The Language of Flexible Reuse

Reuse, Portability and Interoperability of Learning Content or Why an Educational Modelling Language

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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 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 traditional 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 of her needs at that particular time.

In addition, 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 learning affords. Some students may prefer to study individually, shunning contacts with their study-mates, others might prefer collaborative work. Some students may want modern pedagogies such as problem-based, case-based, or simulation-based learning, while others may simply want to be told – orally or in print - what there is to know. All these

preferences, both in terms of subject matter and pedagogy, are included in the mix. The upshot is that modern educational institutions, that want to satisfy the needs of all student, 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 can remain in tune with tuition.

If, however, one intends to meet the specific needs of each and every student, this argument loses its validity. There are no cohorts anymore, so classroom teaching, which is based on cohorts, becomes impossible. On the other hand, 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 costs, which can push up the price of tuition for students.

Traditional distance teaching has 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 these problems. Particularly, the flexible reuse of educational materials 'content' or learning objects (LO) is a cornerstone of this argument. The slogan is: 'write once, use may times'

Although the development costs of LOs 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 LOs 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 chapter, 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 LOs

and show it to be wanting. My argument will be that the use of LO 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, I will show, is indeed capable of fulfilling all the needs of customised learning, both the need for custom content and the need for custom pedagogies. Some possible criticisms of my line of reasoning will conclude the chapter.

The information technological approach and why it will fail

What it is

This perspective, which is strongly espoused by the Advanced Distributed Learning Initiative (ADL), holds that LOs should be durable across technological changes, 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 this view, LOs consist of (collections of) computer files: text, graphics, video and audio, etc. An instructional designer may deploy these files as he or she sees 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.

If everybody were to store its LOs 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, digital LO repositories are now being established.

Examples of repositories include Merlot <http://www.merlot.org>, the Scottish electronic, Staff Development Library SeSDL <http://www.sesdl.scotcit.ac.uk> and the Universal Brokerage Platform for Learning Resources <http://www.ist-universal.org/>. They may provisionally be described as databases for educational materials. To add to the discoverability of the LOs in the database, the objects are described with the aid of their own metadata, which for the most part is based on the IEEE LOM metadata specification, which is now becoming accepted as an international standard for this purpose.

Furthermore, LOs preferably aren't uploaded as plain files but in the form of *content packages*. A content package contains, not only the physical files themselves, but also their metadata descriptions, and an indication of the way the content coheres or is organized, for example like a book's table of contents. The IMS global consortium has put together a specification that details what content packages should look like. A content package thus is a compound LO, with metadata and an organizational description that speaks to its intended use.

Since these kinds of LOs are treated as computer files that happen to contain educational materials, they pose little challenge to the current state of information technology. The details have yet 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 LO metadata) have to be worked out, and perhaps localised, and agreed upon.

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 (ontologies) for the fields'contents. For example, the American category 'K12' does not translate to any equivalent category in the Dutch educational system, etc.

But this standarization and localisation 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 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 'LO' economy into a computer and Internet based economy. While the changes may even be considerable 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 LOs, may be swapped between software systems. Hence, the interoperability of software systems seems to be assured. Or is it?

Why it will 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 is far from substantial. 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 begun? Some early users of this approach include the Dutch Digital University <http://www.digiuni.nl>, and the Finnish Virtual University <http://www.virtuaaliyliopisto.fi/index.php?language=eng>. See also Werbach, 2000.

In part my evidence derives from ill-boding impressions 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 other, a priori arguments as to 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 keeping with their true nature, they had perhaps better be called *information objects*. That term has actually been used, for instance in a Cisco whitepaper on the reuse of learning materials (Wieseler, 1999; see also Barritt et al., 1999; and Wiley, 2002). But since the term LO has stuck and is extensively used in the sense of a chunk of information, I will conform to this usage.

The important observation to make is that they can 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 evidence for how

the metadata author intended the LO to be used. This, however, does not suffice to start up an efficient and effective LOs economy, as the following example will illustrate.

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 a version of Afro-American English.

The example shows that this LO, as that is what the speech is, may be used in may 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, LOs 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 repository of LOs (albeit, usually without the metadata descriptions). Nobody doubts that the Internet is a valuable repository, likewise repositories of LOs are valuable. The question is, however, whether it is rich enough to support the flexible reuse needed for customised learning . I do not believe it does, nor that it will given enough time. The approach is fundamentally at fault since it fails to address education specific aspects. A digital repository of these kind of LOs has little educational value, in spite of its name.

The education-technological approach and why it may succeed

What it is

An educational approach to customized learning would examine what is required to generate full-fledged educational experiences. It would not stop at examining pieces of content and investigating what their ingredients are. Of course, an examination as meant here will reveal resources, such as books, collections of hyperlinks, graphics, video and audio files. These are the LOs of the information technological approach.

But, in addition to this, the investigation will focus on the educationally relevant *structure* that the LOs are part of. This does 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.

