The WEBWORKFORCE –a learning repository to support educators, trainers and Information Technology courses

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Abstract

This paper provides a first account of[1] the Building the Internet Workforce project. A number of further papers are planned. An outline of the project's progress and outcomes is provided and the WEBWORKFORCE Learning Repository, a major deliverable of the project, is described. Theoretical perspectives about learning objects and their reuse, storage and retrieval are discussed and an outline of requirements gathering is given. The learning repository system supports the development of emergent cataloguing structures that closely resemble specialist library models. These structures provide contextual support for the Learning objects to be archived and retrieved thus enhancing their access and reusability. Examples of information structures presented via the user interface are provided. The structures feature rich contextualisation based on curriculum and body-of-knowledge frameworks.

Keywords: Subject gateways; Digital Repositories; Digital Libraries; Learning Repositories; Elearning Tools; Information Technology Curriculum.

1 Introduction

The Building the Internet Workforce project is an initiative of the Faculty of Information Technology at Monash University, the School of Information Technologies at the University of Sydney and the School of Information Technology & Electrical Engineering at the University of Queensland. The project is funded through a grant by the Federal Government's Department of Education, Science and Training as part of the Science Lectureships programme.

The main objectives of the project are:

- To develop core teaching resources for the education of software, network, and application developers who will comprise the internet workforce
- To develop and utilise new and innovative approaches to course delivery
- To provide materials and resources produced via the participating institutions in existing and new programs at undergraduate, postgraduate, and professional development levels
- To encourage more young Australians to undertake courses and careers in IT / internet development
- To make materials and resources produced available to all tertiary Australian Information Technology (IT) educational institutions, including universities and TAFE colleges in order to assist them in offering educational programs pertaining to the Internet that meet the IT needs of Australian industry
- To encourage young Australians to take up courses and careers involving IT and Internet technologies
- To make best practice materials available to Australian secondary schools to assist Information Technology teachers in nurturing an interest in IT/Internet development courses and careers.

Given the diversity of the educational groups targeted by these objectives, it was decided that a learning repository was required that would need to provide facilities for storage and retrieval of learning objects. These facilities should support diverse organisational and pedagogical contexts. Structure would need to be provided to assure learning objects' quality and reusability as they were created, stored and managed.

Focus meetings with stakeholders served to clarify the fact that a learning repository should deliver similar services to those that are provided by the cataloguing facilities of a library. A focus on supporting educators' specific needs would be crucial. The system should incorporate cataloguing facilities that provided order and consistency, quality assurance of learning materials, and retrieval facilities that supported quick access to reusable learning materials that matched specific student contexts and teaching styles.

The requirements for a repository system that provided a high degree of structure and contextualisation had extensive implications for the design of the database and the processes that would govern its operation. The user requirements definition and modelling of the WEBWORKFORCE Learning Repository led not only to the creation of a working repository, but also resulted in the development of a system that has made it possible to create and support emergent cataloguing structures. Guidelines about important characteristics of learning object repositories in general have also been developed.

2 Learning Objects and Curriculum – theoretical orientations

There is a wealth of literature that seeks to define the meaning of the term ‘learning object’. Wiley (2002) warns against oversimplification in defining learning objects when he cites the 'LEGO block' analogy.

In the early days, this analogy was useful for introducing the potential of a system that would provide learning objects that were reusable. The logical extension of this analogy however, has limited the way people think about learning objects, leading to simplistic interpretations and some unrealistic expectations. Wiley highlights a number of fallacies that develop from such a view.

Fallacy 1 - LEGO blocks are such fun and so simple that even children can put them together. Fallacy 2 - any Learning Object or LEGO block by definition should be easily and seamlessly combinable with any other LEGO block and Fallacy 3 - LEGO blocks can be assembled in any chosen manner.

