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# Digital libraries and their use in e-learning

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**Abstract**

*How e-learning providers do business and produce content has changed dramatically over the past few years. Technology advancement and increased use of broadband coupled with the need to develop content optimised for size, richness and personalization have been key drivers. Due to the high costs associated with producing content, much progress has been made adapt old material to courses that may apply a different style guide. The fact that there are millions of duplicating courses covering the same material across the world, which cannot be re-used or shared, is an issue we discuss in this paper in the context of elearning and digital libraries. We look at some of the ways in which this can be addressed and some of the problems associated with the area such as cost, re-creating material to the new standards and good meta-tagging for particular communities of practice.*

## 1. Background

The focus of nearly all e-learning material to date has been linear, by which I mean it starts at point A and progresses to point Z without exception. In the current evolving learning environment there are many changes taking place in terms of the quality and richness of learning objects with a user focus. The legacy e-learning curriculum has become dated with little scope and ability to change and reflect the requirements of the user or even assess the user effectively. Ubiquitous computing has also brought with it many more challenges which it is thought the use of digital libraries can address due to the ability to effectively store and accommodate varying learning object types.

In this paper we illustrate one of the evolving processes whereby learning objects should be able to be shared and collected by digital libraries whether they be academic or industry based. There are other issues being targeted here in the area of dynamic creation of courseware with optimal learning objects to facilitate the blended learning environment. There is now more of a technology drive than a pedagogy drive. This is aided by the fact the technology is being driven currently by WEB 2.0, is heavily supported by the pedagogy models and the theories of the Social Constructivists including Vygotsky. This now facilitate a user driven collaborative approach applied.

## 2. What is the Problem?

There is no one problem! There are several major challenges to be overcome in order to get digital repositories initiated, built, collaborating and updating digital objects. This will include metadata standards, which must be driven by:

1. Real sharing potential of learning objects and metadata: It is essential that developed learning objects must be sharable and re usable to a high degree.

2. Digital Library standards: It is essential a standards based approach be applied to this area similar to that for e-learning.

There are several terms that are used to describe and define a digital library; they are often used interchangeably and we list some of these below with some background to their origins.

These are:

1. Digital Repository Definition:
   This is where digital content like pictures, notes, mp3 files etc are stored in an ordered manner so as to allow import, export and storage.
   http://www.jisc.ac.uk/media/documents/programmes/digitalrepositories/repositoriesbp2005further.pdf

2. Eportfolio:
   An eportfolio can be a web-based information management system that uses electronic media and services. The learner builds and maintains a digital repository of artefacts, which they can use to demonstrate competence and reflect on their learning. Having access to their records, digital repository, feedback and reflection students can achieve a greater understanding of their individual growth, career planning and CV building. Accreditation for prior and/or extra-curricular experiences and control over access makes the eportfolio a powerful tool. (http://www.danwilton.com/eportfolios/whatitis.php )

3. Digital Library Definition:
   A digital library is a collection of documents in organized electronic form, available on the Internet or on CD-ROM disks. Depending on the specific library, a user may be able to access magazine articles, books, papers, images, sound files, and videos.
   (http://whatis.techtarget.com/definition/0,,sid9_gci750204,00.html)

4. Digital Portal Definition:
   There is no common agreement as to what a portal is. Many point out that the word means doorway (often taken to be a grand doorway such as that found at the main (west) door of a cathedral), with the implication that a portal is simply a way of accessing a number of services, but as Strauss has stated "*A Home Page Doth Not A Portal Make*". By which he means that it is not enough to simply bring a number of different channels or information sources together on a web page, there is a need to provide some degree of integration and customisation. He goes on to describe a portal as a "*Customized Personalized Adaptive Desktop*" and it is worth exploring what he means by each of these terms before looking at some of the implications for how one might build a portal, and equally how one can set about shifting the entire organisation from where it is now to having a portal.

   - *Customised* – The portal adapts to the user, and the more it knows about the user the better it should be able to adapt to their needs, whether the user is a member of teaching staff, administrative staff, a researcher, a student or a prospective student (or someone who occupies several of

those roles – for instance a post-graduate student who also teaches). It should also be able to adapt to the type of hardware that the user is currently using (PC on a LAN, PC on a dial-up line, Personal Digital Assistant (PDA) or smart phone). This should be done as the user logs into the portal.

- *Personalised* – Allows the user to change the portal's interface and behaviour to meet the user's needs and preferences. This would include the appearance (colours, fonts, size), channels subscribed to and their location on screen.

