DESIGNING
LEARNING OBJECT REPOSITORIES

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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 descibe them so users of the respositories area 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 activate can be done much 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 usages 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 carries 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 in size, number and file type. Sometime, LORs are created to meet specific organisational aims, where each LOR has it 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 placed 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 underlaying 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** (**L**earning **C**ontent **M**anagement **S**ystem); **LOMMS** (**L**earning **O**bject **M**etadata **Ma**nagement **S**ystem) or **VLE** (**V**irtual **L**earning **E**nvironment), they were designed and developed in recent years to provide information to learners; (Edtechpost, 2004; Karampiperis & Sampson, 2003; and Wikepedia, 2005). They are based on metadata and use metadata standards such as **IEEE LOM** (**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers **L**earning **O**bject **M**etadata) and **DC** (**D**ublin **C**ore) 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.

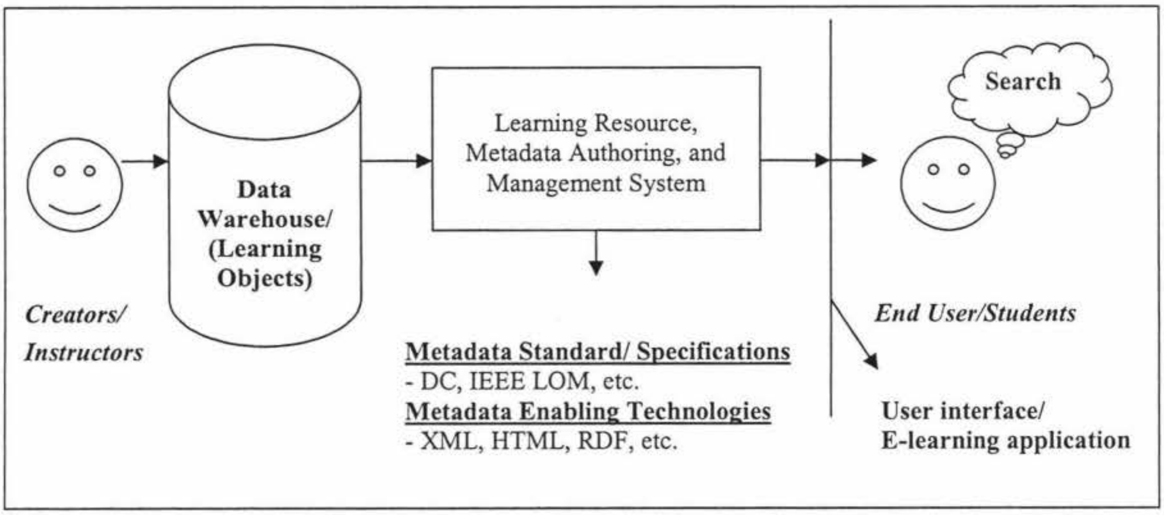

Figure 2.1: ***Components of the Learning System***

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 Profile[1] 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 **L**earning **T**echnology **S**tandards **C**ommittee **(LTSC)** of the **I**nstitute of **E**lectrical and **E**lectronics **E**ngineers **(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).

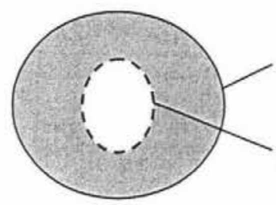

Figure 2.2: ***Structure of LO***

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.

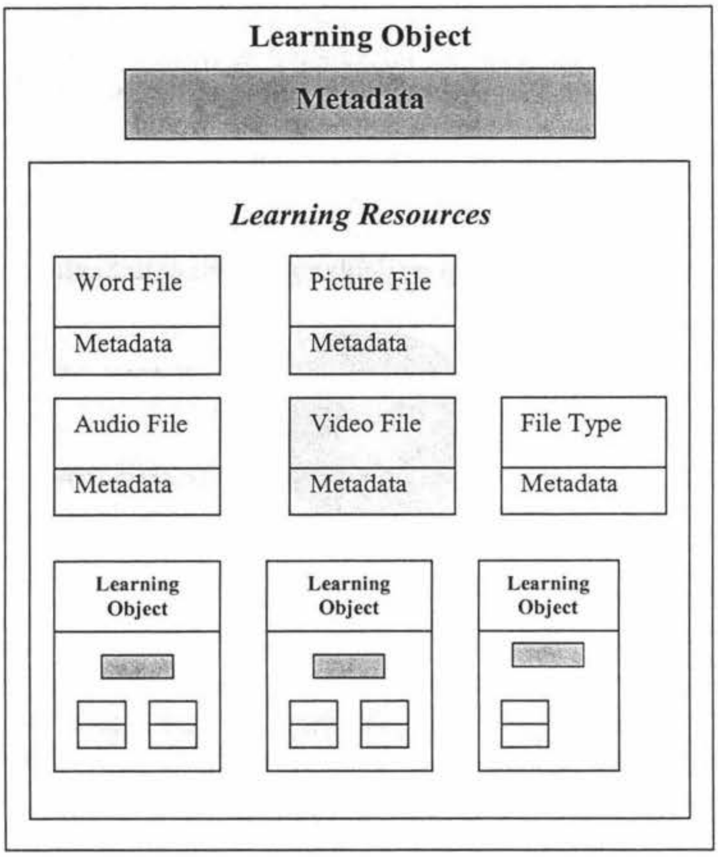

Figure 2.3: ***A complex Learning Object Model;***
Adopted from Ward, (2003; p.3).

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 proposes.

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 hight 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** (**H**yper**T**ext **M**ark-up **L**anguage) or **XML** (E**x**tensible **M**ark-up **L**anguage). 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** (**D**ublin **C**ore Metadata Initiative); and **IEEE LOM** (IEEE **L**earning **O**bject **M**etadata). However, the most popular and commonly used metadata standards are the DC and IEEE LOM metadata standards; (Taylor, 2003, and Duval, 2004).

The **DCMI** (**D**ublin **C**ore **M**etadata **I**nitiative) 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** **L**earning **O**bject **M**etadata) was developed by the **IEEE LTSC** (**IEEE** **L**earning **T**echnology **S**tandards **C**ommittee) 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** (**A**dvanced **D**istributed **L**earning) initiative, the **SCORM** (**S**harable **C**ontent **O**bject **R**eference **M**odel), the **IMS** (**I**nstructional **M**anagement **S**ystem) 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"** (**I**nternational **S**tandards **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 JTCI** (**J**oint **T**echnical **C**ommittee on **I**nformation 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 JTCI, 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, (MeClelland, 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 mėtadata, 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 became 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 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 - e**X**tensible **M**arkup **L**anguage 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** (**R**esource **D**escription **F**ramework), 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.

CHAPTER 3

DEVELOPMENT OF DATA SCHEMA FOR A MANAGABLE LEARNING REPOSITORY

The main goal of this paper is to identify how learning object repositories (LORs) can be better managed. In order for a learning repository to manage the LOs efficiently, and for it to deliver useful search results to its users, it is necessary to look into the data level of the repository. As explained by Baker, Blanchi, Brickley, Duval, Joshnston, Kalinichenko, Neuroth and Sugimoto (2002) that in "*the computer-science field of database design there is an older practice, dating from prior to the "Web era" that the term "metadata" is engaged to designate information about the database schema*". In this sense, it is a data schema that is required to develop.

For information system storage such as LOR, it will require an ability to handle large amounts of data with complex relationships, which are often stored in relational or object databases. The data modeling will be based on the **Information Systems Department** (ISD) of Massey University as example, using the scenario on how a LO is could be utilised – as Rob and Cornonel (2004) explains "*the most effective database designs use models, simplified abstraction of real-world events or condition*", (p. 25). In this phase, it is necessary to determine what sort of information and what are the data that exists within this organisation. Firstly, this is an attempt to propose how the available learning materials in an educational provider could be better managed, and how could the instructors gain access to these available learning materials and make full use of them.

The previous chapter covered the subjects and issues involved with learning repositories, and subsequently provided the basis for understanding the fundamentals required in a learning repository. This chapter introduces the concepts of data modeling and is followed by a section containing the design of the database schema, and the chapter ends with an analysis of the database system required in the learning repository.

3.1 CONCEPTS OF THE DATA MODELING

As mentioned previously, a LOR functions like storage like a database, a place where search queries obtain their results. Hence, data model is the main requirement in structuring a LOR. Often, the creators of LOR would use a database schema to represent the information stored in the LOR. As in the database field, metadata is essential to understanding and interpreting the contents of data storage.

The emphasis of data modeling is a conceptual representation of the data structures that are required by the database. Before a database system can be used, it is necessary to know what information is held within the system. Database design is the process of determining the organisation of a database application. Thalheim (2000) suggests that in order to have efficient management of a database, it is essential to acquire the structural, semantic and operational information of the application, and the information of the organisation needs to be considered as well.

In addition, the data model should concentrate on what data object is required and how it is organised, and it focuses on representing the data as the users perceive it in the real world situation. Data structures in the data model will include the data objects, the relationships between data objects, and the rules that control the operations on the data objects.