The project team would argue that creation, selection and reuse of learning objects in education require an approach that acknowledges far greater complexity than that suggested by the LEGO analogy. In the project, the term ‘learning object’ has been taken to mean a digital resource that can be reused for education or training. This term is being used interchangeably with terms such as learning materials, instructional materials, or learning resources. This was important because it allows a degree of flexibility and creativity for those designing and creating learning objects. Further to this, those who wish to reuse learning objects will be expected to bring their own expertise and perspectives as they select, modify and reuse then as a basis for engaging students.

The process of curriculum development via reuse of learning resources provided by the repository was envisaged via a metaphor describing the curriculum.

The term curriculum in ancient Greek usage referred to an obstacle course through and over which athletes passed. The metaphor of the obstacle course when applied to the modern curriculum is evocative. Consider students who progress through a course composed of learning experiences and materials (obstacles) provided by educators. Courses incorporate the tasks and challenges that are required for students to achieve the intended learning outcomes.

Via a curriculum development process, educators create an appropriate course by selecting, modifying, sequencing, or packaging courseware (obstacles). How they go about doing this is dependent on their understanding of their students’ capacities and needs. In this context, the learning repository will provide a contextualised toolbox via which educators store and select materials with which they will build their courses.

Wiley also refers to three paradigms that describe conventional understandings about systems that aim to support reuse of learning objects. Paradigm 1 is the ‘teacher bandwidth’ paradigm. Such a paradigm places educators at that part of a functional system that is failing, producing a constraining effect on system output. If more students are to enter the system and complete courses, then the teachers who have to take time to select and modify learning materials and sequence and facilitate learning activities based on their understanding of their students’ needs must be replaced. Paradigm 1 systems seek to replace teachers as the decision makers about selection and sequencing of learning materials by making the systems that do this.

Wiley describes two further Paradigms. Paradigm 2 systems recognise the importance of educators as they carry out the complex process of analysing students’ requirements and selecting and sequencing learning materials. Educators’ understanding of the unique nature of their students’ needs is seen as critical to such a process. Finally, Wiley describes a third Paradigm which in which communities of educators are engaged and which are often self-moderating. Wiley suggests Slashdot (www.slashdot.org) provides an illustrative example of such a system.

In a number of focus meetings with stakeholder groups it was agreed that the processes that the learning repository system should support were more closely aligned with those perspectives exemplified by Paradigm 2 and to a lesser extent those suggested in Paradigm 3.

2.1 User Scenarios

During the feasibility analysis and preliminary requirements engineering phases a number of typical user search scenarios were developed and discussed:

- I am a lecturer who has been given the job of taking a full semester 1st Year programming subject in 6 days time. I have SOME curriculum resources but these are only enough for about 5 weeks’ work. As I need to assemble a 13 week lecture course, I need to use the system to complement my existing resources. I wish to search via the keyword facility and the browse catalogue facility.
- I am a lecturer who is expert in the teaching of Java but who wants to look at developing different ways of teaching my course to keep it alive and up to date. I want to see what other people are doing. I want to browse by ACM Body of Knowledge code and/or separately by keyword.
- I am a secondary teacher and my students are researching network performance. I need to gain an understanding of the key areas and to select some useful resources to which my students may be pointed in order to complete their assignments.
- I am a secondary teacher who has a fairly strong background in IT. It is early December. I have been teaching the same Information Systems course content for the last 3 years and have decided to re-write next year’s course. I wish to change the programming language and to add some new topics which reflect more current IT environments. I intend to spend some of the summer researching and studying the topic areas, and selecting and acquiring curriculum materials

Stakeholder groups included the tertiary, secondary and TAFE education sectors and a number of prototypical input and output screens which were developed, provided valuable feedback. Including stakeholders in this process was important as ownership of the system design by all stakeholders was achieved.

3 Issues of timeliness and continuity

For Information Technology courses particularly, a major issue that was highlighted in focus meetings was to do with the time it takes to create usable learning materials that engage students, while developments in technology move at a rapid pace.

