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DESIGNING
LEARNING OBJECT REPOSITORIES

A thesis presented in partial
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ABSTRACT

Learning object repositories are expanding rapidly into the role of independent educational systems that not only are a supplement to a traditional way of learning, but also allow users to search, exchange and re-use learning objects. The intention of this innovative technology is to have such repositories to collect a database of learning objects catalogued by the learning content management system. However, for users to perform an efficient search, these learning objects would need to use metadata standards or specifications to describe their properties. For learning objects stored within the repositories, metadata standards are often used to describe them so users of the repositories are able to find the accurate resources they required, hence metadata standards are important elements of any learning object repository. In this paper, a courseware example is used to demonstrate how to define a set of characteristics that we want to describe for our courseware, and attempt to map the data schema in the database with the available metadata standards. The outcome is to identify a set of metadata elements that would fully describe our learning objects stored within the learning object repository, and these metadata elements will also assist instructors to create adaptable courseware that can be reused by different instructors. Metadata standard is known as a critical element for the management of learning objects, not only it will increase the accuracy of the search results, it will also provide more relevant and descriptive information about the learning objects to the searchers.

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CHAPTER 1

INTRODUCTION

At present, our world is becoming a very technology-based setting. With all the different types of technology emerging around us, our daily activities can be done much more easily and effortlessly. It is undeniable that computer networking which is known as the Internet has been one of the rapid developments in the last several decades. Its various functions provide us with many alternatives in communicating with others, conducting business, requiring & obtaining information, learning and many more. Not only does the Internet influence the way we live, but because of its increasing usage, people are dependent upon it more than ever. With the increase in the popularity of the Internet, there is no doubt it has been taking place in the educational sector because the use of online learning has become almost everywhere. Sequentially, these changes have also affected how educational resources are designed, developed and delivered to the learners.

Due to the fast growth of the Internet, the availability and amount of learning objects also expanded rapidly to the users, therefore it has become difficult to perform a quick search for desired resources on the Internet. As a result of the increase in usage of the Internet for resources, metadata standards are being employed so a search can be performed more effectively and efficiently. The purpose of this research is to determine the appropriate way in managing the learning object repository, but first of all, we need to identify what are the fundamentals in this subject area which would require us to understand.

1.1 THE CONCEPT OF “LEARNING OBJECT REPOSITORIES”

Similar to library catalogues which carry information about their books, *Learning Object Repository* (LOR) will hold a collection of information about their *Learning Objects* (LOs). LORs are used to store LOs, and LOs are often described by metadata which are used to provide descriptions of the LOs' characteristics stored inside of LORs. LORs are known as the storage place for LOs, and these LOs come in different sizes, numbers and file types. Sometime, LORs are created to meet specific organisational aims, where each LOR has its own purposes. Despite of its different purposes, they will always have the same aim that is to facilitate sharing and reusing the learning objects. With this digital development and delivery of LOs in LOR, it has created some problems with the ability to identify, locate and situate within an appropriate learning experience for the most suitable LO.

In order to look for LOs stored within a LOR, a search function is often in place so searchers can retrieve LOs from the LOR. There are different search methods for users to look for LOs, however, like many search engines presented on the World Wide Web, most LORs are frequently built with a keyword-based search paradigm. With these LORs, searchers are able to specify a string of keywords and expect to find

relevant LOs. In order to make the search much easier, LOs are tagged with metadata elements to describe each LO. These tags contain technical and instructional details for LOs, information indicating its content area; level of complexity; delivery requirement; and the like; (Ahern, Cleave, Martindale & Smorgun, 2003). Within the retrieval system, developers and designers of LORs need to define the metadata elements required for their particular LOR, especially in design principles, data structures and algorithms that will facilitate the ease of use in LORs. Nevertheless, due to other reasons that there are still issues with regard to obtain an efficient and optimal search result.

1.2 RESEARCH OBJECTIVE

In this paper, the aim is to investigate the underlying aspect of learning object repositories, focusing on the technical/operational aspect of data that are used in a repository and issues which revolved with the LORs. Before a repository could deliver desirable search results to its users, one needs to understand what information is needed or must present to its users in order for them to understand the learning object fully. In addition, to illustrate how to capture information that is significant to the searchers, and how to select a set of metadata elements that will be applicable to our learning resources is derived.

It is in hope to produce a metadata tagged application system that could be utilised within the Information Systems Department (ISD) of Massey University. This is to encourage developers of the LOs to label their LOs as they are being created, where learning resources within the department will not be wasted but will be reuse and share with the others. It is believed that with better management and maintenance of the underlying data storage will able us to present better retrieval system where users could perform searches and create learning objects within the repository more efficiently and effectively.

1.3 THE OUTLINE OF THESIS

The paper is broken down into the following chapters; preliminary description of the research topic; development of the data schema; study of metadata standards; the framework of the learning repository; process in selecting the required metadata elements; discussion on the use of courseware application; and lastly, conclusion and future work that could be carried out in the later stage.

This paper covers on the use of Learning Objects (LOs) and how they are being integrated into the core of LOR development, discovery, and delivery process. Also, to investigate how the LOs stored within could be better managed. In the process, it will look into the creating of learning objects, utilising the function of metadata to gain reliable and efficient searches in the LOR. Note that learning object repositories could be managed in such a way where not just the end users can be benefited from it. In the following chapter, it provides outlines of different subject that revolved with LORs, and it talks about the works and findings done by other researchers in this area of expertise.

