

When Worlds Collide

*The intersection of constructivism, learning objects,
and peer-to-peer networking technologies*

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The current conception of learning objects

There is a vision. A vision in which the creation of instruction can be automated; in which a computer program is capable of inspecting, selecting, and assembling learning objects in order to instantiate an instructional design. And why not? From automobiles to computer processors, humans have succeeded in automating some pretty complex assembly processes.

Historically, the success of automation has relied on two factors. The first is an understanding of the assembly process, first discovered and performed by hand, then captured, studied, and expressed in a technology. The second factor is the standardization of component properties. The standardization of component properties creates a marketplace in which many vendors can create components competitively. The broad availability of inexpensive standardized components makes assembly processes easier to express in concrete terms. For example, once standard building construction components such as bricks and two-by-fours were widely available, it became easier to create detailed building plans.

The construction metaphor is an apt one for the current discussion, as the current term “learning objects” is borrowed from the 1994 CEDMA working group entitled “Learning Architectures and Learning Objects” (LALO), in which the Architecture is the expression of the construction or assembly process (the blueprint), and the Objects are the standardized components (bricks and boards).

But our concern is the facilitation of learning. In our case, the assembly plans are probabilistic instructional design theories and models, prescriptive methods likely to facilitate learning. The wide availability of standardized learning objects (*not* standardized *descriptors* of learning objects, standardized objects themselves) will make these probabilistic instructional design plans easier to implement technologically, so the argument goes.

However, there has been a movement in educational psychology against top-down, instructor-designed facilitations in favor of scenarios where students actively engage in constructing their own knowledge and meaning for themselves. Proponents of this constructivist learning theory and its instructional implications have gone so far as to call the learning objects notion (with its plans and decontextualized objects clearly defined for the learner by someone else) “an oxymoron” (Jonassen, 2000). Even to those of a more traditional philosophy, it must seem incongruous that the latest advances in instructional technology are currently being paired with educational theory over twenty years old.

The collision

The challenge with which we are presented, then, is to pair a more advanced learning theory with this more advanced instructional technology. The collision theme of this paper comes from the fact that as currently defined and formulated, constructivism and learning objects are incompatible: a pairing will require a reformulation of one or the other. Although there are those within the educational community calling for a reevaluation of our ideas of constructivism (Rocci, 2000; Wilson, 199x), constructivists seem unlikely to budge. So for the purposes of this discussion we will hold constructivism constant and allow our formulation of learning objects to vary.

Simultaneously, networking technology is changing in a manner as radical as the shift from a mainframe-terminal to client-server paradigm. Napster, Gnutella, FreeNet, and OpenNap are only our first glimpse of the networking paradigm of the future: peer-to-peer networking (P2P). And it again seems absurd to combine some of our best thinking with a technology already being obviated. And so our challenge is multiplied. To clearly state the research problem,

Can learning objects be reformulated in a manner compatible with a constructivist learning theory and expressible in a peer-to-peer framework?

Our goal will not be to provide the final, definitive answer, but simply to provide an existence proof.

Napster for learning objects

Let us consider P2P and learning objects first. Keeping our focus on an educational audience, why is Napster so wildly popular with students? First, almost every student has a collection of music to share. Second, almost every student wants access to more music than they have.

The educational analog is true. Students have all kinds of educational material (learning objects) lying around their hard drives: essays, term papers, other types of homework, notes taken during lectures, etc. And every student wants access to more of these learning objects than they have.

Significantly, the same is true for faculty. Faculty have all kinds of material lying around their hard drives as well: syllabi, lecture notes, research instruments, data sets, articles in progress, articles never published, etc. And faculty want access to more of these materials than they have as well.

So from an information access and provision point of view, learning objects and P2P seem to be a good match. But where's the learning? The difficult issues of component standardization and predefined assembly plans are instructional issues, and have to be considered in the context of constructivism.

Constructivism and Napster for learning objects

The learning objects described above are valuable resources. They are context-rich as opposed to being purposely decontextualized (the traditional formulation of learning objects). They lack a meaningful notion of granularity or standardization. This lack of standardization will make selecting specific objects for use in planned assemblages much more difficult and expensive if it is to be done correctly.

And therein lies our tie to constructivism. What if there is no *correct* assembly method? What if assembly *per se* is not involved in the utilization of learning objects at all? What if learning objects were treated as nodes in a massive distributed knowledge network? Assembly of objects according to designer-defined rules could be supplanted as the main mode of learning object utilization by learning object linking (creating new paths between network nodes) and annotating. And because the designer would not mandate the ways in which the learning objects will be assembled ahead of time, there is no requirement for standard grain sizes. The learner would collaborate with other learners (whether students, faculty, or other) to socially construct their own understanding through active, collaborative knowledge construction. Such a system would be similar to CSILEs (Computer Supported Intentional Learning Environments) in many ways.

