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Overcoming the Limitations of Learning Objects

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1. Issues facing employers of learning objects

There are a number of issues facing those who wish to employ learning objects in the facilitation of learning. There are a number of issues facing those who wish to employ learning objects to facilitate learning. These issues are not, however, inherent in the component-based paradigm. The first section of this paper describes some of the most difficult issues to be resolved. In the second section, we present a model of the use of learning objects that is grounded in a project-based paradigm. In the third section, we describe the manner in which we believe the new model overcomes the problems outlined in the first section.

1.1. Decontextualized learning

The instructional design of learning objects is moving increasingly toward decontextualization. This is true because of an inversely proportional relationship between the internal context or size of a learning object and its potential for reuse. Here, we define “context” as a spatial or temporal juxtaposition of elements, and define “internal context” as the primitive assets (photos, videos, blocks of text) juxtaposed within a learning object. Learning object “size” correlates with the number of elements juxtaposed within a learning object’s internal context (more elements juxtaposed within a learning object making for a “bigger” learning object). Thus, a learning object’s size is proportional to its internal context.

As Wiley and colleagues have described previously, learning object use is more accurately understood as contextualization (Wiley, Recker, & Gibbons, 2000). When an instructional designer or automated system uses a learning object, the act of use is the act of placing the object in an “instructional context” (a spatial or temporal juxtaposition of learning objects). The relationship between the internal context of the learning object and the instructional context into which it is being placed determines whether or not the object “fits” into that context. For example, a small learning object comprised of a single image of da Vinci juxtaposed against three blocks of text about da Vinci (creating an internal context which, roughly speaking, is “about da Vinci”) would fit nicely into a collection of learning objects (or instructional context) “about inventors,” but would fit poorly into an instructional context “about amphibians.”

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.”

Focusing on removing or separating as much context as possible from learning objects in order to maximize the reuse of the learning objects can be problematic. A paradox arises because 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 contextual 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 will likely fail to produce a meaningful context for learning, necessitating the creation of alternative models of learning object use. *If decontextualized learning objects are to developed and deployed, a method of reintroducing context must be utilized.*

1.2. Megaphone not mediator

While learning objects can be conceived in a number of ways, including content objects, strategy objects, and discourse objects, 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) are gaining popularity. 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 Leontev’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 severely under-explored. Research along these lines would require instructional designers to deploy learning objects in problem-based environments, as opposed to the “next, next, next” manner in which learning objects are frequently used. 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 unit of analysis must be 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).

1.3. Scaling through automation

Many individuals and institutions pursue learning objects research with the goal of enabling “anytime, anywhere” learning through computer-automated assembly of learning objects personalized for individual learners (e.g., Martinez, 2003; Hodgins, 2000; IEEE/LTSC, 2001; ADL, 2001). The potential 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 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. While a collection of quality content is a necessary condition for facilitating learning, it is not sufficient. *If good content were enough to support learning and human interaction were unnecessary, libraries would never have evolved into universities.*

1.4. 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 content objects from a databank for delivery to learners provides as close an implementation of this metaphor as is imaginable. The current paradigm of learning objects delivery (as expressed in various standards and specifications) completely ignores discourse or dialogue; in other words, many 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, the learning objects paradigm could be seen as “oppressive.”*

1.5. 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 existing content before it can be “reused” in a given learning objects system. For example, an existing webpage would have to be edited in order to utilize the SCORM API to communicate with a standards-conforming LMS. Wiley (2000) criticized Merrill’s (1999) Instructional Transaction Theory and other object-based approaches of being particularly guilty of this problem, requiring literally every object to be extensively prepared and formatted in order to be reusable. There exists a paradigmatic choice between few specialty objects which can be automatically processed by intelligent systems, and many objects which can be reused by humans. *It seems desirable to develop a method of learning object utilization that could reuse existing material as is.*

1.6 The reusability paradox

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. That is, proceeding and following utterances significantly alter the meaning of a word or other utterance. Vygotsky (1962)

explained:

The senses of different words flow into one another - literally “influence” 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. From the learning objects perspective, 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. The “Sixth Sense Effect” is the common school experience of understanding a lecture up to a certain point and then “realizing” that you haven’t understood it at all. “I was with you right up to the last sentence; but now I think I must not have understood anything you said.”