- *Adaptive* – Changes its behaviour depending on context. Many people will have multiple roles, and will present information or channels depending on activity. It will also have an understanding of time and be able to support workflows for example around marking exam papers.

- *Desktop* – It replaces the desktop environment, hiding the operating system by providing access to all applications and information that the user needs regardless of whether these are local or networked. (http://www.franklin-consulting.co.uk/PortalDefinition.html)

5. Digital Collections Definition:
   This is an electronic Internet based collection of information that is normally found in hard copy, but converted to a computer compatible format. Digital books seemed somewhat slow to gain popularity, possible because of the quality of many computer screens and the relatively short 'life' of the Internet. (http://www.africandl.org.za/glossary.htm)

6. Learning Objects Definition:
   Learning objects are digital content that can be used and reused for teaching and learning. They are modular, flexible, portable, transferable (interoperable) and accessible. Learning objects may be used to teach a particular skill or concept, or to provide stimulating thinking and learning experiences for the teacher or student. A learning object, as defined by SCORE, includes digital content, practice activities and assessment tools that are linked to one or more educational objectives and classified in a plan that allows information about the content to be stored and retrieved (metadata schema). For teaching and learning purposes, effective learning objects use documents, interactivity, graphics, simulations, video, sound and other media tools that go beyond static textbook presentations to engage students in real-world content.
   (http://www.sreb.org/programs/EdTech/pubs/PDF/05T03-PrinciplesEffectiveLO.pdf )

7. Ontology Definition:
   In information technology, an ontology is the working model of entities and interactions in some particular domain of knowledge or practice, such as electronic commerce or "the activity of planning." In artificial intelligence, an ontology is considered the specification of conceptualizations, used to help programs and humans share knowledge. In this usage, the ontology is a set of concepts - such as things, events, and relations - that are specified in some way

(such as specific natural language) in order to create an agreed-upon vocabulary for exchanging information.
(http://whatis.techtarget.com/definition/0,,sid9_gci212702,00.html )

**3. E-learning Standards**

It is essential that we have standards in place in e-learning so that we can apply and create quality content and to that extent we identify a number of relevant standards.

These are:

1. SCORM:
   The Sharable Content Object Reference Model (SCORM) was first developed by the U.S. Department of Defense (DOD) to address training development and delivery inefficiencies across its service branches.
   (http://sorubank.ege.edu.tr/~e190411147/scorm/scorm4.pdf)

2. LOM:
   Any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. Examples of technology-supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. Examples of Learning Objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning.
   (http://www.ibm.com/developerworks/xml/library/x-think21.html)

3. AICC:
   The Aviation Industry CBT Committee was originally designed to standardize instructional material for aircraft manufacturers and buyers. AICC covers the way in which content units (learning objects) communicate with learning content management and Learning Management Systems.
   http://www.centre-inffo.fr/pdf/adapt/adapt2001_chap4_angl.pdf

4. ISM:
   The Instructional Management System has been working as a group for four years. The oldest section covers metadata tagging i.e. the tagging and identification of content. Other specifications include enterprise, content packaging, user profiles and question and test. The IMS Metadata specification may soon have the distinction of being the world's first official e-Learning standard since it has also been included in the IEEE and ISO standardization process.
   http://www.centre-inffo.fr/pdf/adapt/adapt2001_chap4_angl.pdf

5. CANCORE:
   The CanCore guidelines for the implementation of learning object metadata provide an element-by-element guide to interpreting the semantics and syntax of all elements in the IEEE LOM. The aim is to simplify and interpret this standard in order to help implementers and record creators with design, development, and indexing work. If CanCore's recommendations are used as a basis for LOM

interpretations and implementations generally, the potential for the interoperability of LOM implementations will be greatly increased.

The main problem with the standards that have evolved is that developers and academics must for the most part conform to one as they are all different and one cannot switch between standards easily if at all. There is an additional problem with standards and that is to what extent a standard is applied. To that end we examined six leading e-learning companies who advertised their content as conforming to SCORM. However, the SCORM standard is huge and developers seem to only apply part of the standard or part of LOM, itself a subset of SCORM. This leads to the illusion of having applied a standard when in fact no standard was applied completely. So what quality mark should these products have or be allowed to advertise? Who knows for sure, but there seems to be a level of compliance accepted in the industry (http://standards-catalogue.ukoln.ac.uk/index/CanCore).

