The Trouble with Learning Objects[1]

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Abstract

Object-oriented instructional design offers the promise of universal access to online instructional materials, increased productivity among trainers and educators, and solutions for individualizing learning. However, it is unclear whether it can fulfill these promises to the degree many envision. As for every new instructional technology, it is easy to become over-optimistic about learning objects, but we should remember that problems of education are always more complex than technology alone can solve. The author takes a critical look at the proposed benefits of learning objects described in the published literature, particularly *scalability* and *adaptability*. The author also looks at both the difficulties in defining the term *learning object* and the limitations of metaphors used to describe the concept, and concludes with propositions for learning object usage.

The Promise of Learning Objects

The Problem

Scenario 1. For years, the director of the Instructional Development Center for a large, multi-campus university has been frustrated with her efforts. She has put together a solid staff of instructional designers and multimedia developers, has a reputation for quality work throughout the university, and gets plenty of involvement from faculty. But the instructional materials the center has created haven't gone very far. The faculty member who requested the materials may have used them heavily for a time, but she knew of few instances where the materials were used by other faculty. Many of the materials, she felt, were good enough to see use across the country in other universities, but they weren't even being used much internally. When asked why, faculty members typically answered first that they didn't know about them, and second, that the product didn't quite fit their courses, or weren't quite up-to-date. The faculty who might benefit from borrowing materials typically didn't consider the possibility of updating or modifying existing materials. If they were going to bother to change a few things, they felt it would be easier just to start over—to make it a little more in line with their own way of teaching. The result for the center was redundancy and a plethora of high-cost, low-impact projects. The center must continually justify its value to the institution, and in all honesty, that is sometimes difficult to do with a direct cost-per-student ratio.

Scenario 2. The training heads for a group of national weather services are frustrated that existing online training from a variety of countries, while of high quality, can only be used to best effect for a limited audience. The meteorological community is highly successful at international cooperation in sharing weather data and scientific knowledge (weather is obviously a common concern and doesn't stop at national borders), so why can't they do a better job at sharing weather forecaster training? While much of the content within training produced in one country is immediately applicable to another, there are also language differences, geographical differences, and differences in the technologies available to forecasters—all of which can make the training inappropriate. If trainers in one country could simply borrow what is useful from the online training produced in another, then all countries could increase their available training resources. Unfortunately, most of the training is hard to "take apart" or modify easily. In particular, developing countries with small training budgets could benefit from borrowed training, especially if they could easily add examples and cases from their own regions of the world.

The Solution

The apparent problem in each of these scenarios is needless redundant effort or limited impact of online instruction. In the first scenario, potential users may not see a benefit in reusing good instructional materials because (a) it may seem more difficult and less effective than using their own, or (b) because they value their autonomy more than they do efficiency. In the second scenario, training on meteorological topics produced in one country must be reproduced in another if it is to be properly "localized." The solution to the resulting redundancy or low impact may be the strategy for online learning delivery known as "learning objects," which aims to make online instructional materials broadly accessible, searchable, and reusable. For example, if the university Instructional Development Center and the meteorological training developers described above could modularize instructional content and avoid locking it into one particular look and feel, it would be relatively simple to customize that content for many users. If modular content could reside on the Internet, and was indexed with embedded "metadata" such that a search engine could find it via multiple criteria, not only could the university's online content be shared more broadly, but organizations could more easily create custom training without starting from scratch, and could more easily assign online training targeted to individual employees. Assignments could be made automatically via online or on-the-job performance assessments.

The promise of universal, unlimited access to online instructional materials, increased collaboration and productivity among trainers and educators, and simplified technological solutions for individualized learning is creating a contagious enthusiasm. World-wide, practitioners are tackling the issues surrounding learning object development and implementation, and standards bodies work to improve the metadata specifications that will ensure wide acceptance (e.g., ADL, 2001; ARIADNE, 2002). According to Gibbons, Nelson, & Richards (2002), learning object strategies will fulfill the long promised rewards of computer-based learning by offering improved ways to make instruction *adaptive* to individual learners, *generative* (able to compose individually appropriate instruction on-the-fly), and, above all, *scalable* (able to extend to large audiences without a proportional increase in cost). Furthermore, the promises of adaptability are more than for delivering individualized instruction. Learning objects, if designed appropriately, will be adaptable to many instructional contexts and organizations, and will facilitate the development of a sharable "instructional object economy" (ADL, 2001, p. 1-12). Expectations are high, as some envision an order of magnitude increase in productivity and performance through such widely accessible instruction (Hodgins, 2002).

The Trouble

With such apparent promise, it can be difficult to see a downside to learning objects. But it is by no means yet clear whether learning object strategies can live up to this promise (Hartnett, 2002; Welsch, 2002). For example, large *scalability* benefits assume a broad willingness to share and to borrow that may not exist. They also assume that the processes of composing, distributing, and combining learning objects do not create substantial new costs. *Generativity* benefits assume that we understand enough about the learning process to create algorithms that can specify effective learning content sequences, that learning can be modeled algorithmically, and that interactions with learning objects can be sufficient for effective learning. *Adaptability* benefits assume that making instruction adaptable does not diminish its instructional effectiveness. In addition to these uncertainties, we also may not be anticipating new problems that learning objects may create, or biases they may engender. McLuhan and McLuhan (1988, p. 95) suggest that "man cannot trust himself when using his own artefacts." While we can create technologies that extend our inherent capabilities (communications media that extend the reach of our voice, writing systems that preserve and broadly share our ideas, computer technologies that augment our computational abilities and enhance certain kinds of creative manipulation), we lack the instincts to fully grasp their repercussions. It is difficult for us to realize what we give up when we use our technologies (e.g., physical contact with others, the oral tradition, forms of computation and creative expression that are less technology-bound). The "laws of media" are such that new media extend or enhance some aspects of our experience, but at the same time unavoidably contribute to the obsolescence of others (McLuhan & McLuhan, 1988). Burbules and Callister (2000) warn us that we need to consider both the risks and promises of new instructional technologies and adopt them only with a healthy skepticism. It is easy to get caught up in the promise of technological solutions to the sticky problems of education and training. But the problems of education are always more complex than technology alone can solve.