It is entirely possible that a single, misplaced object could, via this Sixth Sense Effect, undo significant portions of previous learning as students struggle to reinterpret what they have previously understood in terms of new material presented inappropriately. For example, imagine concept instruction teaching the identification and classification of Baroque period music. After several examples and nonexamples are displayed, a twentieth century example is inappropriately selected and presented as an example of Baroque. One can imagine students thinking back to the previous examples and nonexamples, struggling to understand how Stravinsky fit the mental model they had worked so hard to develop. While humans may make occasional selection errors of this kind, we believe that machines are much more likely to err in this manner – especially in more complex instructional domains where meaning-making plays a more significant role. *This implies that humans may have to assemble learning objects by hand for all but the most rudimentary instructional content.*

1.7. The intellectual property pit

In recent years every major content creation industry has seen its core digital product line exploited and freely traded online. First the music industry saw its 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 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 online 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 movie content is abundant on file sharing services such as Kazaa. The commercial content industries have learned the hard way that, despite rights management attempts, digital content will always make its way

into free distribution. We strongly doubt that the educational content industry has not learned a lesson watching these other industries, which will likely prevent them from making or marketing digitized versions of their content. *Publishers' fear of file-sharing networks will likely prevent an "educational object economy" from ever materializing.*

2. A project-based model of learning object use

This section discusses a model of learning objects use employed in the development of an online, learning objects-based Masters of Business Administration in Enterprise Informatics for Northface University. This approach to using learning objects is called O₂.

O₂ is a project-based model of using learning objects which focuses the learning experience on a sequence of increasingly complex projects, following Wiley's Learning Object Design and Sequencing (LODAS) approach (Wiley, 2000) and Gibbons and associates' Work Model Synthesis method (Gibbons et al., 1995). Learning objects are selected and made available to students by course designers in order to support the accomplishment of project tasks and goals. This use of learning objects follows the "Octopus Method" outlined in our previous work, in which a project or problem is placed at the center of the learning experience and learning objects "hang off of the project" like legs off an octopus. O₂ is also strongly influenced by van Merriënboer's Four Component Instructional Design (van Merriënboer, 2000) model and Hannafin and Hill's work in Resource-based Learning Environments or RBLEs (Hannafin and Hill, 2002).

Table 1 describes the individual content components of the O₂ architecture. According to Wiley and Edwards' (2002) definition of learning object, "any digital resource which can be reused to mediate learning," each of the components qualifies as a learning object.

Table 1. Content Components of the O₂ Architecture, Northface Implementation

Component	Description
<i>Lesson</i>	"Lessons" are a generic HTML container for the other system components. Students work through one lesson per week.
<i>Project Description</i>	A typical course contains a sequence of three increasingly complex projects. The Project Description introduces students to the project they will be working on for the next several weeks.
<i>Task Description</i>	Each week students are required to deliver a project task. The Task Description introduces students to the week's assignment.
<i>Presentation</i>	Presentations are modules of overt instruction designed specifically to meet the current learning need. In the NU implementation, presentations were combinations of slides and audio scoped to the level of an individual topic (or small set of very closely related topics) which students use to gain knowledge and expertise necessary to complete project tasks.
<i>Learning Resource</i>	Learning Resources are any other materials presented to support student learning, including example artifacts from a fictitious prior project team's deliverables and other information resources (such as websites).

The "Lesson" component contains all the other components directly or by reference as illustrated in Figure 1, a screenshot of a typical lesson. The Lesson also contains links to

discussion areas, whether they be for discussion with the Professor in a chat/shared application space or for discussion and collaboration with peers in a threaded discussion environment.



Figure 1. A typical O₂ Lesson using presentations and other learning objects to support project-based learning.

The relationships between the components of the O₂ instructional architecture are formally described in the Object Role Modeling (ORM) language in Figure 2. The taxonomy of learning object types is taken from Wiley (2000). To summarize, Fundamental learning objects are individual assets which cannot meaningfully be broken down further (e.g., PDFs or images). Combined-closed learning objects are those containing two or more Fundamental learning objects combined in a manner which precludes the simple reuse of the Fundamentals (e.g., streaming Flash with audio, streaming video with audio). Combined-open learning objects are those containing two or more Fundamental learning objects combined in a manner which does not preclude the simple reuse of the Fundamentals (e.g., images and text combined in a webpage).