## 4. Digital Library Standards

We hoped, with the many standards that exist in e-learning content development, that the digital library standard practitioners would have learned a lesson and have one world wide accepted standard, but this is not the case. We find several examples exist which were all developed in isolation with little or no consideration for other standards that exist currently. Some of these examples around instructional digital libraries came about from what was initially a standalone system, which never envisaged the possibility of interlibrary cooperation and sharing digital media. More information may be found at www.ifla.org (2005). As yet I have not found any digital library standard which can clearly standout as a defacto standard, so it would seem a lot more work will have to go into this evolving area.

This has been a steep learning curve with regard to what is expected in the digital library and what we have included. As things stand, we are still refining our digital library model and will continue to refine it until we are happy with what is currently being stored and what indexes are used so as to allow us to have all data related to objects captured sufficiently.

***Sample Digital Library Structure and content for an e-learning package***

1. Topic
2. Description
3. Sections
4. Media
    a. Source
    b. Options for reuse and existing places used.
    c. Proof of availability
    d. Ownership
    e. Licensing
    f. Cost
    g. Payment Method
    h. Optimum speed of access and use
    i. Ability to apply Style guide
5. Types supported currently and in the future as yet not known
6. Handles or tags: Specific topics covered
7. Context
8. Modality for Delivery
9. Format
10. Conversion speed
11. Assessment of topics
12. Assessment of Specific areas (level 1-10)
13. Depth of assessment
14. Level of adaptability
15. Feedback
16. Author
17. Version number
18. Date Created
19. Where Used

*Figure 1: The above fields were the starting point for the digital library we created from scratch. Initially we had 90 fields but very quickly found the majority were unsuitable for the purpose intended.*

## 5. Information Architecture

The initial information which aided us in our research to structuring and consideration came from Arms (1997), Hastings and Tennant (1996), Roberts (2005).

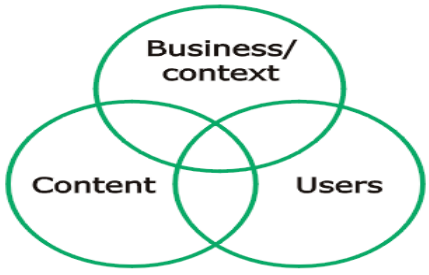


*Figure 2: The Information Architecture of a Digital Library*

The issues to be addressed in structuring information within a digital library include the following:

- Digital materials are frequently related to other materials by relationships such as part/whole, sequence, etc. For example, a digitized text may consist of pages, chapters, front matter, an index, illustrations, and so on. In the World Wide Web, a typical item may include several pages of text, with embedded images, and links to other information. A single computer program is assembled from many files, both source and binary, with complex rules of inclusion. Materials belong to collections. These may be collections in the traditional, custodial sense; they may be the on-line groupings provided by a publisher; or they may be the pages maintained by a Webmaster.

- The same item may be stored in several digital formats. Sometimes, these formats are exactly equivalent and it is possible to convert from one to the other (e.g., an uncompressed image and the same image stored with a loss-less compression). At other times, the different formats contain different information (e.g., differing representations of a page of text in SGML and PostScript formats).

- Because digital objects are easy to change, different versions are created continually. Indeed, some organizations change their Web home page several times per month. When existing material is converted to digital form, the same physical item may be converted several times. For example, a scanned photograph may have a high-resolution archival version, a medium quality version, and a thumbnail.

- Each element of digital information may have different rights and permissions associated with it.

- The manner in which the user wishes to access material may depend upon the characteristics of computer systems and networks, and the size of the material. For example, a user connected to the digital library over a high speed network may have a different pattern of work from the same user when using a dial-up line (http://www.dlib.org/dlib/february97/cnri/02arms1.html#info-arch ).

A digital library (figure 3) and its subcategories could facilitate context, different devices of differing characteristics, modality. They may require objects, standards notes or even notes in different languages.

