New Pedagogies and Re-Usable Learning Objects: Toward a New Economy in Education

Betty Collis & Allard Strijker
University of Twente, The Netherlands
Collis@edte.utwente.nl, strijker@edte.utwente.nl

Abstract While the idea of reusing objects in digital learning environments is not new, continual strides are being made toward improving the prospects of reusability. However, four of the main steps in reusability--finding a pedagogy in which both contribution and reusability are regular aspects, having a convenient technology for all stages of contribution and reuse, and finding institutional motivation and support for reuse--are far from common procedures in most higher education and company training settings. In this paper we describe a shift in pedagogy and technology requirements that we see as a major step in accelerating the reusability process. We also position in the reusability process in a broader context: an evolution in education and training toward either a Stretching the Mold Scenario or a New Economy Scenario.

Reusability of Learning Materials: An Old Ambition with Still-Unsolved Problems

The reuse of digital learning material has been a goal and a problem for more than two decades in the educational sector (Bork, 1976; Ely, 1989). Reasons that reuse has been seen as desirable are educational, economic, and social (Collis, 1995; Collis & De Diana, 1990). However, although there is a general agreement that reuse is valuable, it has also been long established that reuse (or even first use) of digital learning materials often does not yet occur to any meaningful extent in mainstream higher education and company training settings. For example, as recently as 1998, Draper analysed the many digital learning materials emerging from the TLTP Initiative in higher education in the UK and found that most of the products produced did not get used beyond the niche for which they were produced. Also, in a new study of higher education institutions in The Netherlands, it was found that although a majority were using Web-based course-management systems, few instructors were making use of reused objects within these, preferring to use the course environments supported by the systems primarily for dissemination of information about particular courses (xx, 2001). And although e-learning is becoming a much-discussed term in company settings, the majority of company training still takes place in classroom settings with no use of digital learning materials (Barron, 2000).
There have been many analyses of factors that influence use of digital learning resources which can also offer clues to the lack-of-reuse problem (Collis & Pals, 2000). One major barrier has been the instructor's perception that material created elsewhere does not fit well enough with the situation in his own instructional setting, with their own ways of working, the rest of their course materials, and the characteristics of their students. One response to this problem is to reduce the extent, or \textit{granularity}, of the potential reuse object, and also to make it instructionally neutral, so that the instructor can increase his likelihood of being able to embed it as a small nugget in his own learning setting (Schatz, 2000). For this to occur, it is likely that the instructor needs an electronic environment in which the reusable object will be embedded. In terms of this combination of embedding systems and objects to be embedded, it has been predicted that the future of educational software is now moving toward two sorts of products: (a) large, complex systems that can serve as management and delivery environments and which are linked to database environments; and (b) small units of electronic learning material that can be chosen from many different origins and combined together, as "beads on a string" in an order appropriate to the local context (Collis, 1998, 2000; Stephenson, 2000). Granularity refers to the size of the small units.

To realise such user-determined combinations of reusable objects within a course-management system supported by the institution involves many complex issues. There is much focus currently on standards and metadata. Singh (2000) claims that "Standards-based metadata tagging will be the linchpin that enables interoperability." There is not yet however an international consensus on which set of standards to use, although this is an area of intense research, debate, and commercial interest (as an example see Schatz, 2000).

What is missing in Singh's analysis as well as in most of the various international initiatives relating to standards and metadata is the overall "use in practice" aspect. Not only must reusable objects be available and findable, but the instructor or learner must be motivated to look for them, supported in making decisions about how to find them and integrate them into the rest of his learning experience, have easy-to-use tools that help him make this integration, usually within the course-management system in place in his institution. Finally, the reuse process must be part of an overall institutional strategy in order to develop the infrastructural support and critical mass of usage that will make reuse mainstreamable. We do not see much progress yet in this overall approach to reuse occurring in practice. We do not believe it is enough to focus primarily on standards and metadata in terms of the reuse problem. We believe that an integrated approach is necessary, such as shown in Figure 1.
In this paper, we approach the reuse issue in some new ways that are grounded in the strategies of the institution in which the reuse may occur. We suggest a new approach to pedagogy, a new view of the way the course itself is implemented in practice, and new approaches to an underlying database technology that supports not only courses but also other forms of learning in the institution. We also look toward a future where new scenarios ("Stretching the Mold" or "The New Economy") will come to steer the institutional learning setting in both universities and company training departments.

