



Learning Object Economies: Barriers and Drivers

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Abstract

The massive development required to achieve the goals of governments and educators - support for lifelong learning; enough variety to allow anyone to choose material that suits their learning style; comprehensive access to all subjects domains to eliminate the need for proximity to dedicated teachers - requires the reuse and sharing of educational resources.

Reuse and sharing of learning objects is held by some to be difficult (e.g. Downes, 2003 states that "learning design and reusability are incompatible") and by others to be the only sustainable route (e.g. Littlejohn, 2003). This paper examines the barriers to reuse and sharing of learning objects with historical evidence based on projects such as the Education Object Economy (EOE) and the Scottish Electronic Staff Development Library (Campbell et al, 2001) to identify the barriers and drivers that impede or encourage progress towards learning object economies.

Learning object economies are marketplaces for the sharing and reuse of learning objects. The currency of these marketplaces may or may not be cash, but normal market economics is only one of many factors influencing the learning object economies. Other factors are personal - willingness to share, ownership, copyright, accessibility, incentive; technical - interoperability, granularity, configurability; societal - kudos, not-invented-here, cost-benefit; international - language, culture; pedagogical - context v neutrality, activity v content.

This paper examines trends in these barriers and drivers and concludes that, while problems still have to be overcome, learning object economies are closer to a thriving reality now than ever before. The paper concludes by examining the community aspects of learning object economies to identify the scale and membership issues that will produce learning object economies with greater or lesser success.

Introduction

In a Boulder bar, on a warm July evening in 1993, a group of meteorology trainers attending a conference speculated that they could all benefit if they could share images on a global basis using the newly prevalent CD-ROM drives. Before their next conference they had produced a CD that was simply a collection of images and other resources with details of who had provided them and the conditions under which they could be used. This CD, containing over 6000 images, contributed from more than 10 countries, was an early example of a learning object economy based on reciprocity (Campbell, 2003) – the benefit for everyone was much greater than the contribution. Technology enabled this development but a need for resources for training was the primary driver. The number of requests still received for this CD shows that this need is ever-present.

In the ten years since the “Images of Meteorology” CD was conceived (Duncan, 1993) there have been many attempts to share and reuse resources for education and training¹. As these resources have come to be described as “learning objects” the various models for sharing have become known as “learning object economies” (Richards, 2002; Johnson, 2003; Wiley, 2000). The objective of this paper is to review learning object economies of the past, examine the issues that led to their success or failure, formulate principles for successful promotion of learning object economies and highlight some recent major new developments.

Some examples

Although it could be argued that learning object economies and the technologies that support them are still at an early stage of development there have been a number of examples from which lessons can be learned. Several examples are described below. They are not comprehensive but have been included to illustrate different issues arising from each and contributing to a pool of lessons learned.

- Java Gamelan: One of the earliest repositories for sharing objects using web technology was Gamelan established in 1995. This repository of Java applets was not specifically focussed on education but many of its objects were educational. People contributed applets and the number of useful objects grew rapidly. On the other hand, once there were several hundred objects available the rate of growth diminished. This raises the issue of *motivation*. When Java was a new technology, Gamelan offered a “shop window” for people to demonstrate what they could do. As more objects were created and Java programmers become more numerous it was increasingly difficult to gain credit through contributing to Gamelan. The Gamelan site still exists but it has moved from acting as a repository to a community resource base.
- Education Object Economy: An early learning object repository was established by EOE, the Education Object Economy. In fact this went further than trying to establish a repository and offered a model for many similar repositories based on its Generic Object Economy. The EOE recognised the need for metadata to describe the objects although at the time there was no recognised standard for this metadata. The EOE suffered some of the same fate as Gamelan. After an early rapid growth it reached stability but failed to establish itself as first choice for people seeking learning resources. A difficulty common to EOE and many similar repositories is that learning objects are *integral* and cannot be broken into their component parts and modified.
- Scottish Electronic Staff Development Library: SeSDL developed between 1999 and 2001 as a means of sharing staff development resources between universities in Scotland (Campbell et al., 2001). At an early stage there was tension between partners about the basis of sharing. Large institutions considered they would gain little from the contributions of smaller institutions so the partnership was unequal. Some contributors insisted that their learning objects should be used only in their complete form and that they could not be broken into smaller parts and used in different contexts. A few institutions regarded some activities of universities to be