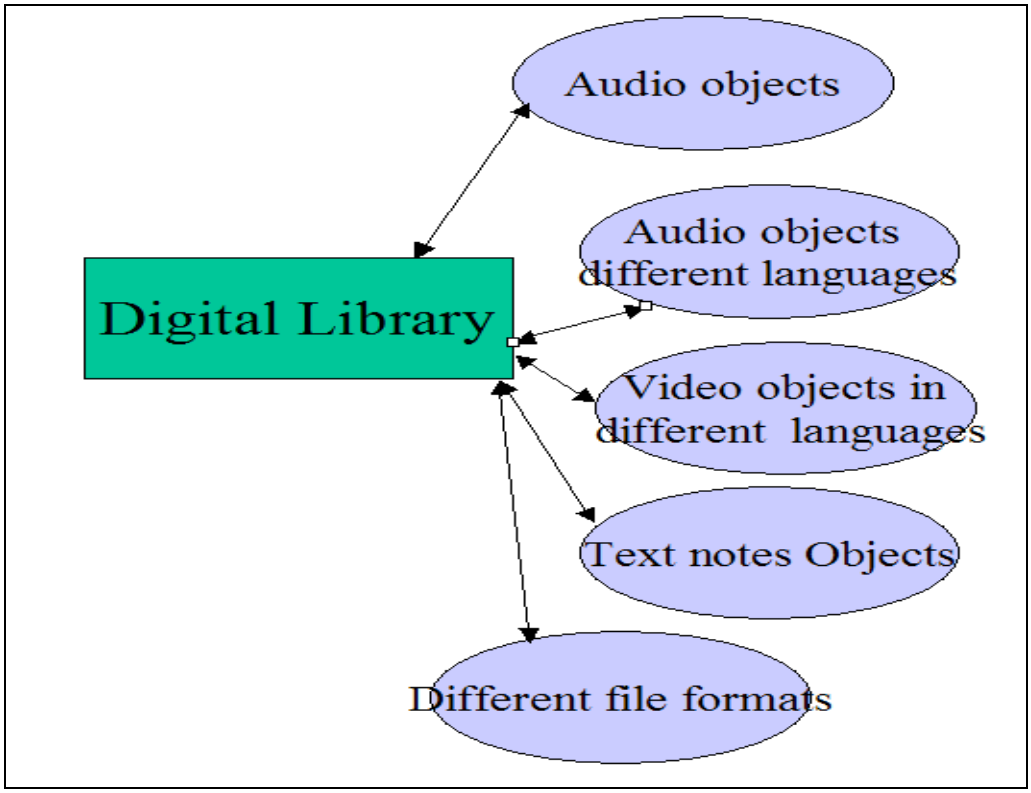


*Figure 3: Simplified outline of a Digital Library and subcategories*

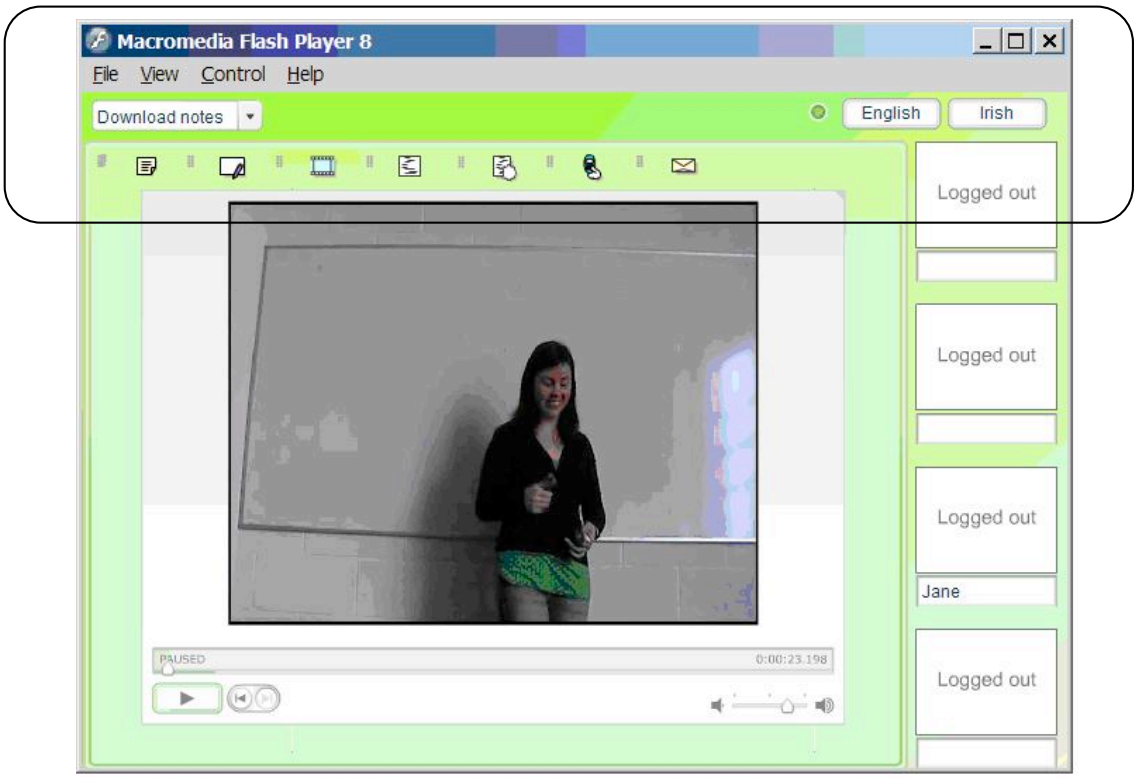


*Figure 4a: The above screen is designed to help students with Dyslexia use the system.*

As can be seen clearly in figure 4a, there are intuitive icons; the screen indicates the modalities available that someone with Dyslexia can best avail of and learn from. Dyslexia is very complex so we have had to make some appropriate assumptions in our research. What was achieved was the optimisation of the UI in this context by the changing of the interface colour to one that suited the users preferences plus much text was removed as possible from the menus.

We also provided three versions of the notes.

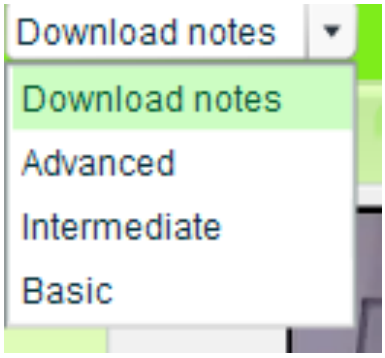


*Figure 4b: Screen indicating the additional types of notes available to users depending on the level of detail or text required.*

Our intention is that the '*levels* of information' is the same within both the set of notes and the bullet point versions. One set of notes with bullet points, as in PowerPoint slides, would also be preferable to this type of user as well as being used as study notes for all students. There were also more media rich options here than in other individual profile types, plus easier access to the media rich wiki and blog.