**New Pedagogy: Focus on Contribution Intended for Reuse**

What is a pedagogical aim that is highly related to re-use? Not one primarily related to finding content from elsewhere, but one with a strong orientation toward learning from experiences, from one's own and from those of others. We see a shift, away from an emphasis on learning as acquisition of predetermined content, toward a balance that includes or even emphasizes learning as participating and contributing to the learning experience in a way which can be captured and reused by others (Collis & Moonen, 2001; Sfard, 1998). The basis of this pedagogy is educational (see also for example, Kearsley & Shneiderman, 1998); however, it also is based on strategic and practical considerations. By an approach in which participants themselves contribute resources in a way that is intended for use by others during the course itself and at least in subsequent cycles of the course, a large collection of relevant resources is accumulated on an on-going basis based predominately on the work of the participants and thus less on the preliminary work of instructor or course designer, the
resources accumulated fit with the style and level of the participants (avoiding the "not invented here" problem), and in the company setting particularly, the tacit knowledge of the participants is made available to others. An important point is that the resources are not to be seen as professionally made, self-contained study materials; their use and reuse comes from the way the instructor or learner makes use of them as the basis for learning activities, reflection, and better understanding and application of concepts and processes.

How does this contribution-oriented pedagogy work in practice? We have been working in this direction for several years in our own university and now also are implementing the ideas in various company-training settings. The following steps (Table 1) are the ones we are using; each is based on a considerable amount of literature and experience (see Collis & Moonen, 2001; see also http://teletop.edte.utwente.nl).
Table 1. From content delivery to building on experience contributed primarily by participants

<table>
<thead>
<tr>
<th>Steps</th>
<th>Strategies and tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Start where instructors are at; extend their strongest skills so that learners who are not present can also take advantage of these skills.</td>
<td>1. Begin by extending an existing course, not &quot;creating&quot; or &quot;buying&quot; a &quot;Web-based course&quot;</td>
</tr>
<tr>
<td>2. Shift the focus from content to activities</td>
<td>2. Assume you can go on, for awhile at least, with the existing textbook or course reader; don't start by trying to put it &quot;on line&quot;. Focus instead on new forms of activities that will bring new resources into the course.</td>
</tr>
<tr>
<td>3. Plan activities around learner contribution, and learner (re)use of resources contributed from a variety of sources</td>
<td>3. Use a Web system that makes upload and download of resources easy, for both instructor and learners. Uploaded resources need to become objects in a database, indexed or managed on the fly to make them immediately available for re-use.</td>
</tr>
<tr>
<td>4. Plan activities so that learners who are present in a face-to-face session create a base set of resources, which can be built upon by learners who are not present.</td>
<td>4. Use a Web system linked to a database; write activity descriptions that involve building upon the inputs of others; commenting, synthesizing, adding to, comparing to one's own ideas, etc.</td>
</tr>
<tr>
<td>5. Gradually add more self-study content materials, but preferably based on the input of others in the organization.</td>
<td>5. Re-use good input; move toward an idea of a course site as a collection of resources, with the course focusing on structured use of and addition to those resources.</td>
</tr>
<tr>
<td>6. Make activities meaningful, and required.</td>
<td>6. Plan activities so that each participant's contribution is visible, valuable, and needed in order to continue with the learning activities. Activities are aimed at contributing to the learning resources, not individual practice exercises.</td>
</tr>
<tr>
<td>7. Assess via contributions</td>
<td>7. Assess the adequacy of course participation via what is submitted to the course Web environment. &quot;Passing&quot; a course is not a matter of only attending course sessions or completing an individual examination, but rather of showing one can relate to, build upon, and add to, learning-related resources.</td>
</tr>
<tr>
<td>8. Aim for contribution and flexibility, distance and time are not the key points.</td>
<td>8. With a contribution approach, learners can participate at locations of their choice and within certain time periods. The same learning resources can also be used for &quot;just in time&quot; and individual learning. Distance and time flexibility gradually and naturally increase.</td>
</tr>
<tr>
<td>9. Think of content as coming from a variety of sources.</td>
<td>9. Use the Web environment (based on a database) as a tool to bring together different views of a variety of content objects: those produced by professional instructional designers, those created by the instructor, those contributed by learners, and those documents found in house or on the Web which may not be created as &quot;learning objects&quot; at all.</td>
</tr>
<tr>
<td>10. Be less concerned about the &quot;perfection&quot; of the content objects and more concerned about the contribution and re-use processes</td>
<td>10. Be very careful about how activities are described, about what is expected in sub-tasks, about how to monitor progress, about how to bring in peer interaction, about how to evaluate and determine completion. Re-use model contributions.</td>
</tr>
</tbody>
</table>