3.1.1 The Details of Data Modeling in ISD

Previously, it is mentioned that a library catalog card would provide us information such as author; title; topic; publisher; location of the book; etc. This information is referred to as "metadata elements", and their values are called the "metadata instances" - where these metadata instances would allow users to summarise the meaning of the LOs. In order to present our data model, it is necessary to decide the type of database system best suited.

A relational database is chosen because it uses a table that holds the data within a two-dimensional table, and it contains rows and columns. Database designers often engage the relational database system, partly because **DBMS**s (Database Management Systems) are a mature technology that has been widely recognised, and it is easy to design, implement, manage and use. Furthermore, it is a single data repository that provides structure and data independencies where changes in the database structure will not affect the data access in any way, therefore it is easier to maintain its contents.

Before the actual data modeling, it is necessary to consider the information required to be gathered. The **Information Systems Department** (**ISD**) is used as a setting for the data modeling so real data could be adopted in order to produce relevant examples. It is essential to study the ISD's website to extract what are the information required in the data modeling, it is where information with regards to the courses offered in the department is located. Most importantly, it is to identify how the course materials are being delivered to the students, as well as to understand the environment the courses are operating within the department.

<u>Description of Courseware in the ISD</u>

In this demonstration, the courses offered by ISD are employed to illustrate how the information will flow through in the relational database system. Before going into the schema, a comprehensive description of how courses function in the ISD is shown below: -

(i) Each instructor is identified by his or her name, they could be also identified by their position and roles given by the ISD. In this paper, the word "instructor" is used to include course coordinator, lecturer, tutor, graduate assistant or the like, referring to any person that is involved in developing and preparing the course and course materials.

(ii) Courses in the ISD are scheduled in advance, when assigned to a course, the roles and responsibilities of course controller, lecturer and tutor are allocated accordingly. Each instructor is given responsibilities and tasks, for example, the course coordinators will provide the prescription of a course that they are given to take control off. It means, they have the most authority, and who is better in understand what are the entry requirements a student who wants to participate in the course. They would also probably take on the responsibilities such as to outline the learning objectives and paper content; decide on the teaching approach and assessment; conditions of passing the course, set required text and any other materials that are related to the course. In addition, they are in charge of the course's Web-page. Note that there could be more than one instructor for each course.

(iii) Course materials are designed to allow students to understand what is being taught in the course. Especially, it is to fulfil the objectives set in the course. Course materials will include learning materials such as lecture notes, hand outs, assignments, lab instructions, supplementary readings, study guides, tutorial worksheets, and the like that are posted to the course's website, and all these course materials are referred to as "courseware" (learning objects) in this example.

(iv) Courseware is delivered in class but they are also made available on the course's Web-page in advance where students are able to make a copy before the lesson so attention is paid to the lesson instead of taking lecture notes. Usefulness of the Web-page is that students can do their self-learning from the links provided, take note of important dates, conduct online tests, look for their results, and other useful resources, but most importantly is for students to access to these courseware their own pace, which also applied to extramural students.

Note that there are two types of delivery mode in the ISD's teaching: - Internal and extramural.

Internal mode: Study is conduct in the campus, where students are required to attend to lessons as what is scheduled to them.

Extramural mode: Study is conduct through distance study, essential course material will be dispatched to students before the course commences. Like internal students, extramural students are also able to access to courseware through the Web-page.

The idea is to encourage reuse of courseware within the ISD's teaching. It is natural to assume the instructors who are involved in this course would be those who will prepare the courseware. For instance, to prepare a course for 2006 then the instructors would want to update the current courseware. They will have the choice whether to update from the old version or maintain the old version and make a new version. In all cases, it is essential to keep track of the work that are taking place on these courseware, so information on the date created and data updated would be important. Furthermore, if an instructor wants to create a courseware in database system with the topics of RDM, DDL & DML and find courseware which only contains DDL and DML, but not RDM. Hence, it would be more sensible for this instructor to look for this missing topic of RDM from other available courseware within ISD to include in his or her courseware instead of creating a new one.

With the above listed information, entities and relationships are being identified and could be modelled into entity and relationship types. The methodology of the Entity-Relationship (ER) modeling is used to model and set up the relational database, and to produce an efficient and appropriate database modeling.

3.1.2 Data Modeling Languages

- **Entity-Relationship (ER) Model**

In order to further illustrate these data structures in the learning object repository, a data modelling language such as **E**ntity-**R**elationship (**ER**) modeling is engaged. It is "*a data model or digram for high-level descriptions of conceptual data models, and it provides a graphical notation for representing such data models in the form of entity-relationship diagrams*"; (Wikipedia, 2005). The ER model is a well-known conceptual model and it was originally proposed by Chen (Thalheim, 2000) in 1976 as a technique to unify the network and relational database views.

The ER model is seeing widespread use in practice for the task of conceptual database design. That is the database schemas are initially designed using the ER model, and is later translated to schemas in a data model. Normally, the relational model which is supported by a DBMS. The ER model is often used to communicate the design to the end users and it acts like a design plan before being implemented into a data model. Additionally, the ER model also maps well to the relational model, and the constructs used in the ER model can be easily transformed into relational tables in the database. The followings are the three main components that are used in the ER model: -

Entity: This representing the primary data object about which information is to be collected, and an entity is represented as a table in a database. Entities are typically recognizable concepts, either real or abstract, such as people or events which will have relevance to the database.
Attribute: Attribute is the property of an entity or relationship, a particular instance of an attribute is a value, and an attribute represents the column in a database.
Relationship: Relationship stands for an association between two or more entities, which it can be classified in terms of degree with integrity constraints.

There are many different entities held in a database, and firstly it is to list the entity types and to identify what are the relationships that associated between these entities. The ER model specified that the diagram use rectangles for entities, diamonds for relationships, and connected lines coming from those shapes for attributes, which is shown in **Figure 3.1**. An entity would have a distinct set of attributes (metadata) where each entity has its own values (metadata instances) for each attribute. Hence, such values held by the attribute will represent the main part of the data stored in the database (LOR), and the relationships will indicate how those entities are related to each other.

Figure 3.1 Entity and Relationship Types

With the given description, the ER diagram is illustrated in **Figure 3.2**, the ER diagram presents the internal catalogues in the relational database system, where it consists of table and columns specifications – which will show in the later section. The ER diagram has the explanation of the connectivity as follows: -

- An instructor teaches 1 to many courses in ISD, or a course is taught by 1 to many instructors.
- An instructor designed 1 to many courseware, or a courseware is designed by 1 to many instructors.
- A course contains 1 to many courseware, or a courseware is contained by 1 to many courses (which means a courseware could be used in more than one course – "reuse of LOs").

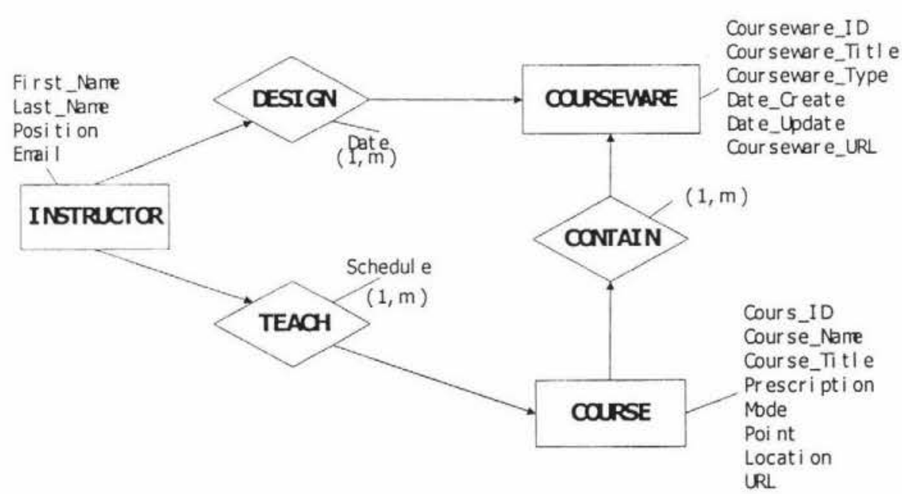

Figure 3.2 ER diagram of the Courseware Application

The ER model is a tool for analysing the semantic features of an application, and an ER diagram is used to illustrate a summary of the entities and relationships. Hence, it is important to identify what are the correspondence relationships between the set of attributes as often these attributes are related to each other with a more complex relationship. For example, entities of instructor and student could be grouped into a super-type called person, where instructor and student will belong to this parent entity using relationships to track.

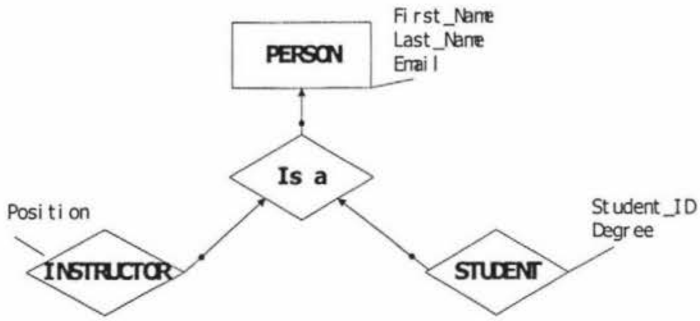

Figure 3.3 Specialisation in an ER diagram

In this case, there is a specialisation but it can be illustrated on the ER diagram. The ER diagram offers a convenient method for visualising the interrelationships among entities in a relational database, it is a graphic representation to model the database components. It has proven as a useful tool in making the transition from an information application description to a formal database schema.