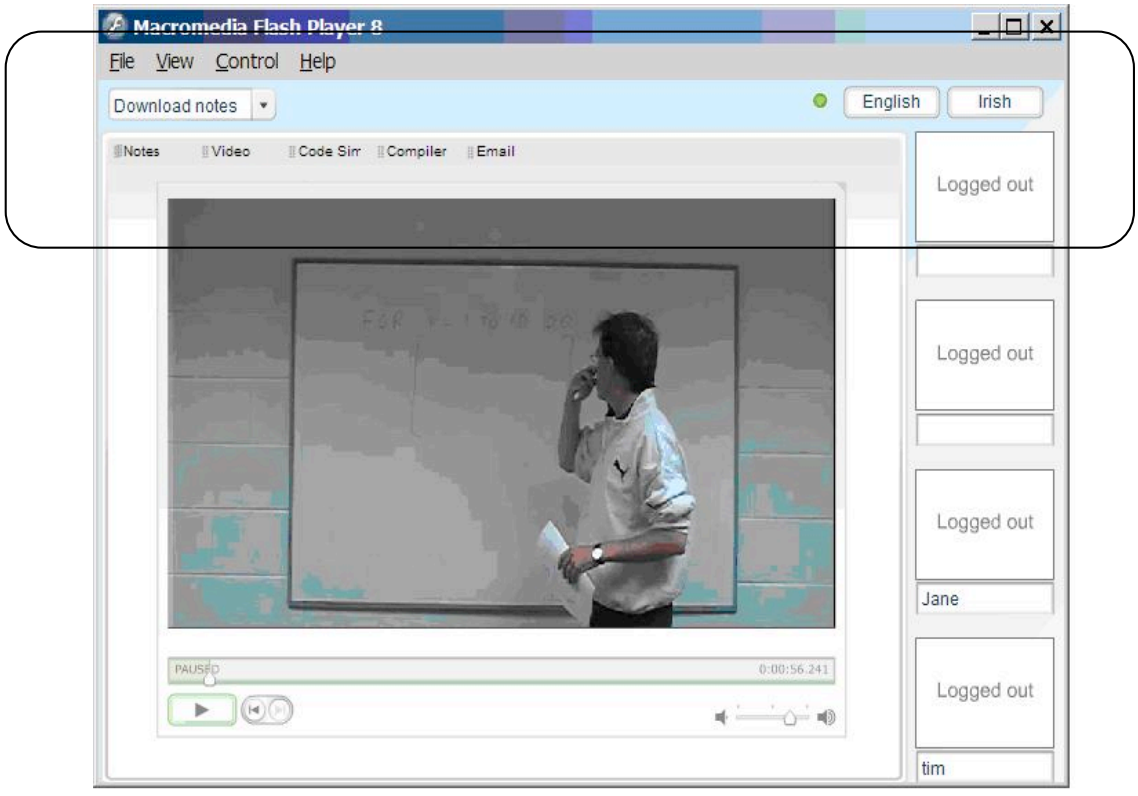


*Figure 5: Application screen from our profile-based digital object based system*

The screen in figure 5 came from an application within our profile-based digital object system that user surveys indicated would suit mature students and their particular needs. The modalities available in this example (figure 6) are different from the modalities in the other screens (figures 4a and 5).

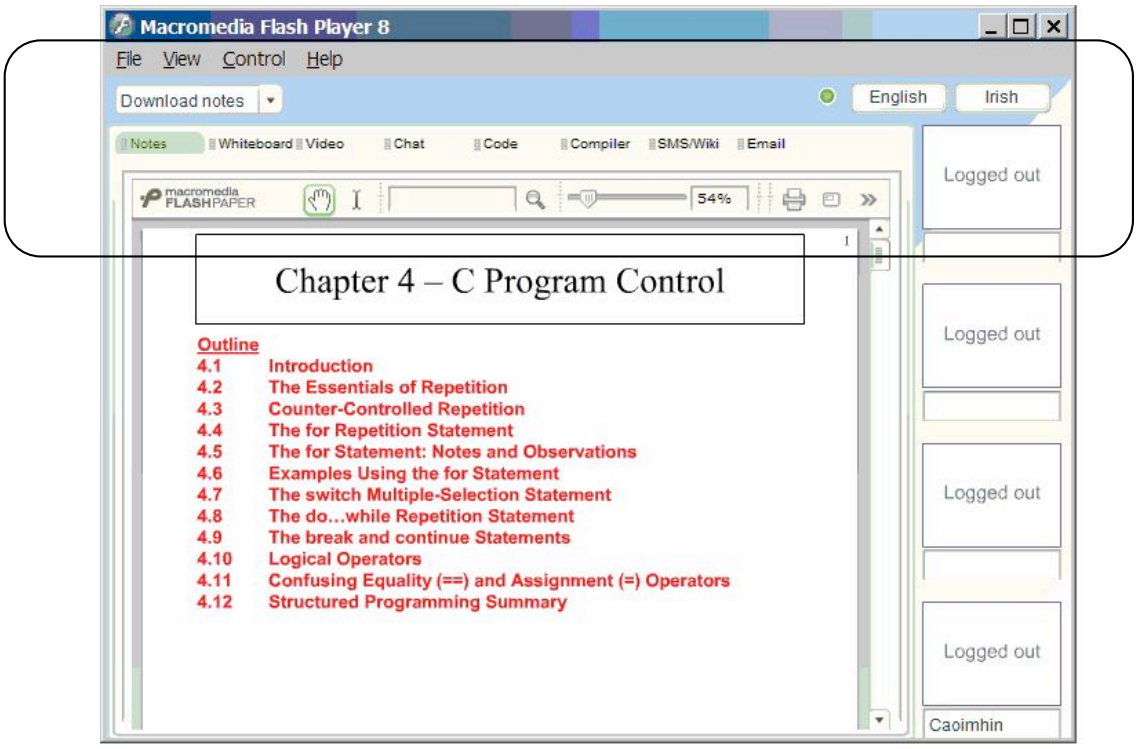


*Figure 6: The screen for the non-Dyslexic and non-Mature student*

The screen in figure 6 indicates the screen that would normally appear for the non-Dyslexic and non-Mature student.

The three versions of the application were only possible through the existence of a sizable digital library and use of profiles, where we can change all test notes depending on the type of student, languages and context required. We have language support for Irish, English, French, German and Swedish. This requires additional object categories and specific digital libraries relating to vocabulary, video, audio etc. The first screen, which was for the Dyslexic student, was created for a female student who specified they wanted their lecturers to be female also, so we had to have a complete set of learning objects for that subject done by a number of female lecturers to be able to deliver in the languages supported in this element of the research. This had a major effect on the storage required and the file formats for different types of video. All of these are aspects and considerations to be taken into account when building a digital library. This gave us some idea of the storage structures that we would need to support additional objects for mobile devices like laptops and mobile phones and handheld tablets. Ultimately much time and space could be saved if one format could be used in all situations or adapted to facilitate the different situations and contexts.