This paper examines both the promises and risks of learning object systems (LOs), including some of the unintended consequences they may produce. Its goal is to take a critical look at the benefits being proposed by LO proponents, but also to develop a set of recommendations for effective LO implementation. Its stance is critical, yet admiring and hopeful. The high level of energy going into creating learning object strategies and the sometimes hyperbolic claims are enough to raise the eyebrows of many skeptics. Voices of doubt are being raised on several fronts. In the academic community, when LO is acknowledged at all, we find laments for the reductionist assumptions of learning that many proponents of LO are adopting (e.g., Bannan-Ritland, Dabbagh, & Murphy, 2002). (The concerns are rising, however. Since the preparation of this paper, Wiley [2003] and Friesen [2003] have also offered useful critiques of the learning object phenomenon, raising many concerns similar to those expressed here.) In the practitioner community, some authors see little evidence that LO can deliver on its promises due to general lack of interest in reusing materials (Hartnett, 2002; Welsch, 2002). These are excellent points, and they will be treated below, but as Bannan-Ritland et al. (2002) and other authors also demonstrate (see Wiley, 2002d), the LO concept is resilient because it is so fundamental to our ways of thinking about instruction, and therefore has the potential to support widely varying instructional strategies, theories, and philosophies—not simply reductionist approaches. But first we have to avoid the trouble that can surround it.

The Elusive Learning Object

The Struggle Toward a Definition

The trouble begins in the effort to define the concept. Unfortunately, there are as many definitions of "learning objects" as there are people offering them, which suggests that maybe we are defining the wrong thing. Most have attempted to define learning objects as entities or particular kinds of artifacts, and have inevitably failed in the attempt to make the term both broad enough to encompass all that they might be and at the same time eliminate what they are not. For example, the IEEE (Institute of Electrical and Electronics Engineers), in its proposed standard (IEEE, 2002) defines a learning object as "any entity, digital or non-digital, that may be used for learning, education or training." (For additional definitions that are nearly as broad, see ASTD & SmartForce, 2002; Gibbons et al., 2002) Wiley (2002d, p. 5) reacts negatively to the inability of this definition to exclude "any person, place, thing, or idea that has existed at anytime [sic] in the history of the universe." He suggests an alternative definition for "learning object" as "any digital resource that can be reused to support learning" (p. 6). You can see that this refined definition limits LOs to *digital* entities, to those that can be *reused* (not just used once), and to those that *support* learning (adding a more direct connection to learning with the use of that transitive verb). Wiley's much more useful definition, however, upon further examination does not eliminate software tools a student might use to generate products (word processors, concept mapping tools, calculators) or to engage in active discussion (chat, email, or even a fellow student's telephone number programmed into a cell phone). Wiley may indeed intend to include these tools in his definition, but this is significantly divergent from the common view of LOs as artifacts that present instructional content or activities, and counter to his goal of narrowing. To complicate the issue further, even when viewing LOs as instructional content, some specify that they must, at minimum, be units of instruction treating a single learning objective (ASTD & SmartForce, 2002), while others clearly indicate the benefits of LOs that are much smaller in scope, such as an individual graphic (Wiley, 2002b). Finally, the attempt at definition degrades into a business agenda when Smartforce (ASTD & SmartForce, 2002) defines and classifies learning objects according to the e-learning product line they are marketing.

Instead of trying to define learning objects as entities or particular artifacts, it may be more useful to view “learning objects” as a process or strategy, or to speak of “object-oriented instructional design.” Construed this way, what is designated as an object is contingent on the LO system being discussed, and we don’t get stuck in fruitless disagreement and confusion. When we think in terms of strategy, a clear definition is easier to achieve:

> Object-oriented instructional design is a strategy for designing digital (typically online) learning content and activities as discrete, addressable, and adaptable units, in order to achieve fine-grained accessibility and improved reusability. Object-oriented tactics include:
>
> - dividing instructional content and activities into discrete, coherent units;
> - embedding “metadata” (cataloging information) that accurately describes the characteristics of that content such that a person or learning management system can retrieve it; and
> - using a relatively context-free design that facilitates adaptability such that the content can fit within multiple contexts (visually, conceptually, and functionally).

The advantage of this definition is that we’ve defined a strategy that could have many incarnations, and not attempted to define the indeterminate thing resulting from the strategy. Instructional content becomes a learning object when it is *used* as a learning object.

The Source of the Concept (and the Trouble?)

For many years, software engineers have realized the benefit of object-oriented programming, wherein discrete components of a computer program (objects) are created with both assigned properties (data structures) and functional capabilities (behaviors) (Rumbaugh, Blaha, Premerlani, Eddy, & Lorensen, 1991). As the program is created, these objects then form prototypes for the creation of more context-specific or elaborated versions of themselves. This eliminates the need to recreate each new content element or function in its entirety, and, more important to our concern here, incrementally creates a structure of interrelations between components, in other words, the functionality of the program (Downes, 2000). In this way, not only is software development more efficient, but updates and revisions are easier as well, increasing the potential for reuse of code in future projects. Developers of computer-based instruction (CBI) have naturally been inclined to borrow development strategies from the software engineering profession (Ross, 1996), and object-orientation has been a fruitful inspiration. For example, using object-like templates for multiple choice questions and other common interactions means much less coding effort is required to produce interactive CBI—reducing development time or allowing more time to focus on the quality of the content. (However, note that while CBI features such as navigation buttons may be true software objects, instructional content itself is unlikely to ever exhibit object-orientation in the purest sense. For instance, it lacks the quality of *inheritance* that would allow parent object changes to be global changes for all copies derived from it.) Object-like templates for creating, recreating, and reusing functional components of CBI have almost always existed in CBI authoring systems, but what the Internet has engendered is the desire to take object-orientation beyond functions and to the level of content. The accessibility of the Internet offers the potential for CBI developers to easily share and borrow content, anything from individual illustrations to entire lessons, for reuse within their projects. And because these components of instruction will contain metadata to describe their properties and functional capabilities (in an instructional sense), developers are presumably provided guidance as to how components can be combined to form well-designed instruction.