Figure 2 shows how the building process of a course can occur as the course progresses, with on-going input from both the instructor and other participants. In this approach, the course environment grows with each learner.
For the products of such activities to be reusable as digital resources in other learning settings, the underlying database and system technology as well as the user interface must meet several requirements.

Technology Requirements

The technology required for support of this pedagogy requires an underlying object-oriented database. Gradually, an experience management architecture (Layton, 1999) will need to replace the now-familiar course management systems. Figure 3 shows the concepts of such an architecture, based on an object-oriented database.
Figure 3. Building on experience: Use of an object-oriented database to both acquire new contributions and also to offer different views and combinations previous submissions in different learning settings (De Boer, 2000)

Figure 3 shows a high-level abstraction, but for contribution-based reusability to grow in an institution, the technical tools and user interface functionalities are critical. First, there must be a simple way for participants (instructors and learners) to enter new resources into a common database. Figure 4 shows one of the templates we make directly available in the course environments running under our local TeleTOP course-management system.
At the moment that an object is thus submitted into the database, metadata based on SCORM standards can be automatically assigned for some of the SCORM fields. Figure 5 shows a metadata record created automatically for a submitted item.

Figure 5. Automatically generated basic metadata record associated with a submitted contribution

In the TeleTOP system, the submitted items can be directly made available to all course participants. Figure 6 shows a view of submitted contributions.

Figure 6. Submitted contributions, available for discussion or analysis by other course participants
The reuse of submitted contributions however is not automatic simply because the contributions are available to all in the course environment. Their reuse comes from the pedagogy used by the instructor. As an example, students can be asked to study one or more of the contributions of others in the current course or previous courses if available for reuse, and as the next assignment compare and contrast their own ideas with those of their classmates. Or, the instructor can select one or two submissions that can serve as good examples for the other students, and direct the students to compare their own work with those of the targeted submissions, perhaps filling in a checklist to indicate similarities and differences in their work and the targeted examples. This can shift part of the assessment task away from the instructor and onto the learners. There are many such possibilities (Collis & Moonen, 2001).

For the submitted objects to be reused outside of the immediate course context as well as within it, the instructor needs to make a selection of which materials are good candidates for reuse. For these selected objects, the instructor can then add a broader range of metadata to help in the later retrieval process. Figures 7 and 8 show fill-in forms associated with objects in the TeleTOP system, using the SCORM fields. In Figure 8, the "Submit" button is shown via which the user-selected metadata is added to the database.

![Figure 7. Metadata creation template](image)
Figure 8. Metadata creation template, ready for submission

Note that it is not every item submitted during the course which requires this attention; only the relatively select and small sample that the instructor sees as good candidates for reuse. Figure 9 shows the metadata document generated by the process.
Subsequent searches of the objects in the database to look for candidates for reuse are made via the metadata document forms, which are in turn related to the actual submitted objects and can facilitate their being copied into the next desired environment. A simple interface needs to be available to support the search process using any keywords on the metadata documents, and to facilitate the copying process, to move the items selected for reuse into a new course environment. Figure 10 shows a copy interface in the TeleTOP system.