By the time educators have become aware of new technologies that should be incorporated into their courses; there is a considerable amount of time that needs to be spent in researching and locating appropriate materials to support courseware development. Lengthy publishing lifecycles for educational texts create further pressures upon education systems that require regular and timely updating of curriculum materials.

Because traditional Information Technology textbooks do not provide materials that can be readily incorporated into educational and training programs, educators often need to look at a variety of texts and to select a number of resources from each. Teaching materials themselves must then be produced and tested in courses. This takes a lot of time.

A further concern that was raised was to do with the loss of learning assets caused by staff turnover. When a teacher leaves an organisation, their learning materials are often not left in a form that can readily be used by others.

The learning object repository was seen as having the potential to improve these and related problems.

4 User and System Requirements – WEBWORKFORCE Learning Repository

There was consensual agreement among stakeholders in focus meetings that a structured approach towards cataloguing would be important. This was not dissimilar to how a traditional library operates.

The idea of a trusted space that is easy to visit, and where high quality materials can be easily located was clearly valued. To achieve this, libraries provide thorough and consistent cataloguing systems that serve a wide range of users and search criteria. These systems are designed to provide quick access to materials with a high degree of relevance for specific needs.

4.1 General functional requirements

As a result of user and system requirements analysis, a number of general functional requirements were defined for the WEBWORKFORCE Learning Repository system. The system needed to provide:

- Facilities that support easy creation of user groups.
- User group 'portals' (to support configuration of search and discovery functionality and look and feel for specific needs).
- Facilities that support authoring, uploading and management of learning objects.
- Facilities that support re-aggregation of learning objects so that content authors can create Content Packages using existing objects.
- Facilities that support authorisation of users to a variety of roles (eg General User, Content Author, Group Administrator, Content Reviewer, etc).
- Support for quality assurance of learning objects.
- Object typing to match pedagogical practice (eg Rich Item, Expert Advice, Sample Exam, Annotated Code Sample, Presentation, Exercise, Annotated Reference, Case Study) and the facility to make these available to suit the needs of specific user groups
- Extensible Cataloguing facilities that allow new catalogue structures to be created as required and that allow easy assignment and configuration of these to user groups. Any learning object must be able to be attached to and retrievable via any number of catalogues
- Extensible metadata schema facilities that allow catalogue structures to be created as required and that allow easy assignment and configuration of these to user groups

4.2 Metadata required to support effective cataloguing and retrieval

In education and training, subject and context specific cataloguing structures are often used to support the archival and retrieval of curriculum materials. Examples of IT catalogue structures that are used widely include the Association of Computing Machinery's Body of Knowledge for Computer Science (ACM CS BOK) and the Australian National Training Authority's (ANTA) Information Technology Training Package (ICA 99).

For cataloguing and retrieval of Information Technology courseware, the repository was required to provide catalogues structures for at least the following:

- The internationally recognised Association of Computing Machinery's Body of Knowledge for Computer Science (ACM CS BOK)
- Information Systems 2002 (IS 2002)
- The Australian National Training Authority's Australian Information Technology Training Package (ICA99)

It was decided that this could be achieved by implementing a system that would support extensible creation of any hierarchical metadata schema (catalogue structure).

To further support storage and retrieval of learning objects via information stored about them, the system would need to allow extensible creation of nonhierarchical metadata fields or tags. Dublin Core, EdNA and IMS are all examples of such schemas. Each of these schemas provides a means of storing important information about objects such as ‘Author’, ‘Keywords’ etc. These schemas have different emphases (for example IMS has attempted to concentrate on metadata for Learning Objects) and they are regularly modified.

Because of this, it was decided that an extensible creation facility for simple metadata was also required. If simple metadata schemas could created and modified at will, interoperability between the WEBWORKFORCE system and other repositories that may use any of these schemas would be possible.

Via a rich picture (see Figure 1) that employed UML (Unified Modelling Language) notation, definition of metadata schemas and cataloguing structures that were appropriate for IT educators was achieved in focus meetings.