The benefits might seem obvious to those who see instructional design as a kind of software engineering. But creating instructional content and activities is *not* software engineering. Many seem to argue otherwise. Downes (2000, part B, section 1, para. 2), proposes that "from a certain perspective, an online course is nothing more than just another [software] application, and software engineers have long since learned that it is inefficient to design applications from scratch. " He also suggests "educators need to learn design techniques learned by the software industry long ago." But is it really appropriate to equate the design of software tools with the design of instruction that just happens to be delivered via the computer? While we can draw useful analogies between ID and software engineering because they are both design activities with analysis, design, and implementation phases, we should be careful not to take the analogy too far. A computer program is not a learning environment (although it can certainly be an element in that environment). Key to object-oriented software approaches is the need to abstract properties of entities to their "essential" properties, while ignoring their "accidental" or incidental properties (Rumbaugh et al., 1991, p. 7). In other words, their context is ignored or highly simplified. While necessary in the realm of software design, this reductionist activity is contrary to current conceptions of situated cognition and knowledge based in communities of practice (Lemke, 1997). (Another "accidental" property of instructional content objects ignored in object-oriented approaches is their expression or form. The significance of this oversight is discussed later). While object-oriented design can be seen as a movement toward authenticity in software applications with its focus on modeling real-world situations, it is more likely a move toward abstraction in instructional design.

For nearly twenty years prior to the 1990s, information processing models of learning, heavily influenced by a computer metaphor of human cognition, dominated our thinking about learning and instruction (Wilson & Myers, 2000). It is understandable, then, that the computer metaphor has influenced our models for the design and production of instruction as well. But for more than a dozen years now, the majority of educational theorists have begun searching for other perspectives, beyond those grounded in technological metaphors such as transmission or computation (Jonassen & Land, 2000). Within constructivist, cultural-historical, situated, and ecological psychology conceptions of knowledge and learning, software engineering offers less value as a model. In each of these conceptions, participation in social systems is the central activity of learning, rather than individual cognition in response to stimuli. To deny this aspect of learning by taking an algorithmic, computer software view of instruction assumes that instruction is free of subjectivity, and free of social, political, and cultural context. In other words, the "object" and "computer software" metaphors may ignore essential aspects of instruction and learning.

Having described what object-oriented instructional design entails and having examined its source, we now take a critical look at its proposed benefits.

A Critical Look at Scalability Benefits

Reducing Redundant Effort

For many LO advocates, the benefits of LO foremost in their minds are the economic ones offered by increased scalability (Downes, 2000). A primary goal of the LO approach is facilitating the reuse of digital instructional material beyond its original context. High development costs have always meant that computer-based instruction can reach an acceptable cost/benefit ratio only when the learner audience is large, and LOs offer a way to substantially increase that audience by reaching other organizations. Standardized LOs can reduce redundant development efforts by allowing anyone to access and use (either freely or at affordable cost) digital materials developed by anyone else. As Downes points out, "It makes no financial sense to spend millions of dollars producing multiple versions of similar learning objects when single versions of the same objects could be shared at a much lower cost per institution. . . . The world does not need thousands of similar descriptions of sine wave functions [for a Trigonometry course] available online" (Part A, section 1, para. 5 and 9). Similarly, he asks, "…do first-year engineering students need a brand-new Shakespeare course, or will the interpretation developed last year (or two years ago, or in Saskatchewan) do the job?" (Part D, section 3, para. 5). The existence of sharable, accessible, and adaptable online instructional materials could potentially save money and time for other instructional opportunities. But will substantial sharing and borrowing take place?

Limits to Sharing and Borrowing

The assumptions beneath scalability benefits are that people will want to frequently reuse materials, that people will be willing to share them freely or for manageable cost (and that methods for charging fees can be developed for reasonable cost), and that developing and reusing learning objects is not more expensive than current methods. The dynamics of sharing and borrowing are likely more complex than it first seems. Why would people *not* want to borrow instructional content that would save them time and money? One answer may lie in the importance of context.

The situativity view of cognition proposes that no meaning can exist outside of a particular context (Lemke, 1997). The realm of performance is made up of specifics, not generalities. We learn to perform specific tasks and make specific kinds of decisions in specific environments. While we may be able to derive principles from one environment to apply to others, the idiosyncratic complexities of environments will likely limit their application. Similarly, it is impossible to create instructional content without an underlying context (particular types of problems, assumptions about background knowledge and resources, the author's values, etc.), and impossible to use instructional content effectively without embedding it in a context appropriate for the learners. Unfortunately, LO developers may strive to reduce the amount of context embedded within LOs so that they can be used more broadly. But that may reduce their effectiveness locally and put a larger burden on instructional designers to add the appropriate context when reusing them. Even with an effort to reduce context, it is likely that potential re-users will find some aspects of the LOs that are inappropriate. Those aspects may seem insignificant to others, but they may be annoying enough to prompt a decision not to reuse. Language is always specific to a context and contains the values of the author, and content becomes dated very quickly. Reusability is not as simple as is assumed. Even originators of object-oriented programming techniques realize this and remind us that "object orientation is not a magic formula to ensure reusability . . . . Reuse does not just happen; it must be planned by thinking beyond the immediate application and investing extra effort in a more general design" (Rumbaugh et al., 1991, p. 8).

Another limit to borrowing could be that instruction is an activity with expressive goals at its roots, and that borrowing doesn't satisfy those goals. Instructors and instructional designers are not ego-less in the teaching process, nor do students want them to be. Formal learning can be seen as an interpersonal enterprise, a conversation between someone knowledgeable and someone seeking knowledge. Just as meaningful learning may occur only when learners are engaged in generative activity (Wittrock, 1990), meaningful teaching may occur only when instructors have opportunities to express their personal knowledge. This aspect of teaching may be de-emphasized in a climate where instructors are advised to act as guide or coach, but instructors typically have more to share than that, are motivated by opportunities to share it, and students seek them out to receive it.

