A Model for the Effective Management of Re-Usable Learning Objects (RLOs): Lessons from a Case Study

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Abstract

The management and reuse of digital learning resources has become a major business. Repositories of reusable learning objects (RLOs) are increasingly popular but pose serious management challenges. In this paper, we report the findings of a case study with a leading distance education provider currently engaged in a RLO strategy. We find that our case organisation has effective strategies for addressing many of the challenges. Based on these strategies, we identify lessons that are generalisable to other organisations and propose a model for effective management of RLOs.

Keywords: Re-usable learning objects; digital leaning resources, education technology management

Introduction

There has been a massive increase in popularity of on-line and flexible learning. This use of digital media to support on-line learning is ubiquitous, from the most basic to the advanced, and in subjects ranging from basket weaving to nuclear medicine. In the US alone, figures for the forecast of internet-based training for the year 2003 in both 'soft skills training' and 'IT training', approach $US12 billion, a growth of almost 100% from the previous year (Clarke & Hermens, 2001; Taylor, 2002). Traditional educational institutions are extending beyond their classroom walls, using on-line and flexible learning to meet market demand for anywhere, anytime education.

The management and reuse of these digital learning resources has become a major business. Organisations are increasingly seeking a means to achieve shorter production times, better use of resources, reduced costs, and improved quality of content for developing and maintaining educational resources, by developing re-usable learning resources, known as Reusable Learning Objects (RLOs) (Kostur, 2002).

RLOs are units of content and educational structure divided into reusable objects and modules. The IEEE Learning Technology Standards Committee defines smaller objects linked together to form learning materials as Learning Objects. Their definition of a Learning Object is "any entity, digital or non-digital, that may be used for learning, education or training." (IEEE Learning Technology Standards Committee, 2002).

Many organisations in different spheres of business are evaluating the benefits of RLOs. In organisations where the core business is education, RLOs are frequently considered an integral part of distance and flexible learning strategies. Distance education pre-dates on-line learning, and is defined as any approach to education that replaces the same-time, same-place, face-to-face environment of a traditional classroom (Volery & Lord, 2000). Distance education is a major user of

online learning, but distance learning does not encompass all the ways in which online education can be employed. Online education may be used as an add-on to traditional classroom presentations, as a stand-alone asynchronous program, or as a synchronous class where all students are on line at the same time (Taylor, 2002). Therefore, online education can be defined as education that utilises Internet technologies to distribute and display materials and relies on a self-learning environment. Education that uses a combination of traditional classroom presentations and online components is known as flexible learning and is an increasingly popular model, especially in the tertiary sector. All of these models are increasingly common in the education sector and have the potential to benefit from use of RLOs.

A learning object strategy allows organisations to achieve shorter production times, better use of resources, reduced costs, and improved quality of content for developing and maintaining educational resources (Freeman, 2004; Kostur, 2002). While a RLO strategy promises potential advantages, there are many potential pitfalls when developing a successful RLO strategy. In this study, we focus on organisational and management issues. Issues associated with the technologies of reuse, for example, XML, have been extensively discussed in other contexts.

For our study, we have chosen a large, mature distance education organisation with 50 years of experience in the structured production and reuse of educational material and a history of successful adoption of new media. In the last three years, our case organisation has adopted a RLO strategy. The aim of this research was to study an exemplar organisation, with the aim of extending existing understanding of effective management practices for RLOs. The research questions are: "What are the management issues involved with developing and maintaining re-usable online educational materials to maximise speed of development, cost of development, and reliability of the completed content", and further, "What insights into the effective management of RLOs can be made based on an exemplar organisation?"

First we review potential issues with managing RLOs, from educational technology, content management, and knowledge management literature. Next we present the research method and describe the case organisation and the results. The paper concludes with lessons learned from the case, a model for effective RLO management, and a discussion of the implications for research and practice.

Literature Review

In this section we briefly examine other disciplines that have contributed insights into issues associated with managing repositories. We then review previous studies on the management of RLOs, informed where relevant by content management and knowledge management literature to derive a list of management challenges associated with RLO implementation.

Insights from Reference Disciplines

Content management

Content management systems were created to deal with the ever-increasing complexity of business websites. This grew out of electronic document management (EDM), where EDM systems were implemented to save paper, speed up communications. and increase productivity of business processes (Sprague, 1995). Content management systems allowed organisational control of the content displayed on an organisation's website and provided a facility for employees to update the organisation's website without losing consistency or the ability to reuse the content (Sprague, 1995). Issues and strategies from content management systems (CMS) can inform research in an educational environment because a significant component of RLOs is "content." In particular,

common CMS features such as **versioning**, and **security and authorisation**, we considered potentially relevant to managing RLOs.

The **security**, especially the authorisation, in a learning repository is very important to keeping a high quality assurance of learning materials, as with any content management system. "Given the variety of users and systems that work with the content management system – as well as the importance of the content – good security is mandatory" (AberdeenGroup, 2001).

If materials are modified, this also raises potential issues with **versioning.** Content management systems provide control of versioning to track "what the current version is and what previous versions are still needed" (Sprague, 1995). Versioning also allows for roll back so that if bugs are found in the current version the previous version can be restored (AberdeenGroup, 2001).

Knowledge management

Problems with implementation of knowledge repositories also offer some potential insights for managing RLOs. Expensive knowledge repositories are frequently not used because they are frustrating for employees. Common issues experienced are knowledge repositories that do not provide a standard knowledge structure (also known as **meta-data** structure) that enables users with different perspectives to share knowledge (Kwan & Balasubramanian, 2003) or do not provide enough **context** for the user to evaluate the quality of the knowledge (Weiss, Capozzi, & Prusak, 2004).

People issues, such as organisational **culture** and attitudes with regard to sharing knowledge, have also been identified as an issue for knowledge repositories (Weiss et al., 2004). Teachers who are accustomed to a synchronous, directed learning environment may have difficulty adapting to the different **role** requirements associated with an RLO strategy (Cohen & Nycz, 2006; Craig, Goold, Coldwell, & Mustard, 2008; Lockyer & Bennet, 2006). When building an RLO, the teacher needs to act as a researcher, mentor, and facilitator, rather than as a director (Craig et al., 2008).