- **Higher-Order Entity-Relationship Model (HERM)**

Similar to ERD, the **HERM** - **H**igher-Order **E**ntity-**R**elationship **M**odel enable the database developer to represent the structure, functionality, semantics and the interaction of database applications. According to Thalheim (2000) that "*HERM is a well-founded theory and it has several advantages in adopting the HERM approach*", (p. 55). He also highlighted that HERM schemas are easy to understand when compared to ER model schema; it supports abstraction in a simple but understandable manner; and it can be combined together with the corresponding constraints, user-defined operations and generic operations into normalized relational, hierarchical or network schemas.

In general, HERM can be translated to ER but in the cost of larger diagram and with more complex constraints that will take place. From the information provided in the previous section, a HERM diagram for a simple courseware application is illustrated in **Figure 3.4**, with the relationship types and their attributes are clearly displayed.

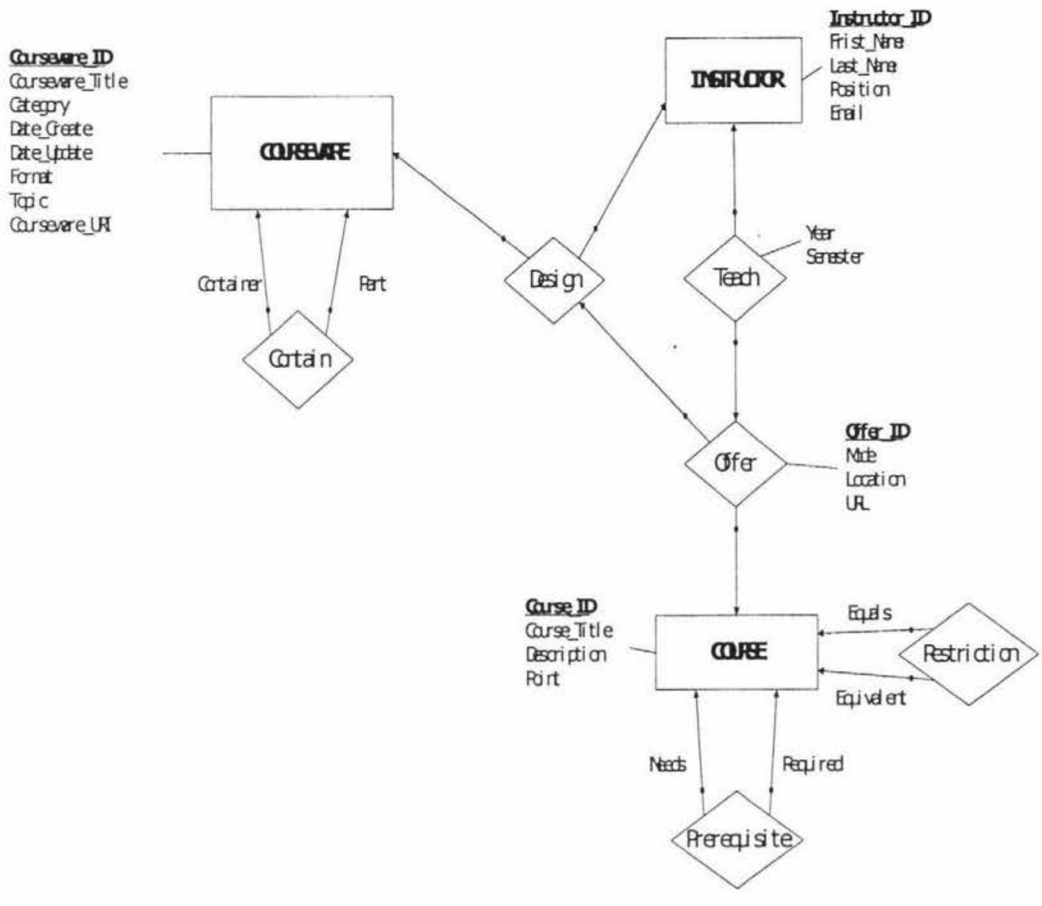

Figure 3.4 HERM diagram of the Courseware Application

Without going into great detail, HERM has the basic modeling constructs of ER models but with a few additions particulars; (Thalheim, 2000; p.59).

1. Different extensions in construction in nested attributes, first-order relationships of higher arities, clusters, and some integrity constraints. Alternatively, the relation types of the relational database schema are produced and listed in **Appendix I: The Relational Database Schema: Relation Types**, which also included the order of the relationships, or this is also summarized in object types in **Figure 3.5**. In the ISD's example, where a courseware might contain one or more other courseware. Therefore, key declarations would required to form of integrity constraint or using mapping cardinalities for form of relationship, using 1to1, 1 to many, and many to many.
2. Objects beside the main objects are to be represented by relationship types, as well as the "is a" relationships can be directly illustrated in HERM. For instance, where an instructor is a course coordinator, or an instructor is a graduate assistant (who is also a student) could be expressed – referred to **Figure 3.3**.

From the information gathered from the HERM diagram, the object types are identified as follows: -

<u>Level One:</u>
INSTRUCTOR = (Instructor_ID, First_Name, Last_Name, Email, Position},
{Instructor_ID});
COURSE = ({Course_ID, Description, Mode, Point}, {Course_ID});
COURSEWARE = ({Courseware_ID, Courseware_Title, Course_Type, Date_Create, Date_Update, Topic, Courseware_URL}, {Courseware_ID});
<u>Level Two:</u>
RESTRICTION = (Equals: Course, Equivalent: Course, Ø);
PREREQUISITE = (Need: Course, Required: Course, Ø);
CONTAIN = (Part: Courseware, Container: Courseware, Ø);
DESIGN = ({Instructor_ID, Courseware_ID}, {Instructor_ID, Courseware_ID});
<u>Level Three:</u>
OFFER = ({Courseware_ID, Instructor_ID, Offer_ID, Mode, Point, URL}, { Courseware_ID, Instructor_ID, Offier_ID});
<u>Level Four:</u>
TEACH = ({Course_ID, Instructor_ID, Schedule}, {Course_ID, Instructor_ID});

Figure 3.5 Object Types of the Courseware Application

There are many ways how the database schema can be developed, as each individual has different concepts of how things are done. However, the theory is that a database designer can build a consistent schema that can be understood by other database designers, and consistently rebuilt during redesign or schema development; (Thalheim, 2000). Most importantly, data modeling in the database system is an important activity, as poorly designed database systems may contain redundant, inaccurate data and can result in poor performance.

3.2 DESIGN OF THE DATABASE SCHEMA

As mentioned previously, there are two types of repository. In order to store information about the learning objects, databases are often used to facilitate this task. According to Ahern et al. (2003) that storing and providing access to LOs in a database is nothing new, but the important part is how one can locate the most appropriate LO for a lesson.

Löser, Grune, & Hoffmann (2002) describe the metadata as "*...content and structural features and components of learning objects*", and it allows a categorization and linking with other LOs. Once the information is gathered, the database schema for this reuse courseware application is identified. However, we use real data from the ISD to illustrate how the relational database would be functioning. Furthermore, to maintain the simplicity of the database schema so only the required information is being employed.

3.2.1 The Courseware's Database Schema

The database schema is to allow us to obtain a better grip of how the information would reflect to the users of LOR. The database schema should be logically correct and to serve the purposes of what is intended - that is to provide a structured data that will help in describing the characteristics of a courseware. The relational database system has its own mechanisms for storing metadata, examples of relational database metadata included: -

(i) Tables of all tables in database, their names, size, and rows.

(ii) Tables of columns in each database, what tables would be used (entity types), and the type of data stored in each column (attributes of entity).

Courseware's Database Schema

Because the LOR is to store courseware, therefore the main priority is to understand what attributes (metadata) would best provide descriptions about the entity (courseware). From the studying of different courses' Web-pages, the display of courseware are either capture in a collection that is under different type categories (lecture notes, assignment, etc) or standalone link which are open for students to access.

(i) In the database schema, there should be a record of "COURSEWARE", where each courseware should has the following attributes: -

	ATTRIBUTES	DEFINITION
COURSEWARE: Learning objects which are prepared by instructors, it could be a file that contain learning materials, lecture notes, study guide, assignment information of the course, and etc.	Coursewar_ID*	The unique key used to identify each available courseware.
	Courseware_ Title	Title of the courseware.
	Category	Category of the courseware; e.g. Resource, Lecture Note, Study Guide, Assignment and etc.
	Date_Create	Date when the courseware is created.
	Date_Update	Date when the courseware is updated.
	Format	Format of the courseware; e.g. Pdf file, text document, and etc.
	Topic	Keywords or phrase used within the courseware, such as the topic or subject.
	Courseware_ URL	Location of the courseware.