Opportunities for personal expression by the instructor do not only serve instructors. Students gain from the opportunity to observe that expression and participate in it. Many have proposed that learning is also an expressive or generative activity in which students must actively interpret their experiences to construct knowledge (Dunlap & Grabinger, 1996). In keeping with this perspective, several authors have proposed LO systems in which students themselves are involved in populating the LO database (Bannan-Ritland et al., 2002; Collis & Strijker, 2001). Creating the LO system becomes not only motivating, but also a means for learners to construct knowledge through engagement in meaningful activity while sharing with fellow students. But Downes' (2000, part D, section 3, para. 9) question, "Do we need a thousand such reinterpretations [of Shakespeare] a year?" is an example of how LO thinking can thwart student-centered approaches. The answer to his question, of course, is that we need a new interpretation by each student who reads Shakespeare's works and an instructor that can help the student achieve that—not a fixed interpretation. Excellent interpretations have always served as guides, but students also need to have a personal transaction with Shakespeare (Rosenblatt, 1985). To help them achieve that, they may need to participate with an instructor in working out an original interpretation. This need is not only in the arts, but the sciences and other disciplines as well. Otherwise, we are in danger of creating epistemologically naïve students, students that believe that fixed meanings are out there to be acquired in rote ways, rather than questioned and reconceived in an evolution of knowledge. In the end, student-generated contributions are a powerful argument for implementing LO systems, but this strategy, suggesting that every student needs to build their own LOs, defeats the scalability argument.

The type of open sharing of LOs that some envision may also be optimistic. Social science research shows that altruistic behaviors, like sharing, are influenced by factors such as empathy, rewards, and potential observers, and don't just happen automatically. Similarly, theories from evolutionary psychology suggest that altruism (outside families and groups) is often a "costly-signaling" behavior, used by dominant members to signal their privileged position (McAndrew, 2002). While we all wish that sharing were the norm, it isn't always. For many, instructional content as intellectual property is important to their livelihood, and the possibility of borrowing from others as reward for sharing may not be sufficient. Charging for LOs is certainly a possibility, but the addition of that extra effort makes it much less likely that they will be used. Some successful organizations that market generalized online instruction for commonly required skills do already exist. Their materials are offered at reasonable per-student costs, but still at a high cost for the subscribing organization. However, the materials they offer are full courses, and not customizable learning objects. Whether such organizations will evolve to offer adaptable learning objects is unknown, as the intellectual property rights issues surrounding adapted materials will certainly intervene to complicate matters. For some, it may not necessarily be profit, but corporate identity and reputation that are at stake with sharing content. If content can be modified, its quality can also be reduced.

Hidden Costs?

Of course, the tremendous scalability benefits touted for LO systems also assume that the costs of creating and using LOs are not higher than traditional methods of design and development. Unfortunately, several characteristics of LO systems could conspire to bring that into question. The first of these is the need to think and plan in a modular way, which can be difficult for instructional designers trained to create interrelated and context-rich content. For many years, relevance has been a mantra for creating motivating instruction (Keller, 1983), and relevant instruction typically means content that is strongly grounded in a meaningful, familiar context. Proposed LO development strategies are typically counter to this intent, with the goal of making content as context-free as possible in order to broaden applicability. What this means is that for LO-based instructional design, context must be built *around* learning objects, not within them. This additional effort may be required at three levels: (a) avoiding the natural inclination to embed context in the design of the LOs, (b) creating a strategy for adding context when integrating of the LOs during their original use, and, of course, (c) creating the alternative context for reuse by the borrower. The touted benefits of LOs often assume instructor-less delivery, but due to their context-free design, instructional design expertise and, most likely, subject-matter expertise are required at both ends. In the development phase, as well, formative evaluation of learning objects by experts can be made difficult if the reviewer can't see the context of use. In the end, instructors will most likely use LOs to augment their courses in moderate ways they might otherwise not attempt, inserting small learning objects within their existing course materials. In other words, the major benefits of LO systems may not be cost savings, but more varied, innovative, and effective instruction.

Another mitigating factor of the economic benefits of LO strategies is the need to include the potentially complex metadata within each learning object. Some are already concerned that if one were to use all the metadata being considered for inclusion in the SCORM standard, the time to create useful metadata content would be formidable (Welsch, 2002). In addition, because there may be no immediate benefit to the original author creating the learning object, the metadata may not be used to best effect (Duncan, 2001). Even if pressure to use metadata exists, there may not be enough pressure to use it well. As metadata becomes increasing complex, to address proper sequencing of learning objects for example, the complications may begin to outweigh the benefits. (Furthermore, sequencing metadata itself begins to add back the context that was originally so important to remove.)

Modest Efforts

Of course, the scalability benefits of LO strategies are not mitigated when the primary intent is not large-scale sharing. When an organization decides to use them for internal training needs, LO systems do not have to meet the test of high scalability. Similarly, for knowledge management applications of LO, the system may pay off with only a few reuses of objects. For LO systems in which learners are the primary contributors, a single reuse outside of the original class can be regarded as a win-win situation. Also, when LO libraries are used by faculty members to try out new strategies and to enhance existing instruction, even in small ways, the benefits of LO can be substantial, but not necessarily economic ones. In other words, LO strategies should not be undertaken simply for economic reasons. Their contributions to learning should be foremost in mind.

Admittedly, instructional content is frequently in the realm of pure verbal information—technical specifications, computer language syntax, step-by-step procedures, dates of historical events, and so on. Greater scalability of learning objects with primarily verbal information content can be highly beneficial. But for complex skills and more general educational goals, learners are in need of multiple *experiences*, not simply verbal information. Questions like Downes' (2000) about whether we need more than one interpretation of

Shakespeare for engineering students are valid only if educational goals have to do with learning a fixed interpretation and not learning the process of interpretation. Ironically, while the elimination of duplicate instruction is proposed as a major economical benefit of LO, it is the opposite outcome, the ability to easily access multiple components of instruction on the same topic that offer different interpretations and different experiences, that turns out to be one of the major educational benefits.

A Critical Look at Adaptability Benefits

The scalability benefits of LO, discussed above, assume that learning objects can and will be used broadly, and that this use reduces costs associated with education and training. In this section, we look at adaptability benefits, which are actually a precondition to those of scalability. The assumption here is that well-designed LOs can be used in a variety of contexts and can support a variety of activities, that they are context-neutral. Only if this is the case will LOs be widely reused. Furthermore, an additional assumption is that LO designs do not limit the effectiveness of instruction and can be utilized for a variety of instructional strategies, that they are theory-neutral. A final assumption is that designing for adaptability does not eliminate important aspects of instruction (such as context, discussed above) that are necessary to engage learners and enrich the communication that must take place. For example, it assumes LOs can and should be visually neutral.

