Learning Objects: Difficulties and Opportunities

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1. The mainstream learning objects movement

The instructional methods explicated by many employers of learning objects are surprisingly similar, drawing largely on the same theoretical work from the 1980s or earlier, including work done by Mager (1975), Bloom (1956), Merrill (1983), Clark (1989), and others working in behaviorist or cognitivist instructional paradigms.

The United States Department of Defenseís Advanced Distributed Learning Network Initiative is similarly positioned. The following quote from its Sharable Courseware Object Reference Model (SCORM; ADL, 2001) specification summarizes the assumptions behind current learning objects approaches:

> Empirical studies have raised national interest in employing education and training technologies that are based on the increasing power, accessibility and affordability of computer and networking technologies. These studies suggest that realizing the promise of improved learning efficiency through the use of instructional technologies – such as computer-based instruction, interactive multimedia instruction and intelligent tutoring systems – depends on the ability of those technologies to tailor instruction to the needs of individuals. In contrast to classroom learning, these approaches enable the pace, sequence, content and method of instruction to better fit each student's learning style, objectives and goals. *The dilemma presented by individually tailored instruction is that it combines an instructional imperative with an economic impossibility.* With few exceptions, one instructor for every student, despite its advantages, is not affordable. Instructional technology promises to provide most of the advantages of individualized instruction at affordable cost while maintaining consistent, measurable, high-quality content (p. 17-18, emphasis added).

There are three significant, implicit assumptions in this statement:

1. A one-on-one instructional model is preferable above others,
2. human interaction in large scale learning environments is economically impossible, and (therefore)
3. automation via intelligent instructional systems is the only viable solution to providing anywhere anytime learning.

The importance of these assumptions cannot be overstated as they color all the design decisions made by participants in the IEEE, IMS, SCORM and other mainstream learning objects efforts (e.g., Cisco, NETg, Click2Learn).

2. Disparities between learning objects approaches and current research on learning

Disappointingly, while they harmonize well with 1980s learning research, the assumptions of current learning objects approaches frequently contradict recent research on learning. Three of the main weaknesses of current large-scale online learning approaches with regard to teaching and learning are outlined below.

2. 1 Decontextualized learning

The instructional design behind learning objects is increasingly moving toward decontextualization. This is true because of an inversely proportional relationship between the size of a learning object and its potential for reuse. As Wiley and colleagues have demonstrated in previous research, learning object "use" is better described as "contextualization" (Wiley, Recker, & Gibbons, 2000). That is, when an instructional designer or automated system "uses" a learning object, they are actually placing the object into an instructional context. The relationship between internal context of the learning object itself and the external context into which it is being placed determines whether or not the object "fits" into that context. The less specific the internal context of the learning object, the more instructional contexts into which it will "fit." Conversely, the more specific the internal context of the object, the fewer instructional contexts into which it will "fit." Figure 1 demonstrates this relationship, using an analogy of learning objects as puzzle pieces.

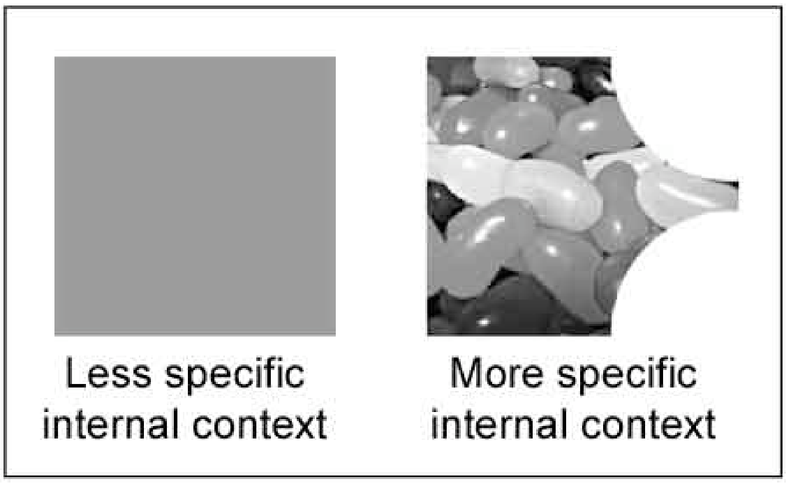

Figure 1. Two puzzles pieces, demonstrating how internal context influences the number of external contexts into which learning objects will successfully fit. Piece A could fit together with a variety of other pieces of varying colors and shapes. Piece B would fit with far fewer pieces, specifically, it would only fit within a context matching its own in terms of shape and pattern.

