Aligning Instructional Design and Technical Standards

Damon Regan, Robby Robson
Eduworks Corporation
Corvallis, OR
dregan@eduworks.com, rrobson@eduworks.com

ABSTRACT

What is a Sharable Content Object (SCO) in an instructional design context? The frequency with which this question is asked is symptomatic of a much larger problem: There is no accepted alignment between units of instruction and units of technical standards.

The SCORM community has tried to create alignment by starting with a SCO. For example, models have been proposed that equate a terminal learning objective with a SCO. These models are not compatible with the inner workings of SCORM and the practice is discouraged by the ADL Initiative (Roberts & Blackmon, 2006). Another approach is to give up on lower levels of granularity and simply equate a course with a SCORM content package. This does not help create reusable content that takes proper advantage of SCORM capabilities.

This paper starts with two observations. First, most proposed alignments consider levels of granularity defined by SCORM but do not consider the units of granularity inherent in instructional design theories. Second, reusability (a key business driver behind SCORM) occurs more often at the level of a complete instructional strategy than at the level of an instructional event. From there, the paper constructs a proposed alignment and discusses its properties and benefits.

ABOUT THE AUTHORS

Damon Regan is a solutions engineer at Eduworks Corporation and a Ph.D. student in instructional technology at the University of Central Florida. He worked for the Joint ADL Co-Lab approximately five years contributing to the ADL Initiative and its implementation of SCORM and the ADL Registry throughout the U.S. Department of Defense. He has supported and developed simulations and web-based applications. Mr. Regan has an MBA from Rollins College and a B.S. in Computer Science from the University of Central Florida.

Robby Robson, Ph.D., is an internationally recognized innovator and researcher in online learning and a leader in the learning technology standards community. Robby has extensive experience leading research teams that developed innovative technologies in mathematics and Advanced Distributed Learning, including several projects for the ADL initiative. He has chaired the IEEE Learning Technology Standards Committee since 2000, has served on the IEEE Standards Board, is Vice Chair of the IEEE Computer Society Standards Activity Board, and has been instrumental in starting what is now LETSI. Dr. Robson holds a Ph.D. in mathematics from Stanford University, and spent 15 years as a faculty member and administrator at Oregon State University. He co-founded Eduworks Corporation in 2001 and Eduworks Software, LLC in 2007.

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INTRODUCTION

In 2007, The American Society for Training Development (ASTD) State of the Industry Report stated that 30 percent of learning hours available were technology-based delivery, up from only 11 percent in 2001. The Web is an important medium for this technology-based delivery outside of classroom settings. The Web and the specialized learning technologies that leverage it are made possible by a large set of standards ranging from standardized protocols like TCP/IP and HTTP to learning technology standards such as SCORM.[1] These standards are typically developed by technologists who focus on the technical and business problems of interoperability and reuse.

Instructional designers use these technologies to deliver instruction. Their focus is on efficiency, effectiveness, and appeal. As end users, instructional designers are generally not concerned with protocols and communication standards that enable the Web, but standards like SCORM can directly affect their ability to do their job effectively.

Leaders in instructional design have called for effective collaboration between the instructional design community and technologists. Wiley (2000) stated that instructional design theory must play a large role in the application of learning objects technology if it is to succeed. Bush (2002) identified the apparent disconnect between the promise of learning technology standards and their successful use.

This collaboration has frequently taken the shape of defining what is meant by a "learning object" in a manner that is consistent with the principles of instructional design (Churchill, 2007; Wagner, 2002; Wiley, 2000; Barrit & Lewis, 2000). However, these definitions and taxonomies are typically complex and in practice do not seem to be fully accepted or understood by instructional designers.

[1] SCORM is a collection of profiles of specifications and standards and formally is not a standard itself. However, it serves as a *de facto* standard and will be called a standard in this paper.

It should be recognized that there is a fundamental difference in the requirements of technical standards and instructional design. Technical standards must be precisely defined so as to enable machines to interoperate. Instructional design must be flexible enough so as to enable people to learn. This leads to an impasse: Instructional designers try to map technical standards onto instructional models and find them too rigid, while technologists try to equate instructional requirements to technical standards and find them too ill-defined. Any approach to collaboration that starts by superimposing an instructional concept on a technical standard, or vice versa, is almost certain to fail. The lengthy debate over the definition of a learning object exemplifies this.

The approach to breaking this impasse advocated here is to start by embracing both views independently and aligning them from both directions rather than from just one. When this is done, the notion of granularity becomes crucial. However, the issue of granularity is not that of granularity imposed by technical standards, but rather of how to apply the choice of granularities to achieve both instructional effectiveness and reusability.