Challenges and Issues with Managing RLOs

In this section we identify challenges with managing RLOs from previous academic and industry studies of RLO initiatives.
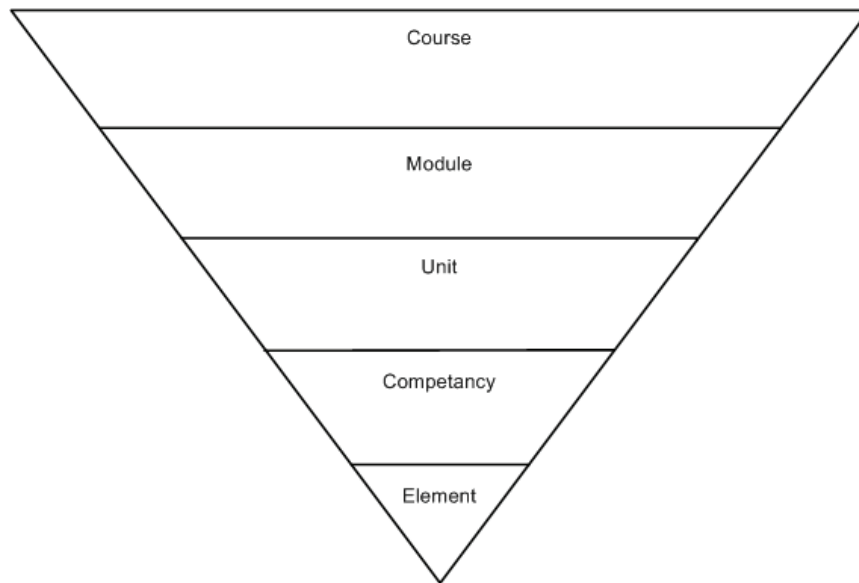
Granularity

The component-based approach to developing learning materials brings into question: How big should those components be? Is a learning object an image, text, sound? Does it have to contain a learning objective to be a learning object? Does it need to incorporate some sort of test of the knowledge acquired? IEEE's (2002) definition of a learning object is very broad and covers the whole area of items that could possibly be called a learning object, from and image or bit of text through to and interactive CDROMs or a book. Smaller learning objects can be combined together to create larger, more comprehensive units. This raises issues of genericity and contextuality.

Genericity and contextuality

For the concept of reusable learning objects to be effective the objects need to be generic, so that many people can use them in many different situations. The genericity of a learning object is affected by the number of references it contains to the context in which it is used (Hiddink, 2001). It has been suggested that to make learning materials generic the designer should avoid using references to local institutions, companies, people, courses, topics, etc. (Hiddink, 2001).

The issue of how generic to make a learning object has been the source of much debate. Some detractors argue that RLO initiatives are doomed to failure because education is highly contextualised. Basing their arguments on those found in computer programming, they observe that only trivial amounts of code can be reused without considerable time and effort being used to transfer the content from one context to another (Kinshuk & Russell, 2001). It has also been suggested that the size of the ideal RLO varies among disciplines, and in some fields a series of small, granular, generic Learning Objects may not be as useful as a few tailored items (Geissinger, 2001). For example advanced level physical sciences may require a large RLO to describe the steps of a complex experiment. Many commercial Learning Content Management Systems (LCMS) for managing RLOs, offer the user nested layers of context, as shown in Figure 1 (Mortimer, 2002).

Figure 1: Layers of context in commercial LCMS (adapted from Mortimer, 2002)

Smaller and more granular objects (elements and competencies) can be "recontextualised" by being included in more than one higher-level object to provide flexibility and re-use.

Central repository

A predominant idea that is in both the content management literature and in the online educational literature is the need for a central repository that stores all the Learning Objects. A significant characteristic of Kostur's (2002) Unified Content Strategy is that it requires the learning objects to be stored in a single source or location, such as a database. A vital aspect of central repositories is the employment of effective metadata so that learners can access content in focused ways (Fleming, 2001).

Metadata

Metadata is searchable information stored about an object to identify or explain it. If the learning object cannot be found, it cannot be reused, so an effective approach to metadata is critical for managing RLOs (Nash, 2005). Metadata for learning objects typically describe such things as what objectives it satisfies, who the intended audience is, the information product in which the element belongs, and the type of learning it supports (Kostur, 2002). Appropriate use of meta-

data can facilitate the reuse and recombination of learning objects in different learning contexts (Yordanova, 2007).

Many RLO projects have devoted a significant effort to setting meta-data standards. A key problem with metadata is with interpretation of the words used. Different developers interpret words differently and, therefore, when searching for the object it may not come under the same word. Therefore, the labels and tags need to correspond to the way the teachers and developers think and be clear and standardised (Hiddink, 2001; Rada, 1995, 2001).

Versioning

A potential risk with a reusable learning object approach occurs when changes are made to an object. This risks affecting all the other people that are using that same object. This either limits the changes that can be made to the learning objects, or the materials in 'courses' must be changed as changes are made to the learning materials. Particularly where a very granular approach is taken, with small, generic, relatively context independent objects being combined in numerous ways, there is enormous potential for a change in one object to affect many others.

In content management systems, this problem is managed by creating differing versions of the materials. When changes are made to a learning object the original version is saved so that those that are already using the earlier version can continue to use it. This allows the materials to be more context-based, reducing the amount of genericity required in the learning objects. Versioning also allows for roll back so that if bugs are found in the current version the previous version can be brought back without too much hassle (AberdeenGroup, 2001).

For versioning to be useful it needs to keep track of "what the current version is and what previous versions are still needed" (Sprague, 1995). This means that within the learning repository, the metadata, most likely, will need to keep track of the versions and, also, whether they are being used and by whom they are being used.

Different policies may apply to modification and adaption of learning objects. Some repositories aim for a more open "co-creation" model, where the user community participates in creation and adaption of learning objects, while others aim for tighter controls (Downes, 2007). These differences can lead to issues with workflow management.

Workflow management

When producing online educational material, there is frequently a tension between pressure to reduce time to market and the quality of the final product (AberdeenGroup, 2001). Contemporary content management systems that incorporate workflow capability are often used to support the tasks and processes associated with creating and managing web-based content in a collaborative, dynamic, and high-volume environment (Morgan, 2000; MSI Systems Integrators, 2002; Wu & Liu, 2001). Workflow and approval processes need to incorporate both subject quality and technical production standards (Thompson & Yonekura, 2005).

Summary

In summary, we identified nine management issues that we considered likely to be important when managing an RLO implementation. These were derived from previous academic and industry studies of RLOs and from knowledge management and content management literature. Some of these issues relate mainly to the organisational culture and process, while others relate more to repository and RLO design and standards. Issues primarily related to organisational culture and process included organisational attitude to reuse, perceptions of roles, and workflow management, process, and authorisation. Issues primarily relating to repository standards and design features include central repository, granularity, genericity, meta-data, and versioning.

Research Methodology

This research uses a case study methodology in which theoretical propositions, presented in the form of potential issues, are compared with empirical materials collected from the field. This creates a link between theory and empirical data "providing a template against which to compare the results of the stud[ies]" in place (Yin, 1993). We expected that issues and practices identified in previous discussions of RLO management would be found in the case organisation to a greater or lesser extent. This approach allows the strategies employed by the case organisation to be easily related to existing literature and allows us to extract lessons learned that will be of potential relevance for other RLO initiatives.