[Allard, please find a good example]

[Allard, do you want to say something about XML exchange here??]

Through the combination of these sorts of technologies and pedagogies, and in the implementation context of a course as a activity and contribution-oriented setting, a number of the barriers limiting the potential reuse of digital resources can be addressed, particularly those that relate to fit with the local context and with the instructor's style of teaching. In a company setting, the reuse aspect brings a gradual increase in the sharing of in-house knowledge and experience. However, as indicated in Figure 1, the institution itself provides
the broader context in which reuse occurs. Without reuse having some relation to the strategies goals and vision of the institution, it is not likely that the infrastructure or culture will develop that will build a critical mass for reusability. What are some strategies for the institution that could provide a framework for reuse?

**Institutional Scenarios: Stretching the Mold or The New Economy?**

In a series of studies relating to the future of the university, we have recently identified two scenarios that are now emerging, and which could evolve as organisational bases for higher education and company training in the near future (Collis & Gommer, 2001a,b; Collis & Moonen, 2001). We call these the *Stretching the Mold* Scenario and *The New Economy* Scenario. For each, reusable digital learning objects, easily integrated with course environments, are key tools.

**Stretching the Mold Scenario**

The Stretching the Mold Scenario involves a gradual expansion of flexibility within the regular program of the institution or training centre. This expansion may involve more flexibility in terms of time and place in terms of participating in the program, more flexibility in terms of options in requirements for the program, and more flexibility in terms of requirements within specific courses. The institution continues basically as before, but with more and more flexibility in its regular course offerings. A critical tool in offering more and more options to the student in terms of a particular course or program is having a collection of resources that can be selected from, in order to offer an adaptation increasingly on-demand to the learner. Technology that can offer different views of a course environment to different types of learners, on demand or close to that, is necessary in order to allow the instructor to quickly choose from alternative examples or to reuse particular exercises or assignments or study resources in tailored situations.

**The New Economy**

The New Economy has a different organisational basis. In The New Economy, a shift has occurred away from the institution offering predetermined programmes and courses but in increasingly flexible ways, toward a situation where the learner as a client has more and more control over what he chooses, and even from where. Learners as customers will not only look for neutral information, but also for opportunities to learn from the experiences of others in a more personal way. Reusable objects that include not only content in different granularities
but also experience objects and through them, contact with others with pertinent experience will be in demand.

While Stretching the Mold is already underway in many universities, the New Economy is emerging more quickly in company training settings. It requires a different level of organization than Stretching the Mold, as well as different pedagogies and technologies. Table 2 compares the Stretching the Mold and the New Economy Scenarios in terms of various aspects particularly important to the learner.
Table 2. The learner perspective for the *Stretching the Mold* and *New Economy* scenarios (Collis & Gommer, 2001a)