CHAPTER 2

PRELIMINARY

Among all the different elements, learning has been an important element in our life and we often participate in it to broaden our knowledge. In recent years, accessing education through the Internet is expanding rapidly, and is well accepted by learners who participate in it. Primarily, it is because online learning helps learners to save time and cost, and learners are able to choose to study at any place, at any time, and at their own pace. With the online education approach being proposed and promoted, many kinds of tools are being developed to accomplish different types of propositions.

According to Douglas (2001), the development of object-oriented programming has promoted the cause of software reuse, which has then been directed to the development of reusable component technologies. From there, “**Learning Object**” (LO) has been a popular term being employed in the learning environment. In this chapter, it will be revealed what there is to know about a learning object, and also the main component – **Metadata** that make the e-learning environment in “**Learning Object Repository**” (LOR) become possible will be studied.

This chapter covers the general context related to the learning object; learning objects; learning object repositories; metadata standards; relationship between database and repositories; issues related to metadata standards; learning object repository; and the findings of other researchers. It would be some general ideas of other people’s thoughts on the functionalities of a learning repository; activities required in managing an object repository; and a brief outlook of learning repositories in the educational context.

2.1 LEARNING OBJECT REPOSITORIES (LORs)

The constant growth of Learning Objects (LOs) emerging in the e-learning environment has alerted developers to be more creative and innovative when it comes to the process of creating and developing a new learning system. These learning systems are sometimes called the **LCMS (Learning Content Management System)**; **LOMMS (Learning Object Metadata Management System)** or **VLE (Virtual Learning Environment)**, they were designed and developed in recent years to provide information to learners; (Edtechpost, 2004; Karampiperis & Sampson, 2003; and Wikipedia, 2005). They are based on metadata and use metadata standards such as **IEEE LOM (Institute of Electrical and Electronics Engineers Learning Object Metadata)** and **DC (Dublin Core)** and the like, or specifications that are similar to the standards, or develop one’s own with which to meet the developer’s needs. It is defined by Edtechpost’s website (2004) that “*an LCMS is a multi-user environment where learning developers may create, store, reuse, manage, and deliver digital learning content from a central object repository. LCMS products allow users to*

create and reuse small units of digital learning content/assets. An LCMS manages the process of creating, storing and delivering learning content. The components of an LCMS are: an authoring application (editors), a learning object repository, a dynamic delivery interface, and administration”.

These learning systems will often have a uniform interface that presents to the end users so that they can search, access and use these stored LOs. Karampiperis and Sampson (2003) also describes LOMMSs as the web-based environment that users can access, maintain and support the learning resources repositories, where it could provide services required for efficient indexing, storing, and reuse of the stored information. In addition, the designers of these systems have a common goal that is to achieve interoperability with other similar systems so educational resources can be better shared and reused. Richards, McGreal and Friesen (2002) stress that part of the key function of these systems are to distinguish the storage location of the learning objects, and also to provide an indexing system that enables the efficient search and discovery of the learning objects within the LOR.

2.1.1 What is a Learning Object Repository?

As for **Learning Object Repositories** (LORs), they function like a database which will attach to another system like a LCMS. It is explain in the Edtechpost’s website (2004) that a LOR is part of the components of an LCMS – “*A LOR is storing content/assets/resources as well as their metadata record*”. The LORs store information used to describe LOs, and they are also the fundamental storage and retrieval systems for learning resources. In this paper, it is to concentrate on this component of the learning systems, which is to understand how to store LOs with metadata records.

LORs started to emerge in the mid 1990s to help educational practitioners in meeting the challenges of finding and selecting learning objects. Therefore, a search and retrieve system is always an essential component of a LOR to allow users to have flexible access to the LOs store within. Furthermore, the information used to describe these LOs could be kept in the LOR because each LO stored within should be tagged with metadata to describe its content, a metadata is sometimes referred as “metadata” or “learning object metadata”, (which would be discussed in the later section of this chapter). With the appropriate metadata attached for each LO, users are able to obtain more appropriate search results.

The LOs stored within the LORs could be educational content stored as text, graphical, audio, interactive media files or even learning activity templates expressed in a learning design format; (Hatala, Richards, Eap & Willms, 2004). Note that there are two types of LOR: -

- (1) LOR which contain both the learning objects and learning object metadata, and
- (2) LOR which contain metadata only, provides URL that link to actual LOs.