This is quite possible as examples of such approaches exist such as Targeteam <http://www11.in.tum.de/forschung/projekte/targeteam/>; LMML <http://daisy.fmi.uni-passau.de/db/literatur.php3?key=S00>; and PALO <http://sensei.lsi.uned.es/palo/>, TML/NetQuest <http://www.ilrt.bris.ac.uk/mru/netquest/tml/>. Still, this approach would not result in flexible reuse of LOs across pedagogies.

What is needed is a system of descriptive categories, a *pedagogical meta-language* that is general enough to capture all (most?) of the various pedagogical approaches and yet specific enough to remain educationally relevant. Various attempts at 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 (Rosmalen et al., 2003). The language that seems to fit the ideal best is the IMS Learning Design specification (IMS, 2003). It is based upon an earlier, field-tested attempt to create such a language: the Educational Modelling Language, EML, which was developed by the Open University of the Netherlands (Koper, 2000). Although EML and LD differ in significantly in their details, from a conceptual point of view they are the same.

ABOUT HERE FIGURE 1

How does Learning Design (LD, for short) succeed in being an adequate pedagogical meta-language? LD 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. 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 identify environments that are specific to some activity or that are common to any collection of activities. The environment really contains the learning *resources*, that is the LOs from the previous section. It may also contain *services*, such as, for instance, a collaborative learning environment, a simulation, a chat facility, etc.

The examples also illustrate the notion of a *role*. Two role types are standard: *learner* and *staff*. However, within each category, subcategories may be freely 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 sub-role of the learner. There is little use in discerning roles if it wouldn't be possible somehow to keep track of what the the persons in a role have been doing. This is achieved through the device of *properties*, which are variables that may be declared at will. Depending on the runtime system that 'plays' LD scenarios, particular properties may be built in already; examples would be 'time-spent-online', 'last-time-logged-on', 'total-session-time', etc.

Others are less generic and are specified by the designer. An example would be the score on a multiple-choice question or a entire questionnaire. If one needs the score to affect the flow of the learning experience, the questions or questionnaire need to be put together in such a way that it affects the values of a property. Such a property may be either local to a particular instantiation ('run') of a design or be carried along from course to course ('global'). In order to be able to set, update, monitor, etc. properties, some sort of container for them is needed. Not only the question or questionaire needs to be made available to the student, he or she also need to be able to interact with it ('click option A', 'review your answers'). The prime candidate for this type of interaction would of course be the IMS Question and Test Interoperability specification, but LD and QT&I have not been harmonized yet. (EML did contain such an interaction model.) Similarly, a specification which in a more general sense would allow one to structure content is needed. XHTML would be a suitable candidate for structuring the content of many learning objects. LD does not contain a specification for structured content , although the use of XHTML is recommended. (Again, EML did contain a whole suite of elements, based on the doc-book specification, for structuring content.)

Now we have activities, environments to support them, roles to carry them out, and properties to keep track of what goes on, but we are still missing is a mechanism for

describing the temporal sequence of activities. This is achieved by the *play* and a few similar devices, such as *acts*, *role-parts* and *activity-structures*. They allow a designer to couple any activity to a role, and to put activities (or groupings thereof) in a temporal order. When aided by conditions, 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 LD.

Why it has a better chance to succeed

A pedagogical meta-language like LD allows one to put the LOs discussed earlier 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 LOs. 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. Therefore not only LOs are 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 from a synchronous, teacher-led face-to-face course to an asynchronous, 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 learning resources:but also didactic scenarios, not only static content, but also dynamic behaviour. This is a big step forward. Another benefit is that stored LOs can now be retrieved not only 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 and at worst, the author wasn't determined enough to throw away. Repositories now (also, only) contain resources that have actually been *typed to 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 LD, 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.

Conclusion

The information technological and the education technological approaches both have something valuable to offer to support the flexible reuse of learning materials. 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 toflourish. This means that we have an even longer way to go to the full-scale implementation of a reusable LO economy. Current MLEs and LMSs cannot run instances of didactic scenarios described in LD. They may with some effort be able to process the LOs, but 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 that it be viewed 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 orchestrate actual reuse of educational materials at all. But if we manage to embed reusable resources in reusable scenarios, then we've made a significant step towards creating a flourishing LO economy.

This is a first step. It will certainly not suffice to guarantee success. It takes actual people, instructional designers, developers, teachers, to get out and travel on the reuse road. People need incentives and rewards to get moving. They need to overcome their fears and anxieties. Organizations need to adapt, etc. We've only just started to survey these social, economical, psychological, and organizational issues, let alone solve them (*cf* Sloep, in press). There still is a long way to go.

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[1] This paper is based on a paper read at the 'Onderwijsresearchdagen (ORD) held in Antwerp, Belgium in June 2001.

Abstract

This chapter 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 LOs 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, LO, interoperability, educational modelling language, EML, metadata, pedagogy, didactic scenario.

Figure 1: A schematic play with roles, activities, and environments