The Language of Flexible Reuse
Reuse, Portability and Interoperability of Learning Content

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Abstract
This paper discusses two approaches to the reuse of learning materials. The first approach is a familiar one, it uses chunks of content that are described through metadata. The metadata should afford their reuse by detailing the conditions of their deployment. This approach, I contend, is not satisfactory and will ultimately fail to elicit actual reuse. The second approach is relatively new, it builds on recently developed pedagogical meta-languages with which the pedagogical inner-structure of learning objects may be described. Through the use of such languages, one of which is described in some detail, actual reuse may be brought about.

Keywords: flexible reuse of content, learning object, interoperability, educational modelling language, EML, metadata, pedagogy, didactic scenario.

1 Introduction
Over the last few decades the demand for higher education has diversified considerably. The demand for initial higher education for adolescents is centuries old. However, since roughly the sixties of the previous century, we’ve witnessed a growing demand for higher education for adults. Initially, this demand was rather traditional in that its focus was on degree programmes. The advent of the knowledge economy has added to this the demand for short programmes which primarily aim at fulfilling the students’ educational needs. This type of education goes by such names as further education, continuous education, life long learning, etc. (Brown and Duguid, 2002; Westera and Sloep, 2001). In virtue of the initial education’s orientation on academic curricula with fixed degree programmes, its programmes are rather homogeneous and mainly teacher led. This contrasts strongly with the needs of further education, with its emphasis on personalised arrangements offered in a setting of the student’s own choice. The further education student has very particular needs in terms of the subject matter. He or she will want a highly specific slice of subject matter, one that exactly fits his or her needs at that particular time. In addition to this, some students may prefer to be taught in a face to face setting while others may go for the relaxed space and time constraints that distance teaching affords; some students may prefer to study individually, shunning contacts with their study-mates, others might rather do collaborative work; some students may want modern pedagogies such as problem based, case based, or simulation based learning, others may simply want to be told – orally or in print - what there is to know. And obviously all these preferences – both in terms of subject matter and pedagogy - mix happily. The upshot is that modern educational institutions which want to satisfy the needs of all students, are required to offer a veritable smorgasbord of options.

The crucial question now is: Can educational institutions meet the modern student’s needs affordably? For although customised learning, as one may call it, may strike us as the best solution, it comes at a price. Although traditional, cohort based classroom teaching may offer little flexibility, it has proven to be affordable. Its
development costs are typically low and as long as the staff to student ratio stays low, delivery costs remain in tune with tuition. If, however, one intends to meet the specific needs of each and every student, this argument looses its validity. There are no cohorts anymore, so classroom teaching, which is based on cohorts, becomes impossible. Or, if groups of students with similar needs and schedules can be put together after all, the staff to student ratio will in all likelihood be very high; this increases the tuition considerably. Traditional distance teaching has always tried to overcome this problem by investing in the development of learning materials that are suitable for (guided) self-study and offering only emergency tutoring. This does indeed meet the students’ needs for flexibility in time, pace and place of study; it also meets the affordability criterion provided there are enough students, but it does not allow for customised content nor customised pedagogies.

E-learning – roughly, the use of networked computers in support of education - has often been greeted as the solution to all these problems. Particularly the flexible reuse of educational materials (‘content’) is a cornerstone to this argument. The slogan is: ‘write once, use many times’. A term often used in this context is the learning object, a piece of educational material that may be reused in various educational contexts (cf. Wiley, 2002). Although the development costs of learning objects may be high - as in traditional distance teaching - through reuse their cost per student can become low (Sloep and Schlusmans, 2001) Thus, the argument goes, tailored content, built out of a collection of learning objects may be developed quickly and efficiently; and consequently, e-learning lowers the costs to such an extent that the modern, further education seeking student’s needs and wishes may be met in an affordable way.

In this paper I shall critically evaluate this line of reasoning. Under the heading ‘the information technological angle’ I shall discuss in some detail the current use of learning objects and show it to be wanting (Section 2). My argument will be that the use of learning object may in principle offer much flexibility in creating content, in practice it will not, particularly since it does not support pedagogical flexibility. Then I’ll offer an alternative view, dubbed ‘the education technological view’. This redefines the concept of a learning object. The newly defined learning objects, I will show indeed capable of fulfilling all the needs of customised learning, both the need for custom content and the need for custom pedagogies (Section 3). A summary of the argument will conclude the paper (Section 4).