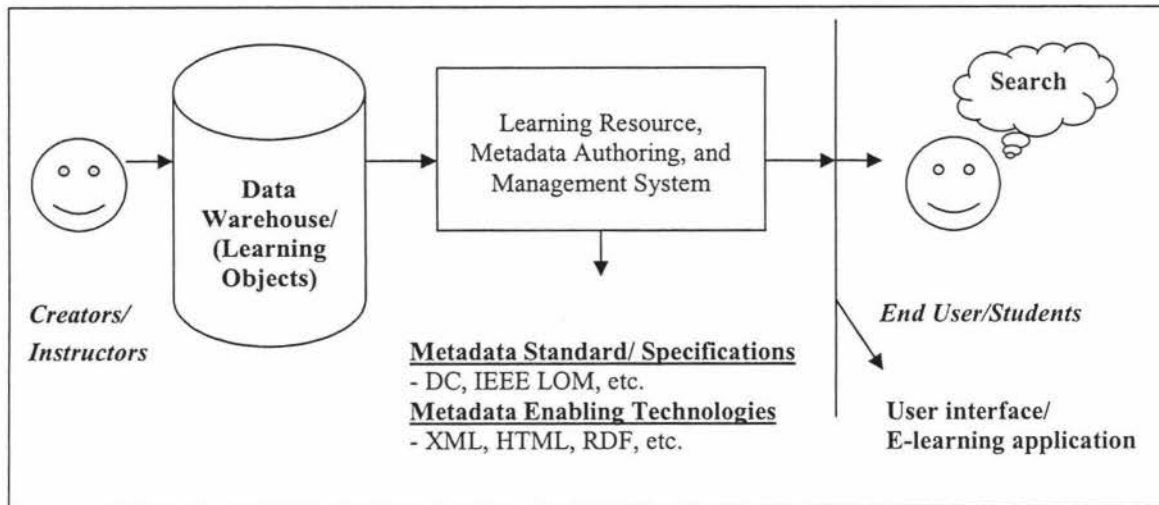


Figure 2.1: Components of the Learning System

For the first type of LOR, this repository is probably used both to locate and deliver the LOs. While the LOR that merely contain the metadata, its LOs are located at remote locations and it is used as a tool to locate learning objects. The above **Figure 2.1** showed the components that are required by a learning system, it presents how a learning system is functioning before the LOs reached the end users. During a search, the search engine will retrieve any LOs that tagged with the same value as the end users entered from the data warehouse.

2.1.2 Examples of Different Learning Object Repositories

Most of the LORs are developed with the intension to share their LOs online. However, there are some organisations which use LOR to hold their resources, such resources is for internal usages and to share within their organisations. With other LORs, a small amount of payment is required before you can get hold of their LOs. The Instructional Technology of the University of Texas at San Antonio (2004) comes out with a list of the LORs, they are sites and organisations either have generated LOs and host their own repository or have provided guideline, templates, or framework for LOs that are stored in their repository.

The following are some examples of LORs that are mentioned by the University of Texas at San Antonio: -

❖ CANCORE

CANCORE is a Canadian initiative, it intends to promote interchange of records describing educational resources and the discovery of these resources both in Canada and worldwide. CanCore is based on and fully compatible with the IEEE LOM standard and the IMS Learning Resource Meta-data specification. The

CanCore Application Profile¹ increases the ability of educators, researchers and students around the world to more easily search and locate material from online repositories of educational objects. These educational/learning objects could be individual web pages, video clips, interactive presentations, or even as comprehensive as complete lessons, courses or training programs and the like; (Cancore Website, 2005).

❖ **CAREO**

CAREO is defined as “*Campus Alberta Repository of Educational Object*”, a project supported by Alberta Learning and CANARIE (Canadian Network for the Advancement of Research in Industry and Education) that aimed to create a searchable, web-based collection of multidisciplinary teaching materials for educators across the province and beyond. Like MERLOT, it contains metadata and provides access to learning objects located on remote locations. Besides in providing a search function, CAREO also promotes an online community where educators can exchange their digital materials, expertise and experience. Its LOs collected within are available to everyone, and those registered members can contribute their own works, review existing materials, and contact other members with the similar interest; (Careo Website, 2005).

❖ **MERLOT**

MERLOT is defined as “*Multimedia Educational Resource for Learning and Online Teaching*”, and it is one of the most popular learning repositories of LOs. MERLOT has been providing free learning resources to its users since 1997, and it is designed mainly for faculty and students of higher education. It is a centralized LOR containing metadata and directing users to objects located at remote locations. MERLOT has a continually growing catalog of online learning materials, peer reviews, learning assignments, and user comments, and these learning resources are contribution of its members. MERLOT was modelled after the NSF funded project – Authoring Tools and An Educational Object Economy (EOE); (Merlot Website, 2005).

Besides storing the descriptions of the LOs, it is obvious from the above examples that these LORs also provided tools and processes that are required to build a LO; provide interactions with the users; store its revision history; gain access to those who have authorisation to access and update it, and who are responsible for managing it. Hence, some of these LORs sound just like a LCMS/LOMMS, but in fact, it is these additional authoring tools that enable a LOR to grow into a greater resourceful repository for its users. Like what is stated by Richards et al. (2002) that for those LORs that are connected to web portals, which will usually have the aim of improving the quality of LOs and enhance the quality of online education through sharing learning resources. In this paper, it is the under-layer of these interfaces that it would be examined – the metadata schemas.

¹ Application Profile referred to a set of metadata elements selected from one or more metadata schemas for the use of a particular LOR.

2.2 LEARNING OBJECT (LO)

More people are employing the term of “**Learning Object**” (LO) in the technology supported e-learning environment. Hence, there are many different definitions being found for LO. It is sometimes referred as reusable learning object, e-learning resource, knowledge object, electronic resource and the like, (Neven & Duval, 2002; Retalis, 2005; Barritt & Alderman, 2004; and McClelland, 2003). Many terms are found because different groups of people perceived their meaning as they created them, especially where the designers and developers would want the functions of their LO to be particular to themselves. For this paper, the term of learning object (LO) will employ to denote of all other terms.

2.2.1 What is a Learning Object?

The Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) was established in 1996 to develop and promote instructional technology standards, they defined the LO as “*any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning*”; (LTSCa, 2004). Other definitions of LO are “*...is an independent collection of content and media element, a learning approach (interactivity, learning architecture, context), and metadata (used to storage and searching)*”; (Barritt & Alderman, 2004). While Willey (2002) describes LO as “*...generally understood to be digital entities deliverable over the Internet, meaning that any number of people can access and use them simultaneously*”.

As more attention is placed on the LO’s definition, more definitions are being established. However, Barritt and Alderman (2004) suggested that users perceive LO from a variety of terms for what they have experienced – some would referred LO as a learning module because this is what they are retrieved from the learning repository. However, a particular favorable definition of LO was when Massey (2003) talked about that the JORUM+² project, as they defined the LO as “*a learning object is any resource that can be used to facilitate learning and teaching that has been described using metadata*”.