(ii) There should be also a record of "PERSON" who has access to the LOR. In this record, each person will have a first name, last name, position, and email address. A unique key should assign to each instructor, not only it will help in uniquely in identifying a person but it could be for security reason – password protection in accessing to the LOR. Please note that an instructor could be a professor in the ISD, but within the course, he or she is might be known as the course coordinator by the students– due to this reason, we would prefer to use the position that the instructor is know by the course, but not by the department's position.

	ATTRIBUTES	DEFINITION
INSTRUCTOR: Person who involves in the course is called the instructor, he or she could be a course controller, lecturer, tutor, etc. Someone who have the authorities to post, update or delete the resources in the learning repository.	Instructor_ID*	The unique key used to identify each individual instructor, which contains 5 numbers.
	First_Name	First name of the instructor.
	Last_Name	Last name of the instructor.
	Position	Not the position held in the department, instead the position in a particular course; e.g. lecturer, tutor and etc.
	Email	Email address of the instructor.

(iii) Courses offered by the ISD of Massey University should also be identified, unique course number will used to characterize them. Note that each course might have different prerequisites and restrictions on the courses.

	ATTRIBUTES	DEFINITION
COURSE: Course which is offer by the university, ranges from 100 level to 800 level.	Course_ID*	The unique key used to identify each course offered by the university. For example, 157.331 - the first 3 digits identify the nature of the course and the last 3 digits represent the level of the course.
	Course_Title	Name given to the course.
	Description	General description used to describe the content of the course.
	Point	Point or credit awarded to student who completed the course.

(vi) A same course might vary from time to time, in order to keep track of the period of a course is offer by the ISD therefore a record of "OFFER" is created: -

	ATTRIBUTES	DEFINITION
OFFER: Able to understand what course will be offered	Offer_ID*	The unique key used to identify what courses are being offer in the university.
	Mode	Deliver mode of the course; e.g. internal, extramural or block.
	Location	Location where the course is offered; e.g. Palmerston North, Wellington or Albany.
	URL	Location that provided the information of the course.

(v) We might have different course coordinator for different time of the years, so using a record of "TEACH" to distinguish the differences.

	ATTRIBUTES	DEFINITION
TEACH: Used to identify the "particular time" the course is available to students.	Year	The academic year when the course is offered; e.g. 2004 or 2005.
	Semester	The semester when the course is offered; e.g. double semester, semester 1, summer semester and etc.

The main part of this database schema is to concentrate on the courseware, to examine what are the courseware that are already existed in the ISD and what sort of information does instructors attempt to deliver to the students. This is done by examine the each individual courses' Weg-pages.

Based on the **Figure 3.4** HERM diagram, a list of definitions of all the required information for ISD's database schema is defined in **Appendix II: Definition of the Entities and Attributes**, and **Appendix III: Relational Database for Courseware Application** where examples using real data extracted from ISD are being utilised.

Suggested by Graves (2002) that data models are "*the requirement specification for a DBMS which describe precisely and cleanly the necessary functionality of a DBMS*", (p. 108). Database design defines the database structure, the DBMS stores the facts about the structure in the database itself. The database thus contains the data we have collected and "data about data" know as metadata. The importance of this database schema is for us to examine what possible metadata elements are there, so we could find suitable metadata standards that will fill in describing them. The plan is to gather the available courseware (LOs) in the ISD and store them into the LOR, where instructors are able to utilise any available LOs that they require. The main idea is so that unnecessary work will not be required in preparing same existing courseware. Most important of all, it is now for us to capture the necessary information that we think users would want to know about the courseware, so users are able to find them through performing a search.

Note that this data modeling is to understand what we need before coming to select the metadata elements. The data modeling is intended to assist with the design of data structures, and as mechanisms for the transfer of the ISD's data rather than as metadata standards. With the available database schema, the next step is to map them into the available metadata standards. Attempt to connect the metadata elements that will be suitable in describe the information required for this courseware.

CHAPTER 4

THE STUDY OF BOTH DUBLIN CORE AND IEEE LOM METADATA STANDARDS

In recent years, many e-learning metadata have been developed which vary in levels of complexity, details of description and means for technical implementations. Commented by Balbieris and Reklaitis (2002) that "*it open up new levels of content description, data presentation, as well as have impact on reuse and interoperability of e-learning content*". It is undeniable that metadata is an important aspect in describing the learning objects as it can significantly assist in effectively accessing and managing LOs; affect the discoverability; and allow use and reuse of LOs.

In order to facilitate learning objects metadata creation it is necessary to gain a better understanding of the characteristics of LOs; the environment they are operate in; and figuring out the data that will be involved in this learning repository. Much of these works were done in the previous chapter and they had subsequently stood as the basis for this upcoming development. This chapter will focus on selecting the metadata standards, naming the LOs with metadata standards, content reside in the learning repository and issues relate to the management of learning object metadata, what is beneath these learning objects metadata, and the design and practical considerations to propose the right ways to manage these LOs and the LORs.

4.1 THE IMPORTANCE IN DESCRIBING THE LOs WITH METADATA

With the use of metadata, contents are easier to manage and discover compared to those with non-metadata contents. For this reason, using metadata is crucial for deliver, discover and reuse the content on the repository system, and also important to the management of online records. However, the poor quality metadata can cause a resource being undetectable within the repository and remain unused; (Currier et al., 2004). This could mean that the selected metadata element is not suitable, the value assigned is not compatible, or the creator of the LO does not possessed the knowledge in naming the LO, and many more other factors.

It is significant to know what information is required by the ISD's courseware. While defining the metadata schema, there are such necessities to look at the available metadata elements, their natures and meanings, and whether they are able to map to the ISD's data schema. It is also necessary to examine the fundamentals, practices and rules that are involved in the courses offered by ISD, to identify what are required in the courseware, especially in understanding the types of information that are crucial to the instructors and users which will motivate them to retrieve courseware in this learning repository.

Hence, to find a set of metadata elements for this courseware application, carefully selecting and naming the metadata would be a significant task. Note that metadata is used to index the LOs rather than understanding it as just as data, index often based on keywords extracted from the description of a LO itself, i.e., a courseware about XML then it is reasonable to use "XML" or "Extensible Markup Language" to index this LO. With more provision information or facts about the LOs, then more precise search can be obtained. Also, using proper and correct definition of "metadata" will inevitably widen its applicability and value, plus such effort will lead to more efficient information technology investments in the later stage.

4.2 DETERMINING THE METADATA ELEMENTS

Like many LORs, they either employing the recognised metadata standards and specifications, or creating their own metadata to meet their needs. Ultimately, it is crucial to select appropriate metadata standards and specifications to label the LOs because it could give a scalable measure which permit integration with future tools and well as it will measure how well a repository is going to perform.

In the recent years, there are many metadata standards such as IMS, SCORM, IEEE LOM, Dublin Core and others have been much more established and settled down. In this section, it will go into detail in introducing and analysing the two most recognised metadata standards – Dublin Core and IEEE LOM. The reason for using these two prominent metadata standards is because these standards have been established and widely accepted by other systems; (Robson, 2000).

4.2.1 Types of Metadata Standard Used

Since Dublin Core and IEEE LOM are the most recognised metadata standards, hence it would be reasonable to adopt their metadata elements for developing our set of metadata schema.

(1) Dublin Core

The *Dublin Core Metadata Element Set* (Dublin Core Metadata Initiative; DCMI) is a standard for cross-domain information resource description, it is commonly known as Simple Dublin Core or standardised as ANSI/NISO Z39.85-2001. It is first developed in the mid-1990s, and originally intended for use in facilitate search and retrieval of the Web-based resources; McClelland (2003). The DCMI is described as 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).

Dublin Core (DC) uses 15 metadata elements in a very broad and generic manner. These 15 element sets are: - title, creator, subject, description, type, date, source, relation, coverage, publisher, contributior, rights, format, identifier and language, and each element is repeatable and optional and entire set is extensible. These 15 metadata elements provide a basic set of description, however, these 15 metadata elements are in many cases not sufficient. Extensible is where DCMI has develop a list of exemplary terms in extending or refining the original 15 elements, it is refered as the "Dublin Core Qualifiers[3]"; (DCMI, 2005a). The DCMI recognises two broad classes of qualifiers: -

(i) **Element Refinement**: - Using this type of qualifier to narrow down the meaning of an element. A refined element would shares the meaning of the unqualified element, but with a more restricted scope. Note that the definitions of the element refinment terms for qualifiers must be publicly avaialble.
(ii) **Encoding Schemas**: - Using this type of qualifier to identify schemes that assit in the interpretation of an element value. These schemes included controlled vacaburies and formal notations, or parsing ruels.

Refer to **Appendix IV: Table of DCMI Refinement and Scheme** for summary of the refinement and scheme's table; (DCMI, 2005a). In addition, DCMI believes the best practice is to choose a value from the controlled vocabulary or formal classification scheme is highly recommended.

The DC elements listed in the table below are grouped into the following meaningful way called the "reference descriptions" which is an idea original from RDF (Resource Description Framework[4]). It is to give guidelines to assist in creating metadata contents, and obviously provide a better picture of which elements are directly related to the content of a LO.