The Flexibility of Object-Oriented ID

Scalability benefits will be realized only if LOs can be used in effective ways. Fortunately, LO approaches appear to support many avenues to effective learning. If the economics of scalability were the only apparent benefit, the enthusiasm among instructional designers might not be quite as high. But LO approaches are also somewhat protean in their ability to support many models of learning and instruction, making their appeal potentially very broad. Personalized instruction has been a central value in education for many decades. From the introduction of behaviorist through cognitive information-processing models of learning, it has been seen as highly desirable for instruction to adapt to individual learners, by allowing individual pacing and by providing context-sensitive feedback and performance-driven direction for sequencing instructional content and choosing learning activities (Wilson & Myers, 2000). More recent constructivist models of learning make even stronger calls for individualized approaches, including giving learners the responsibility to do much of their own evaluation and decision-making about instructional sequencing (Savery & Duffy, 1996). While behaviorist, information-processing, and constructivist conceptions of learning are often seen as mutually incompatible, ironically, they can all be strongly supported by object-oriented instructional design through its potential adaptability.

The flexibility of LO is due to a common underlying construction of almost all instructional design theories. Instructional design (ID) theories typically prescribe a range of methods to be selected based on the conditions of learning (such as the nature of what is to be learned, the desired learning outcome, learner characteristics, learning environment, etc.) (Reigeluth, 1999). Additionally, these prescribed methods are typically broken into component parts that represent steps in a process, variations on the method, or criteria that the method must meet. Clearly, an object-oriented approach to designing and delivering instruction can support the implementation of such modular ID theories. For example, through their metadata, LOs can be specified according to the conditions of learning they support, and according to which components of methods they represent. A learning object designed for meteorology education can be specified as supporting an "understanding-level" objective about weather systems (appropriate for lay persons), as opposed to one that supports a "prediction-level" objective (more appropriate for professional meteorologists). Further, LOs can be specified to fill an "example" role (data or a photograph depicting a weather event) versus a role of presenting a "rule" or "principle" about how a particular weather phenomenon evolves. In this way, instructional designers (IDs) or learners are able to search and find learning objects that will fulfill specific needs as prescribed by the ID theory. Ultimately, the goal is that CBI systems with built-in intelligence (a "content management system" or CMS) will automatically find appropriate LOs that support the learning of an individual learner at some diagnosed stage of learning (ADL, 2001).

Several LO system strategies based on divergent instructional design theories have been proposed. In his work, *The Instructional Use of Learning Objects*, Wiley (2002d) has collected a variety of papers discussing diverse approaches to LO usage (in addition to those described below, see also Downes, 2000; Orrill, 2002). For example, Merrill (2002) suggests that LO systems may be used to create intelligent instructional systems (which apply information processing models of learning) based on "knowledge objects," systems that can represent both knowledge schema elements and facilitate the construction of mental models based on them. In applying this theory, modular content is created to fill predefined roles ("knowledge objects") within various kinds of learning "transactions." On the other hand, Bannon-Ritland et al. (2002) describe several constructivist strategies for using learning objects. One of these, based on Cognitive Flexible Hypertext (CFH) theory (Spiro, Feltovich, Jacobson, & Coulson, 1992), provides (as learning objects) interchangeable examples, arguments, cases, and practice exercises, which can be instructor-guided, system-determined based on algorithms, or based on learner interest and self-determined need. Another proposed system, based on generative learning theory (Wittrock, 1990), is both a learning object repository and an environment for learning activity. In this system, groups of learners would not only use the LOs, but also create them and define their organization. The generative activity required by this system would encourage both individual and social knowledge construction. Obviously, LO strategies can be seen to build upon a range of theoretical bases, and can adapt to meet the differing learning needs prescribed by them. But while the LO approach may be flexible, can the LOs created for them be theory-free? Will they be adaptable to any instructional system?

Learning Theory Limiting?

Wiley (2002d) is concerned that while learning object tools and standards are often touted as being theory-neutral, they may actually be "learning theory agnostic." He suggests that rather than dealing with the tough issue of making learning object standards address good instructional design practice, developers of standards don't care to address the issue at all. He is probably correct in this assessment. However, the situation may be even worse—rather than learning theory agnostic, the nature of LO approaches inclines designers to limit their conceptions of learning.

The first level of concern is the use of the term "object" itself. The decision to apply the word "object" to instruction engenders certain attitudes that aren't compatible with perspectives of learning as a process of meaning making, as opposed to knowledge transmission (Jonassen & Land, 2000). It also suggests a *product delivery* metaphor for instruction, rather than other possibilities that are more systems- or process-oriented (Wilson, 1995). Words are active in determining how we conceive of our world and how we behave within it (Whorf, 1956). For this reason we need to be careful how we let the use of terms like “learning objects” color how we think about instruction and instructional design.

The term “object” typically connotes something visible, tangible, and stable. While representations of knowledge may appear to be *objects* in the physical sense once they are coded as text, graphics, or audio files, treating those representations as objects inclines people to believe that knowledge itself is objective, rather than subjective, tacit, and dynamic (Jonassen & Land, 2000). Proponents of constructivism and situated learning are pointed in their attack on such attitudes, suggesting that a prevailing “transmission” metaphor of learning leads to the accumulation of inert knowledge and skills. An alternative or companion metaphor of “participation” has been proposed (Sfard, 1998), one that suggests that learning is a process of active participation in learning communities or communities of practice (Barab & Duffy, 2000). While such a conception of learning does not exclude the utility of LO (see Bannan-Ritland et al., 2002), it can be difficult to conceive of learning as participation when taking an object orientation. Instead, LO can lead to a more simplistic conception of learning as acquisition. For example, Aldrich (as cited in Peer3, 2000, p. 2) suggests that learning objects will be able to capture “individual moments of understanding,” and the opportunity to control these will then become “the next vendor battleground in e-learning.” These “moments of understanding” presumably become products for learner consumption, eliminating the need for learners to create their own moments of understanding. Maurer (2002, section 3, para. 4) goes so far as to suggest that the widespread availability of online information and computational tools may obviate the need for learning at all: “Thus, what (beyond skills, like skiing, riding a bike, juggling balls, or doing a surgical operation) do we still have to learn if we have all what we usually learn available to us any time, any place?” Such proclamations seriously oversimplify the complex nature of human learning and expertise, and demonstrate the conclusions that can result from seeing knowledge as objective and consumable.