A physical form of LO could come in the form of text files, MP3 files, Flash animation, Media Player movies or even a complete course. With the word of “learning”, it is obvious that LOs are mainly created to support the teaching and learning in a wide range of interests, and are often engaged in the online learning environment. Currently, it is understood that the LO is for a learning purpose and it is the educational content held within that which makes the LO so special, and creators of LO often hope the content that their LO is carrying will be beneficial to its learners. Duval, Hodgins, Rehak and Robson (2003) stated “*the promise and purpose of learning objects is to increase the effectiveness of learning as much or more than their efficiency in terms of cost and speed*”.

² The JISC (The Joint Information Systems Committee) Online Repository for Learning and Teaching Materials (JORUM+) will be a repository service for all “Further and Higher Education Institutions in the UK. It provides access to materials and encouraging the sharing, re-use and re-purposing of them between teaching staff.

2.2.2 Structure and Size of a Learning Object

The basic structure of a LO can be divided into two main parts. First, it is the LO itself, and second is the meta-tag information or metadata which explains what this LO is; refer to **Figure 2.2**. Taking an example in the real-world situation, the LO would be the book in the library and metadata would be the catalogue card that provides information about the book. Without the catalogue card, then it would be harder to search for the book and the book will be meaningless unless the content of the book is read. It has illustrated that metadata describes the LO and places it in context; (details on metadata will be deliberated further in Section 2.3).

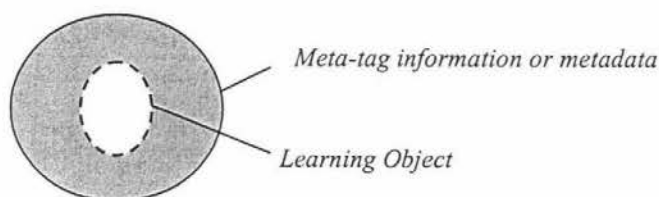


Figure 2.2: Structure of LO

LOs are different from each other as they might contain different types of information, different specific learning objective, and they also vary in size. When referred to size, this brings us to another expression used to measure LOs which is called “*granular*”. This term is often used to describe the complexity of a LO, such as a learning module is considered more granular than a text file, because in a physical form, a text file would be a single or standalone unit of LO. Whereas a learning module would often be a collection of standalone LOs that are put together to deliver a more purposeful learning for learners, which is more complex than a text file.

The importance of granularity take place is when creating a LO as an instructor would need to consider the granular of the LO before creating it. Such as if this LO is granular enough to deliver purposeful learning for its learners, because when it is purposeful in learning then reuse would take place more frequently by learners. Vice versa, if the LO is too granular with content (comprised of many other LOs) then it would be hard to manage, and difficult for learners to understand which would equally lead to discourage of reuse. If reuse of discouraged, then this will contradict the entire purpose of creating LOs.

In general, a more complex LO would be a container that contains information about itself and even other learning objects, which is illustrated in **Figure 2.3**. It presents with a hierarchy level on how a more complex LO would be like, and what is contain within, such as file (type of information), metadata, and other LOs. As mentioned earlier, LO could be as simple as a text file, a graphical picture, an audio file, a video clip or even in an individual state. In another word, for a LO to create some meaningful learning for its users, it is often comprised into an unit of learning, and when these units of learning are collected together then it could be referred to as a

module, a lesson or a course. Hence, these LOs are collected into a larger collection of content in order to create more specific and significant learning for learners.

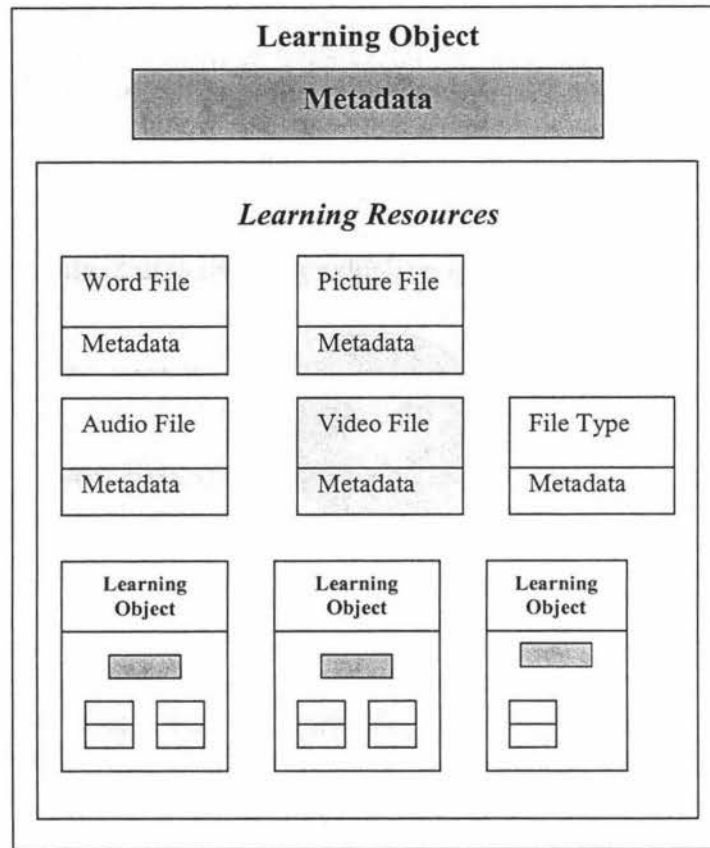


Figure 2.3: A complex Learning Object Model;
Adopted from Ward, (2003; p.3).