¹ An appendix lists several examples of projects and activities supporting sharing and reuse of resources

more commercial than others; there was resistance to one university using resources from another as part of a course run for external fee-paying participants. All of these are different aspects of *intellectual property rights or digital rights management*. SeSDL was one of the first learning object repositories to adopt international standards for the metadata used to describe the learning objects (IMS Metadata Specification, 2000). Substantial benefits are gained from the detailed educational metadata, including the ability to search for learning objects on the basis of the type of educational resource, or the context in which it might be used or the level of education for which it is intended. However, these benefits can only be realised if the quality and consistency of learning object metadata are high. A study by Currier et al. (2004), based in part on experiences in SeSDL, has highlighted the need for both educational and librarian expertise in creating high quality metadata. *Metadata creation* is often seen as a barrier to learning object economies as it requires effort and expertise with little or no reward.

- MERLOT: The Multimedia Educational Resources for Learning and Online Teaching repository tackled several of the issues that arose in earlier systems. In particular it considered *quality assurance*. It is problematic to assign a quality rating to an object because a good learning resource can be used in a bad context. However, MERLOT encourages not only a “star” rating but also comments which can allow people to expand on their views of an object. In terms of freely accessible repositories of learning resources MERLOT is very successful with nearly 10,000 objects². This success raises issues over how to find the right resource among so many. *Browsing and searching* must be very effective and must be in tune with user’s view of their subject. MERLOT has seven basic categories: arts; business; education; humanities; mathematics; science and technology; social science. Each of these categories has another layer of sub-categories. When browsing through these sub-categories it is common to encounter twenty or more objects in a single category. MERLOT is growing steadily, at the rate of 94 new objects in the past 30 days at the time of writing. At that rate it will take another eight years to double in size so it can be considered stable.
- Careo: The Campus Alberta Repository of Educational Objects has a similar model to MERLOT and with similar success. It has nearly 4000 objects organised into six subject domains similar to those of MERLOT. Careo takes peer review one stage further by supporting discussion forums attached to each object. Both Careo and MERLOT are catalogues rather than repositories. They hold metadata describing learning objects but the objects themselves are held elsewhere. Usually the learning objects are on their own web sites. Sometimes it might be difficult to move these objects to other locations and often educators will not have the technical ability to extract all the dependent files associated with a learning object. Packaging an object so that it can be moved and reused is an additional barrier which requires a degree of re-engineering for *portability*. In addition the catalogue has no control over the location of the objects described so changes in location are difficult to track and long-term *persistence* cannot be guaranteed.

Major Issues

The issues highlighted by these examples can be grouped under five headings: personal; societal; technical; pedagogical; international. In this section the issues are defined and in the next section these issues are addressed and solutions to problems considered.

Personal

Developing learning objects requires considerable creative endeavour and those involved deserve credit for their work. Most people are content to have recognition of their ownership and do not seek financial rewards. The primary issue is therefore *recognition*. This also affects the way learning objects are created. Sometimes authors of learning objects will avoid using material from others because they are unsure of the copyright on the material. Learning

² at the end of 2003

objects are often aggregates of material from a number of sources so backward and forward management of rights can hinder development: backwards - clearing all copyright of material used; forwards - ensuring that all copyright is passed on in the event that this learning object becomes part of an aggregation in future.

Another personal aspect of learning object economies is the *motivation or incentive* to take part. The economy involves both contributors and users. People may often take both roles at different times. In fact this is the basis of the “reciprocity” model. If everyone is a contributor of a few learning objects, and there are many contributors, they will have access to a huge collection of objects. This is the basis of many systems, including MERLOT and the Education Object Economy, but there is little evidence that the reciprocity model is scalable to very large numbers of objects (Campbell, 2003). There is an overhead in terms of the effort to contribute objects and create metadata so the incentive must be sufficient to overcome this overhead. Motivation may also come from societal influences which are discussed in the next section.