CSILE is the first network system to provide across-the-curriculum support for collaborative learning and inquiry. Through the use of the CSILE software, a communal database is created by students and their teachers. Students can enter text and graphic notes into the database on any topic their teacher has created. All students on the network can read the notes and students may build on, or comment on, each others' ideas. Authors are notified when comments have been made or when changes in the database have occurred. Various note formats and supports have been designed to enhance the potential of the communal database for collaborative knowledge-building (<http://csile.oise.utoronto.ca/>).

Other constructivist learning environments, such as Hannafin's (1999) Open-ended Learning Environments or Schank's (1999) Goal-based Scenarios could be constructed in addition to CSILEs. These environments would also utilize learning objects that were without meaningful notions of granularity or predetermined architectures.

None of this is to say that the constructivist formulation of learning objects is in some way better than the current formulation. It is simply an alternative formulation. In terms of facilitating learning, it is open to the same praise and prone to the same criticisms as constructivism itself.

Implications

(1) In the instructivist's conception of learning objects, granularity and assembly are the primary research issues. What is the optimal size of a learning object? What manner of putting objects together (instructional design theory) best facilitates learning in which circumstances? How can standardized objects be mapped into instructional design

theories? In the constructivist's reformulation of learning objects described above, neither granularity nor assembly are issues of significance, let alone the primary research issues.

(2) If the Napster pattern is followed then the new learning objects system will be free. Because OpenNap, Gnutella, FreeNet, Blocks, Mojo Nation, and other systems which support the P2P paradigm already exist as open source software, the system software does not need to be written from scratch. The system can be created quickly by editing existing software to add the necessary functionality (bi-directional linking and annotation, for example). Use of the open source model also distributes long-term maintenance and upgrading of the system (Raymond, 1999; DiBona, 1999).

(3) As with Napster, the learning object publication or sharing barrier is greatly lowered over current systems. As opposed to requiring an account on a web server and knowledge of the File Sharing Protocol, learning objects are now shared or published simply by being saved in a special directory on the user's hard drive. Almost all users save files to their hard drive after creation. And almost all users can move existing files from one directory to another on their hard drive.

(4) Metadata plays a large role in the current instructivist learning objects formulation. The assumption is that metadata is absolutely necessary for learning object discovery, and that metadata provides the computer system with the information necessary to make assembly decisions. However, assembly decision-support is no longer necessary in the new learning objects formulation. Also, notice that Napster does not rely on external metadata records, but instead on file-naming-conventions-as-metadata. CSILE research triangulates, showing that system users had to learn to give detailed, specific names to their nodes in order to facilitate their discovery and use. If a naming convention can be agreed upon (as it has been in the case of Napster), then the system discussed herein may be able to function without requiring users to create additional, external metadata records (which is a significant barrier to sharing or publication). Whether or not it can is an empirical question that can be answered during a system pilot.

(5) Because students and faculty already have hundreds of resources stored on their individual computers, and because the learning objects do not have to be retrofitted according to a taxonomy of some kind (and may not have to be indexed with metadata), the entire learning object system could reach critical mass almost immediately after the system software becomes available. And because these objects will generally be of a much smaller file size than even a single mp3, the bandwidth issues that occasionally make using Napster tedious will be a non-issue.

(6) NSF and others are currently funding the development of large digital libraries, and are looking for ways to identify quality materials for admission into their collections. The system described above can serve as a resource incubator, from which the community can identify resources of exceptional value (through some established criteria such as number of accesses or number of in and out links) for possible promotion into an "official" digital library.

(7) Someone will certainly cry “foul” over intellectual property because the system is based on a Napster-like model. However, the proposed system is significantly different in one important aspect: There is currently no market for digitized homework, essays, book reports, lecture notes, syllabi, data sets, etc., from which users could “pirate” material for contribution to the system. Students and faculty are the primary producers of this content. In all but the rarest of cases, once created this educationally-valuable, context-rich information will lie dormant on the users’ hard drive until they “spring clean” in order to install a new application or game. When the producer of content personally opens access to his or her own data, there is no intellectual property violation. Because there is no business plan for use of the files or their contents, there is nothing for the user to lose by sharing. There is nothing to lose, and everything to gain.