2.2.3 Purposes and Functionalities of the Learning Objects

Currently, educational institutions are working hard to create new digital exercises, classroom exercises and lecture notes into digital format, and all these efforts and procedures are more challenging than the traditional classroom methods. However, it is believed the end results does not just benefit the institutions but as well as the end users. As explained by Millar (2005) that there are two main reasons in making LOs:- Firstly, LOs stored in a database and tagged with metadata are easily to retrieve, and are designed particularly for flexibility and reuse compared to the traditional course format. Secondly, making use of the current computing power and network infrastructure that allow readily available learning materials to be easily shared with others such as learners, instructors, organisations, etc. This in turns will also reduce the cost and effort of reproducing similar or same quality learning materials.

Note that different LOs contain different types of information, however it is essential for them to possess the following basic functionalities: -

Self-contained: - LO is self-contained as it could be used independently of other LOs.

Self-explanatory: - All LOs are tagged with metadata which describe the LOs, where this metadata would make it easy to retrieve the LO in a search.

Aggregation: - LOs can be aggregated into large collections of content to create more substantial units of learning for learners.

Reusable: - LOs are reusable because the same LO could be reused in different contexts for different purposes.

Despite their different learning purposes of LO, their functionalities are rather similar.

From the above, reusable is considered one of the functionalities that is most promoted by the LOs. The main idea of the LO is to promote greater reuse of resources within the e-learning context, and for many years, reuse of educational resources has been common, such as textbooks, maps, periodic tables, etc. Reuse of LO allows when developers want to save cost and time in developing new LOs, as these LOs have been already created and are available online.

With availability of many LOs, organisations do not need to come out with high price to develop their own learning materials but could use the existing ones that developed by others. Often, this would involve in paying a reasonable fee to obtain usage or copy right, or some communities would offer their learning materials for free. With this new inclination, it would enhance the quality of teaching and learning for the learning communities. However, to able to find these available LOs, then this lead to the next section – metadata.

2.3 METADATA

Learning objects (LOs) are often developed anew because nobody knew that they already existed. Hence, with the increasing amount of LOs loaded into the World Wide Web each day, it has become trickier for users to search for desirable LOs. Therefore, some sort of instructional technology standards or requirements are needed to manage these LOs, and what is connected with these LOs is the metadata.

2.3.1 What is Metadata?

Metadata is often defined as information used to describe the LOs, and it is also literally understood as “data about data”. It has many similar characteristics to the cataloguing that take place in museums, libraries and archives. One common example is a library catalog card which was mentioned early, it encloses data about the contents and location of a book, such as author, title, subject, etc. It is basically the data about the data in this particular book referred to by this catalog card. Metadata provides us with information about the existence of a LO, such as the origin, size, formatting and other characteristics of the LO. McClelland (2003) stated, “...*metadata is data that describes a physical or electronic resource, and can be used to manage collections of documents, images, and other information in a repository*”.

The primary use of metadata is for searching, that is searching through the database for files based on condition like title, author or publisher. However, there are resources that are in different types of formats and data files. For example, there are non-text educational materials which could not be expressed in text form. In order to find those non-text files, therefore it is necessary to add description to them. With the help of metadata, it would allow users to know the author, title, subject, educational, access, administrative of the LOs, and much more. A typical metadata record consists of a number of pre-defined elements representing specific attributes of a resource, and each element can have one or more values. Following is an example of a simple metadata record that described a particular LO: -

ELEMENT NAME	VALUE
Title	157250_2005 Assignment 1
Creator	Alexi Tretiakov
Publisher	Department of Information Systems, Massey University
Identifier	http://is157250.massey.ac.nz/h/Assignments/157250_2005_Assignment_1.doc
Format	Text/Html
Relation	The official web site of 157.250 Design and Development of Web-based Information Systems

Figure 2.4: A Metadata Record

From **Figure 2.4**, it is understood the basic model used for metadata is known as “attribute type and value” model; (Iannella & Waugh, 1997). Where metadata is represented as a set of fact about the LO. Each fact is represented as an attribute that is also known as an element or metadata element. An attribute will contain a type that will identify what information the attribute contains, in another word, its values. I.e., the metadata is “Title” and it contains a value “157250_2005 Assignment 1” that described the metadata itself.

Note that there are two ways to store metadata, either to include the metadata in the LO or to store metadata outside the LO. For metadata that is stored in the LO is also referred to as “embedded metadata”, it could be a digital image format like jpeg or tiff, or a file tagged in mark-up language such as **HTML** (HyperText Mark-up Language) or **XML** (Extensible Mark-up Language). For metadata that is included in file, then it will always associated and move around with the LO as metadata is embedded with the content, and will require access to the LO itself for access to the metadata. As for metadata that is stored outside the LO, it would be a metadata repository that stored the metadata which separated from the LO (content). It could be also information stored in inverted files in the Internet’s search engines or a collection of links with descriptions of each link. Metadata that is stored in this manner can be shared or accessed without sharing or accessing the LO itself.

The advantages to include the metadata in the file then when the LO is updated then its metadata could be updated at the same time but this will eventually require more work, but it is also most frequently designed to describe the accuracy of the elements of the database. As for those metadata that are recorded independently of the LOs,

there is no need to access to the LOs in order to search the metadata. However, these metadata might not be updated or could be neglected, and will cause an incorrect search result. The benefit of this type of LORs is it could hold a vast of LOs, and much easier to load the required information within the repository.