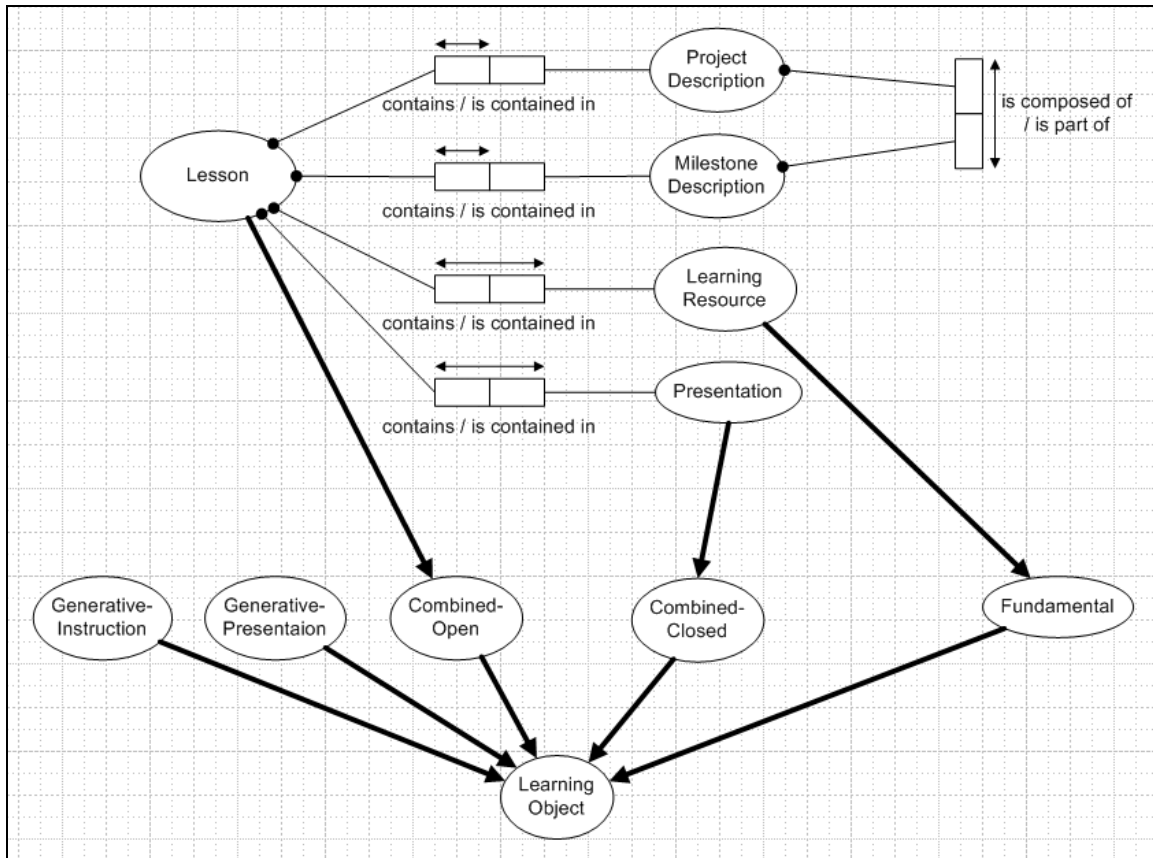


Figure 2. An Object Role Modeling (ORM) diagram outlining the relationships of components in the O₂ instructional architecture.

3. How O₂ overcomes some limitations of traditional learning objects approaches

3.1. Decontextualized learning

In O₂, Presentations are scoped so that one learning object teaches one topic (or a closely related set of topics). While this appears to violate the “specially designed for reuse” principle described above, in practice we found that when working for the first time in a new domain there was no way around it. We anticipate future courses in this domain requiring much less specialty design.

