

Learning objects need instructional design theory¹

The purpose here is to introduce a concept known commonly as the “learning object.” First we will look at the learning objects literature and lay the groundwork for a working definition of the term “learning object.” Next we will note that while there are several efforts to cash in on the learning objects idea, very little actual educational research is happening with regard to learning objects. Finally, we will critically examine the LEGO metaphor commonly associated with learning objects, and suggest what may be a more appropriate metaphor.

What is a learning object?

Technology is an agent of change, and major technological innovations can result in entire paradigm shifts. The computer network known as the Internet is one such innovation. After affecting sweeping changes in the way people communicate and do business, the Internet is poised to bring about a paradigm shift in the way people learn. Consequently, a major change may also be coming in the way educational materials are designed, developed, and delivered to those who wish to learn. “Learning objects” (LTSC, 2001a) currently lead other candidates for the position of technology of choice in the next generation of instructional design, development, and delivery, due to their potential for reusability, generativity, adaptability, and scalability (Hodgins, 2000; Urdan & Weggen, 2000; Gibbons, Nelson, & Richards, 2000).

¹ This is condensed version of the article “Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy” which appeared in Wiley’s book *The Instructional Use of Learning Objects* (2000). The book is also available online at <http://reusability.org/read/>

Learning objects are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science. Object-orientation highly values the creation of components that can be reused in multiple contexts (Dahl & Nygaard, 1966). This is the main idea behind learning objects: instructional designers can build small (relative to the size of an entire course) instructional components that can be reused in different learning contexts. Additionally, learning objects are generally understood to be digital and deliverable over the Internet, meaning that any number of people can access and use them simultaneously (as opposed to traditional instructional media, such as an overhead or video tape, which can only be used in one place at a time). Moreover, those who incorporate learning objects can benefit immediately from new versions. These are significant differences between learning objects and other instructional media that have existed previously.

Supporting the notion of small, reusable chunks of instructional media, Reigeluth and Nelson (1997) suggest that when teachers first gain access to instructional materials, they often break the materials down into their constituent parts. They then reassemble these parts in ways that support their individual instructional goals. This suggests one reason why reusable instructional components, or learning objects, may provide instructional benefits: if instructors received instructional resources as individual components, this initial step of decomposition could be bypassed, potentially increasing the speed and efficiency of instructional development.

To facilitate the widespread adoption of the learning objects approach, the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) formed in 1996 to develop and promote instructional

technology standards (LTSC, 2001a). Without such standards, universities, corporations, and other organizations around the world would have no way of assuring the interoperability of their learning objects or other instructional technologies. A similar project called the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) had already started with the financial support of the European Union Commission (ARIADNE, 2001). At the same time, another venture called the Instructional Management Systems (IMS) Project was just beginning in the United States, with funding from Educom (IMS, 2001). Each of these and other organizations (e.g., the Advanced Distributed Learning Initiative, or ADL [2001]) began developing technical standards to support the broad deployment of learning objects. Many of these local standards efforts have representatives on the LTSC group.

The Learning Technology Standards Committee chose the term “learning objects” (probably from Wayne Hodgins’ 1994 use of the term in the title of the CedMA working group, “Learning Architectures, API’s, and Learning Objects”) to describe these small instructional components, established a working group, and provided a working definition:

Learning Objects are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. Examples of technology-supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. Examples of Learning Objects include multimedia content, instructional content, learning

objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning (LOM, 2001).

This definition is obviously broad, and on examination fails to exclude any person, place, thing, or idea that has existed at anytime in the history of the universe, since any of these could be “referenced during technology supported learning.”

Accordingly, different groups outside the Learning Technology Standards Committee have created different terms that generally narrow the scope of the official definition to something more specific. Other groups have refined the definition but continue to use the term “learning object.” Confusingly, these additional terms and different definitions of “learning object” are all Learning Technology Standards Committee “learning objects” in the strictest sense.