Societal

Learning object economies involve communities, they are of no use to solitary individuals (Wenger, 1998). Communities can be defined in many ways: single organisation (e.g. all staff in one university); subject-focused (e.g. staff in different universities teaching the same subject); formal multi-organisation (e.g. an international federation of national organisations with a common purpose); self-defining (e.g. individuals who share a common purpose but cross organisational and international boundaries). What motivates people to work together – their conditions of employment; unwillingness to let down others in the community; enhancement of reputation? But there are also a number of factors which mitigate against sharing – the “not-invented-here” syndrome; a view of others as “competitors”; an unwillingness to expose to other experts what has previously only been exposed to students.

Another aspect of learning object repositories that determines how they are used by the community is the “critical mass” of objects (Calverley and Shephard, 2003). More work is needed to define critical mass as the level at which a repository is sufficiently well populated to encourage community members to visit regularly.

Technical

When multiple organisations are involved there are also likely to be different technologies in use and incompatibilities between systems may prevent sharing and reuse of learning objects. In fact such constraints can also exist within single organisations, particularly when they are large. Technical interoperability is fundamental to reusing material. While the material is simple (e.g. documents, images, video clips) common file formats form a well-tested bridge between different technologies. However, aggregated learning objects are much more complex and include structure, possibly multiple paths through the material, and even material in different resolutions or formats for delivery on different devices or to increase accessibility for those with disabilities.

There are at least two major technological, or design, barriers to reuse: granularity and editability.

- **Granularity:** Several authors have suggested that there is an inverse relationship between the reusability of an object and its size. Large complex learning objects, for example a whole course, are usable in only a limited set of circumstances, for example, where students have taken the same pre-requisite courses and the curricula are the same. On the other hand if the course is divided into modules, and the modules into lessons, and the lessons into activities and the activities include media assets, then the media assets can be reused in many other contexts, while the activities can be used in slightly fewer, and so on. This is not to say that only small objects can ever be exchanged in a learning object economy. Rather it is a requirement that the user of a large and complex object can easily break it into its component parts and use the best, perhaps combined with other parts from other sources. This overcomes the barrier of integral, indivisible learning objects.
- **Editability:** Where does granularity end? It has been argued (Boyle, 2003) that a document is composed of words and these words are constructed from letters. Similarly an animation is a sequence of images and each image is an array of pixels.

If a learning object is editable there is no end to granularity. It is possible to change any aspect of a learning object if it is available in a suitable form. However in many cases the form is not suitable for editing, for example, a PDF file rather than a Word document, a JPEG image rather than a multilayer Photoshop file, a Flash .SWF file rather than an editable Flash .FLA file. When a learning object, or its component, is editable then it can be reused as the basis for a slightly different learning object.

Pedagogical

Context in learning objects inhibits reuse. Yet context in education is essential. How can these conflicts be resolved? If a learning object contains material that places it in a particular context, for example, “in the last section we showed...”, “this follows on from last year’s experiment on lasers”, “more information is available in the textbook on pages 234-245”, then that learning object is not reusable. With careful design it is possible to create material by combining reusable learning objects with context-setting elements. Any good teaching will normally contain both. In fact it would be very difficult to create a lesson just by joining together a set of reusable learning objects with no context to stitch them together and maintain a thread. So, designing learning objects for reuse means designing learning objects without context. In the case of large learning objects, some context may be provided even by the navigation sequence. To maximise reusability, navigation should be separated from the learning objects.

A teacher can use context-free learning objects in many different pedagogical scenarios. However, the choice of pedagogical approach should not only be in the hands of the teacher – it could be selectable by the student. Granular learning resources can be used in many different ways. It is common for textbooks to use an information-based approach, presenting theory and then applying it, while courses often use a problem-based approach. At the same time students often use a revision mode which is dictated by the assessment method. It is possible to use the same resources in several different modes and to allow the student to select the mode at the time of study.

As the learning object approach to e-learning has developed the emphasis on content has reduced. Learning is not achieved through “delivering” content but through a series of learning activities, some of which will involve content but others will not. Learning design involves creating sequences of learning activities and these learning designs are themselves reusable learning objects.

International

Differences in language and culture continue to present a barrier. If learning objects are constructed according to the principles of editability described above then translation and localisation become possible. However, locating suitable learning objects to translate and localise, when those objects are described using metadata in a foreign language, will always be difficult. The learning object metadata standards now support multilingual metadata and a single learning object can be referred to by many metadata records. These developments with others defined in a later section will help overcome internationalisation barriers.