Data were collected by holding semi-structured interviews with five existing staff members and one former staff member. These six people were chosen because they covered all aspects of creation and management of RLOs, and represented a variety of stakeholders, including management, teachers, and technology support. Interviews sought to gain insight into the participants' understanding of how the organisation's processes influence the effective development and maintenance of RLOs. Interviewing six stakeholders contributed to reliability by acting as verification on organisational memory and establishing a common understanding (Earl, 1993). The inclusion of a former teacher provides insights into organisational capability and readiness before the current initiative started.

Interviews were transcribed in full and analysed using pattern matching with a list of categories based on the issues identified from the literature. Additional issues, not identified from literature, were created as required. Following that, the transcripts were reviewed for organisational responses to the issues identified, and the lessons that could potentially be generalised to other organisations were derived.

Case Description

The case organisation, "D-school", is a provider of distance education for early childhood through to secondary, including special needs, in a western country. The school has approximately 19,000 students, consisting of full-time, dual enrolled (with existing secondary schools), and specialist services students (Education Review Office, 2003). Approximately 10,000 of the enrolments are secondary students, the majority of which are dual enrolled, as well as another 4,000 adult students (Education Review Office, 2003). As a result of the dual enrolled students, D-school has needed close communications with other schools. As an evolution of the schools dealings with dual enrolled students and use of technology, it has taken an advisory role in the setting up of "clusters" of smaller schools that share resources and teaching materials. In this they utilise the experience they have to help the schools to set up the technology and the teaching practices required.

Prior to the widespread use of the Internet, D-school had extensive experience over many years in the production and management of learning materials utilising a variety of media, including paper, radio, video, and television, which were reused for different offerings of the same course for up to eight years. These would fit within the broad definition of a re-usable learning object, although typically they would be large chunks of content only intended to be reused within a similar context (for example a course with similar learning objectives for a similar age-group). The school has sophisticated and mature processes covering the planning, development, and quality assurance processes for learning objects.

Over the last three to four years the school has conducted R&D into the delivery of online learning to students, first starting off with the "E-section pilot," which was aimed at early childhood and primary, and now "connect dot ed," which is aimed at secondary studies. From this and other research the school has developed models for the process of developing courses and course mate-

rials. This process overall is called the DNA model, based on the initial letters of the phases (**Di**scern, **De**sign, **De**velop, **A**ccess, **A**ccount, and **A**ccept). This model includes all aspects of the school's business, from analysing the learning needs of its customers to reporting to outcomes to external government entities. A subset of the DNA model is reproduced as Figure 2. This shows how the Internet and learning technology such as Blackboard, supported by digital RLOs, have been included in the business model. New technology primarily impacts the Design, Development, and Access stages. In broad overview, learning materials are designed for the Internet, developed utilising content management systems implemented as part of the RLO project, and accessed by students using the Internet.
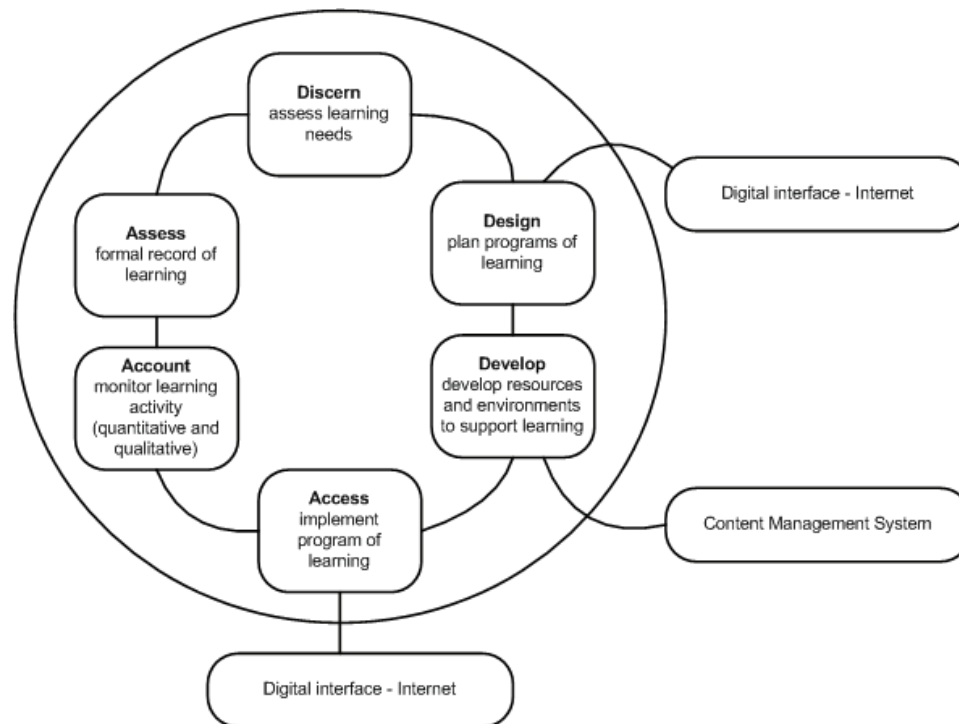

Figure 2: The D-school DNA Model

We found that the D-school also had existing processes in place for the development of learning materials. The generic learning material development process is shown in Figure 3. This process pre-dates the current RLO initiative and has been in existence in the school, in some form, for decades. This is a highly structured and controlled process, originally developed for the traditional process of developing larger chunks of learning materials, such as courses or modules.

A proposal for learning materials planned for development or revision would have to be submitted to a planning round. Accepted proposals would go through a process of development and approval before being reproduced or operationalised. The final steps were ongoing evaluation and revision as required. This is the product of extensive organisational learning and experience and includes considerations of pedagogy, economic, legal, and copyright issues.

