A reformulation of the issue of learning object granularity and its implications for the design of learning objects

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Introduction

Sometime around 1994 the term "learning object" was introduced into the instructional technology vernacular; the idea being that educational resources could be broken into modular components for later combination by instructors, learners, and eventually computers into larger structures that would support learning. Because they would be digital, learning objects could be simultaneously used and reused in different learning contexts, unlike traditional instructional media that can be in only one place at a time. What has followed since the introduction of the term "learning object" has been a flurry of technical activity, financial speculation, and international standards efforts. What has *not* followed is a flurry of principled instructional design work utilizing the new instructional technology. This paper posits that the manner in which the "learning object" has been framed is responsible for this lack of practical application, and proposes a reframing meant to facilitate the principled design and instructional use of learning objects.

Background

The IEEE's Learning Technology Standards Committee has organized a working group to specify a standard set of learning object metadata elements (LOM, 2000). As part of the working group's initial scope and purpose statement, the following definition of learning objects was proposed:

> 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, 2000)

Wiley (2000a) challenged the usefulness of this definition on the grounds that it can be interpreted as the universal set of all things. And indeed, what cannot be "referenced during technology supported learning"? Under this definition, the historical event "The War of 1812" and the historical person "Joan of Arc" are legitimate learning objects. Because the inclusion of discrete, physical objects and historical events works against the design goal of reusability of objects, Wiley (2000a) proposed a slightly narrower definition, "any digital resource that can be reused to support learning" (p. 7). This definition is meant to narrow the scope of what qualifies as a "learning object" while preserving the possibility of reusing the estimated 15 terabytes of digital resources currently available on the publicly accessible Internet (Internet Newsroom, 1999). In the discussion that follows "learning object" is defined following Wiley (2000a).

Instructional Design and Learning Objects

When creating learning objects for instructional use, two design issues are preeminent: granularity and combination (Gibbons, et al., 2000; Murray, 1998; South & Monson, 2000; Wiley et al., 1999; Wiley, 2000a). Succinctly stated, granularity refers to the "size" of a learning object, while combination refers to the manner in which objects are assembled into larger structures to facilitate instruction. Granularity and combination issues are in many ways analogous to the scope and sequence issues with which instructional designers grapple regularly (Wiley, 2000). The first section of this article deals with the issue of granularity.

Current Views of Granularity

Inasmuch as granularity relates to scope, the study of instructional design theories that deal explicitly with scoping issues (e.g., Reigeluth's (1999) Elaboration Theory, van Marriënboer's (1999) Four Component ID Model, and Gibbons et al.'s (1981) Work Model Synthesis approach) can generally shed light on the issue of granularity. Reigeluth and Nelson (1997) suggested that when teachers first gain access to instructional materials they often break the materials down into their constituent parts, finally reassembling these parts in ways that support their individual instructional goals. This description captures one of the basic notions behind the learning objects idea: "pre-deconstruct" instructional media in order to increase the efficiency of instructional design (by eliminating the initial deconstruction step). However, because granularity and combination are so closely related when dealing with learning objects, a more robust view of granularity must be developed recognizing that future learning object combinatory possibilities will be a function of immediate granularity decisions. Two varieties of such a view have been put forward.

The first view of granularity is being championed by several specifications and standards organizations, namely the IMS Global Learning Consortium, the Advanced Distributed Learning Network, and the Learning Objects Metadata working group of the IEEE's Learning Technology Standards Committee. Each of these organizations describes an "aggregation level" in their respective learning object metadata element set (Anderson & Wason, 2000; Dodds, 2000; Hodgins, 2000). The aggregation level is defined as what one might consider the traditional course hierarchy, with a full course being the largest grain size and a single element of instructional media (e.g., an image) being the smallest grain size. Between these extremes two additional levels of aggregation are defined. When several of the smallest elements are combined (e.g., into a web page) they become a "Level 1 resource," and when several Level 1 resources are combined (e.g., into a web site) they become a "Level 2 resource." Thus these organizations view the level of granularity of a learning object as the degree to which small media elements have been combined to comprise the larger learning object. This is a media-centric definition of granularity.

The second view of granularity is more recent and less widely known. Wiley (2000b) defined granularity in terms of work model complexity, suggesting a semi-linear relationship between the relative size of a learning object and the relative complexity of the content whose learning the object is meant to support. Similarly, South and Monson (2000) defined granularity in terms of the domain content of a learning object, suggesting that objects "have the greatest potential for reuse when they center on a single, core concept" (p 5.). Both of these formulations view granularity as the degree to which elements of domain content are combined within a learning object. This is a content or message-centric definition of granularity.

These differing descriptions of learning object granularity share an important similarity: they are both stated in terms of combination. The difference between them is in the identification of that element whose combination affects changes in an object's grain size; in the first case, media; in the second, message. The central argument of this paper is that a common, agreed upon definition of granularity cannot be reached until a unifying framework that highlights the relationships between these and other possible definitions of granularity is established. The remainder of this paper attempts to present such a framework.

A New Formulation of Granularity

Learning objects are artifacts in the sense described by Simon (1969). They are the results of purposive design activity instantiated by means of an authoring tool. Gibbons et al. (2000) examined the purposive design activity called "instructional design" and attempted to generalize layers of this design process through analogy to the layered design of buildings. Quoting Brand (1994), Gibbons et al. (2000) enumerate the design layers of a building and then discuss their applicability to proposed layers of instructional design.