Having multiple definitions for the term “learning object” makes talking about learning objects confusing and difficult. For example, computer-based training (CBT) vendor NETg, Inc., uses the term “NETg learning object” but applies a three-part definition: a learning objective, a unit of instruction that teaches the objective, and a unit of assessment that measures the objective (L’Allier, 2001). Another CBT vendor, Asymetrix, defines learning objects in terms of programming characteristics. “ToolBook II learning objects - pre-scripted elements that simplify programming ... provide instantaneous programming power” (Asymetrix, 2000). The NSF-funded Educational Objects Economy takes a technical approach, only accepting Java Applets as learning objects (EOE, 2000). It would seem that there are as many definitions of the term as there are people employing it.

In addition to the various definitions of the term “learning object,” other terms that generally mean the same thing confuse the issue further. David Merrill has used the term “knowledge objects” (Merrill, Li, and Jones, 1991), and is currently writing a book on the topic of object-oriented instruction design to be called “Components of Instruction” (personal communication, March 21, 2000). This is sure to introduce the term “instructional component” into the instructional design vernacular. The previously mentioned ARIADNE project uses the term “pedagogical documents” (ARIADNE, 2001). The NSF-funded Educational Software Components of Tomorrow (ESCOT) project uses the term “educational software components” (ESCOT, 2001), while the Multimedia Educational Resource for Learning and On-Line Teaching (MERLOT) project refers to them as “online learning materials” (MERLOT, 2001). Finally, the Apple Learning Interchange simply refers to them as “resources” (ALI, 2001). Depressingly, while each of these is something slightly different, they all conform to the Learning Technology Standards Committee’s broad “learning object” definition. Obviously, the field is still struggling to come to grips with the question, “What is a learning object?”

This confusion forces any article on the topic to answer the question, “what is a learning object?” The Learning Technology Standards Committee definition seems too broad to be useful, since most instructional technologists would not consider the historical event “the war of 1812” or the historical figure “Joan of Arc” to be learning objects. At the same time, creating another term only seems to add to the confusion. While the creation of a satisfactory definition of the term learning object will probably consume the better part of the author’s career, a working definition must be presented

before the discussion can proceed. Therefore, the remainder of this article will define learning object as “any digital resource that can be reused to support learning.” This definition includes anything that can be delivered across the network on demand, be it large or small. Examples of smaller reusable digital resources include digital images or photos, live data feeds (like stock tickers), live or prerecorded video or audio snippets, small bits of text, animations, and smaller web-delivered applications, like a Java-based calculator. Examples of larger reusable digital resources include entire web pages that combine text, images and other media or applications to deliver complete experiences, such as a complete instructional event. This definition of learning object, “any digital resource that can be reused to support learning,” is proposed for two reasons.

First, the definition is specific enough to define a reasonably small set of things: reusable digital resources. At the same time, the definition is broad enough to include the estimated 33.5 terabytes of information available on the publicly accessible Internet (Internet Archive, 2001).

Second, the definition is based on the LTSC definition (and encloses a proper subset of learning objects as defined by the LTSC), which makes issues of compatibility explicit. The definition captures what the author feels to be the critical attributes of a learning object, “reusable,” “digital,” “resource,” and “learning,” as does the LTSC definition. With that compatibility made explicit, the proposed definition differs from the LTSC definition in two important ways.

The definition explicitly rejects non-digital and non-reusable resources. The definition of learning object presented does not include people, historical events, books (in the traditional sense of the term), or other physical objects. The definition also drops

the phrase "technology supported" which is now implicit, because all learning objects are digital.

Second, the phrase "to support" has been substituted in place of "during" in the LTSC definition. Use of an object *during* learning doesn't connect its use *to* learning. The LTSC definition implies that a banner advertisement atop an online course web page would be a legitimate learning object. While it may appear at the same time, it doesn't function instructionally. The definition proposed here emphasizes the purposeful use of learning objects to support learning.

Armed with a working definition of the term learning object, the discussion of the instructional use of learning objects can proceed.