ONE VIEW AT A TIME

Technical Units

What are the Web-related technical units available for alignment with instructional design? Candidate units range from individual multimedia standards and formats such as JPG, GIF, PNG, PDF, PowerPoint, Flash, MP3 audio, HTML, and MPEG video to learning technology specifications and standards like SCORM content packages and IEEE learning object metadata.

There are two significant values of learning technology standards like SCORM. The first is the ability to create reusable learning content (based on multimedia standards) that can be sequenced, packaged, and played while tracking learner outcomes and performance. The second is the value that originally motivated the development of SCORM by the Advanced Distributed Learning initiative (Robson, 2002): SCORM learning

content is portable and interoperable. It can be used by any delivery system that conforms to SCORM, thereby preventing vendor lock-in and increasing distribution options.

SCORM has three primary technical units that are candidates for alignment with instructional units: assets, sharable content objects (SCOs), and content packages.

The first unit and smallest unit in SCORM is an asset, which is naturally aligned with the multimedia standards and formats above. To illustrate what is meant by this alignment, consider an instructional designer who wishes to include a wiring diagram in a course. From the instructional design perspective, a diagram is an instructional object with a specific instructional purpose. From the technologist's perspective, a diagram is a multimedia object, probably a graphic or (if it is interactive) a movie. To transmit, display and programmatically manipulate this object, the object must be encoded using a standardized format such as JPG, PNG, or SWF. The SCORM notion of an asset provides a reasonably good match to both the notion of an instructional asset (the diagram) and a multimedia asset (the graphic or movie that represents the diagram). The technologist does not care how the asset is used or interpreted by a learner, and the instructional designer does not care how the asset is encoded for machine use, but both can recognize the asset and understand an asset as an object in the SCORM lexicon.

Two key technical notions in SCORM are those of launching and tracking. An LMS launches content when it loads it into the learner's browser. Once the content is resident in the browser, the LMS may be able to exchange information with the content but cannot control the content until the content signals to the LMS to take over once more. Tracking is the process of recording information about the learner's interactions with the content, typically the duration and results (e.g. scores or answers to questions or what buttons were pushed) of an interaction.

Assets are combined into the second unit of SCORM: the Sharable Content Object (SCO). Conceptually, SCOs are the smallest units that can be launched and tracked by an LMS.[2] A SCO's assets are able to communicate with an LMS using a standardized data model. Data reported by the SCO can influence the order in which the system delivers other SCOs, and a SCO can adapt its own behavior based on information received from an LMS.

A SCO is a conceptual object. On a technical level, a SCO is defined by some XML that resides in a specific file in a SCORM content package (see below). This XML identifies the assets that comprise the SCO, identifies "objectives" associated with the SCO, and includes metadata about the SCO.

The notion of a SCO is fraught with opportunities for misalignment caused by confusing the conceptual notion with the technical specifications. For example, SCOs are often described as communicating with an LMS, but it is actually the assets within a SCO that are communicating. Similarly, in SCORM 2004, SCOs have associated objectives that can have associated scores, completion status, and success status. These are technical objects defined in terms of data types and data exchange. Although they are intended to represent learning objectives, skills, knowledge, attitudes, etc., there is nothing learning-specific in their definition other than the terminology used to define them and there are characteristics and behaviors (such as an expiration date for a certification) that are not incorporated into the technical definitions.

The third and final unit in SCORM is the content package. The content package plays a critical role in SCORM. It is the unit of exchange and the unit within which SCOs are defined. It is the only unit in SCORM with an explicit file format.

The role of the content package has been made even more important in SCORM 2004. SCORM 2004 added the ability for SCOs to be sequenced based on rules. These sequencing rules are defined in a content package. This has increased the importance of the content package and indicates that the focus of sharing and reuse might in fact be the content package and not the Sharable Content Object.

Instructional Units

If SCORM provides de facto technical units, what instructional units are available and where do they come from?

One answer to this question has been the learning object, a term that by many accounts was introduced by Wayne Hodgins and popularized by Ruth Clark (1998) and others (Barron, 2000; Longmire, 2000; Barrit & Lewis, 2000). As described by these authors, learning objects are part of a more general content model and can be reasonably defined as self-contained units of

[2] In this regard, the notion of a SCO derives faithfully from the notion of an assignable unit present in the AICC specifications that preceded SCORM and were the basis of many parts of SCORM.

instruction with a single terminal learning objective (Robson, 2007; Wagner, 2002).

The driver behind learning objects, and the educational object economies that came before learning objects (Roschelle, Kaput, Stroup, & Kahn, 1998), was the idea of constructing online instructional environments from collections of reusable building blocks, as is done in object oriented programming and in many areas of manufacturing and construction. Reuse, which translates into lower costs and more efficient production, is a key business driver and technological challenge but is not valued as highly in the broader instructional design community as, say, learning effectiveness. It is therefore not surprising that learning objects are considered to be poorly defined (Churchill, 2007) and not well accepted by educators (Friesen, 2003). Later efforts by instructional designers to precisely define the concept (Wiley, 2002; Bush, 2002) seem to have added to the confusion, and the concept of a learning object remains ill-defined and untaught in instructional design classes.