In the last year the school has been developing a learning content repository. This is being set up in two systems. The first "official" system is being developed and implemented to hold fully Quality Assure Learning Objects that, in the future, could be shared outside of the school, for example, by schools involved in "clusters." The second, which is based on Lotus Notes, is an internal system for teachers to share, within the school, non-quality assured learning materials and to help encourage the production of reusable materials. As a result of the research and the develop-
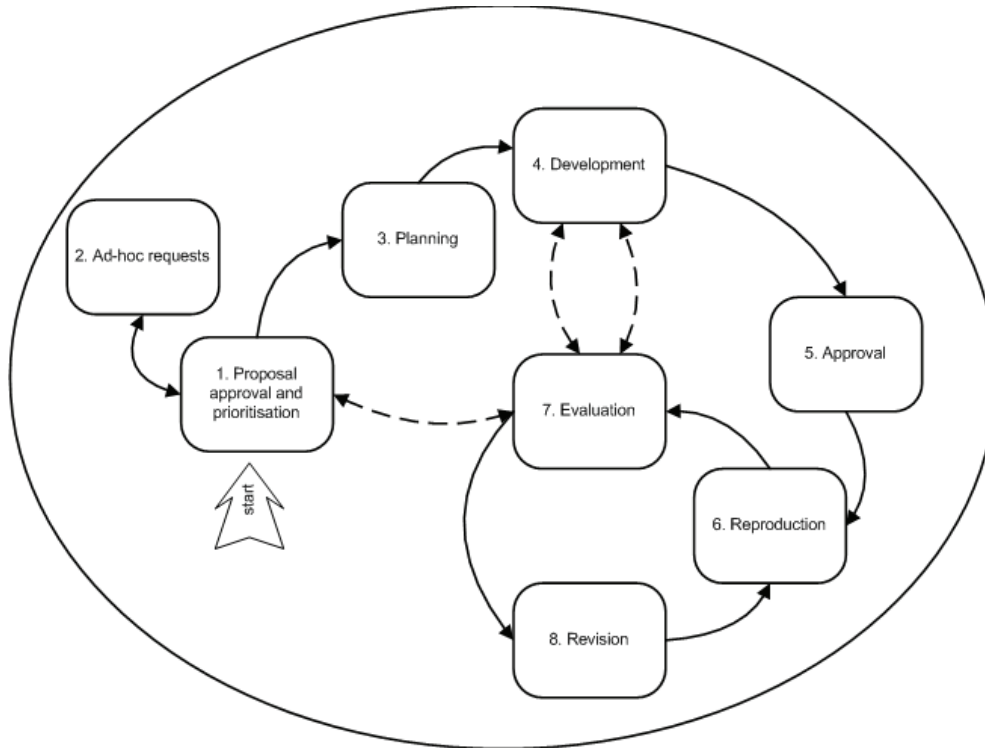
Figure 3: D-school generic process for learning material development

ment of the learning object repository D-school has been recognised as a leading organisation in the use of the online learning environment.

Research Participants

The participants in this research were:

RU: The media services manager, responsible for the management and strategy of the primary groups within the school group that develops online and multi-media RLOs.

CR: A primary school teacher, involved with the e-section pilot, and now a member of the e-learning professional development team developing and designing content.

WT: A retired teacher and manager of the Distance Technology Advisory Group, responsible for advising teachers on the production of learning objects prior to the current development of the online repository.

SM: A member of the multimedia development team, which is a part of the media services group, with a primary focus on technical aspects of development. .

ER: The blackboard system administrator as well as a member of the e-learning professional development team, responsible for technical support, advice and consultancy about the technology infrastructure used for managing RLOs.

FG: A project manager for the development of secondary school courses and resources, responsible for leading all aspects of the development and maintenance of RLOs and other educational resources used by the school.

Analysis

D-school Approach to RLO Management Issues

The projects D-school has undertaken, over the last three to four years, have given the school the opportunity to identify and address many of the issues associated with the effective management of RLOs. All the issues identified in our literature review were present to some degree. The school is migrating to a central repository approach for managing its learning objects. Issues of granularity, genericity, and contextuality have been identified as a major difference between the D-school's emerging RLO strategy and the school's traditional approach to managing learning objects. A homegrown meta-data standard has been developed, informed by international developments in this area. Workflow processes, including management of security and version control, already existed, and are being updated. In this section, we look at the strategies employed by the D-school to address the issues and conclude with a summary of the lessons learned from this experience. These lessons fall into two broad areas: those associated with repository standards and design features, and those associated with organisational processes and culture.

Repository Standards and Design Features

Central repository

D-school has implemented not one but two repository systems. The school decided upon the two-repository set-up for a number of reasons. As RU mentioned, the unofficial repository was "essential for getting buy-in and getting the teaching areas involved." But also they are using the staff repository "as the catalyst for getting the whole concept of reusable learning objects rolling," with a further advantage that they "don't lose all that intellectual property when teachers go."

RU mentioned that the aim was for the "official" school repository in the future to be shared externally. At present, there are a number of obstacles to moving material into the public domain. Currently the contract between D-school and government agencies does not permit sharing of RLOs beyond the school. Sharing the content externally increases the importance of copyright issues. ER talked about the transition required for materials to move from the staff repository to the school repository.

> There is debate... [within the school] we look at it as a closed classroom. And we stick stuff on our classroom wall... I mean, regardless of what happens, teachers or facilitators are going to do it anyway. But once you go through the official process…then it has to go through a really rigorous copyright protection.

FS adds to this, "Copyright laws certainly prohibit a lot of widespread use. You've got to get the clearance and that gets expensive." FS goes on to say that the issue with copyright can affect the longevity of learning materials.

> The shelf life maybe ten years but our copyright is limited in the secondary area to five years and primary to eight years, and that tends to say, 'right the five years is up' we have to now renew the resource.

Granularity

A major focus of the new repository is to make learning objects as open as possible. Staff want to be able to get access to the learning object and make changes within the actual object itself, for example change the text or the image. This is motivated partly by feedback from colleagues about other international repository initiatives.

When talking about the materials coming from an Australian repository ER mentions the problems he sees are involved with the materials.

> The stuff that's coming out of [repository A] it's all done in flash or director, and so it's all locked up. One of the last ones looked at was a little bird sitting by a billabong, which has no context for us, and it's an Australian bird and an Australian billabong, and an Australian gum tree, and Australian talkers. Which is okay, but the problem with that is it's not granular. I can't get in there and take the picture out.

Partly based on this experience, D-school has taken a different approach. The school repository is set-up with 5 levels of nesting; RU gave a short description of the structure of the learning repository.

> From the smallest level, which is your individual component or your file, through to your chunks, to your RLO, through to a topic, then there's a program of learning which is a series of topics for a student.

This is central to the reusable learning object concept that the school is taking.

> If we look at a topic, say the topic was seasons, and within that topic you have winter, summer, or spring. So there's another topic. And then below that you have another topic which is, "What do I wear in the winter? What do I wear in the summer?" So then it becomes more granular down to eventually you can't get any more, it's just a bit of text or a bit of an image. So we'll call that an RIO [Reusable Interactive Object], and an RLO is the next step up.

This nested approach allows teachers to create materials that are a combination of several documents, and images and text. The nested scenario that the school repository is based around supports this.

SM supports this argument through his description of the approach that the multimedia developers take to creating the interactive objects; they are creating much smaller modules that can be joined together (contextualised) rather than creating large interactive objects that cover a whole course.

