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Survey on Learning Object Repositories using Open Re-Usability Benchmark

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ABSTRACT

Open Reusability Benchmark identifies a number of factors that are required to be present in a Learning Object Repository. A repository must comply with these factors in order to define a comprehensive and openly reusable Learning Object Repository. A number of existing systems that actually use a database of learning objects and their internal architecture is somewhat available are studied and analyzed in this survey. Each of the studied system is then measured on the benchmarks and a critical analysis is performed on the basis of results.

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I. Introduction

In the past, many projects have investigated theoretical and practical issues of Learning Object Repository systems. Many prototypes that stored multimedia learning material in databases [1] were built during the last two decades [2, 3], focusing of reuse of multimedia learning material [4, 5, 6]. In order to build upon the results of these systems, we will examine them on Open Reusability Benchmark in this paper. These systems were found by searching the World Wide Web and libraries, and by following literature references. Only those projects that actually use a database of learning objects and their internal architecture is somewhat available are incorporated. These systems are tested and analyzed on Open Reusability Benchmark [7] and results are discussed.

II. Open Re-Usability Benchmark

Due to the use of World Wide Web, the significance of reusability [8] and accessibility [9] of the media has greatly increased. Open Reusability means to re-use and personalize Learning Object in a domain different from the one in which it was originally created and by some other person. Open Re-Usability is a key factor for multimedia Learning Objects as by attaining this, one can address some key problems like high development cost for the multimedia courseware. [7] has defined Open Reusability Benchmark for this purpose. These benchmarks have associated properties like Accessibility, Interoperability, Partial Reusability, Integration and Personalization.

On the basis of this Open Reusability Benchmark and its associated properties, some standards were formed. These are Metadata Standard, Media Data Standard, Schema Definition, Presentation Templates, Partial Reusability and Integration.

Table 1 outlines these standards along with their possible value spaces and examples.

Table 1. Open Re-Usability Benchmark.

Benchmark	Explanation	Value Space
Metadata Standard	What type meta standards are used in the system?	Proprietary Open Extensible None
Media Data Standard	Does the system store the media in a standard format?	
Schema Definition	Does the media contain an associated schema?	
Presentation Templates	Does the media contain a presentational template?	
Semantic Search & Retrieval	Does the system provides semantic search & retrieval for efficient accessibility?	
Partial Reusability	Does the system facilitates the use of media in parts?	
Integration	Does the system allow different media to be integrated in parts or full?	

We have studied and analyzed some of the existing Learning Object Repositories that deal with the creation, storage and discovery of a Learning Object. These LORs were then tested and analyzed on the basis of above mentioned Open Reusability Benchmark. Let's look into each of them one by one.

A. Oracle LMS

Oracle Learning Management [10] supports all education models by providing a single unified learning delivery system to the extended enterprise of employees, customers and partners. The Oracle Learning Architecture (OLA) [11] is an online educational system for delivering and managing interactive, multimedia education and is a commercial course delivery system with some 300 courses that can be ordered online.

The learning materials are stored as so-called “Reusable Content Objects”. It is stated that the input was used from the IEEE Working Group, but as this is a proprietary system, no further details are available about the system’s architecture, labeling system, search algorithms and the composing courses from smaller objects. The analysis on Open Reusability Benchmark is shown in Table 2.

Table 2. Oracle LMS Analysis on Benchmark.

Benchmark	ORACLE LMS			
	Proprietary	Open	eXtensible	None
Metadata Standard	✓	x	x	x
Media Data Standard	✓	x	x	x
Schema Definition	x	x	x	✓
Presentation Template	x	x	x	✓
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	✓	x	x	x

B. KOD – Knowledge on Demand

Knowledge On-Demand (KOD) [12, 13] defines on-demand learning to personalize information for front-end user and supports categorization for back-end user to increase interoperability and reusability of learning material. The knowledge packaging format facilitates the description of the learning objects that comprise learning packages together with navigational rules. As a result, an e-learning system can import knowledge packages (i.e. collections of learning objects), interpret the rules included in them, and present different knowledge routes to each learner according to his/her profile, thus, facilitating personalized learning. Moreover, adaptive knowledge packages (i.e. adaptive learning material) can be easily interchanged and re-used across different e-learning applications and services to promote on-demand, personalized learning. The analysis is shown in Table 3

Table 3. KOD Analysis on Benchmark.