While LO thinking may limit conceptions of learning, this isn’t inevitable. But what is inevitable is that the instructional content of learning objects will always be theory-laden, and that this will likely limit adaptability. Human artifacts cannot be created without embodying the values and theoretical perspectives of their creators (Wilson, 1997). The “object” metaphor suggests to some that this may be otherwise, and that LOs can be created, using the correct tactics, that can be adapted to fit many instructional situations, regardless of their theoretical basis. This will be difficult, and the struggle to create metadata standards for LOs demonstrates this difficulty.

The Metadata Architecture

No one is suggesting that *every* LO will be adaptable for *any* purpose, but calls for flexible LO designs strive in this direction. However, even a more limited adaptability will only be possible if the catalogue information about LOs, the metadata, contains the appropriate data to find them and communicates the uses for which they are most appropriate. In other words, the metadata should allow learners and instructional designers to choose LOs that can be adapted to specific instructional purposes. But this can only occur if metadata exist that describe those purposes. Unfortunately, existing metadata standards may end up limiting object-oriented instructional design to simplistic strategies because of their limited definitions. Wiley (2002c) has made pleas for instructional designers to be better represented in the committees developing sharable learning objects metadata standards. Yet only recently has content sequencing (a fundamental component of instructional design) been a part of the standards development discussion. The SCORM standards developers feel this lack of educator representation is quite natural:

> As long as [SCORM standards developers] are working in the plumbing and infrastructure domain, it's really not for the instruction-types to object…It would be like an interior designer walking up to a new home with only the foundation and pipes running into the concrete and saying, 'This is not adequate!' That would be ridiculous. (Anderson, as cited in Welsch, 2002)

Such a comment demonstrates not only misconceptions about interior design and architecture, in which interior requirements very directly drive infrastructure and exterior designs, but a narrow-mindedness about instruction and learning. The interior *design* (as opposed to *decoration*) is critical to knowing the required infrastructure of the building (where the restrooms and windows need to go, what electrical service is required, etc.). After all, it is through the interiors that people primarily interact with the structure! As long as we view instruction as software manufactured to perform predetermined functions (like foundations and pipes), rather than a process of shaping indeterminate experiences, we risk relegating instructional design to an afterthought—the curtains and carpeting of education.

However, it will be very difficult, if not impossible, to create LO standards around content sequencing and other instructional design considerations that will fit all methodologies and all learning theories (which is probably the reason standards developers have avoided involving IDs in the process). Can we hope to create metadata that will assist both ecological perspectives of learning (Barab et al., 1999) and highly prescriptive theories such as Instructional Transaction Theory (Merrill, 1999)? Even if we could, theory is fluid and evolves with the dynamic intellectual and social climate, while standards are difficult to change. In the end, the role of instructional designers on standards committees might be more one of preventing standards that limit usefulness, rather than contributing standards that connect to particular theories.

Visual Adaptability

Content management systems (CMS) are server-based software tools that provide content, potentially developed by many different sources, to learners based on their choices or performance on assessments. Vendors and proponents of these systems have strongly suggested that for learning object systems to reach their full potential, instructional content must be stripped of its visual presentation, its "visual wrapper" (Bannan-Ritland et al., 2002) or "skin," so that the content management system can add user-defined visual parameters. In this way, content developed by one organization can be adopted and blended cohesively with content developed by another, providing a supposedly seamless experience for learners.

First of all, such thinking under appreciates the ability of learners to see past visual consistency and assumes that they won't notice or be bothered by inconsistencies in the style of written (or spoken) presentation. But more importantly, it illustrates a false dualism in regards to communication, and again, the "object" metaphor may be the culprit. If we view instruction as *substance*, as opposed to *process*, a fundamental conceptual flaw is created. It creates *content vs. container* duality, and assumes that information can be considered separately from its expression. This is impossible of course, just as we all know that the same lecture presented by different people can achieve quite different effects due to the differing styles of delivery. If people feel visual consistency is important, how can they feel visual qualities contribute nothing to the message? Just as Whorf (1956) showed us that language itself creates the range of possible meanings, and McCluhan (McLuhan & Zingrone, 1995) demonstrated that the medium in some ways *is* the message, we can't ignore the contribution to meaning made by the visual presentation of instructional content. Color and font choices, and especially the choice of spatial layout of text and positioning of illustrations, have effects on how we process information, as demonstrated by message and text design research (Fleming & Levie, 1978; Jonassen, 1982). Quite often, visual presentation can be an important component of instructional strategy. In addition, it can have large effects on how learners judge the reliability of content, which equally affects learning.

When proponents of "visually-neutral" content argue, "instructional design is not graphic design," (Claude Olstyn, personal communication, November 30, 2000) they overlook the role of graphic design in instructional communications. If anything, as a communications discipline, instructional design is much closer to graphic design than it is to software engineering. Instructional design is very much about creating the best possible expression of content to foster learning, with attention to both verbal and visual aspects. At a deeper level, it is *all* about designing experiences that will foster learning, experiences in which the visual component holds a prominent influence. In other words, leaving these elements up to the whims of whatever visual standards are currently in use by a particular content management system is to deny an important tool of instructional designers for designing quality learning experiences. In addition, stripping out all visual presentation information could make content management systems required components of online instructional delivery, transforming what was once free exchange into a business.

Putting Object-Oriented Instructional Design to Work

Up to this point, the major thrust of this paper has been to question the benefits of LO. However, even a critic can see the potential of LO strategies to achieve, in some cases, more efficient development methods and effective instructional experiences. In this section, we'll look at some suggested conditions for making this happen.

Finding the Right Metaphor

It might seem strange to begin a section on implementation with another discussion of metaphor, but one way to help make object-oriented instructional design work is to avoid misguided metaphors to explain the strategy. Metaphors not only help us communicate difficult concepts, but also drive how we conceive of our world and influence the way be behave toward it (Lakoff & Johnson, 1999; Sfard, 1998). When people first began discussing the possibilities of learning object strategies, the metaphor used to communicate the concept was that of the LEGO block (Hodgins, 2002). The idea was that if we could create instructional content components of just the right size and with standard "connectors," anyone could combine them to create custom content to meet their specific needs. Wiley (2002a), however, points to the many fallacies that such a simple metaphor can create. It suggests that learning objects are combinable with any other, can be assembled in any manner, and are "so fun and simple that even children can put them together" (p. 12). While the LEGO metaphor is simple to understand, it is too misleading about the ease of interoperability.