> Brand (1994) describes the principle of layering in designs by describing the layered design of building—in what he calls the "6-S" sequence:
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> - SITE – This is the geographical setting, the urban location, and the legally defined lot, whose boundaries and context outlast generations of ephemeral buildings. "Site is eternal, " Duffy agrees.
>
> - STRUCTURE – The foundation and load-bearing elements are perilous and expensive to change, so people don't. These **are** the building. Structural life ranges from 30 to 300 years (but few buildings make it past 60, for other reasons).

> - SKIN – Exterior surfaces now change every 20 years or so, to keep with fashion and technology, or for wholesale repair. Recent focus on energy costs has led to reengineered Skins that are air-tight and better insulated.
>
> - SERVICES – These are the working guts of a building: communications wiring, electrical wiring, plumbing, sprinkler system, HVAC (heating, ventilating, air conditioning), and moving parts like elevators and escalators. They wear out or obsolesce every 7 to 15 years. Many buildings are demolished early if their outdated systems are too deeply embedded to replace easily.
>
> - SPACE PLAN – The interior layout—where walls, ceilings, floors, and doors go. Turbulent commercial space can change every 3 years or so; exceptionally quiet homes might wait 30 years.
>
> - STUFF – Chairs, desks, phones, pictures, kitchen appliances, lamps, hair brushes; all the things that twitch around daily to monthly. Furniture is called **mobilia** in Italian for good reason. (p. 13)
>
> The aging of layers at different rates suggests that layers should be designed to “slip” past each other so that when they require change, update, renewal, or revision on different time cycles that can be accomplished without razing the whole structure. (p. 16)

Brand continues:

> A design imperative emerges. An adaptive building has to allow slippage between the differently-paced systems of Site, Structure, Skin, Services, Space plan, and Stuff. Otherwise the slow systems block the flow of the quick ones, and the quick ones tear up the slow ones with their constant change. Embedding the systems together may look efficient at first, but over time it is the opposite, and destructive as well (p. 20).

Taking Brand’s list of building layers as a jumping off point, Gibbons and his associates proceed to enumerate the following candidate list of instructional design layers:

- Model
- Problem
- Strategy
- Message
- Representation
- Media-Logic

The importance of Brand’s idea of slippage becomes quite clear when considered in the context of learning object design. If the primary design goal of learning objects design is reusability (which enables adaptivity, generativity, scalability, etc.) as Wiley (2000a) has claimed, then model, representation, message, strategy, problem, and media should each be expressed independent of the other to the greatest extent possible. Gibbons and his colleagues describe the opposite of this independence as “compression,” in which several layers are compacting into a single object. Reigeluth and Nelson’s (1997) teachers would attest to the inefficiency of the compression approach and its inherent necessity for deconstruction.

Significantly, two of Gibbons et al.’s proposed instructional design layers are at the core of current definitions of granularity as we have distilled them above, namely message and media. This similarity has two important implications.

First, it would appear that there may in fact be two types of definitions of the term granularity, “simple definitions” and a “robust definition.” Simple definitions such as those reviewed above are unidimensional in that they focus on the state of combination of elements within a single design layer (e.g., media) of a learning object (e.g., the LOM / IMS / ADL definitions). However, it would seem that a more robust definition of learning object granularity is possible within the layered design framework, which definition considers the state of combination of elements at each of the layers of instructional design. For example, in determining the robust granularity of a learning object, one might ask, “what elements of the model, message, instructional strategy, representation, and media-logic layers are compressed within this learning object?” The larger the count, the larger the grain size of the learning object.

Second, this framework provides triangulating evidence for the claims made throughout Wiley (2000c) that learning technology specifications and standards efforts are ignoring critical instructional design issues. This is evidenced by the fact that current simple definitions of granularity are linked to the design layers furthest removed from instructional design: media and message. Imagine what a simple definition of granularity based on strategy or model would be like… It would certainly force authors of standards and systems to deal explicitly with issues of instructional design and technology, which they have to date sidestepped in the name of “instructional theory neutrality” (Wiley, 2000a).

Learning objects design considerations given the new formulation

The ways in which learning objects can be combined with one another to facilitate learning are entirely dependent upon their structure, as will be demonstrated in the next section. In this manner, learning objects are similar to participants in the molecular bonding process: they can only be combined with other learning objects whose structure is compatible with their own. The reformulation of granularity as put forth above provides a new and useful framework in which to investigate the structure of learning objects.

An instructional designer working within a learning object (or other instructional technology) authoring environment that employs a simple definition of granularity (probably either media or message) may never realize that he is simultaneously making design decisions at many layers, because the authoring tool only facilitates his thinking about one of these layers. Ideally, we would expect to see authoring tools and methodologies that support the independent development and management of learning objects at each of these layers. Until that time, instructional designers can consider the multi-layered nature of learning object design within the framework provided above while using their current toolset.

Conclusion

This paper has presented a robust framework for the consideration of learning object granularity, and has shown that current definitions of learning object granularity fit within this broader framework. The critical importance of learning object granularity and structure to learning object combination and use has been alluded to, and learning object design considerations have been presented in light of the new granularity framework. It is the authors' hopes that this broader framework will spur the development of more robust learning objects authoring environments, and thereby, the development of more learning objects themselves. Of course, our true goal is the improvement of teaching and learning, whether it be face-to-face or on the network.

References

Murray, T. (1998). A model for distributed curriculum on the World Wide Web. http://www-jime.open.ac.uk/98/5/