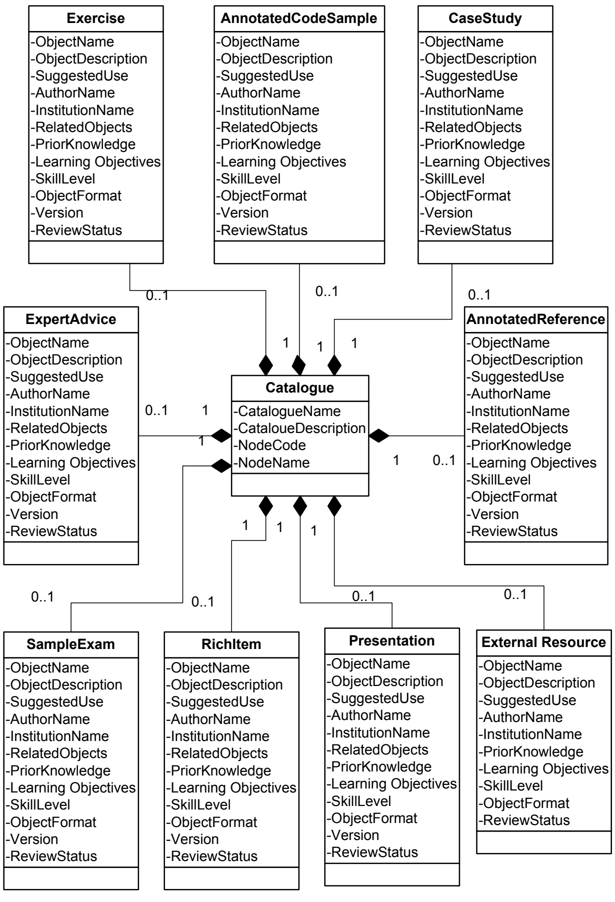


Figure 1: Logical Learning Object Model (with incomplete list of metatags) – WEBWORKFORCE Learning Repository

This was used to engage stakeholders in an informed discussion about how objects should be stored and catalogued. The catalogue/metadata structure was positioned in the context of a scaffold into which objects would be embedded and via which objects could be retrieved. Figure 1 provides a first-cut version of a rich picture that was used to elicit much discussion.

Learning objects entered into the system would be added to a hierarchical catalogue (represented by the centrally placed ‘Catalogue’ object). Each object would also be assigned a pedagogical object type (eg ‘Exercise’, ‘Sample Exam’ etc).

Each object is catalogued to a particular level of a hierarchical catalogue (via ‘Node Code’ and ‘Node Name’) and as a pedagogical object type (eg ‘Case Study’, ‘Annotated Code Sample’). In addition, each object would be given its own simple metadata field values - eg ‘Object Name’, ‘Author Name’, ‘Learning Objectives’ etc. A learning object called “Java Assignment - Tennis Scoreboard” for example is catalogued in the system via the ACM CS BOK as:

Programming Fundamentals / Fundamental programming constructs / Conditional and iterative control structures / Loops/iteration structures - general / Loops/iteration structures in Java/J Script.

This object has been defined as an Exercise object type with appropriate simple metadata values (such as ‘Author’ etc) added accordingly.

4.3 Quality processes

The potential for reuse of a learning object needed to be maximised during creation of the object. The ‘Create Object’ and upload facilities provided by the Learning Repository require content authors to take care to catalogue their object completely. They must decide what sort of pedagogical object type the object is must enter descriptive metadata of high quality. Addition of the object to appropriate hierarchical catalogue structure(s) is mandatory.

Once a learning object is uploaded, the system provides workflow control for expert reviewers, educational practitioners and subject matter experts who may test and review the objects. Users who are searching and selecting objects gain access to all reviews.

5 Usability

5.1 Discovery

Users can search for learning objects by text searching (Figure 4 shows the Quick Search screen) which is carried out on the simple metadata fields. Search results provide links to the retrieved objects as well as all the metadata, both simple and hierarchical, relating to each object.