2 The information technological approach and why it fails

2.1 What is it about?

This perspective, which is for example with much force espoused by the Advanced Distributed Learning Initiative¹, holds that learning objects should be durable across technological change, interoperable across hardware and software platforms (e.g. web browsers), accessible when needed from remote locations, and reusable across applications and contexts. As the terminology reveals, it is very much a hardware and software orientated perspective. According to it, learning objects consist of (collections of) computer files: text files, graphics files, video and audio files, etc. An instructional designer may deploy as he or she seems fit. Typically, designers use authoring tools to create them. A managed learning environment (MLE) or learning management system (LMS) will serve them to students in order to create actual educational experiences.

¹ ADL <http://www.adlscorm.org/> is an initiative sponsored by among others the US Departments of Defense and Labor. It is best known for its Sharable Content Reference Model (SCORM), which is currently in version 1.2. The information referred to derives from the SCORM v1.2 Overview document, pp. 21, 29.
If everybody were to store its learning objects in a simple, local file structure the objects can hardly be reused by other systems or adapted by other designers. Local storage prevents access by non-local systems, the simple file structure prevents the files from being discovered for anything but the smallest content collections. And of course, the benefits from flexible reuse become the more apparent, the larger the collection of objects. For this reason currently so called digital repositories are being established. They may provisionally be described as databases for educational materials. To add to the discoverability of the learning objects (files) in the database, the objects are described with the aid of metadata. To this aim, over the last five years a collaborative project of a number of international parties has put together the learning object metadata specification, LOM for short, which at the time of this writing is about to become an international standard. The LOM allows one to describe such items as the title, language, copyrights and author, but also educational variables like difficulty, interaction type, typical learning time, and typical age range. Software is also being developed to ease the filling out of the various LOM fields and to upload the files to the digital repository.

Furthermore, learning objects preferably aren’t uploaded as plain files but in the form of so called content packages. A content package contains not only the physical files themselves, but also their metadata descriptions, and an indication of the way they cohere (‘organization’, comparable to a book’s table of contents). The IMS consortium has put together a specification that details what content packages should look like. A content package thus is a complex learning object, with metadata and an organization to describe their intended use. The files in the package may themselves be named; in SCORM, for example, they are called SCOs (Sharable Content Objects) and assets.

Since this kind of learning objects are treated as computer files that happen to contain educational materials, they pose little challenge to the current state of information technology. Obviously, the details have to be worked out of how content packages may be swapped. Adequate software tools (repositories, metadata descriptors, content packagers, managed learning environment) have to be created. And the standards that these tools employ (such as content packaging and learning object metadata) have to be worked out, perhaps localised, and agreed upon. But this is a matter of time, not of technological innovation. To give an example, since the information technological approach pivots on swapping files, it does not make highly specific demands on the MLEs that have to serve up these files. Present generation MLEs or LMSs almost without exception use browser technologies on the

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3 Version 6.4, which is a stable version, is at the time of this writing under ballot. See the site of the IEEE Learning Technology Standards Committee (IEEE LTSC) <http://ltsc.ieee.org/wg12/index.html> for details.

4 The IMS consortium <http://www.imsproject.org> was founded by Educause and draws its membership from universities, vendors of learning software, publishers, etc. At the time of this writing, the Content Packaging Specification is in version 1.2 and no immediate updates are foreseen (see <http://www.imsproject.org./content/packaging/index.html>).

5 *ibid.* p.31

6 Localising is relevant for all specifications but particularly the LOM. It encompasses not just the translation to a local language of the labels use (e.g. ‘author’ to the Dutch ‘auteur’), but also and much more importantly the creation of vocabularies and taxonomies for the fields’ contents. Thus the American category ‘K12’ does not translate to any equivalent category in the Dutch educational system.
client side and employ the help of standard plug-ins to render non-html file formats (rtf, ppt, flash, etc.). There is nothing of a specific educational nature here. From an educational point of view the information technological approach to the reuse of educational materials is one of changing a book or paper based ‘learning object’ economy into a computer and internet based economy. The changes may even be big and sometimes even hard to swallow for the educational establishment, they certainly aren’t revolutionary.