Benchmark	KOD			
	Proprietary	Open	eXtensible	None
Metadata Standard	x	✓	✓	x
Media Data Standard	x	x	x	✓
Schema Definition	x	x	x	✓
Presentation Template	x	x	x	✓
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	✓	x	x	x

C. ARIADNE

ARIADNE Knowledge Pool System [14] is a distributed repository for learning objects. The primary goal of ARIADNE is to foster share and reuse of electronic pedagogical material, both by universities and corporations. The key features of the Knowledge Pool System are the underlying metadata. To increase the interoperability, ARIADNE represented metadata according to the LOM standard that enables other repositories to share its metadata. The analysis on Open Reusability benchmark is shown in Table 4.

Table 4. ARIADNE Analysis on Benchmark.

Benchmark	ARIADNE			
	Proprietary	Open	eXtensible	None
Metadata Standard	✓	x	✓	x
Media Data Standard	x	x	x	✓
Schema Definition	x	x	x	✓
Presentation Template	x	x	x	✓
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	x	x	x	✓

D. TeleTOP

TeleTOP [15] is a course management system, developed by “University of Twente”. The goal of the project is to systematically support the professional development of staff in terms of potential applications of telematics in their teaching. It also supports the redesigning of all courses so that they become more efficient, enriched and flexible via innovative and appropriate applications of telematics. The analysis on Open Reusability benchmark is shown in Table 5.

Table 5. TeleTOP Analysis on Benchmark.

Benchmark	TeleTOP			
	Proprietary	Open	eXtensible	None
Metadata Standard	x	✓	✓	x
Media Data Standard	x	x	x	✓
Schema Definition	✓	x	x	x
Presentation Template	✓	x	x	x
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	x	x	x	✓

E. WebCT

WebCT [16] is used to create entire on-line courses or to publish materials supplementing existing face-to-face courses. WebCT offers a wide variety of tools that are: tools for course authoring, tools for delivery of course materials, communication / collaboration, student assessment and administration. It follows a client-server model that exhibits an open, extensible architecture based on software industry standards for e-learning application development. WebCT’s technical details are not widely available; however the functionalities that are available are tested and analyzed and is shown in Table 6.

Table 6. WebCT Analysis on Benchmark.

Benchmark	WebCT			
	Proprietary	Open	eXtensible	None
Metadata Standard	x	✓	✓	x
Media Data Standard	x	x	x	✓
Schema Definition	✓	x	x	x
Presentation Template	✓	x	x	x
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	✓	x	x	x

F. COLIS

COLIS (Collaborative Online Learning and Information Systems) [17] used IMS Content Package, IEEE Learning Object Meta-data (LOM), IMS Digital Repositories working group materials and Open Digital Rights Language. COLIS has divided the Learning Objects into three "tiers"; Digital Assets: the lowest level of files such as text; Learning Objects: that has stand-alone educational value and Learning Activities: the highest level - based on activities and tools such as discussion groups and chat rooms. The analysis on Open Reusability benchmark is shown in Table 7

Table 7. COLIS Analysis on Benchmark

Benchmark	COLIS			
	Proprietary	Open	eXtensible	None
Metadata Standard	x	✓	✓	x
Media Data Standard	x	x	x	✓
Schema Definition	✓	x	x	x
Presentation Template	✓	x	x	x
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	✓	x	x	x

G. Learning Space

Lotus LearningSpace 5.0 [18] is an e-learning, Web-based platform that offers self-paced, collaborative and real-time capabilities, robust tracking and management, and seamless integration of course content, all in one technology environment. It follows the international standards of learning objects like IMS. Its key features and benefits include: Integration Tools, Enhanced Performance and Scalability. Analysis is shown in Table 8.

Table 8. Learning Space Analysis on Benchmark.

Benchmark	Learning Space			
	Proprietary	Open	eXtensible	None
Metadata Standard	x	✓	✓	x
Media Data Standard	x	✓	✓	✓
Schema Definition	x	✓	✓	x
Presentation Template	x	✓	✓	x
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	✓	x	x	x

H. Lotus LMS

The IBM Lotus Learning Management System (LMS) [19] is the successor to LearningSpace. Its architecture is modular and consists of different components: Learning Management Server, Authoring Tool, Delivery Server and Offline Learning Client.