Searching for objects may also be achieved via a ‘Browse Catalogue’ feature that allows users to open any catalogue that has been made available to their User Group. Figures 2 and 3 provide examples of 2 catalogue structures that have been created via the Catalogue Structure creation facility. These catalogues are the Association of Computing Machinery’s Body of Knowledge for Computer Science and ANTA’s (Australian National Training Authority) Information Technology Training Package.

As the figure shows, an interface that is functionally similar to that of Microsoft Windows Explorer provides users with access to learning objects via Catalogue structures.

Figure 5 shows a typical Search results screen, which is provided as a result of ‘Quick’ and ‘Advanced’ searching. To assist users to identify suitable objects, search results group returned objects in pedagogical object types and each object has a title and description metadata field displayed. At the far right of each record a link to ‘View Details’ provides access to all the metadata that have been added to describe the learning object (see Figure 6). This screen provides all important, relevant information via metadata such as ‘General Description’, ‘Pedagogical

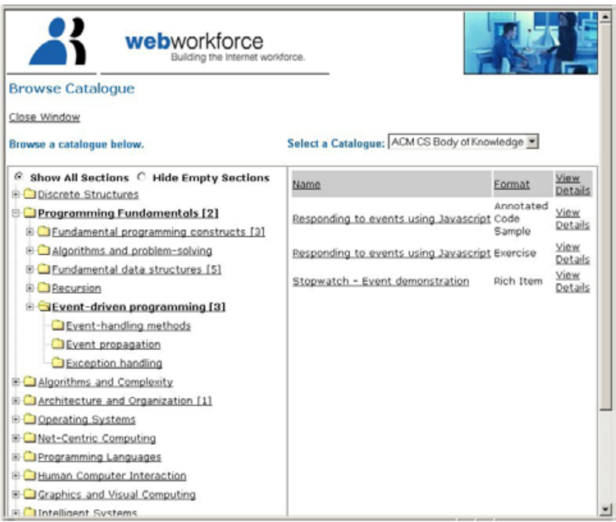


Figure 2: Browse Catalogue – ‘Drilling’ through the Association of Computing Machinery’s Computer Science Body of Knowledge via ‘Programming Fundamentals’

Figure 3: Browse Catalogue – The ANTA (Australian National Training Authority) Information Technology Training Package

Type’, ‘Catalogue Definition’ in this case the object has been added to 2 catalogue structures that are shown), ‘Author(s)’, ‘Keyword(s)’, ‘Learning Objectives’, ‘Prior Knowledge’ and ‘Suggested Use’.

6 The Emergent Model

Due to its obligatory timelines and broad user requirements, the Building the Internet Workforce project provided an opportunity to engage in extensive requirements engineering for a learning repository.

The WEBWORKFORCE project started with a clean slate. It had the freedom to select from an almost unlimited selection of possible learning repository models. For example it could have been a portal site that dispatches intelligent software agents to search the Web domains of the collaborating institutions for content that appears to match user queries. Such models work adequately for commercial search engines on the Web, why not for WEBWORKFORCE?

What in fact emerged from the planning and focus group work and from the practical development of the WEBWORKFORCE platform is that something more like a library model was required: a highly structured environment characterised by a strong collecting policy.

The reason for preferring such a model was that the participants were not only interested in *content* - they were equally interested in *context.*

Context is seen as crucial because of the richness of meaning that it imparts to particular learning objects. By locating a given learning object within - say - the ACM BOK, a whole system of thought about what constitutes the field of information technology is immediately articulated in respect of that object. If the same object is also labelled according to other classificatory schemes, its meaning in relation to epistemologies represented by those schemes is also made manifest. Also essential are the more prosaic indicators of context - the who, what, where and when.