Figures 4a, 5 and 6 represent device or user specific examples of screens that illustrate dynamic screen creation for specific users with different learning styles based on a profile and used in conjunction with a digital library. The screens are from our application that allows dynamic screen generation. This application could, from our experiences, do with more extensive objects in our digital library so as to make the application more scaleable (Wiley 2002) and better reflect the user context.

The complexities associated with placing a photo on a screen in a course must be addressed. There are issues and challenges to do with the types of object created, or searched for across the Internet. Complex search must be achieved very quickly to allow even basic dynamic screen generation to take place. Additional complications will also be present when some objects are created with Flash, Java Script, Java or any of the arrays of tools for creating web content like Dreamweaver etc. These different types of object may not work well together and could well cause transition and integration problems. Ideally, we must not distract the user and cause them to lose concentration. There are many courses on the web like those offering, for example, C programming, and have hundreds of learning objects available from all over the world. We need to be able to use the 'handles' or tags to limit our search. Another issue in this area is the diverse use of tags to describe an entity. This can cause many problems when trying to find suitable objects. We may have to actually physically check the suitability of an object before deployment. It is hoped that a means of solving this issue can be done using new Web 2.0 technology.

These objects must not only be suitable in terms of content, context and user but must be ultimately able to fit into the environment framework.

## 6. Our rules governing addition of new objects and resources

The important contribution we make to this area is in putting forward our own '*selection and addition*' process to maintain quality of our resources and learning objects along with quality in the links to other libraries. We do this to provide the most suitable and effective resources. Some of our considerations are:

1. The tag must match the description of the subject matter being collected to a high degree and provide sufficient detail for an easy decision to be made
2. The creation date of the objects must be stated.
3. The expiry date must be stated.
4. The file formats must be known
5. The size of the object must be known and usable
6. The time to play must be acceptable so as to fit into our course seamlessly
7. The style guide of the objects must be capable of adapting so as to create a standard style guide which applies our instructional design.

## 7. Problems with using digital libraries

Just as when creating a library, we have several considerations before we can start to populate a library. As with a standard library, these relate to the media and whether they are fiction or factual, and within the fiction categorisation the books are in one of the many areas like murder, comedy, mystery, adventure etc. Digital Libraries are no

different and practitioners who have created databases will need to have considered much of the same structure issues.

Most of these issues relate to:

1. How best to store similar topics together in the one place
2. How to find books which match your criteria best and in the shortest possible time. The time and searching aspect are most important when trying to create courseware from multiple libraries instantly.
3. Objects offering different perspectives of the proposed profile based material which can reinforce the information and lessons learned.

Important headings relating to digital object storage in a digital library include:

1. Sharing
2. Tagging
3. Content Descriptions
4. Ownership
5. Licensing
6. File formats
7. Seamless Integration

With digital libraries, an individual can:

- Gain access to the holdings of libraries worldwide through automated catalogs.
- Locate both physical and digitized versions of scholarly articles and books.
- Optimize searches to simultaneously search the Internet, commercial databases, and library collections.
- Save search results and conduct additional processing to narrow or qualify results.
- From search results, click through to access the digitized content or locate additional items of interest (based on information from Sun website).

## 8. Possible Need for Digital Librarians

The role of the librarian is changing in traditional libraries and with the introduction of the digital library there is a real need for a digital librarian with specific skills additional to the skills of a traditional librarian. The major challenge for this librarian is to keep the library up to data with good objects and be constantly on the look out for more (distributed) resources which match the requirement for a specific learning object. This will also require a means of having objects flagged which are not meeting expectations or are no longer suitable for our needs. Another problem to be solved, or at least aided by the librarian, is to be able to support the different formats of the learning objects. This is not straight forward and needs thought and work in order to facilitate Flash, and similar objects, created by different means but which cover the same curriculum as other learning objects in a different media format. Storage is a related issue that the digital librarian will have to manage. The work carried out by this function must conform to the highest standards for the benefit of the digital curriculum to ensure coherence and flow.