In the language of digital educational resources, an image of a molecule is usable in far more instructional contexts than an entire lesson on molecular bonding.

Instructional designers of learning objects problematically focus on removing as much context as possible in order to maximize the reuse of the learning objects they create. A paradox arises because modern learning theorists are increasingly emphasizing the preeminence of context in learning, using language such as "social context" (Vygotsky, 1981); "cultural, historical, and institutional setting" (e.g., Wertsch, 1991), and "situatedness" (e.g., Lave & Wenger, 1990; Jonassen, 1991). While far transfer (implying a type of context independence) is the goal of most instruction, the social, historical, cultural, and institutional contexts of learning are crucial factors that must be considered in the design of instruction if it is to succeed. The simple concatenation or sequencing of decontextualized educational resources does not produce a meaningful context for learning. *While economically sensible, the drive toward decontextualization may actually be counterproductive from the standpoint of student learning.*

2.2 Megaphone not mediator

Learning objects are generally deployed as "content chunks" or "information containers." That is, they are utilized as glitzy information dumps, or "lectures with high production values," as if all that online or distributed learning required were a larger megaphone for the instructor. As learning theorists push for more contextualized, real-world, authentic instruction, instructional strategies such as case-based scenarios (Schank, Berman, & Macpherson, 1999) or problem-based learning (Albanese and Mitchell 1993; Vernon and Blake, 1993) have emerged in response. When learning is understood in the context of problem solving, learning objects and other resources change from info-capsules that transfer inert knowledge from expert to novice, into semiotic tools that mediate and shape the learners actions (Wertsch, 1985), like the cards in Vygotsky's (1978) interpretation of Leontíev's (1932) forbidden colors task.

In the forbidden colors experiment, subjects were asked to describe a number of items without using the name of any color more than once. Subjects were provided with cards corresponding to colors to use during the experiment. Many younger subjects were unable to use the cards successfully, but older subjects used the cards as tools to mediate their performance of the task; for example, turning a card face down once its color had been used. This "tool" aspect of learning objects, in other words, the manner in which learning objects mediate problems solving activities, remains almost completely unexplored. Wertsch's (1991) call for social science research to focus on mediated action would suggest that neither learners working in online environments or the resources they use in those online environments can be studied fruitfully in isolation. Rather than studying learning objects out of context, the research unit of analysis must focus on learners' actual uses of the objects within a learning context. Wertsch (1991) reminds us that, "*Only by being part of action do mediational means come into being and play their role. They have no magical power in and of themselves"* (p. 119).

2.3 Scaling through automation

Many individuals and institutions pursue learning objects research with the goal of reaching "anywhere anytime" learning through computer-automated assembly of learning objects personalized for individual learners (e.g., Martinez, in press; Hodgins, 2000; IEEE/LTSC, 2001; ADL, 2001). And the cost savings of automating instructional design are obvious. But while the model of one learner interacting with one computer matches very well with the 1970s view of computer-based instruction, an isolationist approach is at odds with what modern learning theorists are increasingly emphasizing – the importance of collaboration (e.g., Nelson, 1999), cooperative learning (Johnson & Johnson, 1997; Slavin, 1990), communities of learners (Brown, 1994), social negotiation (Driscoll, 1994), and apprenticeship (Rogoff, 1990) in learning. *Even with significant pedagogical considerations set aside, it seems paradoxical that we would we put hundreds, thousands, or millions of learners in front of advanced communications technology so that they can retrieve data from a supposedly intelligent machine instead of interacting with other people.*

2.4 DataBanking education

Freire was extremely critical of what he labeled "banking education," in which riches of knowledge were deposited into the empty minds of passive learners by expert teachers. Selection of learning objects from a databank for delivery to learners provides as close an implementation of this metaphor as is imaginable. The paradigm of automated selection and delivery of learning objects completely precludes discourse or dialogue; in other words, mainstream approaches to using learning objects present learners with one worldview and no opportunity to experience alternatives, hear the stories of Others, or ask meaningful questions. From this point of view, learning objects can be seen as "oppressive."