Instructional design theory and learning objects

Instructional design theories have been overviewed frequently in the literature (Dijkstra, Seel, Schott, & Tennyson, 1997; Reigeluth 1983, 1999b; Tennyson, Schott, Seel, & Dijkstra, 1997). Reigeluth (1999a) defines instructional design theory as follows:

[I]nstructional design theories are design oriented, they describe methods of instruction and the situations in which those methods should be used, the methods can be broken into simpler component methods, and the methods are probabilistic. (p. 7)

Instructional design theory, or instructional strategies and criteria for their application, must play a large role in the application of learning objects if they are to succeed in facilitating learning. That is, learning objects can't just be treated as pretty clip art – they have to be used in a principled way to support learning. The natural question, then is “how do we do this?” Thinking about two of the largest issues in the learning

objects area – combination and granularity – in instructional design terms might be a good start.

Combination. While groups like the Learning Technology Standards Committee exist to promote international discussion around the technology standards necessary to support learning object-based instruction, and many people are talking about the financial opportunities about to come into existence, there is astonishingly little conversation around the instructional design implications of learning objects.

Indicative of this lack of thought about instructional design was item 7(d) of the Learning Objects Metadata Working Group's (a working group of the Learning Technology Standards Committee) Project Authorization Request (PAR) form (LOM, 2001). The PAR is the mechanism by which IEEE projects are officially requested and approved, and must contain statements of the project's scope and purpose. Section 7 of the PAR deals with the purpose of the proposed project, and item (d) in the Learning Objects Metadata Working Group's PAR (LTSC 2001b) reads as follows:

To enable computer agents to automatically and dynamically compose personalized lessons for an individual learner.

The LOM group was purportedly designing metadata to support this goal. Metadata, literally "data about data," is descriptive information about a resource. For example, the card catalog in a public library is a collection of metadata. In the case of the card catalog, the metadata are the information stored on the cards about the Author, Title, and Publication Date of the book or resource (recording, etc.) in question. The labels on cans of soup are another example of metadata: they contain a list of Ingredients, the Name of the soup, the Production Facility where the soup was canned, etc. In both the case of the

library book and the can of soup, metadata allow you to locate an item very quickly without investigating all the individual items through which you are searching. Imagine trying to locate *Paradise Lost* by sifting through every book in the library, or looking for chicken soup by opening every can of soup in the store and inspecting their contents! The Learning Objects Metadata Working Group is working to create metadata for learning objects (such as Title, Author, Version, Format, etc.) so that people and computers will be able to find objects by searching, as opposed to browsing the entire digital library one object at a time until they find a satisfying one.

The problem with 7(d) in the PAR arose when people began to actually consider what it meant for a computer to “automatically and dynamically compose personalized lessons.” This meant taking individual learning objects and combining them in a way that made instructional sense, or in instructional design terminology, “sequencing” the learning objects. It seemed clear to some that in order for a computer to make sequencing or any other instructional design decisions, the computer would need instructional design information to support the decision-making process. The problem was that no instructional design information was included in the metadata specified by the current version of the Learning Objects Metadata Working Group standard.

The lack of instructional design discussion at this standards-setting level of conversation about learning objects is disturbing because it might indicate a trend. One can easily imagine vendors asking, “if the standards bodies haven’t worried about sequencing, why should we?” Once technology or software that does not support an instructionally grounded approach to learning object sequencing is completed and shipped to the average teacher, why would he or she respond any differently? This sets

the stage for learning objects to be used simply to glorify online instruction, the way clip-art and dingbats are used in a frequently unprincipled manner to decorate newsletters. Wiley (1999) called this “the new CAI – ‘Clip Art Instruction’” (p. 6). Instructionally grounded sequencing decisions are at the heart of the instructionally successful use of learning objects.

Granularity. Discussion of the problem of combining learning objects in terms of “sequencing” suggests another connection between learning objects and instructional design theory. The most difficult problem facing the designers of learning objects is that of “granularity” (Wiley, et al., 1999). How big should a learning object be? As stated above, the Learning Technology Standards Committee’s definition leaves room for an entire curriculum to be viewed as a learning object, but such a large object view diminishes the possibility of learning object reuse. Reuse is the core of the learning object notion, as generativity, adaptivity, and other –ivities are all facilitated by this property of reuse. This is why a more restrictive definition has been proposed in this article.