What many regard as the 'neutral' Dewey decimal classification started as an American curriculum framework for a broad 19th century education. It still serves well for the organisation of library materials by themes. Its international ubiquity helps users orientate as they move from library to library. However its relationship to specific institutional or professional curricula has become attenuated with the passing decades, except at the general level reflected in the periodic revisions to the Dewey schedules.

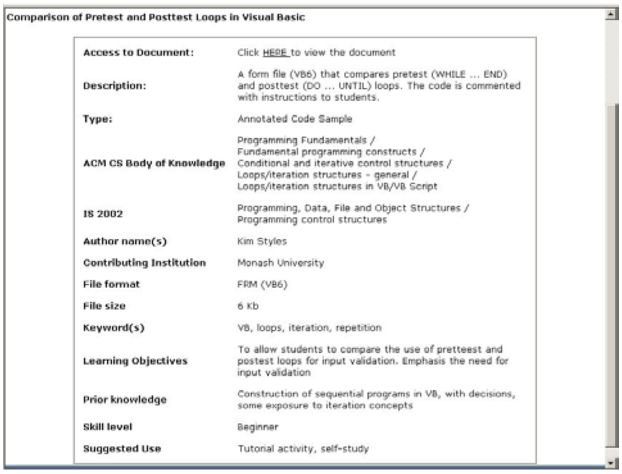
The WEBWORKFORCE model recognises that the very point of a learning object repository is to reflect the scholarly and professional consensus that underlies pedagogy, sharing and standardisation in organised education at any point in time. Whenever a curriculum or BOK is set or changed it means that a particular perspective - a particular way of seeing and thinking about the field - has been established through consensus by professionals and educators in that field. Shareable courseware needs to align to the perspective of a course offered by an educational institution, irrespective of who is teaching the course or where it is being taught e.g. in physically dispersed institutions.

The system infrastructure that has been created for the WEBWORKFORCE repository thus instantiates or models a specific conceptualisation of what a learning object repository is. A learning object repository in this interpretation is a vehicle for supporting educational and training frameworks that are strongly underpinned by strong consensual viewpoints expressed by BOKs or curricula.

The learning object repository is required to make contextual relationships clearly manifest. If a learning object from a disciplined depository is 'sucked out' of its classificatory context by a search robot, context and therefore meaning and value are reduced or lost.

Figure 4: The Quick Search facility

Figure 5: Example of how objects are retrieved via Quick or Advanced Search


Comparison of Pretest and Posttest Loops in Visual Basic

Access to Document:	Click HERE to view the document
Description:	A form file (VB6) that compares pretest (WHILE ... END) and posttest (DO ... UNTIL) loops. The code is commented with instructions to students.
Type:	Annotated Code Sample
ACM CS Body of Knowledge	Programming Fundamentals / Fundamental programming constructs / Conditional and iterative control structures / Loops/iteration structures - general / Loops/iteration structures in VB/VB Script
IS 2002	Programming, Data, File and Object Structures / Programming control structures
Author name(s)	Kim Styles
Contributing Institution	Monash University
File format	FRM (VB6)
File size	6 Kb
Keyword(s)	VB, loops, iteration, repetition
Learning Objectives	To allow students to compare the use of pretteest and postest loops for input validation. Emphasis the need for input validation
Prior knowledge	Construction of sequential programs in VB, with decisions, some exposure to iteration concepts
Skill level	Beginner
Suggested Use	Tutorial activity, self-study

Figure 6: ‘View Details’ provides all metadata information

If no particular criteria of perspective of curriculum or BOK, govern the inclusion or exclusion of objects in a repository - other than that the objects are recognisably knowledge representations - then a generalist library system, or even a generalist search engine, will suffice. A learning object repository is not needed.

The action research embodied in WEBWORKFORCE to date - by identifying classificatory relationships to curricula and BOKs as a primary characteristic of learning object repositories - may help to focus institutional expectations of learning object repositories, and to clarify the roles, relationships and governance models suited to their growth and development as socio-technical systems.

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