3. Other practical problems with current learning objects approaches

In addition to the disconnect between current learning objects approaches and current research in teaching and learning, there are several practical obstacles to successfully implementing current learning objects models. This section describes two such problems.

3.1 Specially designed for reusability

While the primary design criterion of learning objects-based approaches is generally reusability, considerations of granularity (i.e., how "big" the learning object should be) and architecture (i.e., the structure according to which the objects should be assembled) frequently require designers to reformat all existing content before it can be "reused" in a given learning objects system. For example, an existing PDF user manual for a piece of software or hardware may be broken up into several smaller chunks, converted into XML, and stored in a database. Wiley (2000) criticized Merrill's (1999) Instructional Transaction Theory of being particularly guilty of this problem, requiring literally every object to be specially prepared and formatted. In other words, tens of terabytes of existing media on the publicly accessible Internet would be unusable without extensive retooling, and this is true of other learning objects approaches as well (Cisco, NETg, Click2Learn, SCORM). *The vast majority of existing digital educational resources can not be reused in current learning objects systems supposedly designed specifically to support reusability.*

3.2 The reusability paradox

Because the primary design goal of learning objects is reusability in a variety of diverse learning contexts, learning objects are generally designed in a highly decontextualized manner (e.g., South & Monson, 2003). Reigeluth and Nelson (1997) have argued that when working with instructional media of any kind, educators first deconstruct the materials into component parts in order to reassemble the media according to their individual needs. By designing "pre-deconstructed" instructional media, it is believed, greater development efficiency can be achieved as educators bypass the step of personally deconstructing media. However, Wiley, Recker, and Gibbons (2001) have argued that extremely decontextualized media are actually more costly and difficult to utilize in instructional development because of (a) difficulties in indexing extremely decontextualized media for human discovery and use, and (b) computers' inability to make meaning, and therefore combine primitive media into instructionally meaningful units.

In the semiotic sense, learning objects and other educational resources are signs whether they be text, graphics, audio, animation, or otherwise. The learning objects user's task of combining individual resources into instructionally meaningful lessons is similar to the speaker's task of combining individual words and utterances into meaningful communication. Inasmuch as this is true, Vygotsky's (1962) notion of the "influx of sense" applies to learning object assembly. In language, the meanings of words and sentences that proceed and follow an individual word, such as the word "sense" in the proceeding sentence, color the meaning of that word. In other words, proceeding and following utterances significantly alter the meaning of a word or other utterance. Vygotsky (1962) wrote:

> The senses of different words flow into one another - literally ìinfluenceî one another - so that the earlier ones are contained in, and modify, the later ones. Thus, a word that keeps recurring in a book or a poem sometimes absorbs all the variety of sense contained in it and becomes, in a way, equivalent to the work itself.

Creating a meaningful utterance becomes an act in which words and other utterances with overlapping and context-absorbing meanings are intermingled to create meaning. Returning to learning objects, the combination or sequencing of educational resources creates a context in which the resources color and absorb each other's meanings. Even if an automated system could successfully select and sequence learning objects correctly the vast majority of the time, a mistake at any point could cause a "Sixth Sense Effect" due to the influx of sense, in which previously understood material is reinterpreted in light of new information. In all but the most basic instructional applications computers have no hope of engaging in the type of complicated meaning making required to create meaning-full instruction from learning objects. This implies that humans will have to assemble learning objects by hand for all but the most rudimentary instructional content. *Surprisingly, while the most decontextualized learning objects are reusable in the greatest number of learning contexts, they are also the most expensive and difficult for instructional designers to reuse.*