As for the LORs, metadata allows easy access to LOs by providing controlled and systemic way of describing each LO. More specifically, metadata is data about each LO in the database that provides us with the additional information on the LOs used in the repository. Hence, using the metadata standards in the repositories is required, and with metadata in place users of LORs are able to locate a LO quickly without looking into the individual LOs. In addition, metadata standards are not just employed within the LORs, they are also wisely used within the World Wide Web mainly because metadata is the fundamental element in searching, and it plays an essential role in managing, evaluating and sharing of resources. It is believed that metadata is the key to content management as Richards et al. (2002) suggests that *“if a LO is constructed appropriately, warehouse wisely and catalogued accurately, a learning object might find usage beyond its original audience, and instructional context”*.

2.3.2 Metadata Standards/Specifications

With many LOs emerging rapidly, greater interest is being placed on them. At this point, many communities have developed many different metadata standards and specifications to fulfil the needs. The purpose of such development is to encourage creators of LOs to use these many approved metadata standards to describe the properties of LOs. In addition, each of these metadata has a unique focus, many organisations have proposed different specific metadata to suit different LOs. Some of the popular metadata standards included **IMS** (IMS Global Learning Consortium); **DC** (Dublin Core Metadata Initiative); and **IEEE LOM** (IEEE Learning Object Metadata). However, the most popular and commonly used metadata standards are the DC and IEEE LOM metadata standards; (Taylor, 2003, and Duval, 2004).

The **DCMI** (Dublin Core Metadata Initiative) is an organisation committed to promote the widespread adoption of interoperable metadata standards, and to develop specialised metadata vocabularies for describing resources which allow more intelligent information discovery systems, (DCMI, 2005). It was first developed to facilitate search and retrieval of the Web-based resources; (McClelland, 2003), and it will be known as “DC” in this paper. On the other hand, **IEEE LOM** (IEEE Learning Object Metadata) was developed by the **IEEE LTSC** (IEEE Learning Technology Standards Committee) in collaboration with the DCMI, and this standard was first released in 2002. In Steinacker, Ghavam and Steinmetz (2001), they state *“IEEE LOM scheme uses almost every category of the Dublin Core and extends it with categories and attributes tailored to its needs...”*. Like any other metadata standards, IEEE LOM aims to facilitate search, evaluation, acquisition and use of learning objects, and like Dublin Core, all metadata elements in IEEE LOM are optional and its structure can be extended.

Of many prominent organisations that are involved in developing metadata standards for LOs, they are the US Department of Defence's **ADL** (Advanced Distributed Learning) initiative, the **SCORM** (Sharable Content Object Reference Model), the **IMS** (Instructional Management System) and the like. However, there is disagreement that organisations such as ARIADNE and IMS are producing specifications, not standards; (Duval, 2004). The reason is their metadata schemas are based on internal process, hence they are designed to make the needs and requirements of the members of their organisations. Therefore, he stated "*such specification are not standards, as they do not need to take into account the requirements and needs of the whole domain of learning*".

Because of the difference in opinion, the "**ISO**" (International Standards Organisation) has set up a **Metadata Working Group** to take over the responsibility for standards for specification and management of metadata; (Milstead & Feldman, 1999, and Duval, 2004). The scope of the Working Group is sometime known as the **ISO/IEC JTC1** (Joint Technical Committee on Information Technology) because this Working Group is organised under it. The scope of the Working Group included metadata elements, classification and coding schemes, and management and exchange; (Milstead & Feldman, 1999). Besides ISO/IEC JTC1, recognised organisation like IEEE LTSC explicitly have the obligation to meet the needs and requirements of the whole learning domain, and it is known for its maintenance in fair and open process to achieve this aim in the standardisation process. As for IEEE LTSC, it made available drafts standards to the public in the early stages and throughout the standardisation process, this is done in this approach so the community can influence its development of the standard; (Duval, 2004). Due to the above reasons, both of DC and IEEE LOM standards are used in this paper to illustrate the metadata schema that we are going to develop.

2.3.3 Usefulness of Metadata

In principal, metadata standards also allow developers to support an interoperable infrastructure for worldwide e-learning and they are essential for building comprehensive learning object repositories, (McClelland, 2003). As mentioned previously, different LORs attempt to address different needs in the different group of communities, hence a set of elements metadata can be created or selected to meet the requirement of ones community, and any newly found elements or specifications can be later contribute to the standards development.

Hence, it is evidence to claim that no unique standard is in place for developers of information provider (LOR) to follow, and metadata elements are often sourced from different metadata specifications, or new ones are created to meet particular requirements in the applications. Although, developers know the adaptation of a metadata standard is important but later also have their own priorities in place to consider when it comes to selecting a metadata application profile. In Steinacker, et al. (2001, p. 7), they sum up the usefulness of metadata as follows: -

	Usefulness of Metadata
1	Allows summarising the meaning of the data.
2	Allows user to search for data more efficiently.
3	Allows user to determine if the data is what they looking for.
4	Provides information that affect the use of data, such as legal conditions, size, age, etc.
5	Indicates relationship with other resources.

Figure 2.4: Usefulness of Metadata

Metadata not only assists us in locating the information, it also allows interpreting and integrating data. For example, a measure for the difficulty of a course is defined in metadata standards. With metadata, it allows separate or multiple resource collections to appear as one.