So the principles of file based flexible reuse of content seem to be firmly in place. Content in the form of packaged learning objects, may be swapped between software systems. Hence the interoperability of software systems – the term that is used to describe the ability of software systems to exchange content seamlessly – seems to be at arm’s length. Or is it?

2.2 Why does it fail?

The learning technology world is currently in the middle of the implementation of the information technological approach. Vendors of e-learning software abound and bodies like IMS, CEN/ISSS etc., which draft specifications for learning technologies, thrive. So any judgement on the approach’s true merits can only be provisional: it still has to show what it is really able to achieve. In my opinion, the signs aren’t good. Admittedly, the available empirical evidence I have is far from solid. Little to no systematic research into actual reuse has been conducted. And how could it, in light of the fact that the entire approach is new and implementation projects have just been started. In part, then, my evidence derives from similar ill-boding impressions of others personally communicated to me. For another part, it is based on my own inspection of available repositories. But apart from evidence based arguments, there are a priori arguments why the information technological approach is unsatisfactory.

Content viewed the information technological way consists of mere chunks of information used in an educationally informed setting. But for their metadata description, there is nothing that intrinsically characterises them as educational objects. In harmony with their character and following the lead of others, I will call such chunks of content henceforth information objects. From an educational point of view such objects are neutral, they could have been used for any purpose besides education. They only acquire educational significance once they are hooked up in an educational context. This context is absent in digital repositories but for the metadata description, which provides suggestions for how they might be used. Consider the following example by way of illustration of the argument.

7 There may be one important exception to this, although it isn’t of an educational nature either: copyrights and licensing. The music and film industries have experienced how difficult it is to stick to the old licensing scheme’s for digital media. No doubt, the book publishing model does not fit an economy that is to thrive on the flexible reuse of learning content either. This issue, however, seems to result from the use of electronic media tout court and is not specific to the educational context. See for an interesting angle on this problem (Kohn, 2001; Sholtz, 2001).


10 The term is also used by others, for instance in a Cisco white paper, in which Cisco describes its strategy with respect to the reuse of learning materials. See Wieseler (1999) and Barritt et al. (1999), but also Wiley (2002).
Martin Luther King’s speech, held in Washington, August 28 1963, in which he repeatedly uses the phrase “I Have A Dream”, may be used for educational purposes in many different ways. Obviously, it could serve as a resource in a modern history course on racial policies in the USA in the sixties. Questions could be asked about what those policies were and what King’s role was in changing them; or students could be asked to write a paper on King’s ideas. Alternatively, the speech – i.e. the repeated use of the phrase “I Have a dream” - could be used in a rhetoric’s class to illustrate a particular figure of speech. Students could be asked to name this figure, provide other cases, etc. Or the speech could have been used in a linguistics class to illustrate southern American English.

The example shows that this information object, as that is what the speech is, may be used in many different ways for educational purposes. A metadata description would typically capture one or a few of them, but certainly not all. It is even logically impossible to capture all, as there is no limit to the imagination of the educational designer who might want to utilize it. Nevertheless, information objects may be stored, retrieved, changed, described, much the same way information on the internet at large is stored, retrieved, changed, described. Indeed, the internet may be seen as one large digital repositories of information objects (be it usually without the metadata descriptions). Nobody doubts that the internet is a valuable repository, likewise repositories of information objects are valuable. The question is, however, whether it is the best way to support custom learning, for that is what we are after.

I do not believe it does, nor will in due time. The approach is at fault in that it largely ignores educational aspects. So this kind of digital repository has no typical educational value. Admittedly, metadata descriptions may be added that contain such items as ‘typical learning time’, ‘typical age range’, and ‘interactivity type’ in the educational subcategory. Perhaps, these can be used to indicate that, say, a problem based learning scenario was used. However, in that case scenario and content are inextricably intertwined in the learning objects and reuse is limited as a consequence of this: although a chunk of content may be chopped up in smaller (learning) objects for reuse, the diversity of the contexts of their reuse is limited since the objects come with a specific pedagogy stamped on them. In short, although there is content flexibility, there is no pedagogical flexibility.