Addressing the Issues

The major issues identified in the previous sections have, for some time, presented barriers to the development of learning object economies. Some of these barriers have been effectively removed, such as peer review improving quality assurance in MERLOT and Careo, and the reward is a more vigorous exchange of learning objects. The following table highlights the issues and the emerging solutions.

Recognition	Ensuring people obtain credit for their work in a non-commercial, sharing environment is the driving force behind the Creative Commons (2003) initiative. This offers a simple selectable set of conditions of use without resort to individual legal agreements (Gadd et al., 2003a, 2003b). In a mixed economy where some learning objects are produced commercially while others are shared non-commercially, digital rights expression languages can ensure that the rights associated with each learning object, even individual elements within
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	an aggregated object, can be asserted. International standards are under development for digital rights languages (IEEE, 2003; CEN/ISSS, 2003)
Motivation	The reciprocity model will not be sufficient to motivate everyone. Several other models are currently being tested. These include subscription models in which organisations pay a membership fee but choose to use learning objects as and when they wish. Subscription models are suitable for users of learning objects but they do not provide motivation to contribute objects. Other models include returning a share of the subscription to those who make the largest number of contributions. However, this does not take into account the quality of the contributions so an improved model is one in which the reward for a contribution is based on its value to others, measured by its subsequent use. Some organisations now make it a condition of funding that learning objects produced should be shared through a learning object repository. With the increasing use of peer review it may be possible to enhance academic reputations through the publication of high-quality learning objects, mirroring what already happens with research publications.
Interoperability	Interoperability offers the ability to move learning objects from one system to another. Specifications developed by IMS (2003) and adopted by ADL SCORM (2003) have made interoperability a reality. Tools for creating learning objects from suppliers such as Microsoft and Macromedia produce learning objects that can be stored and shared in repositories such as that produced by Intrallect then included in virtual learning environments such as Blackboard and WebCT. Interoperability now includes a wide range of assessment questions, conditional sequences and learning activities.
Granularity	The IMS content packaging specification has been widely adopted for creating complex learning objects and tools to handle these packages are now widespread. There is every expectation that objects can now be exchanged at any level of granularity and the objects can be disaggregated and rebuilt at will.
Editability	There has never been a technological barrier to editability but there is an overhead in providing files in more than one format. The IMS content packaging specification makes it simple to include editable as well as deliverable versions of files. It is open to question whether people will take advantage of this facility to make life easier for the reusers of learning objects.
Including context	The recent development of specifications for learning designs based more on learning activities than content enables more varied pedagogical approaches and simple methods of incorporating reusable learning objects into the context of specific lessons.

Recent and Future Developments

Previous sections have equated the learning object economy for a particular community with the repository they use to support exchange of objects. In fact the average working environment is much more complex and each individual may play several roles in that environment.

Repositories for learning objects may exist for departments, or for entire institutions. There may be national repositories for collections of national importance and subject-based repositories which cross institutional or national boundaries. While such an array of repositories allows learning objects to be stored in appropriate locations so that the communities they serve can locate them, there needs to be a simple search mechanism that does not depend on knowing which learning objects are in which repositories.