2.4 ISSUES WITH LEARNING OBJECT REPOSITORIES

Learning systems often attempt to present a complete platform for online learning, where it will provide an integrated environment for students, instructors or any other users. Moreover, they will include some sort of management and administration tools for both learning materials and users. However, as part of the components of learning system, it is vital for LOR to manage its under layer appropriately in order for users to accurately retrieve their LOs. Furthermore, metadata are required when it comes to describing the LOs, hence it is essential to examine the related issues that link to the LORs.

2.4.1 Issues Related To The Use Of Metadata

Within the LOR, it contains LOs and their associated metadata which tailored to specific needs of different users. Because of metadata, it makes LOR possible in term of providing structured information about the LOs; describing educational purpose of the LOs; providing interoperability with other LORs that use the same standard; allow reuse of LOs with others; giving information about its rights; and accessibility to other users. It is obvious that metadata is not something new, and information providers know its importance if wanting better precise search results in a search function.

(i) Different metadata standards and conversion

Undoubtedly that many metadata standards/specifications are being developed, but there is not yet to know how many standards/specifications are out there. To avoid confusion between standard and specification, the term “standard” would include specifications in this paper. However, some or most of these standards are rather similar, because they are either based on the well-known standards such as DC or IEEE LOM. As for other metadata schemas,

they would use a mix of well-known standards along with their newly created metadata elements.

With the vast varieties of metadata standards, therefore problems will take place when it comes to interoperability between different LORs. Mainly, it is because with different LORs using different types of metadata standards, it is a challenge on how to map and transform metadata between different metadata standards if we want to share them. As metadata mapping would allow us to share and to exchange learning objects as well as their metadata, (Najjar, Duval, Ternier & Neven, 2003).

(ii) Selecting and Naming the metadata elements

Hatala et al. (2004) argues that the locating and re-use of LOs is restrained by a lack of coordinated effort in addressing issues related to their storage, cataloguing and rights management. Partly, this is often caused by not able to understand the description of the metadata required, and users will rely on the automated generation in some of the fields while filling in the information.

The significant challenge to create effective metadata is the amount of work required to do a good job. Especially if the metadata can include different types of elements, then it requires someone that has the experience to do the job. Often, there are many possible descriptions for a LO as it is hard to decide on the theme or subjects on a LO, and there are still questions of whether the creators of learning objects pose the knowledge to give the correct information. Therefore, human expertise is preferred in conducting metadata indexing but this can be expensive and human errors could also take place.

(iii) Missing metadata

Emphasis has been stressed to users to employ metadata while creating LOs. However, there are many reasons why this adoption is not taking off as one desires. For example, not understand the LO fully to name the metadata, unsuitable metadata is selected, too much work to fully describe the LO, etc.

Currently, there are many LORs available for users that wish to add on their opinions and information about an existing LO. Sometime, a form is provided with drop-down list for users to select the appropriate metadata elements. However, this means additional work is required for users to insert or compose the metadata information at the different elements, and this is up to the users whether they are willing to take the time and making the effort in providing the information. Or sometimes, such work is being done for users where the auto update metadata is being done on systems where the computers would fill in as much metadata as possible. Despite all these, there are still missing metadata. Hence, it is the individual author that requires improvement because competitive advantage can be gained through such effort, (Sonntag, 2004).

With several issues regarding to the metadata, it is believed that early precautions and strict guidelines will always be the remedies that will resolve such problems, or other alternatives are also found before a final solution can be identified.

2.4.2 Reusable of Learning Objects

Depending on the size, a LO could be expensive and time consuming to create, and it is agreed by Martindale and Ahern (2002) that part of the benefit in adopting a learning object approach is because it will potentially reducing the development cost, time, and resources for instructional delivery. Hence, developers of LORs would often prefer to reuse some of the LOs. Furthermore, with many education providers around, there would be the same or similar courses that are carried out in other universities, colleges or schools. The reason of many people adopting the use of LOs is mainly its reusability in the educational environment.

(i) Modularisation

LOs can be as simple as plain text documents or images, but these LOs might not be valuable to the users. Note that a single LO should be designed to provide purposeful lesson to its users, or LOs should be grouped together to deliver a more meaningful learning lesson to their users. However, in order to prevent presenting the users with a LO that represent the whole course, the use of modular development or modularisation has become another alternative in manage reusable LOs. That is by breaking down the whole course into different sections. Modularisation of courses usually involved with packaging the course content, the idea is to allow to structure learning topics into semantically meaningful units so that they may be used or reused in various courses; (Ateyeh & Mülle, 2002).

This courseware reuse has been an aspect of the ARIADNE project, a project that is focus on the development of tools and methodologies for producing, managing and reusing computer-based pedagogical elements and telematics supported training curricula, (ARIADNE, 2005). It is suggested by Ateyeh and Mülle (2002) that “*applying modularisation to courseware design and the use of ontologies will result in high quality that can be re-used beyond today’s practice*”, (p. 1). Furthermore, the reusable courseware can be supported by applying modularity to courseware design; (Ateyeh & Mülle, 2002), and it is believed that LOs are easier for reuse if they are broken up in different meaningful learning unit.

2.4.3 Search in LORs

Richards et al. (2002) mentioned that the keyword-based search is currently widely used, however it has also proven its inadequacy for the location of high quality resources appropriate to specific learning contexts, levels and styles. With almost all search engines being text based, hence one of the greatest barriers in finding information is the difficulty of coming up with the right terminology, (Milstead & Feldman, 1999).

It is logical for developers of LORs to build their required metadata schemas to suit their LOs that they are collecting. Inevitably, naming of the metadata elements would be a vital task as certain terminology such as “topic” and “subject” is commonly used in describing theme of a chapter, a book, a course, or the like. Furthermore, one needs to keep in mind that the World Wide Web is called because it is used internationally, but with a terminology used in a country might be used differently in other countries. Hence, another issue with metadata will be internationalisation, where Iannella and Waugh (1997) advise that English is usually the preferred set model but the use of some names for metadata might have no meaning in some other cultures.