Content	Intellectual Property	Instantiation
Coverage	Contributor	Date
Description	Creator	Format
Type	Publisher	Identifier
Relation	Rights	Language
Source		
Subject		
Title		

Figure 4.1: ***Different Categories of Dublin Core Element Sets*; adopted from DCMI (2005).**

This DC element set is created with the intention to "*... provide a core set of elements that could be shared across disciplines or within any type of organisation needing to organise and classifiy information*"; (DCMI, 2005). Just to note that the DCMI also provides guidelines for encoding Dublin Core metadata in XML and RDF, using XML to allow interoperability across different platforms, languages and systems.

[3] **Qualifier** is the generic heading traditionally used for terms, it is now usually referred to as Element Refinements or Encoding Schemes; (DCMI, 2005a).
[4] **RDF** is a family of spedifications for a metadata model that is often implemented as an application of XML; (Wikipedia, 2005).

(2) IEEE LOM

The IEEE Learning Object Metadata (LOM) is also known as IEEE 1482.21.1-2002 Standard. It is part of a multipart standard which is used to descibe the IEEE LOM data model. Like other metadata standards, IEEE LOM is also designed to describe the LOs in order to facilitate the discovery, location, evaluation and acquisition of LOs by searchers. The IEEE Learning Technology Standards Committee developed IEEE LOM in collaboration with DCMI, and this standard was first released in 2002. Note that "*IEEE LOM scheme uses almost every category of the Dublin Core and extends it with categories and attributes tailored to the needs of learners and authors searching the Web for material*"; (Steinacker, et al., 2001). Hence, IEEE LOM is mappable with DC, and this is shown in **Figure 4.3**.

IEEE LOM comprises more than 60 metadata elements which are organised into categories (also referred to as the aggregate metadata elements): - general, life cycle, meta-metadata, technical, educational, rights, relation, annotation and classification – see **Figure 4.2**. Each of these nine categories, it will contains sub-elements and these sub-elements will also contain further sub-elements (also known as simple metadata elements or leaf nodes of hierarchy). McClelland (2003) stated that its many metadata elements have provided a means of developing more comprehensive descriptions of LOs and providing further support for user service.

Category	**Description**
1. General	General information that describes the LO as a whole.
2. Lifecycle	Features that are related to the history and current state of the LO and those who have affected the LO during its evolution.
3. Meta-Metadata	Group information about the metadata instance itself.
4. Technical	The technical requirement and technical characteristic of the LO.
5.Educational	The educational and pedagogic characteristics of the LO.
6. Rights	The intellectual property rights and conditions o use for the LO.
7. Relation	Define the relationship between the LO and other related LOs.
8. Annotation	Provide comments on the educational use of the LO and to provide information on when and by whom the comment were created.
9. Classification	To describe the LO in relation to a particular classification system.

Figure 4.2: ***Different Categories of IEEE LOM Metadata Elements*; adopted and modified from Draft standard for LOM, LTSC of the IEEE (2002).**

IEEE LOM standard is a well established and recognised by majority in the e-learning environment. For example, IMS and ARIADNE's are the two well-known organisations that employ IEEE LOM. Note that in IEEE LOM all metadata elements are optional and that IEEE LOM structure can also be extended; (Duval & Hodgins, 2003). – Refer to the following **Figure 4.3**. It is very similar to DC standard, here it uses its extended sub-elements to be more specific in describing the LOs.

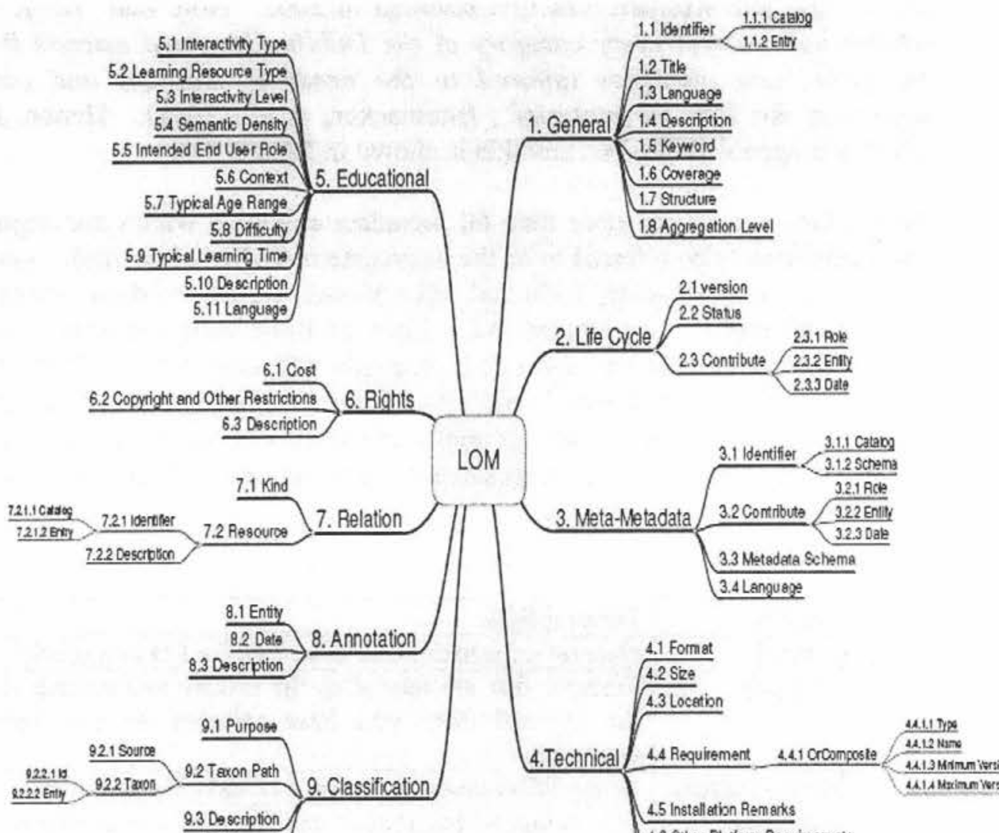

Figure 4.3: ***The LOM Hierarchy Diagram*; from IMS (2004).**

4.2.2 Differences between Dublin Core and IEEE LOM

In DC and IEEE LOM, all elements are optional and repeatable within a chosen metadata schema, which is used to structure metadata elements into records customized for specific audiences. DC is used to structure descriptive information about a resource but it is also able to map readily to other descriptive schema, where it would facilitate sharing information across different metadata schemas and user communities; (LTSC, 2002). The advantage of DC metadata is its simplicity but it has its deficiency, where the information on a learning resource may lie outside this intentionally limited scope. In addition, it might be confusing to interpret the meaning of a metadata element, such as DC.Date – is it when the LO was written, or it is when the LO is published, or maybe it is when the LO was added to the repository? In such cases, one might need to look into the extensibility of the standard.

Because IEEE LOM scheme uses almost every category in DC metadata set, hence they are very much similar. However, the only difference between the two standards is in specialisation. DC is more simple and general, while IEEE LOM is a more extensive schema for describing learning objects and offers much more. The IEEE LOM placed much of its concentration on the educational side of the learning resources. For example, its educational category collects the educational and pedagogic characteristics of the LOs. When compared to DC, IEEE LOM contains a broad range of metadata elements and leaves open many possibilities for interpretation. As explained by Edvardsen (2005), the disadvantage of IEEE LOM is it could be more difficult, complicated and time consuming to fill out and maintain its metadata. Nevertheless, users who are employing the IEEE LOM metadata standard can choose to focus on the minimal set of attributes needed where it would allow these LOs to be better managed, located, and evaluated. The IEEE LOM standard would specify the syntax and semantics of learning object metadata, which are defined as the attributes required to fully or adequately describe a LO. That is when a metadata element contains a list of values instead of single value, then the order of the values in the list is important, and if the intended educational use in 3 different languages, then the order of these texts is not significant; (LTSC, 2002). A good example is to follow the order from more general to more specific, refer to the hierarchical classification structure in **Figure 4.3**, is to describe a LO using the main branch (main category) to the sub-branches (sub-elements) and move outward. In addition, to achieve highest degree of semantic interoperability with other LORs, users of IEEE LOM are to use the recommended vocabularies.

Barker (2005) explained that the IEEE LOM data model specified which aspect of a LO should be described and what vocabularies maybe used for these descriptions, and provided creators of LOs with much more options to consider before giving a LO a descriptions. With DC, there is a lack of detailed rules on how to interpret the content of a LO, where it will require the creator of LOs to be more consistent in assigning values. It is highlights in the LTSC of IEEE (2002) that IEEE LOM is "*a data element for which the name, explanation, size, ordering, value space and data-type are defined in this standard*". In IEEE LOM, each aggregate metadata element will have no individual value but are defined using name, explanation, size, order and example. The simple metadata elements have individual values that are expressed using the "value space" and "data-type": -

Value space: - set of values for a given data-type, it defines restriction, if applicable, on the data that can be entered for that metadata element.

Data-type: - a property of distinct values, where it indicates whether the values are LangString, DateTime, Ducation, Vocabulary, CharacterString or undefined.

In addition, IEEE LOM also defines how the data model can be amended by additions or constraints.