<table>
<thead>
<tr>
<th>Learner activity</th>
<th>Stretching the Mold scenario</th>
<th>New Economy scenario: Same as Stretching the Mold, but also:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makes initial choice</td>
<td>Chooses an institution and programme, some variation of choice within programme</td>
<td>Chooses programme, course, module, other knowledge unit; may pick and mix among institutions</td>
</tr>
<tr>
<td>Requests tailoring within the initial choice</td>
<td>Requests, to the extent allowed by the institution, variations in programme requirements Requests flexibility within a course (to the extent the institution allows and the instructor agrees)</td>
<td>Client or employer on behalf of group of clients requests options within a module or other knowledge unit (to the extent the institution allows and the instructor agrees) Via “Beads and String” approach (Stephenson, 2000) mentor, learner or instructor may string together different knowledge units, even from different institutions, to suit the learner's needs</td>
</tr>
<tr>
<td>Manages the costs</td>
<td>Generally pays a fixed fee per full-time enrollment, to the home institution; (fee generally paid by government or employer, or in many non-European countries, paid by the learner himself)</td>
<td>Pays by knowledge unit or negotiated mix, with vouchers or personally or via employer</td>
</tr>
<tr>
<td>Expects accreditation</td>
<td>Earns accreditation by following the structure of the home institution (a pre-set number of credit units or study points needed to receive degree. Some flexibility allowed by the home institution)</td>
<td>May not be oriented toward a pre-specified degree, but rather just-in-time learning; validation of the learning comes from being able to use it in one's problem setting. May negotiate for degree-level or certificate-oriented recognition of accumulated competencies May shop around via the Internet until finding a base institution that will be flexible enough to meet his needs with respect to accreditation</td>
</tr>
<tr>
<td>Learns via some sort of instructional pattern</td>
<td>Accepts the pattern organised around the schedule of the institution (lectures and examinations on certain days set by the institution) although occasionally requests exceptions to this pattern; Accepts the instructional approach used within the course which is generally determined by the instructor,</td>
<td>Chooses either a pre-set instructional pattern or selects a combination of knowledge units from a combination of institutions and brokers to fit his wishes about instructional approach (i.e., may prefer problem-oriented learning, so shops around until he finds a problem-learning approach for the content he desires)</td>
</tr>
<tr>
<td>Expects the institution and instructor to offer:</td>
<td>Flexibility support within the course, can involve re-usable knowledge objects</td>
<td>Re-usable knowledge objects and tools to &quot;string&quot; the knowledge objects together</td>
</tr>
</tbody>
</table>

A key point of difference is in the degree to which the institution pre-determines a programme of study and of courses for the learner compared to the extent to which the learner can herself identify and select various combinations of learning experiences. Is the institution organised around programmes and courses which it offers in increasingly flexible ways; or is the
institution organised like a library, department store, or cafeteria, in which basic knowledge units can be selected, mixed or matched to the client's needs? We can contrast these as a programme-based approach and a knowledge-unit based approach. In a knowledge-unit approach, a client may wish to select a full course or programme, but may also wish to order an adaptation of a course or a portion of a course, or even a finer granularity. (Perhaps a one-hour consultation with an expert?). Although many of the reusable objects will originate in a learning context (i.e., made for a course setting), an increasing number of them will come directly from the experience base of the institution itself, and from sources outside the institution, such as via professional portal sites on the Web. Reusable objects will be increasingly valuable in Stretching the Mold, and essential in The New Economy.

**Technology Requirements and Architectures**

In both scenarios, resources of different granularities will come into the database, from different origins and of different data types. There are substantial implications for the organisation of the database in these sorts of fluid conditions. The indexing of a dynamic flow of (multimedia) objects into the database as well the management of access privileges per knowledge unit will be major challenges. When costing and use tracking needs to be associated with reusable object, the complexity increases even more.

The need for learners to organise and manage their own learning and learning activities will grow rapidly in both scenarios but particularly in The New Economy. The capacity for personalisation of Web-based portals has only begun. There is a rapid evolution occurring from bookmark collections to agent-maintained knowledge collections (Jensen, 2000). Tools to organise, visualise and share knowledge will be useful in the Stretching the Mold scenario and almost necessary in the New Economy scenario. These sorts of tools can help users (instructors seeking items for re-use and learners or their counselors seeking appropriate knowledge/experience units) to move through large datasets in a way that is tailored to the user's own approach to combining concepts. Learners will be able in the future to design new combinations of learning resources or knowledge units using such tools and "order" their combinations directly via the tools. Agent technology will become increasingly powerful, to remember the knowledge-related profiles of the learner and manage knowledge collections accordingly. The interfaces provided by the tools will have to link to the information systems of the institutions providing knowledge-unit services.

To anticipate the New Economy scenario as well as to optimise the Stretching the Mold scenario, various user requirements can be identified for which integrated tools and
functionalities to meet those requirements will be needed (see for example, Hochstettler, McFarland, Martin, & Watters, 2000). In Table 2 a mapping is made between various user needs in the New Economy scenario and technology requirements. Some of the user needs and also present in the Stretching the Mold scenario.