The LMS authoring tool is a client-based tool that one can use online or offline to create courses. The authoring tool requires no programming skills, enabling instructors with little or no coding experience to prepare courses. Meta-data is used to categorize and organize course contents and knowledge searches. LMS meta-data is IMS SCORM 1.2 compliant. The created course content can also be reused. Table 9 explains the findings.

Table 9. Lotus LMS Analysis on Benchmark.

Benchmark	Lotus LMS			
	Proprietary	Open	eXtensible	None
Metadata Standard	x	✓	✓	x
Media Data Standard	x	x	x	✓
Schema Definition	✓	x	x	x
Presentation Template	✓	x	x	x
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	✓	x	x	x

I. MDMC

Modular Development of Multimedia Courseware (MDMC) [20, 21] presents a concept that opens a potential for the cooperative development of reusable multimedia courseware. It suggests dividing the learning materials into semantical units, known as learning modules, that allows to structure learning topics into meaningful units that may be reused in various courses. It organizes the learning modules on several abstraction levels such as didactical and pedagogical concepts. Furthermore, it also integrates them into cooperative authoring environment. MDMC uses open standards such as IMS and XML to develop contents that can be easily shared and exchanged between content development and content management systems.

The design process is divided into the phases that are Content-based design, Structural design, Presentational design, and Course design. The analysis on Open Reusability benchmark is shown in Table 10

Table 10. MDMC Analysis on Benchmark.

Benchmark	MDMC			
	Proprietary	Open	eXtensible	None
Metadata Standard	x	✓	✓	x
Media Data Standard	x	✓	✓	✓
Schema Definition	x	✓	✓	x
Presentation Template	x	✓	✓	x
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	✓	x	x	x

J. IDEALS MTS

MTS (Modular Training System) [22] is developed on the concepts and technologies to achieve the goals like supporting self-driven learning, reduction of time and place restrictions as well as availability to wide audience. Each module is complete and self-contained. Modules can make use of other modules, but they are not allowed to contain modules. Instead they only refer to other modules. Modularization enables exchange, re- and multiple use of courseware and therefore creates the basis for efficient production and usage of digital courseware. The second major aspect is a subdivision into three courseware layers, that reflects the different layers of abstraction in the production of courseware. These layers are; Content layer, Learning layer and Material layer. The analysis on Open Reusability benchmark is shown in Table 11.

Table 11. IDEALS MTS Analysis on Benchmark

Benchmark	IDEALS MTS			
	Proprietary	Open	eXtensible	None
Metadata Standard	x	x	x	✓
Media Data Standard	x	✓	x	x
Schema Definition	x	✓	x	✓
Presentation Template	x	✓	x	✓
Semantic Search & Retrieval	x	x	x	x
Partial Reusability	x	x	x	✓
Integration	✓	x	x	x

III. Critical Analysis

In this paper, we have studied and analyzed some of the existing Learning Object Repositories that deal with the creation, storage and discovery of a Learning Object. These LORs are tested and analyzed on Open Reusability Benchmark. The comprehensive findings from this survey are outlined in a tabular form and is shown in Table 12. Comprehensive analysis defines that most of the existing Learning Object Repositories lack in Open Reusability.

Table 12. Survey Analysis.

	Metadata Standard	Media Data Standard	Schema Definition	Presentation Template	Semantic S&R	Partial Reusability	Integration
Oracle LMS	P	P	N	N	N	N	P
KOD	OX	N	N	N	N	N	P
ARIADNE	PX	N	N	N	N	N	N
TeleTOP	OX	N	P	P	N	N	N
WebCT	OX	N	P	P	N	N	P
COLIS	OX	N	P	P	N	N	P
LL Space	OX	N	N	N	N	N	P
Lotus LMS	OX	N	P	P	N	N	P
MDMC	OX	O	OX	O	N	N	P
Ideals MTS	N	O	N	N	N	N	P

P → Proprietary O → Open X → Extensible N → None

IV. Conclusion

Respondents to the survey appear to be somewhat inefficient in terms of Open Reusability of Learning Objects. Research on open reusability for Learning Objects identifies a number of factors that are required to be present in a LOR. In many cases, the systems do follow a standard for Metadata Specification but none of them provides the standardization of media itself. Another factor that is of great importance i.e. semantics through its presentational templates, is also not considered by these systems. Hence, emerges a need of a system that complies with the factors identified in the Open Reusability Benchmark in order to define a comprehensive and openly reusable Learning Object Repository.

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