Finally, if we are to enrich DC with more metadata elements and more regulations, then this action will contradict the desire to keep DC simple. But just keep in mind that the DC metadata set was primary intended for discovery of web-based discovery, and DCMI is currently also delicate in promoting the widespread adoptation of interoperable metadata standards and also developing specialised metadata vocabulary for discovery systems; (DCMI, 2005).

4.2.3 Common Vocabulary and Mapping between DC and IEEE LOM Standards

From the examination of both standards, it reveals that there are semantic coincidences between some attributes of the different schemes. The following table is adopted from the Draft standard for LOM, LTSC of the IEEE (2002, p. 44), it shown the mapping between Dublin Core and IEEE LOM standards. With the definitions of these elements adopted from Dublin Core Metadata Element Set; (DCMI, 2005), and the IEEE LOM's Final Draft Standard; (LTSC of the IEEE, 2002).

Dublin Core	IEEE LOM
1. **Title** – A name given to the LO.	**1.2 General.Title** – Name given to the LO.
2. **Creator** – Someone who is responsible for making the content of the LO.	**2.3.2 LifeCycle.Contribute.Entity** – The identification of and information about the entities (i.e., people, organisations) contributing to the LO. **2.3.1LifeCycle.Contribute.Role** – Kind of contribution where it has a value of "Author".
3. **Subject** – Topic of the content of the LO.	**1.5 General.Keyword** – A keyword or phrase describes the topic of the LO.
4. **Description** – An explanation of the content of the LO.	**1.4 General.Description** – A textual description of the content of the LO.
5. **Publisher** – Someone who is responsible for making the LO available.	**2.3.2 LifeCycle.Contribute.Entity** – The identification of and information about the entities (i.e., people, organisations) contributing to the LO. **2.3.1LifeCycle.Contribute.Role** – Kind of contribution where it has a value of "Publisher".
6. **Contributor** – Someone who is responsible for making contribution to the content of the LO.	**2.3.2 LifeCycle.Contribute.Entity** – The identification of and information about the entities (i.e., people, organisations) contributing to the LO. **2.3.1LifeCycle.Contribute.Role** – Kind of contribution.
7. **Date** – A date of an event in the lifecycle of the LO.	**2.3.3 LifeCycle.Contribute.Date** – The date of the contribution.
8. **Type** – The nature or genre of the content of the LO.	**5.2 Educational.Learning ResourceType** – Specific kind of LO. The most dominant kind shall be first.
9. **Format** – The physical or digital manifestation of the LO.	**4.1 Technical.Format** – Technical datatypes(s) of the LO. This data element shall be used to identify the software to access the LO.
10. **Identifier** – An unambiguous reference to the LO within a given context.	**1.1.2 General.Identifier.Entry** – The value of the identifier within the identification or cataloguing scheme that designates or identifies the LO. A namespace specific string.
11. **Source** – A reference to a LO from which the present LO is derived.	**7.1 Relation.Kind** – Nature of the relationship between this LO and the target LO, and has a

	value of "is based on". Identified by 7.2 Relation.Resource. **7.2 Relation.Resource** – The target LO that this relationship references.
12. Language – A language of the intellectual content of the LO.	**1.3 General.Language** – Primary language used within the LO to communicate to the intended user.
13. Relation – A reference to a related LO.	**7.2.2 Relation.Resource.Description** – Description of the target LO.
14. Coverage – The extent or scope of the content of the LO.	**1.6 General.Coverage** - The time, culture, geography or region to which the LO applies.
15. Rights – Information about rights held in and over the LO.	**6.3 Rights.Description**– Comment on the conditions of use of the LO.

Figure 4.4: ***The Mapping between DC and IEEE LOM*; adopted from Draft Standard for LOM, LTSC of the IEEE (2002).**

4.2.4 Writing the Metadata Records

Using the same example as in Appendix II, a brief demonstration on how a LO could be written in DC metadata standard in HTML and XML: -

In HTML

```
<HTML>
<HEAD> ....
[document TITLE here]....
<meta name="DC.Title"
        content= "Assignment 3">
<meta name= "DC.Language"
        content= "en">
<meta name= "DC.Creator"
        content= "Schewe Klaus-Dieter"> ....
</HEAD>
<BODY> ....
...[document BODY begins]...
</HTML>
```

IN XML

```
<metatdata>
<dc:title> Assignment 3 </dc:title>
<dc:language> en </dc:language>
<dc:creator> Schewe Klaus-Dieter </dc:creator>
<dc:subject> Relational Calculus </ dc:subject>
<dc:description> The third assignment for the course of 157.331 Database Concepts, students are
to make an attempt to complete all questions. </dc:description>
<dc:publisher>Department of Information Systems, Massey University </dc:publisher>
<dc:date> 18-02-2005 </dc:date>
<dc:type> Pdf file </dc:type>
<dc:identifier> http://is157331/assignments/ass_3.pdf </dc:identifier>
</metadata>
```

META tags are used to hold the descriptive element and their values in HTML. In XML coding, element names appear in the tags with a prefix "dc", and are required for all to be in lower case. If the above metadata records were written in the IEEE LOM, then the metadata tags would be named differently – simply because metadata elements are named differently, and it is more complex in details.

The above work is to examine the two metadata standards, in term of as well as to know how to use them. The following phrase to do is to map our database schema to the metadata standards. As for now, the question is how could we find a better way to manage and organise these LOs stored within this LOR. It is not the entire system, but rather the foundation work within the system is vital, as it would impact on how it would allow a LOR to store reusable and shareable learning objects. In the following chapter, it involves with illustrations on how the instructors could make use of the available courseware in the LOR, and how the students could interact and perform search with the LOR.

CHAPTER 5

THE FRAMEWORK OF A LEARNING OBJECT REPOSITORY

Subsequent to the previous work, it is necessary to recognise how this LOR will function in the ISD for its users. Besides outlining the current issues and challenges faced by LOs and LORs, part of the objectives in this paper is to select suitable metadata elements for the LOs where users could use search to obtain required LO within this LOR to create other new LOs.

In this chapter, it provides directions in how this LOR could be use for the users, and it also deliberate on the objectives and functionalities of this learning repository. It is about how this learning repository should function, and how it will serve its purpose in the Department of Information Systems (ISD) of Massey University.

5.1 OBJECTIVES AND FUNCTIONALITIES OF THE LEARNING REPOSITORY

The aim here is to come up with a repository that will house the valuable learning resources that already exist, and also for the new one to be developed in the future within the Information Systems Department (ISD), so all the learning resources can make available to any potential users within the department. Part of the notions of this research is also based on the information and knowledge gathered through the preliminary on how a LOR could be best managed in the e-learning situation. Also, to determine what are the key elements involved in developing a successful learning repository, and what sort of proceedings are required in order to achieve these objectives.

- **Objectives of the LOR**

  A learning repository which will store learning resources (LOs) that are created within the ISD. Where the instructors can store, search, reuse, delete and update their LOs, and to share these LOs with other users of this LOR. In brief, a learning repository that would encourage search, reuse, and exchange of the LOs.

- **Functionalities of the LOR**

In order to make these objectives become possible, it is important to set a set of the functionalities. This is to gain a better picture of what functionalities would be required in the LOR, and in hope that these functionalities could fulfil the set objectives. Hence, this LOR should come with this main set of functionalities: -

- It is a keyword-based search.
- Allows for assemble LOs to create new LOs, and
- Users can update or delete of a LO.

In general, this is a LOR which allows users to conduct a keyword-based search just like any other LORs. Where a user should be able to search through using keywords of a subject; course number; course name; course coordinator, and etc. It would allow the instructors to search for LOs, where they could identify if there is some existing LOs that they may reuse to create new LO, and be able to update or delete the LOs into the LOR. This LOR is for students to look for LOs that are taught in their courses, where they can retrieve them and study or revise them at their own time.

Above is just a brief description on how the LOR should function, and it is believed these functionalities are the basis for a typical LOR – detailed discussion is in the up coming sections. However, amendments could take place if certain functionalities might not seem to be practical or appropriate to implement. Note that this LOR should be Web-based, where it is accessible through the department's website because this site is where the searchers often access.

5.2 THE CONCEPTS FOR USING THE LEARNING OBJECT REPOSITORY

To benefit in building a LOR to store learning materials, a set of descriptions on how each individual group of users would use or engaged with the LOR are required. In these descriptions, there are two user-types in the ISD - instructors and students/learners who are the fundamental users to be considered. It is believed that use case would be an ideal tool to be employed to analyse the situation. A "**Use Case**" *defines a goal-oriented set of interactions between external actors and the system under consideration*; (Bredemeyer Consulting, 2000). Where actors are referring to the members outside the system that interact with the system, and an actor can be a class of users, roles play by the users, or other systems.

5.2.1 Use Cases Analysis

A use case is commenced by a user with a specific goal in mind, and consider completed when the goal is satisfied. The use case analysis refers to "*the abstraction process of generating a view of a particular system focusing on the interaction with external entities (Actors) and the actions they want to perform on the system (the Use Case) the sequence of interactions between actors and the system necessary to deliver the service that satisfies the goal*"; (Wikipedia, 2006).