From an “efficiency” point of view, the decision regarding learning object granularity can be viewed as a trade-off between the benefits of reuse (the smaller the object, the more places I can use it) and the expense of cataloging (the more objects, the more metadata I have to create). From an instructional point of view, alternatively, the decision between how much or how little to include in a learning object can be viewed as a problem of “scope.” While reality dictates that financial and other factors must be considered, if learning is to have its greatest chance of occurring, decisions regarding the scope of learning objects must also be made in an instructionally principled manner.

From this point of view, the major issues facing would-be employers of learning objects, granularity and combination, turn out to be perhaps the two considerations known best to instructional designers: scope and sequence. Unfortunately, no one seems to be talking about learning objects from this perspective – they're always talking about the technology or the financial opportunities.

Interest in the learning objects idea

A report released by investment banking firm W. R. Hambrecht contained more than the common predictions for the future of online learning (e.g., that the online learning market will reach \$11.5 billion by 2003 [Urduan & Weggen, 2000]). As evidenced in the report, even brokers are talking about learning objects and encouraging investors to make sure that the e-learning companies they buy rely on the technology:

[Online learning content] development cycles are predicted to shorten by 20% every year to two or three weeks by 2004. This imperative will drive more template-based designs and fewer custom graphics. Learning objects will be created in smaller chunks and reusable formats. As a consequence, the industry will become more efficient and competitive... We are convinced that the move to defined, open standards is crucial to the continuing successful adoption of e-learning, especially as it begins to transition beyond early adopters into the rapid growth phase of the market. Authoring tools will need to operate across different platforms and communicate with other tools used to build learning systems. Content and courseware must be reusable, interoperable, and easily manageable at many different levels of complexity throughout the online instructional environment. Enterprise learning systems have to accommodate numerous and

varied learner requirements, needs, and objectives. Corporate customers need to be able to easily track content created by multiple content providers through one training management system and search vast local or distributed catalogs of content to identify learning objects or modules on a particular topic. The race for education technology standards is on (Urdan & Weggen, 2000, p.16).

Whether or not the learning object paradigm is grounded in the best instructional theory currently available, there can be little doubt that the United States and the world are about to be flooded with learning object-based tools. Microsoft has already released a toolset it touts as “the first commercial application of work being delivered by the Instructional Management System (IMS) Project” (Microsoft, 2001). Recognition, adoption, and the potential for future support for the learning objects idea is significant, and includes some of the biggest players in software, higher education, and even investment. Learning objects seem to be poised to become *the* instructional technology of online learning. However, technical standards and venture capital are not enough to promote learning. In order to promote learning, technology use should be guided by instructional principles.

Conclusion

Wiley (2000) posited and presented three components of a successful learning object implementation: an instructional design theory, a learning object taxonomy, and “prescriptive linking material” that connects the instructional design theory to the taxonomy, providing guidance of the type “for this type of learning goal, use this type of learning object.” In addition to providing a worked example of this process, Wiley (2000) also presents design guidelines for the five learning object types identified in his

taxonomy. This three component approach is, however, largely untried. We need empirical trials of this and other approaches. These trials need to be reported and improved on. This is the scientific method, the way we make things better.

The main theme of this article, if you haven't noticed, has been that instructional design theory must be incorporated in any learning object implementation that aspires to facilitate learning. Like any other instructional technology, learning objects must participate in a principled partnership with instructional design theory if they are to succeed in facilitating learning. Everyone seems to be banking on learning objects' ability to revolutionize learning. This revolution will never occur unless more voices speak out regarding the explicitly *instructional use of learning objects* – the automated or by-hand spatial or temporal juxtaposition of learning objects intended to facilitate learning. These voices will have to be powerful and articulate to penetrate the din of metadata, data interchange protocol, tool/agent communication and other technical standards conversations. While instructional design theory may not be as “sexy” as bleeding-edge technology, there *must* be concentrated effort made to understand the instructional issues inherent in the learning objects notion. The potential of learning objects as an instructional technology is fabulous, but will never be realized without a balanced effort in technology and instructional design areas.

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