As an alternative, Wiley (2002a) proposes a metaphor of molecular structure. As he explains, atoms are fundamental in that they can be combined and recombined to form molecules, but they exhibit appropriate limitations that LEGOs do not. Like instructional content, atoms can be usefully combined only with a limited number of other types of atoms. In addition, the ways that atoms can recombine can be predicted by their own internal structure (reflecting the internal context, purpose, and other characteristics of the LO). Finally, the complexity of molecular processes is an appropriate metaphor for the complex nature of creating instruction. While the atom/molecule metaphor better reflects the wider variety of learning objects that might exist, and better emphasizes the complexity of combination, it still suggests a limited set of rules and algorithms for combination that may not reflect the dynamic, open-ended nature of knowledge. It falls into a similar trap of oversimplifying human knowledge and communication by using a physical metaphor.

What we really need is a metaphor that reflects the nature of instruction as open to interpretation and fluid in meaning and use—we need a metaphor drawn from human communication. Such a metaphor will be less likely to take us unwittingly into other, possibly unrelated conceptual domains that could distort our thinking (Sfard, 1998). A possibly more useful metaphor, more in keeping with the human and dynamic nature learning and instruction, is that of film montage (the sequencing of images in motion pictures). Not only are films composed of temporal segments, like musical pieces, but they are also physically composed of photographic frames that in various combinations become shots, scenes, and sequences. As in instruction, the components of film can be combined in any number of ways, each with a unique effect on the viewer. Yet there are cultural norms for how to tell a story with motion pictures that determine how effective a film montage will be. Classical montage methods create sequences composed of establishing shots (providing context), medium shots (documenting action of social dimensions, such as two or three people interacting), and close-ups (inserted details that help reveal the subtleties of the scene or action). Instructional content follows similar patterns, with context establishment, demonstrations of relevance, and finally details of fact or concept.

The film metaphor also offers other human dimensions that parallel education and training—the economic pressure to produce and distribute efficiently and the need for a degree of expertise and artistry to create and manipulate the objects. (The film metaphor is also used profitably by Lamos and Parrish [1994] to discuss instructional multimedia development processes in general.) In addition, it implies the need for a planned object orientation and careful integration. Rarely do filmmakers (even documentarians) simply combine found footage or shoot a scene in any style, leaving the final construction entirely to the film editor. As a metaphor drawn from human communication, film montage contains more appropriate connotations, and leads us to think more broadly about the nature of learning and instruction. Substance metaphors, like LEGOS and atoms, imply that rules akin to physical laws determine how we think and learn. On the other hand, a communication metaphor of instruction is barely a metaphor at all, and reduces the potential for misconception.

Propositions for Learning Object Systems

Object-oriented ID could turn out to be an interesting new facet of ID practice, and, applied with the right precautions in mind, could create highly effective learning experiences for students, promote better collaboration among developers, and provide resources for instruction when they might not otherwise exist. But further study is required to help instructional designers understand how their roles, and the roles of SMEs and developers, might change when using LO strategies. This section concludes with some thoughts on next steps for practitioners and researchers. Some will seem obvious, but they should be articulated nevertheless.

- Remember that learning objects are just components in a larger learning environment. Don't think that student encounters with information-oriented learning objects are sufficient for learning. Learning complex skills requires experiences in problem solving, exploration, collaboration with instructors and fellow learners, opportunities for learners to reflect and articulate their knowledge, and access to cognitive tools to support the problem solving process (Jonassen, 1999). Interactions with LOs can support some of these learning activities, but cannot fulfill them alone. Access to learning objects may occasionally save time in building instructional presentations, and may even supply interesting interactive experiences for learners, but they won't replace the need for generative activity by the learner and interaction with others.

- Use LO systems to play a supporting role within instruction that supports active learning strategies (Case-Based Learning, Problem-based Learning, Generative Learning, Collaborative Learning, etc.), rather than simply as collections of static lessons or even dynamic lessons with predefined algorithms (e.g., see Bannan-Ritland et al., 2002). For example, within problem-based learning environments (Savery & Duffy, 1996), learning objects can be the supporting instruction and information resources that enable problem solving. In generative learning environments, learning objects might be the static information that forms the starting point for unique, student-generated products (Dunlap & Grabinger, 1996). In case-based learning environments, learning objects might be the case elements that students analyze to generate solutions (Kolodner & Guzdial, 2000). In each of these cases, LOs provide stimulus and support for students as they practice complex tasks, and don't simply present information or attempt to drive deterministic outcomes.
- Use LO systems for more than simply libraries for student or instructor access. Also use them as the basis for generative learning activities. If learners can interact with and modify learning objects and learning object sequences to meet their own learning needs, this will encourage knowledge construction more than static or predefined systems (Jonassen, Myers, & McKillop, 1996). Systems that allow communities of learners to create their own learning objects set a high level of expectation for student work, increase relevancy, and encourage deeper learning through their "contribution-oriented" pedagogy (Collis & Strijker, 2001).
- Create techniques to allow IDs to interrupt and annotate LOs at many articulation points, without having to actually modify the objects themselves. LOs are less likely to be useful if they can't be customized in these simple ways. If articulation points exist in the LO (frame numbers of Flash movies, Javascript events, etc.), a parent program can easily add context and relevance at predefined points without the need to modify the LO in substantial ways. Annotations, comments, and questions can be added in this way, much the same as an instructor can pause and comment on a video when playing it for a group of students.
- Contrary to proposals to develop context-free content, develop learning objects only for specific applications at hand, not simply for general or speculative use by others. Without a target in mind, objects won't have enough grounding to be useful to anyone. Design for a context, but allow for adaptation if necessary. Don't let designing for broad use sacrifice the quality of learning experiences for the original audience. However, designing that instruction such that it is highly granular will allow it to be decomposed by others for modifications.
- Use learning objects as vectors for innovation. People are more likely to try small-scale innovations in instruction than complete curriculum changes. Creating small lessons or lesson components that employ progressive tactics may be useful in convincing educators and trainers to try out alternative strategies and methodologies at a larger scale. The real benefit of LOs may come from enriching instruction, not making it more cost-effective. For example, learning objects in the form of interactive Java applets can provide discovery-learning opportunities in classes that primarily use direct instruction methods (e.g., see http://profhorn.meteor.wisc.edu/wxwise/index.html).