- **Instructors: -**

  Every instructor in the **ISD** have their own field of specialities, hence it is sensible for each individual instructor to take charge of courses that they are specialised in. However, instructors would come across with overlapping topics and the same or similar courses that they are participated in. Thus, for a more efficient and effective way to get a new course ready, an instructor could use the concept of share and reuse the LOs where the required learning resources might already exist within the LOR.

  With the repository, the instructors can conduct a search for a LO to identify if this particular LO comply with his or her needs. If no such LO exist, then it is necessary to develop such LO anew. On the other hand, if the result of the search is not optimistic, instructors could consider another alternative, such as modify or assemble different available LOs to suit his/her target group of students. The idea is these LOs can be adaptable in different contexts and can be later reused by other instructors for many other target groups and in different courses. Basically, a repository which allows instructors to look for available learning materials that they could reuse.

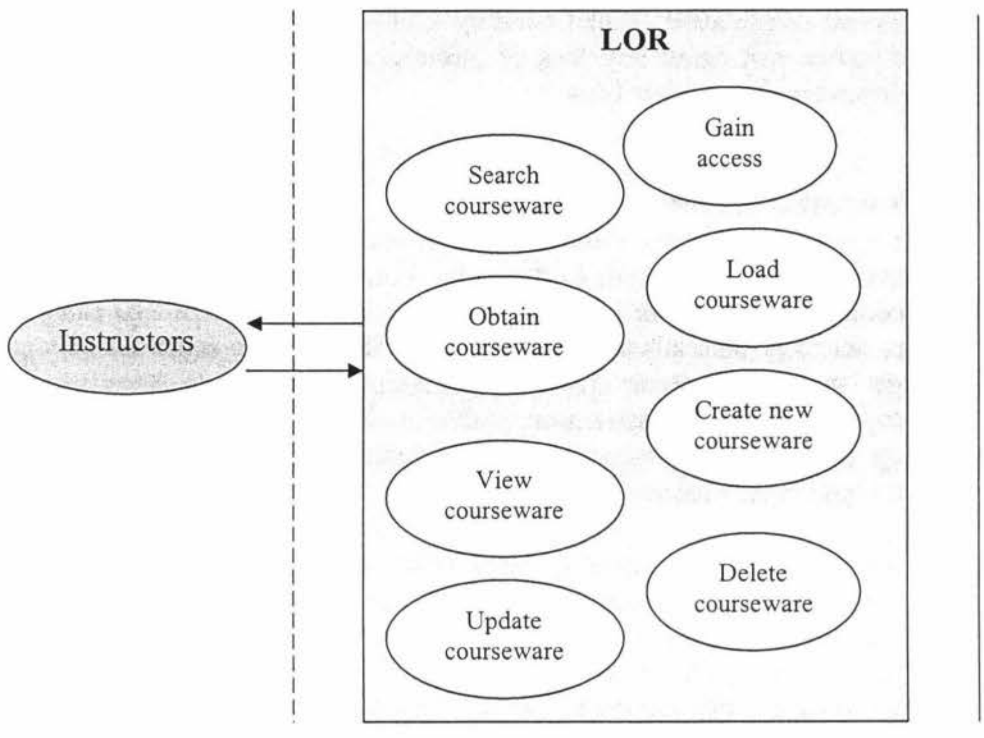

Figure 5.1: ***The interaction between LOR with the instructor***

For this LOR, instructors are the only user-type that has the rights to access to load, update and delete his/her own LOs.

Gain access: Gain access right to the LOR with email address and password.

Search courseware: Search for LOs using possible keywords of the topic, course number, course title, etc.

Obtain courseware: Found the required LO or LOs, where it will require an intelligent search system that will optimise the search.

View courseware: Click the toolbar link to view the LO.

Load courseware: This activity would be the time-consuming, will require instructor to assign the metadata elements the LO. It is believed that the owner of LO would hold better judgements and possess better knowledge about their own LO, which mean will be able to name their accurately compare to other users of this LOR.

Create new courseware: Assemble other available LOs to create a new courseware. There is much more to consider when we need to utilise other LOs to create a new LO.

Update courseware: For updating a LO, we would need the indication of "rights" – authorisation to indicate owners of LOs in order to update it. If the older version of this LO is maintained in the LOR, then we need to version these LOs because this will help us in recognising each individual courseware. Note that when a LO is updated then we need to update its metadata records immediately that is to make sure the content is consistent to what is being described in the metadata records.
Delete courseware: When deleting a LO, it is crucial for us to check if this deletion will cause any loss of information for other LOs – because of the dependencies to other LOs.

- **Students/Learners**

For students/learners, they are either the students of ISD who are familiar with the field of Information Systems, or those students who are interested in the courseware. To store LOs in a repository is so students of ISD can gain access to learning materials at their own pace. However, in order for the students to get the only suitable LOs, then instruction needs to be given or under supervision by the instructors. Additionally, students are able to search under the category of courseware where students are able to find learning materials, assignments, workshop material, lecture notes, study guides, and many more.

As part of the purpose of this LOR, it is to able students to have an understanding what topics will be taught in a particular course through a search. This action is to allow them to learn if they have knowledge to meet the course requirements, and if they would be interested in the topics taught in the course. For example, the search would provide students the URL of a course of their interest, which contains brief outline of the course and it should also contain information to if the student is able to enrol in the course. E.g., need to complete course number -157.223 before taking course number -157.331.

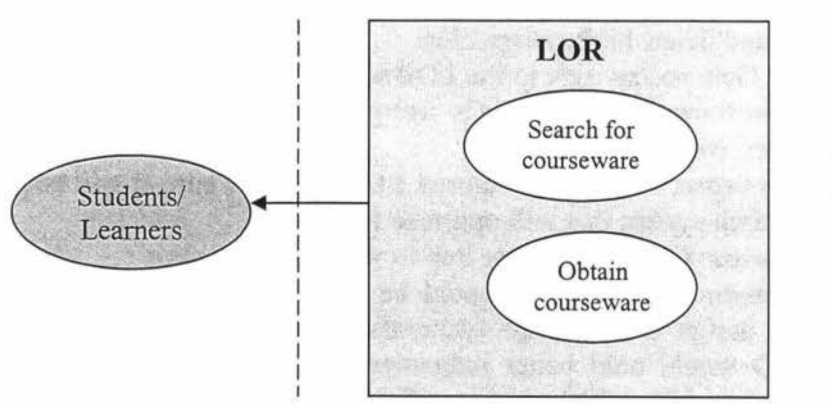

Figure 5.2: ***The interaction between LOR with its users***

Search for courseware: Students are able to conduct searches using the, keyword of topics, name of lecturers, course numbers, course titles, etc at their own time. Otherwise, to perform search follow the instructions given or under the supervision in a class's environment.
Obtain LOs: Students can choose the more desirable LO from the search results, and using the provided link to view the actual LO.

The above two user-types are most important, as they would be the regular users of this LOR. Note in **Figure 5.1**, there are two arrows interacting with the LOR for instructors because instructors will have the authority to access the courseware but the students do not, hence instructors play more responsibilities than the students.

It is undeniable that the Massey University (ISD) would have some involvement with this LOR, it would be acting as an administrator instead of a typical user-type. Its direct involvement in designing and developing of this LOR would be minimum, however its support in technical needs for this LOR to become possible would be great. Overall, the utter benefit for ISD to create this storage place it will be reduced cost for making unnecessary learning resources, and their instructor will spend less time and efforts in creating new LOs. Ultimately, if this LOR is interoperable, then we could exchange and share our course materials with other education providers that have the same specialisation.

Lastly, this LOR would be used to store learning materials developed by the instructors in the ISD, and it should be able to exchange LOs that cover a specific topic within the department, or even working with different departments and other universities in the future. However, the questions are how would an instructor know a particular LO is already exists within the repository without redeveloping a new one? How can we create a new LO that reuse some of the materials from the existing LOs? Can those found LOs be ready for reuse without any work to be carried out? There are still many questions arise on how a learning repository will best suit these desires, therefore these are the challenge of developing of LOR.

5.3 THE CHALLENGE

The objectives and functionalities of this LOR were listed above. However, there are other issues that will require attention – where the challenges take place when such following scenario occurred. For example, an instructor wants to cover a course in relational database with the topics of data independence, relational algebra and universal relation. Therefore, a search is conducted in the LOR, but the research results of a LO only found topics that included data independence and relational algebra. Hence, the instructor is faced with the following options: -

1. Creating a LO for universal relation, and a LO that assembles the other two (atomic) LOs.
2. Take the LO that contains data independence and relational algebra, and then update this LO by adding the topic of universal relation.
3. Assume the student already know the topic in universal relation (because it was covered in paper 157.2XX, a prerequisite).
4. Search at other repositories that hosted by other education providers.