3 The education technological approach and why it will succeed

3.1 What is it?

An educational approach to custom learning would examine full-fledged educational experiences, not just pieces of content, and investigate what their ingredients are. Of course, one then does find resources, such as books, collections of hyperlinks, videos and audio; i.e. the information objects of the information technological approach. But in addition to this, an instructionally relevant structure will reveal itself. Obviously, these do not become apparent immediately. A thorough analysis is required. And even then one should be careful not to become enthralled by the particulars of the various possible pedagogical approaches, such as competency based learning, problem based learning, case based learning, etc. That would lead to one set of descriptive categories for each approach investigated. Although this is quite possible and even examples of such approaches exist\(^{11}\), it would not result in flexible reuse of learning objects across pedagogies. What is needed, then, is a set of descriptive categories, a pedagogical meta-language that is general enough to

capture all the various pedagogical approaches and yet specific enough to capture what is educationally relevant. And, of course, the information technological approach is an example of an approach that is too general. Various attempts a devising such a meta-language have been made in recent years. Some have been more successful than others in steering clear of the cliffs of pedagogical specificity and educational irrelevance. The language that seems to fit the ideal best is EML\textsuperscript{12} (Educational Modelling Language), developed by the Open University of the Netherlands (Koper, 2000). It is part of a survey undertaken by the Workshop Learning Technologies in CEN/ISSS\textsuperscript{13} and forms the basis for the Learning Design specification that IMS\textsuperscript{14} develops.

\begin{figure}
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\includegraphics[width=0.8\textwidth]{diagram.png}
\caption{A schematic play with roles, activities, and environments}
\end{figure}

How does EML succeed in being an adequate pedagogical meta-language? This is not the place to go into the intimate details of the language. Suffice it to say that EML succeeds by discerning such categories as ‘activities’, ‘environments’, ‘roles’, ‘properties’ and ‘plays’ (see Figure 1). Activities may be either learning activities or support activities, depending on whether they are carried out by students or staff members. Learning activities guide students through their study, they may vary from ‘read the accompanying paper and answer the following questions’ to ‘get together with your fellow students, discuss the accompanying problem, and jointly write a report on its solution’. Support activities can of course show a similar heterogeneity.

\textsuperscript{12} EML has been developed by the Open University of the Netherlands. Like most languages of this type, it uses XML (eXtensible mark-up language) as a binding for the underlying concepts (information model). The DTD, which describes the EML vocabulary, plus reference manual and several documents describing EML’s philosophy and rationale may be accessed at \texttt{<http://eml.ou.nl/>}.

\textsuperscript{13} A comparative study of pedagogical meta-languages is being carried out under the aegis of the CEN/ISSS workshop learning technologies \texttt{<http://www.cenorm.be/issss/workshop/lt/>}. Progress reports as well as a list of the participants in the study are available via the DIN website at \texttt{<http://www.ni.din.de/sixcms/list.php3?page=test&rubrik_id=422>}

\textsuperscript{14} The IMS consortium is not particularly forthcoming about works in progress. According to the IMS site at \texttt{<http://www.imsproject.org/>}, the Learning Design Team has produced a scope document, detailing the work to be done. This document has been approved by the Technical Board over the summer of 2001, and the team now works on a base document, that should contain a first specification. According to the IMS’s standing procedures, this document is to be expected some 6 month after the approval of the scope document.
These two examples also illustrate what the environment is. In the first case, it is the paper to be read, in the second the problem description that accompanies the activity. One may specify environments that are specific to some activity or that are common to any collection of activities. The environment really contains the learning resources. It may even contain links to for instance a groupware environment. The examples also illustrate the notion of a role. Two role types are standard: learner and staff. However, within each category, subcategories may be defined. In the collaborative problem solving case, it might be a good idea to appoint a chair and a recorder. Either one would be a specific subrole of the learner. There is little use in discerning roles if it wouldn’t be possible somehow to keep track of what they have done. This is achieved through the device of properties, which really are variables that may be declared at will. Some events will be logged automatically, such as time spent online or the completion of an activity, others may be specified (‘declared’) by the designer, such as the score on a set of multiple choice questions. The only important thing left now is the temporal sequence of the various activities. This is co-ordinated by the play. It allows a designer to couple activities to roles and put activities (or groupings thereof) in a temporal order. The play also allows for conditional branching, so that various ordered subsets of activities can be identified and played out, depending on the teacher’s choice, the students’ preferences, or a particular set of property values. Although much more can be said, the present explanation suffices to grasp the essentials of EML.