Table 2. User requirements, tools and functionalities for the New Economy scenario (Collis & Moonen, 2001, p. 209; Collis & Gommer, 2001b)

<table>
<thead>
<tr>
<th>User actions and requirements</th>
<th>Technology requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access &amp; privileges</strong>: A professional community shares access to a common database or interconnected distributed databases and evolves a procedure for certain categories of resources into the database for communal use.</td>
<td>Privileges for distributed users, allowing differentiated read and write access</td>
</tr>
<tr>
<td><strong>Entry &amp; labeling of objects</strong>: When entering a resource into the shared database, a simple to use check-list process allows the addition of metadata tags to the resource. The least number of tags for use in practice is the goal as instructors will not take the time to make more than a few key indications.</td>
<td>Granularity will be expressed in terms of what can be entered as a single file or linked to from a single-view overview. Tools for users to easily add or adapt metadata tags and add new ones if necessary must be available. Views of the objects in the database selected around any given set of tags or other key categories can be called up in which the associated objects can be listed in terms of frequency of access. Rules can move objects to an archival status after a designated period of non-access.</td>
</tr>
<tr>
<td><strong>Instructor support</strong>: To create a course-support environment, tools are present in the system leading the instructor through the steps in setting up a course environment, in terms of general organisational features, communication features, a device such as the TeleTOP Roster which presents an integrated overview of study materials and activity instructions and support, groupware features, resource-management features, and special features such as quiz tools. This is also needed for Stretching the Mold.</td>
<td>The course-management system should be integrated with an instructor-support tool to lead the instructor through options associated with the organisation of his course. The tool should directly generate a new database associated with the underlying database.</td>
</tr>
<tr>
<td><strong>Re-use tools</strong>: The instructor should be able to sort and choose from resources from the associated database (the general database and other databases created in relation to this) and copy whatever resources she wishes to the new site and also move the objects from a completed version of the course that she wants to re-use in other settings back to the main database. This is also needed for Stretching the Mold.</td>
<td>A sort and copy tool relating to all databases to which the user has access is needed to facilitate the copying of resources. Copying allows new privileges to be assigned to the resources, privileges that may be different in different data bases.</td>
</tr>
<tr>
<td><strong>Learner-contribution tools</strong>: Learners studying with the new course environment not only use the selected resources provided by the instructor (both from other courses or from non-course related sources) but also enter new resources into the course database. The instructor can indicate with a simple click which of these learner-contributed resources are candidates for re-use and thus transfer to the master database or to a</td>
<td>The system must handle student submissions as ordinary objects, and should provide a tool for the instructor to easily designate which student submissions should be copied for possible re-use.</td>
</tr>
</tbody>
</table>
new copy of the course database adapted for a different learner population. This may also be desirable for Stretching the Mold.

**View options:** Different views of the database can identify different categories of objects, different patterns and dates of access, and different authors, among other possibilities. Members of the community can also attach comments and rating codes to objects. This is also needed for Stretching the Mold.

The system should allow user-tailored views and the adding of notes or additional codes to objects. Tools such as concept-mapping tools can show different clusters and categories.

**Ownership:** The knowledge community itself decides on procedures for maintenance of the database, for updating categories, and assigning read and write privileges.

Tools in the shared workspace should support these activities.

All of the technology tools identified in Table 2 are already emerging but there is much to be done before they can be used to scale-up a Stretching the Mold or New Economy scenario to rollout use. Ongoing accumulation and reuse of digital resources, directly integrated with Web-based course environments that are in regular use by instructors (or course managers, in The New Economy Scenario) as well as learners are key features. A process by which a critical mass of usage, reusable objects, and reusage occurs requires the integration of new pedagogies, technologies, implementation strategies, and institutional commitment.

**References**


Collis, B. (2000, 21 January). *Getting larger, getting smaller: The future of educational software.* Keynote presentation while assuming the IBM International Chair in Computer Science, Faculty of Science, University of Gent, Belgium.


De Boer, W. F. (2000). *Decision support for e-learning flexibility and enrichment.* Internal report, Faculty of Educational Science and Technology, University of Twente, Enschede, NL.