Looking back on this state of affairs, Hodgins (2006) remarked that, "in hind sight I can see that one of my greatest errors was in assuming that everyone would understand that Learning Objects exist within a conceptual model for content. Overall they were not meant to be a single fixed thing." This statement hints at a solution: instead of starting just with a model of content, also start with a model of instructional design. Instructional design models describe the procedures instructional designers use to develop efficient, effective, and appealing instruction. They provide two concepts that are taught in instructional design classes: instructional goals and instructional strategies.

Instructional goals are the critical starting points for instructional design. Instructional units emerge in discussions of instructional goals. The amount of instruction required to address an instructional goal can vary tremendously (Dick, Carey, and Carey 2005). Some goals require less than an hour whereas others may require many hours (p. 44). Goals also apply to differing levels of granularity such as units, lessons and courses (Smith and Ragan, 2005, p. 77).

Once a goal has been sufficiently analyzed and objectives and assessments defined, instructional strategies can be developed for lessons, units, courses, or curricula (Smith & Ragan, 2005, p. 128; Dick, Carey, & Carey, 2005, p. 185). Smith and Ragan (2005) distinguish between strategies developed for the macro level (i.e., curriculum, course, or unit) and the micro level (i.e., lesson), where a lesson is considered the amount of instruction that can be completed in one meeting. In the Smith and Ragan model, micro-level strategies are considered independently of macro-level strategies.

Every instructional strategy should be based on an instructional theory that outlines the events of instruction. Smith and Ragan (2005) accomplish this by explicitly scoping instructional strategies to lessons. Dick, Carey, and Carey (2005) do this implicitly when they tell designers to cluster instructional events based on the time required to complete all events in a specific instructional strategy (p. 189). Essentially, both models are describing the same unit: Smith and Ragan call it a lesson, while Dick, Carey, and Carey call it a cluster. This unit represents the smallest unit of instruction containing all of the events of an instructional strategy. Anything smaller that does not include these events may just be what Merrill calls information as opposed to instruction (Zemke, 1998).

This suggests that the appropriate approach to aligning instructional design theories to SCORM is to focus on this unit. As an abstraction, this could be termed an instructional strategy or instructional template. When applied to an actual course of instruction, it becomes the lesson as defined by Smith and Ragan. In content design and development workflows, this unit is often represented by a storyboard. We will follow Smith and Ragan and use the term "lesson."

Almost any term can introduce confusion because different authors use it in different ways. For example, Dick, Carey, and Carey refer to lessons, courses, and curriculums when considering delivery systems (p. 185) but do not clearly distinguish between these units. By and large though, the English word "lesson" connotes a series of instructional events resulting in something being learned, which is consistent with the usage proposed here.

A PROPOSED ALIGNMENT

Just as there is a natural alignment between instructional assets and media assets, there is a natural alignment between lessons and SCORM 2004 content packages. The notion of this alignment has previously been suggested by Hirumi and Regan (2007). A lesson consists of content that supports all the events of a grounded instructional strategy. With SCORM 2004, a content package represents a collection of content organized into an instructional strategy. In SCORM 2004, the instructional strategy is represented by objectives and sequencing rules.

Table 1 shows this alignment at multiple levels of granularity. Instructional design concepts are on the left and technical concepts on the right. These are aligned through the middle two columns, one of which is the representation of that concept in SCORM 2004 and the other is the corresponding representation using standards. This table is to be interpreted as an alignment, not a precise map, and is not meant to give preference to the instructional design concepts or to technical concepts. The table would carry the same information were it reversed from left to right.

Table 1. Proposed Alignment

Instructional Design Concept	SCORM 2004 Concept	Standardized Representation	Technical Concept
Lesson	SCORM Content Package	Zip file with XML and content	Portable, reusable, packaged content
Instructional Event	One or more SCOs	Aggregations defined by XML in a SCORM package	Units launched and tracked by an LMS
Instructional Strategy	Sequencing and Navigation rules	Rules defined by XML in a SCORM package	Instruction set for LMS
Instructional Content	Resource	Universal Resource Identifier	Location of content to be delivered
Instructional Asset	Asset	Standardized format	Media asset or Web page

SCOs

The term "SCO" stands for "Sharable Content Object." As pointed out earlier, a SCO is not really a content object at all. It is a conceptual object used to aggregate content assets and to demark the boundary between LMS control and browser control in the SCORM delivery paradigm. As a unit of reuse, it is problematic. Bush (2002) points out:

> To be reusable, a SCO by itself should be independent of learning context, something that seems difficult or even impossible with respect to designing objects with sound instructional design principles. How can a well-designed object not embody principles of instructional design that are by definition dependent upon context?