3.3. The intellectual property pit: RIP Educational Objects Economy, 2003

In recent years every major content creation industry has seen its core product line exploited and freely traded online. First the music industry saw its unprotected CD content "ripped and swapped" via Napster. Subsequent attempts to create secure digital music formats (SDMI) were publicly defeated by researchers at Stanford (and others) who were subsequently threatened with lawsuits. The book publishing industry saw its champion eBook protection format defeated, and lawsuits filed against the programmer who accomplished the defeat incited such rage in the Internet community that Adobe eventually dropped the charges. The motion picture industry's best attempts at securing DVD content have been publicly defeated by teenagers on at least two continents, and video content has appeared on next-generation file sharing services such as Kazaa and Morpheus. *The commercial content industries have learned the hard way that, despite rights management attempts, digital content will make its way into free distribution. This fact of Internet life will prevent an "educational object economy" in which large amounts of commercial content are available for purchase and reuse from ever materializing.*

3.4. Summary of learning objects difficulties

While we wholeheartedly believe that the problems discussed above are problems, one caveat deserves attention. Many of the problems identified above only actually become problems as desired learning outcomes climb further up Bloom's Taxonomy. Issues of decontextualization, mediation, and socialization are all but non-issues when the desired learning outcome is acquisition of a list of associated pairs of information and the assessment is a recall task. However, to the degree to which higher order learning outcomes (such as synthesis and evaluation) are called for, or to which an explicit emphasis would be placed on transfer from the instructional context into a later performance context, we believe these issues quickly become critical problems.

4. Opportunities for learning objects

While there are a variety of problems with traditional conception of learning object use, we believe there remain many opportunities for learning objects to be productive tools in facilitating learning.

4.1 The programming library view of reuse

Jeremy Roschelle has stated that there is no reason to expect that educational objects will ever be widely reused, when empirical research has demonstrated that OOP objects (the model on which learning objects are supposedly built) are infrequently if ever reused. While a few notable exceptions exist in both the education and programming domains, Roschelle's insight is important. If we are to continue pursuing computer-based instruction as a research area and continue to believe in reuse as a desideratum of such a system, we must arrive at a new, non-OOP grounds for thinking about reuse.

A common sense (or empirical) evaluation of reuse in computer programming shows that there is, in fact, a class of programming resources that are very frequently reused in the development of software – libraries. These modules provide basic functionality needed by larger programs which authors either cannot or do not wish to implement themselves, such as performing complex mathematical calculations or capturing and sending output to and from various locations. However, programming libraries are not reused in the sense that we traditionally think about reusing learning objects. One would never think of writing a piece of software that consisted solely of the lines:

```
#include <time.h>
#include <math.h>
#include <stdio.h>
```

Such a program wouldn't even compile. Programming libraries aren't useful until you place their functionality within a broader context. And why would we expect learning objects to function instructionally when simply concatenated?

A fundamental difference in actual programming practice and traditional learning objects thinking becomes apparent. Learning objects (the entity of reuse in instructional development contexts) have generally been portrayed as bits of content, sharable content objects, content packages, etc. However, programming libraries (the entities of reuse in software development contexts) are not content at all – they are content-free algorithms for manipulating content. This suggests that research in learning objects should follow a very different path. *If we are to follow the software development model we claim to hold dear, learning objects should not contain content at all; rather, they should contain the educational equivalent of algorithms – instructional strategies (teaching techniques) for operating on separately available, structured content.*

4.2 The educational object commons

As the economic realities of nonrivalrous, digital resources prevent commercial content producers from releasing content in a "learning object format," an alternative source of content is quickly filling the empty channel. With funding from the Hewlett, Mellon, Moore, and other charitable Foundations, MIT, Carnegie Mellon, Rice, and other world-class universities are creating large, high-quality content collections whose contents are free to be used and reused under licenses similar to open source software licenses, such as those provided by the Creative Commons or OpenContent projects. Rather than spend energies on trying to create an "economy" by artificially restricting access to nonrivalrous materials via digital rights management efforts, these organizations and many individuals are instead focusing their efforts on creating an "educational resource commons" where people create, modify, use, discuss, and learn from open access educational resources.