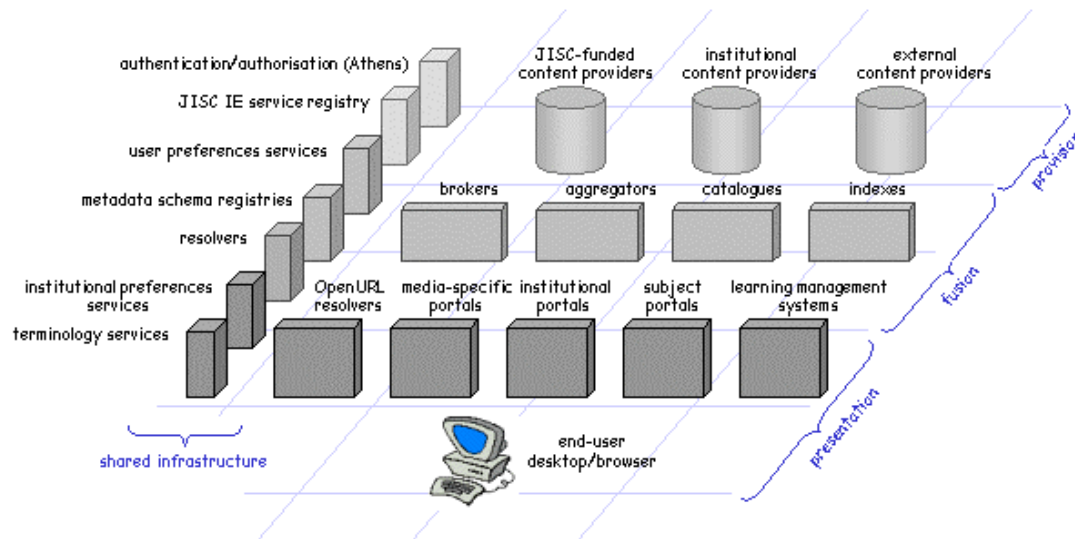


Figure 1: JISC Information Environment (from Powell, 2003)

A good example of this type of environment is the JISC³ information environment. Figure 1 (Powell, 2003) shows a set of distributed content provision repositories but between these and the user are a fusion layer and a presentation layer. The repositories expose their metadata using standards such as OAI-PMH (2003). The elements in the fusion layer gather the metadata and present it to the various portals in the presentation layer. This architecture is based on the ability of all the components to expose and recognise learning object metadata.

One of the JISC-funded content providers will be the JISC National Repository for learning objects. A requirements analysis for this national repository was recently completed and some of the recommendations for the system architecture and its relationship to the JISC Information Environment are:

- The transfer of learning objects between repository and other environments should be effected by use of the IMS Content Packaging specification
- The system should support a collaborative approach in deposit of learning objects
- The system should provide user-friendly mechanisms for input of metadata on deposit
- The system should provide support for copyright/legal clearance stage on deposit
- An OAI-PMH interface should be implemented by the repository
- The system should provide a mechanism for creating Globally Unique Identifiers (GUIDs)
- The system should support annotations by users
- The system should support disaggregation of deposited content packages
- The system should support automation of metadata as far as possible
- The system should have platform independence for client interface

Full details of the requirements for this national repository, prepared by the JORUM⁴ project team, are available from JISC⁵.

These requirements show that learning object repositories are moving beyond proving that they work and that they can sustain communities but that they can also be integrated into a fully distributed information environment.

Conclusion: Foundations of Successful Learning Object Economies

³ Joint Information Systems Committee of the UK higher and further education sector

⁴ www.jorum.ac.uk

⁵ www.jisc.ac.uk

The story at the beginning of this paper was based on the emergence of standards, the MPC⁶ specification enabled PC manufacturers to equip all machines with a standard CD-ROM drive. Standards and specifications are often at the heart of large-scale developments because they support sharing across many organisations, continents and technology platforms. One of the keys to a successful learning object economy is the adoption of international standards.

However necessary standards are, they are not sufficient. The scaffolding of a learning object economy is that learning objects use international specifications for metadata and packaging, but the foundation of the economy is the community which it serves. The people who participate in exchanging and using learning objects must be able, willing and happy to participate. Their rights must be protected, their jobs made easier, and their careers enhanced through use of the learning object economy.

For communities to work together they often need to agree how to use standards. Although IEEE Learning Object Metadata is an international standard there is a need for communities to agree on how to use metadata. This includes vocabularies, classification systems and common use of identifiers to gain maximum advantage. Examples of agreement in educational communities have led to UK LOM Core and CANCore.

Example Repositories mentioned in the text

Java Gamelan

Originally at www.gamelan.com but now at www.developer.com/java

CAREO (Campus Alberta Repository of Educational Objects)

<http://www.careo.org/>

Scottish electronic Staff Development Library

<http://www.sesdl.scotcit.ac.uk/>

MERLOT (Multimedia Educational Resources for Learning and Online Teaching)

<http://www.merlot.org/>

EOE (Education Object Economy)

<http://www.eoe.org/>

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⁶ Multimedia PC: a specification agreed by a number of computer manufacturers in 1992

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