Most important of all, Norgard, Kim, Buckland, Chen, Larson and Gey (1999) have commented that users are often not aware of how data is classified, categorised, abbreviated, named and represented in the database. There are new approaches could be developed that map the metadata and query terms to a cluster of word that are related; (Milstead & Feldman, 1999). For example, where some of the Web search engines, like Excite which is the leading personalisation Web portal, featuring world-class search content and functionality; (Excite, 2005). It will do “concept searcher” which are based on the co-occurrence of terms within the database. Which means, if one term keeps appearing near another then there should have some kind of relationship between the two. Hence, the user should be interested in seeing documents that contain either one of the terms. On the other hand, Norgard et al. (1999) propose the use of “Entry Vocabulary modules” (EVM) that they hope to use in bridging up the gap between the user’s original language, as well as the database system’s metadata and stored data. That is using EVM to respond adaptively to the user’s ordinary language query with a ranked list of search terms in the target metadata vocabularies that may more accurately represent what is sought in the unfamiliar database.

2.5 INTEROPERABILITY BETWEEN LORs

In Karampiperis & Sampson (2003), they stated the main goal in designing a learning object metadata based system is to “...achieve interoperability between similar systems and reusability of the stored and managed information”. The main reason for a LOR to be interoperated is so the LOs stored within could be share and reuse by other users, and that is the reason for LOs to be created. This is particular useful when users who are interested in a particular LO that they cannot find in their own LORs. Therefore, to be able to interoperate with other LORs seems to be the right thing to do, as users do not need to create new LOs but to exchange their educational contents with other instructors at same or different geographical location. Interoperability will come in handy when instructors of other universities are creating similar or same learning materials, hence it is wasteful not to make use of exchange of LOs.

2.5.1 Issues with Interoperate

The current trend in LORs is to link with other LORs to share their resources through different architecture frameworks. However, with interoperability there are some key issues that need to take note of, areas such as registration of metadata schemas, extensibility, and internationalisation are the problems face by the metadata communities; (Milstead & Feldman, 1999; Iannella & Waugh, 1997; IMS, 2004; and DCMI, 2005a).

Registration of the metadata schemas is mostly for them to be able to be recognised in the metadata communities. Extensibility is created with the need for precise retrieval of LOs, for example the DC metadata standard has extended the DC element set for additional discovery needs. Internationalisation is to ensure that the development of a metadata schema needs to consider the multilingual and multicultural nature of the electronic information space, because metadata could be used internationally.

The key problem is because each individual LOR is intended for different needs, therefore metadata designers will opt for a number of metadata elements with their value sets from one or more metadata standards; (Heery & Patel, 2000). Hence, it will be impossible for all LORs to use the same metadata standard, let alone these other issues. Lastly, the discussion on interoperability will not be in a profound mode in this paper, but just to remain us what are the issues faced by the metadata communities.

5.5.2 The Impact of XML in LORs

XML - eXtensible Markup Language is a good language for data exchange, it is often used in communication between systems; (Graves, 2002). XML is known as one of the essential technical advances that have facilitated the development of content management applications, such as a content management like learning repository. It has a standard format that allow us to define the structure and semantic of data and information.

Note that there are three main characteristics of XML which make XML unique, they are heterogeneity, extensibility and flexibility; (Graves, 2002). By using XML, users of the LOR will be able to make a more complete query combining conditions such as ands, ors and parenthesis. Furthermore, good styling in XML will offer good application performance, especially when it comes to storing, retrieving, and managing information. In White (2005), it recommended “*XML is a database-neutral text language that facilitates the re-use of the content*”, (p. 16).

Similar to **HTML** – **H**yper**T**ext **M**arkup **L**anguage, XML also makes use of tags and attributes but the difference is that HTML expresses its information with four fundamental components: - tags, attributes, metadata elements, and hierarchy. Where as XML allows users to design their own tags, which then enable the definition, transmission, validation, and interpretation of data between applications. XML does not replace HTML but complements it, because the focus of HTML is on the structure of a document and how this document displayed by a web browser. There are many

LORs are using XML, such as SCORM uses XML greatly in defining its “Course Structure Format”, a system that represents course structures so educational materials can interoperate between platforms and systems; (Ogbuji, 2003).

For LOR to enhance its performance in the Web, a technology used to incorporate with XML is called **RDF (Resource Description Framework)**, it is a family of specifications for a metadata model. It is also known as a declarative language which provides a standard way for using XML to represent metadata in the form of statements about properties and relationships of items on the Web; (Wikipedia, 2006). With LORs that are related to interoperability will encounter with some technical issues, however most of these technical issues are being dealt with through technologies like XML, RDF, and ontology which will allow communities to concentrate on semantics.

In this section, there are a number of issues with revolved around LORs are being discussed. Potential solutions are being developed to mend with some of the issues faced by the metadata, but not all of which are resolved yet. Note that there is not doubt that metadata has a vital role for supporting the use of electronic and non-electronic resources on the Internet, and it is concluded by Richards et al. (2002) that the key to a successful repository strategy is the ability of repositories to share information and exchange records about learning objects, and their provision of access to the learning objects themselves. Therefore, engaging in metadata standards would allow developers of web-enabled technology to support an interoperable infrastructure for worldwide e-learning, and standards are crucial aspect for building a comprehensive LOR.