Genericity

The issue of genericity is tightly interwoven with that of granularity. The school's approach is to remove the context, or the 'glue', from the learning objects and components. Higher up in the hierarchy of nesting, from the topic through to programmes of study the glue is included to give the course context and meaning. FG:

> The plan is for our content management system to treat all those as searchable objects, so the teachers can actually grab those and put them together if they want. Or they can work at the level of the RLO, or even further up the line. They can group a whole lot of RLOs together into a topic and put some context around it.

This mentions the need to put context around the learning objects brought in, to create a topic. Therefore, D-school is developing the lower hierarchical components generically, but once getting to the level of the topic, staff are adding context into the materials to make them more useable to the students. WT noted that part of the skill of a distance educator is to construct learning materials in a way that is open enough for students to add their own context, in a dialogue with the teacher.

One of the methods D-school uses to make the learning materials more generic is to remove all indication of topic. RU describes the schools approach to making learning materials generic as follows:

> We try to be as vanilla as we can. …What we've been working to is actually been removing any indication of the subject areas. And that is something we have come to over time, because everything used to say science, or economics, or chemistry, or whatever on it. So we've started to take that off and only have it on your splash pages so it is easily removed.

Removal of indications to the subject area allows for the use of theme-based teaching, which is becoming increasingly utilised within the schools courses, especially in early childhood and primary schooling. As with the seasons example, theme based teaching is not about a given subject area, but may include many subject areas.

Despite the current RLO initiative, the pedagogical debate over levels of granularity, genericity, and context continues within D-school, reflecting unresolved issues that also exist within the current research literature.

Metadata

The set up of the learning repository, with the images, text, and sounds being searchable, makes the metadata a very important aspect. The school has created a metadata schema for the school repository, which is homegrown but informed by international experience, and is having a significant role in the development of a country-wide meta-data schema, ER:

> That metadata schema is based on international standards, so it completely covers Dublin core, NZGLS, the tikiti oporangi standard; it also covers the learning federation standard, which is an Australian & New Zealand consortium for digital objects.

ER in describing the searching system that the school repository is going to use, based on the metadata, cautions that they would be unwise to develop an extensive, organisation-specific metadata structure and emphasises the need for the metadata standard to be able to communicate with other systems.

> So you're going to have to have low level and reasonably, sort of, sophisticated levels of searching, at the moment, and build it. But we also have to be cautious as to how far or how deep we go, because if we can't interact with our Australian friends or English, then we've got problems further on down the track. But I don't think that it will ever be solved.

RU describes two approaches taken by other repositories: the weaknesses inherit in them and the problems that the lack of a strong coherent metadata standard brings.

> There is [a repository] in Catalonia in Spain, where it is very much a free for all; teachers can put whatever they like on there. They can develop stuff, they can change stuff, and they can reuse stuff. There are not a lot of controls at all….The Catalan approach; they can't find anything on there. They've got 20,000 objects in there, but because they do not have the structure on their metadata…it is difficult for them to find stuff.

Versioning

D-school has implemented a flexible approach to version management that allows RLOs to grow and change over time in response to demand, while protecting the integrity of existing objects for their users. RU describes these capabilities in the following way:

> What we are to do, rather than update existing ones, is actually create a new one and say okay, this is version one, and all these topics are happy with version one. This is version two and these people are using version two. And it may be that version one is no longer needed after three years, so we throw it away.

Organisational Process and Culture

Organisational culture

Organisational culture issues associated with the production of materials for reuse are largely absent at D-school. This can be attributed to the school's history. The core business of the school for decades has been the production of distance learning materials for pupils ranging from pre-school to secondary school. For many years, courses were developed and reviewed on an eight-year cycle, so each course (effectively a large RLO) would be reused approximately eight times. As WT noted:

> One of the things that many people found difficult moving into the D-school environment was teaching from material produced by someone else.

Teacher roles

As a specialised distance provider for many years, D-school teachers are accustomed to acting as researchers, mentors, and facilitators rather than directors (WT):

> We see ourselves as carrying out a guided conversation with the student.

Workflow management, process, and authorisation

The management of copyright for the official repository emphasises the need for a quality assured process when creating or transferring materials. At a high level, D-school has their existing DNA management model to work from, and this has proved robust and adaptive to the challenges of new media. At a detailed level, some of the processes are still a work in progress. SM mentions that for the new multimedia team, some of the processes have not evolved completely.

> So we haven't got to a process where we are thinking great this is going to work for everything we do and it's the best way of doing things... It's a continuous iterative process.

Moving from the overall business of the school to the processes associated with managing specific learning materials, we also found that D-school had existing, mature processes that could be adapted to new media and an RLO approach. The school is adapting their existing processes to manage the development and maintenance of learning objects for the "official" repository. ER:

> Currently we have a revisions process, and basically ... it's only the level of curriculum leader or faculty leader who can authorise those changes.

Our interviewees noted that there is significant potential for tension between achieving appropriate levels of control and authorisation and achieving the desired degree of agility and flexibility. This had been observed in the experiences of other RLO repository initiatives around the world. One Australian repository is very tightly controlled, as RU noted:

> If you look at the learning materials repositories around the world, there are a number of different approaches to it. There's approaches like the learning federation in Australia, where everything is totally controlled. Everything that goes into that repository is locked down. It is very difficult to get stuff on there; they have a long birthing process.

In summary, D-school has extensive organisational knowledge and existing processes relating to developing and managing learning objects. Despite this, some tension remains between appropriate controls and agility. The two-repository model, with minimal controls on the unofficial repository, is allowing experimentation with the workflow management, processes, and authorisations required for RLOs.

Timeliness

A key theme from the majority of interviewees was the need for speeding up the content development process. This is sometimes noted as an issue in marketing material provided by RLO system vendors, but it has not been a major issue in the research studies we were able to identify. RU noted that the time taken to develop material in some overseas repositories was perceived by D-school as a major weakness, because by the time the materials are out, the lifetime of the learning object is shortened considerably.

> The [Australian repository] approach is great, because you know you have Quality Assured materials, but the bad thing is they only produce a very small number of them, and it takes a long time for them to come, and if you want something that is relevant at a certain stage, then you may be out of luck.

FS and SM noted that development time for a set of multi-media objects, which previously took a year on average, had dropped to approximately three months. In describing their roles, both FS and RU mention that one of the major tasks they have is focusing on keeping everything on time.

Summary

Table 1 provides a summary of the issues identified from our literature review, the extent to which they were an issue for our case organisation, and the strategies employed to manage the issues.