- Don't allow the semantic content contained in the visual layout to be sacrificed for the sake of creating "context-free" learning objects. While innovations like XML offer the ability to create Web content that is flexible for many presentation formats, it can also be an excuse not to bother with the careful formatting that could make content more meaningful. (In addition, XML may add another layer of complexity that can be beyond some novice developers, limiting potential reuse, although this will eventually be overcome through new tools.)
- Create systems for capturing and accessing user-defined metadata. The captured opinions and descriptions of how learning objects are used could become more valuable to other users than the standard metadata, which may be too general to be of help. Non-authoritative metadata, or "annotation metadata," could work much the same way that Amazon.com book reviews do, helping buyers of books get more information and more varied opinions than those typically found on jacket covers or in published book reviews (Recker & Wiley, 2000). It can also create a history of use and users, which could stimulate LO developers to create more useful objects.
- In addition to funding the development of LO repositories, grants organizations should also fund research and development efforts focused on the creation and implementation of active learning strategies that incorporate LO tactics. To aid in understanding how to best design LOs, design-based research studies should also be performed to determine how learning objects are actually implemented by learners and instructors and what impacts they have. Some questions might include: How do learners utilize online resource objects during problem solving? How do different types of learners use them differently? How context-neutral can an online resource object be before it loses effectiveness?
- In addition to design-based research on learning impact, we need research on design and development practice by IDs doing object-oriented design. How do they created context, and how do they avoid created too much? How to they apply strategies for building motivating instruction? How do they communicate with SMEs who may have difficulty understanding the highly fragmented nature of the content? (It is difficult enough to help SMEs envision the final multimedia product during content development.) How does object-oriented ID change prototyping and formative evaluation practices?

Summary

One cannot deny the high costs of education and training and the virtue of attempts to contain those costs. The cost of educating a population to participate in the information society is high, and the cost of providing ongoing training for a workforce to function effectively in a time of rapid technological change is formidable. It is imperative to look for technological solutions to such problems. However, we need to be careful that we do not view the problem *only* as a technological one (Burbules & Callister, 2000). Instead, we must acknowledge that the teaching/learning endeavor is a difficult, complex, and imperfect activity of human, and not technological, dimensions.

LO strategies and the metadata standards that accompany them are seen by many as the savior to inefficient and outdated methods, yet what is offered in return may be misleading to learners and detrimental to quality learning experiences. To enhance efficiency, practitioners are looking to the twentieth-century manufacturing models of division of labor, assembly-line production, and distribution channels to overcome the inefficiencies of a *craft* model of instruction. The practice of instruction has elements of art, craft, science, *and* industry, but overly stressing the industry aspects can ignore the benefits of crafting instruction to meet the needs of a particular audience and the unique contributions of a skilled teacher or instructional designer. A factory model of education and training turns learners into consumers and instruction into a commodity to be manufactured. The implication is that knowledge gain is simply a matter of access, rather than a personal commitment to a process. It has been posited that “the most obvious benefits of reusability are the possibility of large content repositories and the development of a new ‘content economy’ where Sharable Content Objects are traded widely” (ADL, 2001). Barter and open-source systems may be implied, but commercialization and control of educational markets are not far back in the minds of some learning objects proponents. One investment banking report has suggested that through the use of learning objects “the [e-learning] industry will become more efficient and competitive,” and that “the race for educational technology standards is on” (Urdan & Weggen, 2000, as referenced in Wiley, 2002a). A competition for control of the distribution network of LOs is counter to the needs of a society that must count on dynamic knowledge evolution and innovation. However, larger content repositories, while useful and potentially liberating, just as public libraries further democratic values, are not the primary solution to our education and training needs. Solutions lie in more effective instructional practice that includes active and adaptive learning strategies, not simply access to more content. To the extent that the learning object movement can foster effective learning, by introducing active learning experiences and supporting student-centered learning environments, propagating new ideas about instruction, and increasing collaboration and sharing of resources, it can play a major role in improving education and training.

While Ross (1996) has suggested that LO represents a paradigm shift that will receive a reactionary response from those stuck in traditional ways of thinking about ID, in fact LO is a phenomenon that finds itself being drawn between two currently competing paradigms. Wilson (2001) describes two broad trends currently in competition in distance education. One trend looks towards automation, standards, and control as directions for improvement; the other looks to open-systems and learner-centered approaches. The learning objects movement will be a prominent venue in which to watch these competing forces in action. While most of the proponents of LO seem to be arguing for the benefits of automation and standards, there are also many who see LO as supporting open systems and learner-centeredness. This paper has primarily been concerned with the potentially false promises and true risks inherent in the arguments from the former group, but has attempted to show limitations to the arguments of the latter group as well.

The trouble with learning objects is the same as for all new learning technologies. They offer novelty, potential, and apparent economic benefits that can lead us down paths that ignore our true nature as learners, and even down paths that are already well-tread and generally believed to lack promise. Shakespeare told us that “there is nothing either good or bad, but thinking makes it so” (Hamlet II. ii.). What does this insight suggest when we are speaking of information technologies, which are understood to change our thinking, leaving a “cognitive residue” as we use them (Bell & Winn, 2000; McLuhan & McLuhan, 1988)? If we adopt learning object strategies in the ways and to the extent that some propose, could how we think about learning and instruction change in ways that devalue important considerations? We need to carefully consider what is being proposed for learning objects and how we tend to talk about them. Only then can we judge whether we are fully anticipating their range of impacts and keeping an open eye for those impacts that we can’t anticipate.

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Footnotes

[1] The title of this paper is a reference to the popular Star Trek episode, “The Trouble with Tribbles”(Gerrold, 1967). In that episode, one of the crew of the Enterprise adopts a cute, furry, and apparently harmless alien creature for a pet, only to find that it reproduces with a fury. Soon the population of tribbles outstrips the resources of the ship, floods its compartments, and threatens the crew’s mission, as well as their lives. The spirit of this paper’s title is to suggest that while object-oriented ID holds tremendous promise on many levels, it also has potential dangers. We need to carefully study these creatures called learning objects before we adopt them so readily, lest we find ourselves up to our ears in ineffective education and training endeavors.