of content, they should all be accessible from the same universal search.

One example of the federation of content is the Learning Registry, whose purpose is to show users what content is available, regardless of the repository in which it is stored, and to assist users with registering their content. It has resulted in a web service that connects different repositories together, so users can search a wide range of content that is tagged with common metadata. (The Learning Registry was not developed specifically for the TLA but allows the TLA to build on its accomplishments.)

Another example of federated content is the Re-Usability Support System for eLearning (RUSSEL), an open-source software project. It is an out of the box content repository or digital library with a specified workflow that integrates instructional design components.

The six components of the RUSSEL workflow are:

1. Design content by identifying objectives and selecting instructional strategies
2. Find and add content from multiple sources using a single search
3. Hand off to developer
4. Develop content
5. Review and revise content
6. Share content by uploading it to RUSSEL and publishing metadata and paradata (derived data) about the content

Learning Objects and Instructional Design

The content brokering component of TLA in particular highlights the integral role of instructional design, as discussed above. Content brokering belies the notion that learning objects or content objects are like LEGO building blocks that can easily be assembled to create a particular structure and just as easily reassembled to create a different structure. The LEGO analogy erroneously implies that a given learning object can be combined with any other learning object and that no training is needed to combine learning objects. The problem with this analogy, as Wiley argues, is that it bypasses the instructional design decisions of scope and sequence that are required to create a cohesive structure that is instructionally useful. In place of the LEGO analogy, Wiley proposes a "bricks and mortar" analogy, in which learning objects are like bricks that require the mortar of instructional context to give them meaning and effectiveness.

As Wiley has observed, technical specifications have tended to dominate the discussion of learning objects, for example, the use of learning objects in different kinds of learning management systems and the metadata that is used to catalog learning objects. He argues that instructional design theory must be brought to the forefront in any discussion of how and whether to assemble learning objects (combination) and the size of any learning object (granularity). Wiley argues that learning objects do not change the fundamental instructional design practice of making purposeful choices under constraints. Learning objects impact instructional design by requiring purposeful decisions about which learning objects to include, how to include them, and whether or how they should be modified in the new instructional context.

This is particularly apparent in the developing area of open educational resources (OERs). OERs are learning objects with open source licensing, thus permitting instructional designers to reuse and repurpose them without the traditional intellectual property constraints. Wiley believes this allows designers to embrace localization, which he defines as the process of "adapting instructional materials in ways that make them more appropriate for target users in linguistic, cultural, and other ways." (Wiley, 2009, p. 362) Because the OER movement seeks to provide quality education to persons in developing countries, and because OERs do not have intellectual property constraints, this allows instructional designers to repurpose learning objects in a variety of contexts.

Wiley also identifies the reusability paradox while discussing content objects. The paradox states that "the instructional usefulness of a learning object is inversely proportional to its reusability in instructional scenarios." In other words, the very thing that makes a learning object useful in a given scenario—namely, the particular juxtaposition of concepts, examples, images, and media—makes it less reusable in that precise form in a different instructional scenario. This further confirms that repurposing content is not a matter of mechanically inserting previously created content in a new context but requires instructional design analysis and the selection of instructional strategies so that the repurposed content is effective in its new context.

Learning Objects and Online Education: A Case Study

Hardin et al. present a practical example of how learning objects can be embedded in a contextual narrative in medical education (Hardin et al., 2011). Consistent with Wiley, Hardin et al. note that more attention has been paid to the technical requirements of learning objects, such as interoperability and compliance standards, than to pedagogical considerations. Hardin et al. build on the bricks and mortar analogy proposed by Wiley (Hardin, 2011, p. 287), which emphasizes the importance of the integrated whole facilitated by instructional design as opposed to the individual objects.

Hardin et al. present a case study that illustrates the brick and mortar approach to a curriculum built from learning objects. The topic for the curriculum was the cardiovascular system. Approximately 1600 learning objects on this topic were available in the International Virtual Medical School (IVMEDS) repository; particular learning objects deemed appropriate for the curriculum were identified and retrieved, and a curriculum map was created with learning objects inserted at particular nodes on the map. (Hardin, 2011, p. 287) A teacher then created running commentary for the selected learning objects that functioned as a student's personal learning assistant; the commentary wove together the learning objects, highlighted important points, previewed upcoming learning objects, and connected new learning objects to previous learning objects.

Strategies for Using Learning Objects in Online Learning

The possibilities for using learning objects in online learning are endless, whether someone is repurposing existing learning objects or creating new learning objects. The strategies suggested below for making the best use of learning objects in online learning will of course evolve as the Training and Learning Architecture (TLA) project evolves.

1. Identify available repositories for existing learning objects. Determine whether the repository is open source.
2. If there is more than one repository for a category of learning objects, determine if the content has been federated and allows for a single global search of the content.
3. Evaluate whether the learning object is appropriate for the module you have decided to build.
4. Determine whether the learning object can be modified to suit your particular module.
5. Evaluate whether the learning object(s) can be integrated into a Learning Management System (LMS) and adapt it (them) to permit integration if necessary.
6. If no existing learning objects are available or cannot be easily modified, develop the necessary learning objects.
7. Determine the appropriate instructional strategy for the module, including the sequence of and context for the learning objects to be included.
8. Develop the module.
9. Submit any learning objects that have been created to the relevant repository for use by others.

Conclusion

Online educators have an increasingly wide array of learning objects in multiple disciplines to select from as they build their own curricula. The move toward federation of content will make searching for content faster as the rich cataloging of metadata makes reuse easier. Yet as the tracking, sharing, and reusing of content evolves from learning management systems on web browsers to mobile applications and virtual learning environments, instructional design principles remain as paramount as ever to effective learning in the selection, repurposing, and placement of content.

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