## 9. Requirement to Evolve and Change

The repositories and digital libraries we are using for the most part are suitable for educational instruction but must also have the potential to facilitate business use where appropriate. However, both types of focus have greatly differing needs and the contexts of information they need, along with the types of problems they must solve vary considerably. Additional to that is the need to be able to adapt to change. This may involve the structure and content of the required objects (Lynch 2003).

## 10. New Technology and Terminology

There is constant change in the types of media available for the many varying types of platform to which educational content must be delivered. So, as a result, we want to make the system as open and expandable as possible, and future proof the digital libraries, to the greatest extent possible, to best cater for future eventualities. We see the need for an ontology that can be utilised in future developments.

We are ever mindful of making our library as open as possible. Firstly, we make the resources freely available to everyone on the web but secondly, available to be accessed by as many types of devices as possible. In the creation of the library all objects have already been verified with our model for assessing instructional design and learning potential. This model, motivated by our earlier research, is suitable for use in the digital library model and can play a significant role in the structure of the library and the quality of objects stored.

The main digital library participants' worldwide include:

1. National Digital Learning Repository NDLR (IRL)
   This project is an Irish multi-campus attempt to create an educational digital library which will solve problems specifically in the Irish educational context and structure. Learning objects and resources are for the most part freely available to individuals who provide their objects to add to the NDLR.

2. MIT:
   MIT were one of the first digital library developer and research groups to make their libraries open access to all users who wanted to find learning objects. The digital library created by MIT is called DSPACE.

3. Open Archive
   The Open Archives Initiative (OAI) develops and promotes interoperability standards that aim to facilitate the efficient dissemination of content. OAI has its roots in the open access and institutional repository movements. Continued support of this work remains a cornerstone of the Open Archives program. Over time, however, the work of OAI has expanded to promote broad access to digital resources for eScholarship, eLearning, and eScience (http://www.openarchives.org/).

4. The Canadian ARL (CARL) Institutional Repository Pilot Project
   In the summer of 2002, CARL launched the Institutional Repositories Pilot Project. Institutional Repositories (IR) are digital collections, indexed in a standardized way and searchable using one interface, which capture and preserve the intellectual

output of a single or multi-university community. The CARL IR project is a national initiative that will test the feasibility of the IR concept. The project aims to facilitate discussions of lessons learned and best practices for implementing institutional repositories. Thus far, several libraries have implemented IR platforms, while other participants are at various stages of planning.
(www.carl-abrc.ca/projects/ir/index.htm)

5. The Flexible Extensible Digital Object Repository Architecture (FEDORA)
   Fedora open source software gives organizations a flexible service-oriented architecture for managing and delivering their digital content. At its core is a powerful digital object model that supports multiple views of each digital object and the relationships among digital objects. Digital objects can encapsulate locally managed content or make reference to remote content. Dynamic views are possible by associating web services with objects. Digital objects exist within a repository architecture that supports a variety of management functions. All functions of Fedora, both at the object and repository level, are exposed as web services. These functions can be protected with fine-grained access control policies. This unique combination of features makes Fedora an attractive solution in a variety of domains. Some examples of applications that are built upon Fedora include library collections management, multimedia authoring systems, archival repositories, institutional repositories, and digital libraries for education (http://www.fedora.info ).

6. Harvard Digital Repository
   The Digital Repository Service (DRS) provides Harvard affiliated owners of digital material with a storage and retrieval system for their collections. Digital repository services and facilities typically include:
   - An electronic storage facility within which the digital objects created or purchased by Harvard agencies reside
   - Management of administrative and structural metadata associated with stored objects,
   - Preservation policies and procedures to ensure the continued usability of stored objects, and
   - Delivery of an object to a registered or known software application (e.g., an online catalogue).

7. University of Southampton *EPrints* initiative

## 11. Lessons Learned From Creating a Digital Repository or Archive

It can be a very daunting task to attempts to progress an instructional digital library in an elearning context. The lessons we have learned over the course of this research relate to issues of storage and categorisation structure, compatible and transferable file formats, the life span of objects, content and context, interoperability, timing, library structure and searching capability. Internationally, we note that research (Hastings and Tennant 1996; Chaudhry and Khoo 2006) has started to address these areas.

## 12. Summary

Digital Libraries have the potential to solve many of the problems we have experienced over time within our research. Resolution of the important issues of global standards for digital libraries will hopefully lead to a limited number of robust, interoperable

standards to mirror the e-learning standards. Ultimately, we can look forward to an interesting time ahead with many fruitful developments for research in e-learning and actual digital libraries available for use in elearning.

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