So a genuine, i.e. useful learning object consists of activities, environments, roles, properties for these roles, and a play that ties all the elements together in a temporal sequence. Of course, learning objects may be and actually should be described with the aid of metadata in order to facilitate their flexible reuse.

### 2.2 Why does it work?

So with a pedagogical meta-language like EML one may put resources – the files of the information technological approach, now dubbed information objects – in environments and thus separate them from the didactic scenario in which they function. Crucially, one may edit the didactic scenario, i.e. the play, in isolation of the resource files. Thus the same objects may be used in various pedagogical scenarios. By taking the resources out of a particular play, one may even reuse the same pedagogical scenario with a different set of content items! So not only resources are fully reusable, so are the didactic scenarios. Obviously there are limits to the extent to which one may repurpose a particular didactic scenario. Or rather, a radically different implementation - say switching from a class based, cohort based course to a distance taught course that employs collaborative learning - requires more effort than a marginal adjustment –say from a synchronously, teacher-led face-to-face course to an asynchronously, teacher-led distance mode course. But in this respect the repurposing of resource materials fares little better.

The upshot is that now, for the first time, reusability has been extended to cover not only resource materials but also didactic scenarios, not only static information, but also dynamic behaviour. This is a big step forward. Another benefit is that stored resources now not only can be retrieved through their metadata descriptions but also through the actual educational experiences that they are a part of. This way, repositories do not become odd collections of chunks of content that, at best, someone has quite successfully used in some irreproducible way, at worst, the author wasn’t determinate enough to throw away. Repositories now only contain resources that have actually been put in their context of use. So one may in fact inspect how they have been used. Obviously, this does not imply a commitment to reuse them in the same way. Rather, much like textbooks, one may become inspired by them and employ them however one sees fit. There is one big difference, though. A textbook contains an implicit pedagogy that cannot be changed easily since it is
inextricably tied to the written material. One may skip paragraphs or even chapters, the pedagogy stays in place. Through the use of a pedagogical meta-language like EML, for the first time one may alter the pedagogy without necessarily altering the content. This is a genuine educational innovation and a substantial contribution to the flexible reuse of learning materials.

4 Conclusion

So the information technological and the education technological approaches both have something valuable to offer to the flexible reuse of learning materials. It should be clear by now that I believe, in contrast with the current consensus, that the information technological approach on its own falls short of the mark. Both, working in concert are needed for actual reuse to happen. Obviously, this means that we have an even longer way to go to the full-scale implementation of a reusable learning object economy. Current MLEs and LMSs cannot make use of learning objects described in EML, or any other pedagogical meta-language for that matter. They may with some effort be able to process the information objects, rendering the scenario instructions will take much more as the scenario instructions will have to be interpreted and passed on to a user interface. At first glance, this may seem a vice, but I suggest to view it as a virtue. As argued, the information technological approach has little to offer in the way of innovative educational practices, if it is able to pull off actual reuse of educational materials at all. But if we manage to embed reusable resources (information objects) in reusable scenarios (learning objects), then we’ve made the first step towards creating a flourishing learning object economy.

Let me hasten to add, though, that this is a first step. It will certainly not suffice to guarantee success. It takes actual people, instructional designers, developers, teachers, to get the reuse ball rolling. People need incentives and rewards to get moving. Reusing learning objects is a form of trade. Either developers get paid, as is the case in the book and paper based learning object economy we now have; or they need assurances that the users of their learning objects will reciprocate by also submitting learning objects to the shared repository. Given the problems that the music industry experiences since their media have become digital, it shouldn’t come as a surprise to us when the book and paper based payback model does no longer work for learning objects the moment they reside in digital repositories. So perhaps an open source type of system based on reciprocity is in order. But now I’m speculating on what might work and might happen. This is too serious and difficult a matter to be dealt with here and now. I shall leave it for another occasion.

References