Table 1: Summary of issues and organisational strategies

RLO repository standards and design features	Sources	Issue for D-school?	Organisational Strategies employed by D-school
Granularity	(AberdeenGroup, 2001; Hiddink, 2001; Sprague, 1995)	Yes	Offer support within the RLO repository for multiple layers of granularity from small, generic items of content (for example, a single image) to larger modules and courses.
Genericity and layered contextuality	(Geissinger, 2001; Hiddink, 2001; Kinshuk & Russell, 2001)	Yes	Develop individual components to be as generic as possible, allow context to be added by individual teachers when combining small RIO's into larger RLOs.
Version control	(AberdeenGroup, 2001; Downes, 2007; Sprague, 1995)	Yes	Create new versions rather than modifying existing objects to preserve the integrity of existing objects for their users. Retire old versions as they become redundant. Two-repository approach supports both a co-creation and a more controlled model.

Metadata	(Fleming, 2001; Hiddink, 2001; Nash, 2005; Rada, 2001; Yordanova, 2007)	Yes	Follow international standards, and allow meta-data to be applied to multiple layers of RLOs as they are grouped together to add context.
Central repository	(Hiddink, 2001)	Yes	D-school has adopted a two-repository solution. One repository is tightly controlled and contains larger RLOs intended for formal, planned reuse, within D-school and externally. The other repository is unofficial and loosely controlled. Teachers need to follow meta-data standards when storing RLOs, but otherwise can create, store and reuse materials freely and flexibly.
Organisational culture and process	**Sources**	**Issue for D-school?**	**Organisational Strategies employed by D-school**
Organisational culture	Weiss et al, 2004	No	Creating and managing reusable learning content, incorporating new media is already a core organisational competency
Teacher role	(Cohen & Nycz, 2006; Craig et al., 2008; Lockyer & Bennet, 2006),	No	A less directive role than that of a traditional classroom teacher was already part of the culture.
Workflow and process management	(AberdeenGroup, 2001; Morgan, 2000; MSI Systems Integrators, 2002; Wu & Liu, 2001)	Yes	Finding an appropriate balance between control and agility is an issue, but this is facilitated by the two-repository approach. D-school has existing expertise in the development and management of reusable learning materials, and these form the basis of new processes to support the RLO strategy. The RLO strategy has not changed the core business model of the organisation, although it has had a significant impact on the Design, Development, and Deployment of materials. At a detailed level, some processes for digital and multi-media RLOs are still a "work in progress."

Security & authorisation	(AberdeenGroup, 2001; MSI Systems Integrators, 2002; Sprague, 1995)	Yes	Apply controls only where appropriate and where legal issues (e.g. copyright) or pedagogical issues (e.g. quality assurance of modules intended for extensive reuse) require it. Otherwise foster agility, flexibility, and experimentation to promote learning, develop buy-in to the RLO approach, and allow time and cost effective production of RLOs.
Timeliness	No	Yes	Remove obstacles and controls on experimentation. Only introduce controls as processes mature and become more widely implemented, or for learning materials intended for the public domain.

Lessons Learned

Organisational Process and Culture

A balance must be achieved between exercising appropriate controls and fostering a culture of agility, flexibility, and timeliness when developing RLOs.

D-school is an established distance and flexible educational institution, with an international reputation as a distance educator and a history of successful adoption of new media. This has facilitated many aspects of the successful transition to a RLO approach. The creation and management of reusable educational content was already a core organisational competency and had been for many years. The RLO approach does not represent a change to the core business model of the organisation. D-school had existing processes for workflow management, security, and authorisation that could be adapted to the production of RLOs.

This experience suggests that established distance educators, rather than software vendors or organisations specialising in other business domains, may have significant advantages in successfully implementing RLO initiatives. A compatible cultural environment, which supported co-creation of resources, and teachers who viewed themselves as guides, mentors, and facilitators already existed. To avoid cultural conflict, a primarily face-to-face teaching organisation contemplating an RLO strategy should perhaps consider implementing a separate RLO unit initially.

D-school has balanced agility with control by allowing relatively uncontrolled creation, sharing, and use of RLOs within the organization, while using existing quality assurance processes for RLOs that are to be used externally or that will be widely re-used for a large number of students. This ensures that time and resource intensive control processes are only used where they are necessary and appropriate.

Repository Standards and Design Features

D-school has opted for a high degree of granularity and genericity. The lowest level repository items, RIOs, are highly granular, highly generic components, with the context stripped off. This offers a high opportunity for re-use and addresses a common problem with repository strategies, that re-use is low because the context is subtly different. In the D-school approach, nested layers of context (up to 5 layers) can be added by the user of the materials. The new, recontextualised

RLO can also be stored. Future users may chose to re-use these larger nested groupings, if they are appropriate, or to decontextualise the contents and recontextualise them, depending on their requirements. This needs to be supported by sophisticated and rigorous meta-data standards that allow RIOs and RLOs at various levels of context layering to be identified.

By way of example, an image of the famous Maori church, Rangiatea, near Otaki, New Zealand, might be an RIO. One layer of context might be added in the form of a brief description of the history of the building. A further layer might be added that considered the building from an architectural perspective. This might be extended into a learning module that included exercises and discussion topics. In the future, the image of Rangiatea and the brief description (an RIO with one layer of context) might be included in a module about the history of the Otaki region. Different context would be added to support the different learning objectives.