While the "educational object economy" will never materialize for the reasons stated above, the commons is well into a growth cycle which will completely revolutionize teaching and learning in developing nations (and already is completely revolutionizing it). When a unionized group of students at a major U.S. university discovers that a free, MIT-produced collection of content exists as a possible alternative to a $100 textbook by an individual they've never heard of before, with no resale value, the educational resource commons has a chance of revolutionizing teaching and learning in developing nations as well. Of course, utilizing an open, distributed collection of educational resources may require more effort of instructors than opening and reading from a textbook, but students who are already feeling price gouged by rising tuition costs will likely find the commons and "recommend" it to their instructors. *When intellectual property issues and concerns disappear, money, effort, and other resource can be allocated to building up a library of free, nonrivalrous educational resources.*

4.3 Social support for learning objects use

A large collection of high quality learning objects are a necessary but not sufficient condition for scalable network-mediated learning. If high quality reusable content were all that were required to support learning, libraries would never have evolved into universities. That is to say, interaction with other human beings always has been and always will be an integral part of the learning process. This is especially true when learning of higher-order skills.

Fortunately, the Internet is full of examples of individuals providing support for other people engaged in a learning process mediated by reusable, digital educational resources. Almost every Internet user has had the experience of joining an online group, seeking help, and receiving needed information, advice, or resources. Whether the problem is technical (how to fix a computer or write a program), health related (dealing with cancer or overcoming anorexia), social (locating an old friend or finding a date), or school related (researching a historical person or trying to understand differential equations), there are online groups scattered around the globe that are happy to share their expertise with others in a variety of synchronous (chat or IM) and asynchronous (news groups, listservs, or web boards) formats.

There is currently a ground swell of interest in the intersection of "blog-based learning" and learning objects. Patterns of weblog use (including metablogs, aggregators, trackback, and other services) for supporting learning are still emerging, but appear to add richness and depth to the online experience of distributed learning communities. For example, I can easily imagine individuals learning about a topic (like the Civil War) by subscribing to the RSS syndication of learning objects from one or more digital libraries / repositories which collect such resources (possibly via an aggregator), and participating in a topic-focused community of discourse utilizing blogs. *Blogs and other social software provide a perfectly valid, socially intensive way of utilizing learning objects to support learning.*

4.4 Supporting problem-based learning

While many of the canonical definitions of learning objects have insisted on explicit instructional strategies, links to objectives or reusable competencies, and assessments in one form or another, problem-based learning (PBL) presents another way of thinking about learning objects. In a PBL model, students are introduced to a problem or project which they must solve or accomplish. Traditionally, students are provided access to a variety of (not necessarily instructional) resources, such as existing readings or websites, which are selected as a collection to contain what students need in order to solve the problems or complete the projects.

If learning objects are used as PBL-supporting resources, many of the problems of contextualization of resources go away. Learning objects are simply *x* of *n* resources supporting learning in a problem-solving context. And this externalization of the context from the learning object itself and into the problem is a key shift from traditional learning objects thinking. This would allow learning objects with no specific internal context matching to be reused in a wide variety of problem-solving contexts, while context specific information for a given learning episode is expressed completely in the (highly contextualized, nonreusable) problem. *Assuming an instructional design other than direct instruction opens doors to extremely interesting learning object use cases.*

5.0 Conclusion

As traditionally conceived, learning objects are useful in a variety of situations in which low level training needs to be carried out with maximum efficiency. However, when higher-level learning or deeper learning are desired, traditional approaches to using learning objects seem to leave something to be desired. This is not a shortcoming of reusable educational resources themselves; rather, the problem lies in the received view of what learning objects are and how they ought to be used. This paper has tried to point out that learning objects can be thought of in some interesting alternative ways, and demonstrate an alternative future for learning objects research and learning.