The context dependence to which Bush refers includes the context of instructional events working together to form an effective unit of instruction. From this perspective it is clear that a SCO aligns reasonably well with the notion of an instructional event, and this is supported by the SCORM delivery paradigm in which an LMS takes a learner from SCO to SCO.

Table 1 reflects this alignment, and this alignment helps address the perennial question "How big is a SCO?" If one thinks of representing an instructional event as one or more SCOs, and further thinks of a SCO as a technical unit that can be launched and tracked by an LMS, the question doesn't make much sense from an instructional designer's perspective.

This view is reflected in Roberts and Blackmon's (2006) suggestion to let the programmers determine the size of SCOs:

> So instead of asking "How big should a SCO be?" we suggest that the more proper question for instructional designers to ask is, "How do I create effective instruction that enables Re-use (with a capital R)?" After answering that question, designers should work with programmers to tackle the follow-on question: "And how will we create this instructional experience using SCOs?"

Moreover, Roberts and Blackmon hit on another key alignment issue, that of reusability, which will now be discussed.

REUSABILITY AND GRANULARITY

The conventional approach to reusability and granularity focuses on Sharable Content Objects as technical units and Learning Objects as instructional units. The smaller these objects are, the more reusable they become.

Whereas there is no question that assets such as images can be highly reusable, it does not follow that their reusability always increases as granularity decreases. In an object oriented programming environment, each object has meaning unto itself, but in an instructional design environment, smaller units lose their meaning unless they exist in the context of an instructional strategy. This destroys the monotonic relationship between size and reusability: lessons are in many cases more reusable than parts of lessons, which in turn are less reusable than the assets they contain!

This point can be further expressed in the context of a learning object vision offered by Rory McGreal. McGreal (2004) imagined having seamless access to a

vast store of learning resources such as animations, videos, simulations, educational games, and multimedia texts in the same way that Napster users had access to .mp3 files then and iTunes users have (legal) access now. If this vision were realized as the equivalent of iTunes, what would be bought and shared? Just as music is bought and shared as whole songs and not short phrases or just the guitar part, instruction would be bought and shared as lessons and not small individual objects.

Learning Objects

Returning to the notion of a learning object, one definition of a learning object is as a unit of reuse. There is no reason to believe that this unit is constant or precisely defined.

As pointed out by McGreal (2004), learning objects could take many forms, now and in the future. This paper suggests that content packages are the natural unit of reuse for SCORM 2004 content and are therefore most closely aligned with the notion of a learning object. McGreal (2004), Wagner (2002), and others have suggested that with appropriate metadata, smaller learning objects can be assembled to form lessons and courses. As technology, standards, and instructional techniques evolve, it may very well turn out that smaller objects will become more reusable and more valuable to instruction designers.

In today's world, however, the lesson, as defined in this paper, is a natural candidate for reuse in instructional design, with the content package serving as a suitable, existing technical instantiation of it. This meets the challenge, posed by Bush (2002), of standardizing those useful things in the middle between an individual media object on the one hand and a full course on the other.

Macro-level Strategies

The proposed alignment is based on micro-level strategies. It does not address alignment of macro-level strategies such as courses and curricula. Issues such as scaffolding and maintaining a consistent underlying world view are not addressed. These may be less important in applications to performance support and compliance training but are critical in educational applications.

At this point in time, macro-level strategies are programmed into an LMS. However, there might be benefits to technical standards offering the ability to encode these in a similar manner to content packages, which includes sequencing capabilities. This is one of many areas that might fruitfully be addressed as SCORM and other standards evolve.

BENEFITS OF A CLEAR ALIGNMENT

Perhaps the greatest benefit of the proposed alignment is the clarity of communication it can offer among professionals developing instruction. If instructional designers can express requirements in ways that are aligned with SCORM, and SCORM concepts can be easily mapped to technical implementations, then there will be less frustration and more consistent outcomes. It will be easier to develop instructional design tools whose functionality is enabled by SCORM rather than dictated by it.

With a clear alignment between content packages and lessons, instructional designers are able to focus on making effective instruction while collaborating with technologists to determine how that instruction may best be instantiated as SCORM content. When that content is appropriately tagged with metadata, it can be searched and discovered for reuse, but only if there is good alignment between the granularities of objects being tagged and the ability to reuse them.

By focusing on lessons (as defined in this paper) instructional designers can concentrate on the most important goal of effectiveness. Once an effective design is in place, technologists and artists can focus on implementation and appeal. As the development process continues, designers can consider how to optimize the events of the lesson. This is the development process that SCORM has been trying to support and to which a clear alignment between instructional concepts, technological concepts, and SCORM will contribute greatly.

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