In summary, organisations implementing an RLO repository need to seek a balance between objects that are too large and contextualised, limiting re-use, and objects that are small, granular, and context independent. This is achieved by supporting nested layers of context. The granular lower level objects and higher-level groupings need to be supported by rigorous meta-data standards that recognise the nested layers of context. You need to be able to find the object you are seeking, before you can reuse it.
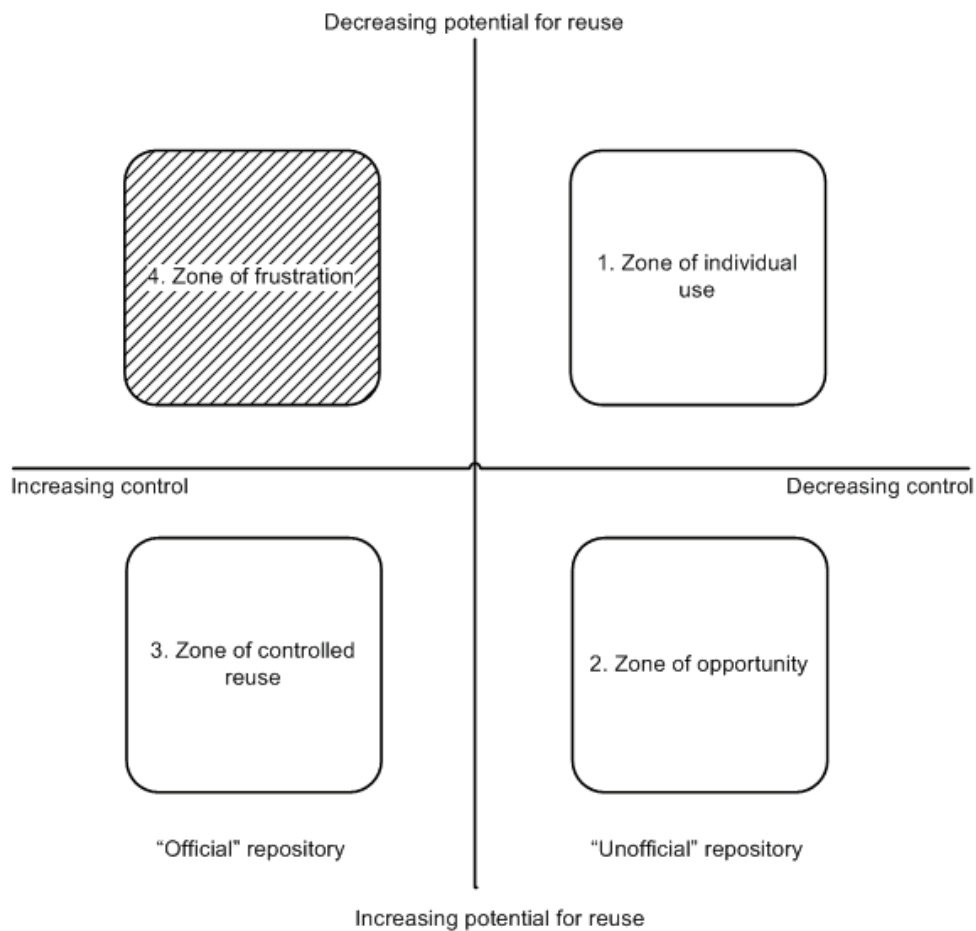

Figure 4: The "Zone Model" for effective RLO management

A Model for Effective RLO Management

Based on the lessons learned from D-school, we developed the "zone model" for RLO management (Figure 4). This models the tension between control and flexibility and between low and high re-use.

Zone 1, the zone of individual use, is relatively uncontrolled, with low potential for re-use. This zone describes the real or virtual classroom of an individual teacher running a course. It is uncontrolled, because so long as teachers follow the curriculum they are largely free to select examples, illustrations, and images, set exercises, and develop informal assessments and concept checks. These might vary from one day to the next. The potential for re-use is low because it is ephemeral, regularly changing, and determined by the style and day-to-day choices of the individual instructor.

Zone 2, the zone of opportunity, is relatively uncontrolled, with high potential for reuse. This zone describes the permanent digital materials developed and used by individual teachers. This could include images, text objects, exercises, quizzes, assessments, or other learning materials. If these materials are stored in a repository as RIOs and RLOs, they are available for "discovered" re-use by other staff members. If a strategy of nested layers of context is followed, the reuse opportunities are increased, as the objects can be reused in contexts different from those for which they were originally created.

Zone 3, the zone of controlled reuse, is highly controlled, for objects known to have a high level of reuse (for example, course materials that are sold commercially or provided to other institutions, or that form part of a core curriculum with a large student numbers). Objects in this zone will be extensively quality assured and conform fully to all applicable standards. As these processes can require extensive time and resources, they are reserved for situations where they are really necessary and not applied to the informal development and sharing of materials.
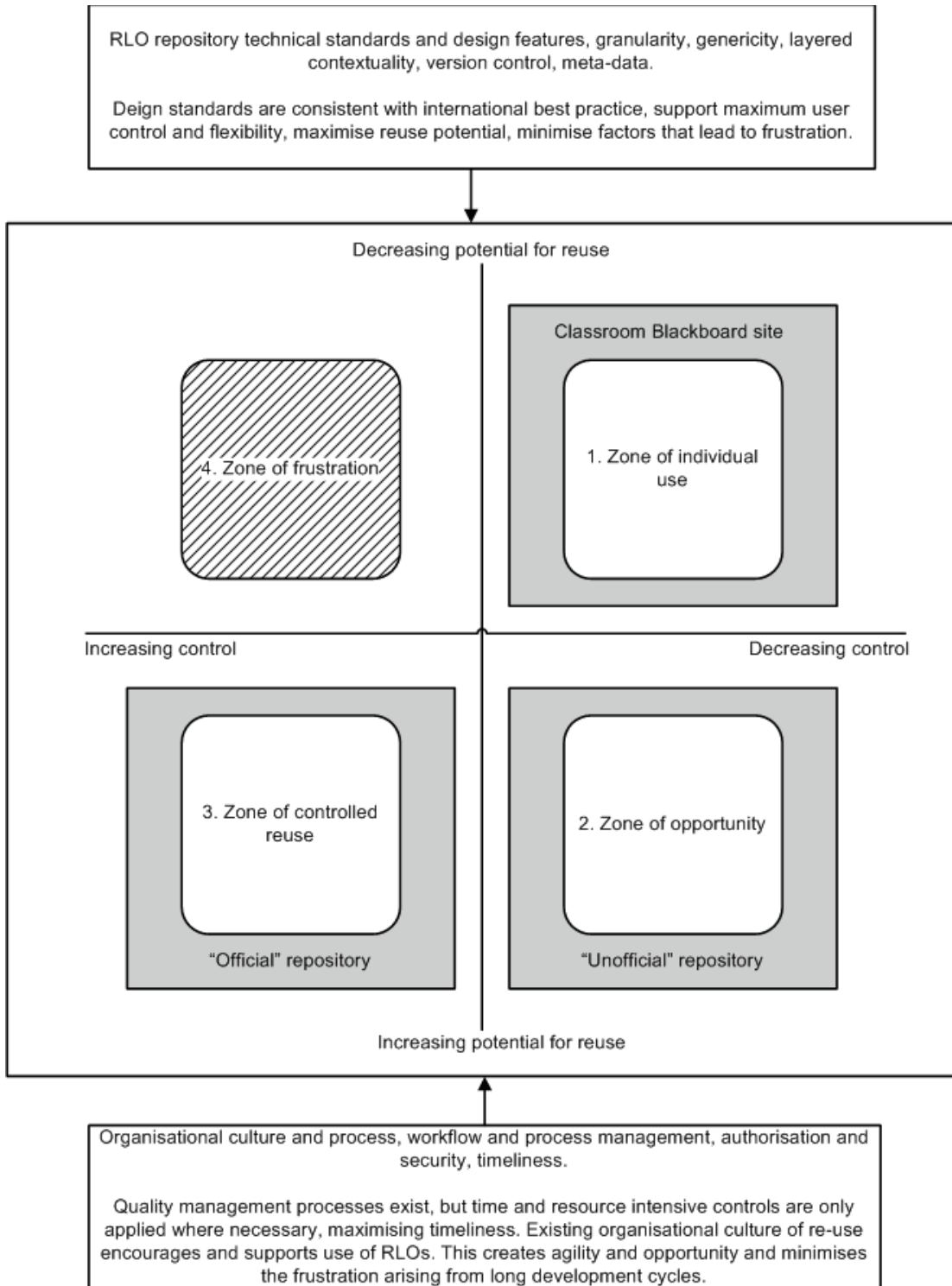
Zone 4, the zone of frustration, is highly controlled, with low potential for re-use. This zone occurs when excessive controls are applied to the development of objects with low re-use potential, or when objects are too large and cannot easily be de-contextualised and re-contextualised, limiting the reuse potential. RLO strategies should try to avoid having objects in this zone.