The guiding question used in working with subject-matter experts has “can you ever imagine wanting to teach some portion of this topic without teaching the others?” This notion of modeling the domain and reflecting that model in learning objects is taken from Wiley’s work with LODAS described above (Wiley, 2000). When the answer is “no,” the remaining collection of topics is scoped as a single learning object. While these objects are highly decontextualized both by their small grain size and by a scrubbing process which removes references to specific supertopics, instructional context is provided to students through the use of project statements. Looming milestones provide learners with motivation for studying and provide immediate opportunities for students to practice and apply the knowledge and skills taught in the learning objects. Because the learning

objects *are* highly decontextualized, they can be easily reused to support different projects in different courses.

3.2. Megaphone not mediator

Learning objects in O₂ are not the focus of the instructional episode. As opposed to many learning object systems, in which the instruction is completely comprised of a temporal sequencing of content components, in O₂ learning objects are used to mediate the solution of specifically designed projects. In other words, lessons are centered on the solution of problems and completion of projects. As students find they are lacking in necessary expertise or skill, they use learning objects to gain the abilities needed to complete intermediate milestones and larger projects.

3.3. Specially designed for reusability

Because learning objects are used strictly as mediators in the O₂ framework and do not contain embedded assessments which must participate in roll up or otherwise communicate with the LMS, there are no technical issues restricting the use of any resources in any digital format within the O₂ framework. While Presentations were specially designed as described above, we were able to reuse a number of resources exactly as we found them in the wild.

Also, in keeping with the O₂ philosophy, there is no need to reformat the “look and feel” of resources. Once students leave the virtual classroom and return to their lives, they will again encounter problems which they will only be able to solve by marshalling a collection of disparate resources, whether learning objects, books, journal articles, job aids, or other. Interacting with disparately formatted resources in the O₂ experience prepares students for the experience later in life. O₂ simply scaffolds the process by narrowing the space of possible resources students must wade through.

3.4. The reusability paradox

We have argued elsewhere that while decontextualization and reusability vary proportionally for any given object, either property varies inversely with the ease of learning object reuse (from discovery or location through to inclusion in a specific lesson). In O₂ we have tried to find a sweet spot in terms of grain size for the resources we are forced to create from scratch (as opposed to those existing resources we might reuse), following work published by South and Monson (2002). As indicated above, analysts go through an iterative process of asking SMEs “can you ever imagine teaching one of these topics without teaching the others?” until the SME says “no.” The remaining collection of topics is scoped as a single learning object.

In selecting closely related topics as the grain size for new resources, we create a low to moderate amount of internal context which will admittedly prevent some reuse which would have been possible at a far finer grain size (for example, if an instructional situation arose which called for instruction on one, but not all of, the topics). However, we feel that a conglomerate of media that teaches a single topic or closely related set of topics is the optimal grain size for this circumstance, as well as many others.

3.5. The intellectual property pit

As MIT acknowledged in its bold OpenCourseWare project, bare educational content is valuable, but it is not a core value proposition for educational institutions. Books by MIT faculty are available for free in many libraries, and now MIT course content is available for free on the Internet. The majority of the value of educational experiences comes from the value added through interactions with human beings. Thus, Northface University can open its collection of presentations and learning resources to the world without giving away its core value – the structuring of those resources to support specific projects and interactions with world-class faculty in project contexts. This component architecture could allow NU to release its library of presentations and learning resources free without letting core value out the door, meaning that they can contribute to the educational object commons (*not* economy) without putting themselves out of business.

3.6. Scaling through automation and DataBanking education

Social interaction is an absolutely necessary companion to the O₂ model of learning objects use. In the case of the Northface University installation of O₂, human-to-human interaction happens in a variety of contexts: weekly topical discussions among students and faculty on course bulletin boards, live weekly sessions in which faculty walk students through specific problem-solving processes related to software development, and online office hours.

4. Conclusion

Despite the many criticisms which have been raised regarding learning objects (e.g., Friesen, 2003), we continue to believe that learning objects hold significant potential for the advancement of both commercial and humanitarian educational enterprises. Commercial educational enterprises will continue to see value in the “create once, sell for reuse many times” economic model. Humanitarian educational enterprises will continue to see value in the ability to fund the development of one set of instructional materials and open them for reuse to individuals in developing nations and other spaces without additional costs.

O₂ provides a single view of what educationally effective, project-based learning objects use can look like. We believe that many other instructionally feasible models exist and will continue to be identified as instructional technology continues to move into the future.

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