Implementing the zone model at D-school

The challenge for organisations is to implement the zone model effectively to address the management challenges posed by their RLO strategy and, in particular, to avoid the frustrations of over-large and highly contextualised objects, which limit the opportunities for reuse, or of overly long development cycles with excessive management controls that increase costs and risks and may produce objects that quickly become dated.

The D-school implementation of the zone model is shown in Figure 5. At D-school, Zone 1 is implemented by the Blackboard distance teaching and flexible learning product. Teachers chose what objects will be used in this environment and change them on a regular basis based on the dynamics of each class. For example, if the class were struggling with a concept, the teacher might decide, in response to questions, to provide additional examples and practice exercises.

The "unofficial" Lotus Notes repository provides D-school with an effective implementation of zone 2. Staff can store RIOs and RLOs in the repository at will and can add, remove, and alter context flexibly and with minimal control (so long as meta-data standards are followed). This has resulted in rapid, agile, and flexible population of the unofficial repository so it has become a significant resource of potential RIOs and RLOs in a short period of time. These objects become a source of opportunity for the organisation. The D-school implementation is also supported by an existing organisational culture and history of re-use.

RLO repository technical standards and design features, granularity, genericity, layered contextuality, version control, meta-data.

Deign standards are consistent with international best practice, support maximum user control and flexibility, maximise reuse potential, minimise factors that lead to frustration.

Decreasing potential for reuse

Classroom Blackboard site

4. Zone of frustration

1. Zone of individual use

Increasing control   Decreasing control

3. Zone of controlled reuse

2. Zone of opportunity

"Official" repository   "Unofficial" repository

Increasing potential for reuse

Organisational culture and process, workflow and process management, authorisation and security, timeliness.

Quality management processes exist, but time and resource intensive controls are only applied where necessary, maximising timeliness. Existing organisational culture of re-use encourages and supports use of RLOs. This creates agility and opportunity and minimises the frustration arising from long development cycles.

Figure 5: The D-school implementation of the "Zone Model"

The official, fully quality assured repository provides D-school with an implementation of zone 3. Rigorous quality engineering processes are applied to populating the official repository. These can be time and resource intensive and are applied only when the level and nature of the reuse (for example, materials planned for wide distribution to other schools) justify the time and ex-

pense. Furthermore, the quality assurance time is reduced by the fact that a prototype of all or some of the material has already been tested in the unofficial repository. Materials in the unofficial repository that are proven to be popular and effective can be re-engineered to meet the quality standards for the official repository, reducing the risk of failure. At D-school, existing organisational competencies and quality assurance processes have been adapted to enable the population of zone three with fully quality assured RLOs.

This implementation also means that D-school can largely avoid having objects in zone 4. Unnecessary and frustrating controls are minimised by the use of the unofficial repository. Larger, more highly controlled and more highly contextualised objects from the official repository can be reused where appropriate. For example, a school with no Spanish teacher might chose to use modules from the official repository for students to self-study, confident that the material is quality assured and covers the syllabus. In other situations, larger objects from either the official or unofficial repository can be broken down into smaller, more context-independent objects. Version control also allows people re-using an object to modify it and create a new version without affecting the integrity of the original. This greatly extends the re-use potential of objects in the official repository.

The two-repository concept

A cornerstone of the D-school approach is the two-repository concept. The unofficial repository is a Lotus notes environment that staff members can store RIOs and RLOs in and select materials from in an uncontrolled fashion. Meta-data standards must be used when depositing materials in the repository, and version control is embedded in the repository environment, but otherwise, little control is exercised over what is placed there and how it is used.

This experience suggests that organisations seeking to implement an RLO repository should support an informal, prototyping environment. This allows experimentation, creativity, relatively rapid development by non-specialists, and fosters "discovered re-use", where staff browsing the repository find materials of interest and value in other contexts than those for which they were originally developed.

A formal, highly disciplined environment with extensive controls should be reserved for materials where the re-use requirement is well established and where the controls are necessary for legal, commercial, or copyright reasons.

In both cases, the application by D-school of international best practice in terms of repository technical standards and design features has been essential to success. Appropriate levels of granularity, nested layers of context, consistent use of internationally based meta-data standards, and implementation of sophisticated and flexible version control are all essential if the RLO approach is to be successful.

Relevance for Research and Practice

The study was based on a single case study of an exemplar organisation. We believe that the applicability of the RLO management issues, the lessons learned, the zone model, and the two-repository implementation is potentially useful for organisations implementing an RLO strategy, but it needs to be evaluated in other organisational contexts.

One interesting question for future research is the degree to which the availability of learning object technologies contributes to building a culture of sharing. Organisations such as D-school, with an established culture of sharing learning materials and resources, are the exception. However, an increasing number of organisations, including many tertiary institutions and private sector organisations, are implementing web-based training and e-learning technologies such as

BlackBoard™ and Moodle™. Many textbook publishers in the tertiary sector make supplementary learning objects, such as presentation slides and multi-choice question banks, available to faculty members who order their texts. Increasing use of these resources may lead to a cultural change with regard to RLOs. It may be that e-learning technologies increasingly begin to act as informal repositories – zone 2 in our model. However, specialised subject matter may limit the degree to which objects can be reused in different contexts.

Managing granularity, contextualisation, and reuse are not issues that are confined to leaning objects. Other disciplines, such as communication and linguistics, and software, also address these issues. It would be valuable to see what insights could be obtained from examining studies of context and granularity in other fields.

Conclusion

Despite the limitations of a single case study, we consider the experiences of D-school are of considerable interest and value for both research and practice. Our literature review and several of our interviewees suggested that RLO repository initiatives have the potential for many issues that cause frustration. In this paper we identify the key management issues and suggest strategies and a management model for addressing them. Based in insights from D-school, we offer a way out of the "zone of frustration" for organisations. This opens the way for organisations to achieve the benefits promised for RLOs: lower costs, faster production time, and higher quality.

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