By selecting option 1, it will require more time and money to develop this particular LO, and instructor will have to ensure that the LO will deliver on time for the students. In option 2, the instructor will probably interfere another instructor's work and he/she might not have the authority to do such an update. Option 3 might not work in all case and seem unrealistic at times, hence it would be necessary to store "topics" with a LO, and perhaps even "definition" or "concepts" of a LO -which would assist in narrowing down the search result. As for option 4, unless this LOR is work with other LORs, otherwise it cannot exchange or load this available LO from other repositories. In this case, a fee might require to get the LO in universal relation. Subsequently, this LOR should support all of the above options as it is always the decision of the instructors on how to proceed in creating their choice of LOs.

From the above scenario, it makes us think about two main issues that required attention – (1) How to construct the LOs stored within the LOR so they can ready for reuse by the instructors, and (2) how to enhance the search in the LOR.

5.3.1 Construction of LOs

In order to encourage the instructors to make use of the existing learning materials, and without much trouble in editing or modifying the materials, then it is necessary to think about the structure of LOs, such as how would the arrangement of a LO be ready for reuse by other instructors?

- **Modularisation**

  Ideally, suggested by Ateyeh and Mülle (2002) in term of content aspects that there are two kinds of reusable learning units in modularisation- learning atom and learning module. The learning atom is the smallest reusable unit in the learning module, but it is not independent and not reused without the context of the learning module to which it belongs. And the learning module is semantically independent and adaptable by using name, metadata, and ontology. This is done because of their modularisation concept is based on the separation aspects, separates the content and other aspects in integration, structural, and presentation of the module; (Ateyeh & Mülle, 2002).

  As for our situation, we would have LOs that are independent because they are learning atom and cannot be broken down further. As explained by Boskic (2003) that a LO should be an elemental constituent component that cannot be broken down any further and is ready for instructional use in different combinations. Note that the level 0 of modularisation in Ateyeh and Mülle (2002) would be an ideal concept to adopt, referred to **Figure 5.3**.

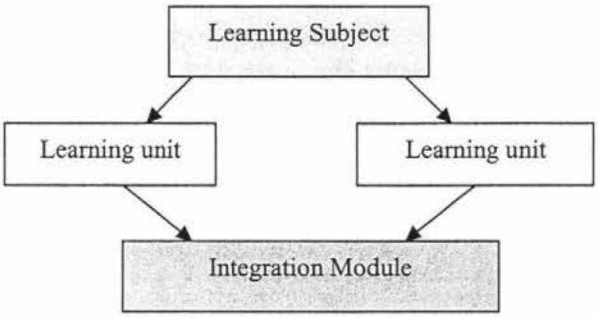

Figure 5.3: ***Ground level of modularisation*; adopted from Ateyeh and Mülle (2002).**

Follow from the above,
- A learning subject would be a topic from the course.
- Dividing a course's topic or course's domain into a reusable learning unit. For example, to divide the topic of relational database into adequate learning units of data independence, relational algebra, universal relation, etc.
- Instructors would search the LOR for available LOs (learning units), which in turn can be collected and assembled to a new learning unit, not the integration module.

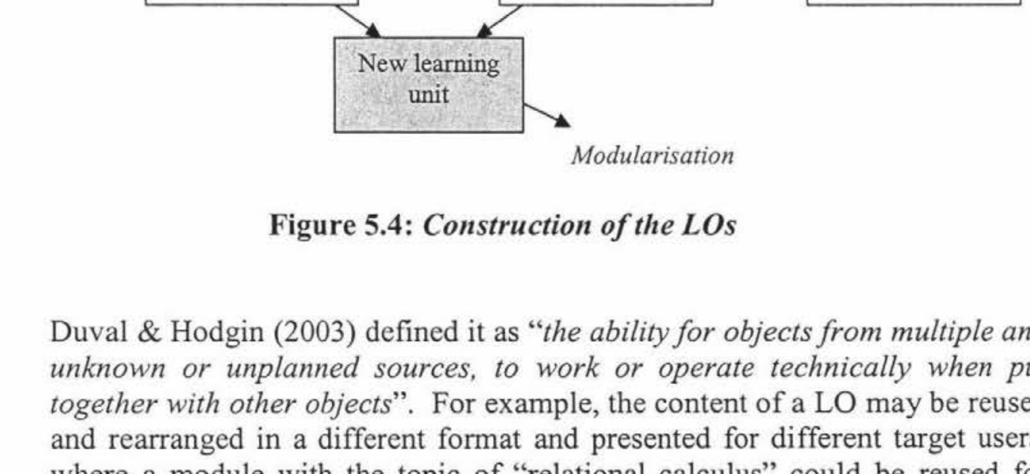

Figure 5.4: ***Construction of the LOs***

Duval & Hodgin (2003) defined it as "*the ability for objects from multiple and unknown or unplanned sources, to work or operate technically when put together with other objects*". For example, the content of a LO may be reused and rearranged in a different format and presented for different target users, where a module with the topic of "relational calculus" could be reused for several different courses in the University, which may assist instructors to speed up course preparation.

5.3.2 Search in LOR

A course usually will cover a specific framework of topics that the target students are required to learn, and it often represents the view and intuition of an instructor on a learning subject. Thus, when a LO is created then it is crucial to establish what topics it will contain, examine the topics' definition and concept, identify what possible "keywords" from the topics will facilitate searchers to obtain ideal search results, and finding other resources (LOs) that could be useful and related to this particular LO, etc.

- **Keyword-Based Search**

The keyword-based search is widely used in the search engine's context and well known by many users. This keyword-based search is to make use of the selected metadata elements so when the entered "keywords" match to the values of metadata elements, it would response the queries and to retrieve relevant LOs. Ideally, using the intelligent search engine to present query results of a queries in a logical format and to be able to rank its relevancy to the queries that are readable and are easily understood by users.

Keywords are single words that will identify the information, and it can retrieve many results that are not all relevant to what we want, hence it is significant to describe our "topic" properly in a LO. In our case, we need to cater not just the "keywords" of a topic such as "relational database" but it is important to provide the definition and concept that related to this LOs. In addition, it will allow students to have a better grasp of a LO in a search, and it will benefit students that have no background of a particular topic.

Further to the illustration on how an instructor will interact with the LOR, there are much more that we need to think about – whether an instructor wants to create a totally new courseware, or to reuse courseware. There are some issues to consider when we describe the LO with regard to search: -

(1) A set of guidelines on how a "topic" of a LO should be defined is needed. For example, if an instructor needs to design a courseware in "Relational Calculus" which contain topics in both Tuple and Domain Relational Calculus.

For example,
<meta name= "dc.subject" content= "Relational Calculus">

And it will need to use relevant keywords which contain within "Relational Calculus": -
<meta name= "dc.subject.keywords" content= "Tuple Relational Calculus, Domain Relational Calculus">

Obviously, this will not work as there could be more information that is related to this courseware. Such as, Relational Algebra is related Relational Calculus and they are both part of the Database Management System, and

Tuple Relational Calculus talks about Syntax and Semantics of TRC (Tuple Relational Calculus) queries, and so on. Now, an inter-relationship between topics has occurred. Hence, when the instructors create their courseware in a topic or topics, they need know the balance of how general and complex their topics would lay in the LOR – educational level, and how it would integrate with other courseware of same or similar topics. Therefore, a mechanism on how they should define the "topic" is essential, and we need to think about the different terms and abbreviation that users would use in conducting searches.

(2) Prerequisite is used so students can have a better idea whether a particular courseware is required in their boundary of learning, and if the content within is designed for their needs. If a student is searching in "Integrity Constraints over Relations" but the search result on a courseware found is consisted of two sets of topic, – (i) "Integrity Constraints over Relations", and (ii) "Enforcing Integrity Constraints". Where (i) is a prerequisite of and (ii) is not a prerequisite, then this would contradict the purpose of this LOR and the students are not sure how to deal with this courseware.

In this case, the instructor will need to consider whether to cover both topics in one courseware or divide both topics into individual courseware.

(3) During the search on "Relational Calculus", the search result would give us all courseware in the LOR that contains this phrase, from a complete lesson on database system to a sole learning unit on "Relational Calculus". In this case, we need to go through the search results to look for the one we need, and this topic might be embedded in a learning module of a courseware.

If the instructors choose to modularise the courseware then they need to make sure that all "topics" contained within can be identified in the database. That is to ensure that "sub-topic" or "sub sub-topic" at the lower level (less complex or standalone topics) would be identified as they might be too specified in term of the subject they are carrying. Moreover, the instructors would need to verify if their courseware would be independent or dependent (modularisation) from other courseware.

Note that the instructors would need to take these issues into consideration when they are developing a new courseware, to think about the educational context and level, learning objectives and specialisation of learning resource at different granularity levels. Lastly, we would need some sort of intelligent search system to support us in resolving the above problems.

5.4 LORs AT OTHER EDUCATIONAL PROVIDERS

Many educational providers have built their own LOR to accommodate LOs for their learners. Each of these LOR has different sorts of focus and objectives because each of their aim is to service their own community. According to SHERPA, an organisation that involved in developing open-access institutional repositories in a number of research universities that there has been a rapid growth in the number of institutional repositories in UK Higher Education in 2004; (SHERPA, 2005).

Some of prestigious universities that have built their own LORs to cater their own needs, they are: - Oxford University at UK, which is called the "Oxford E-prints" and defined as a digital archive to store research articles written by Oxford University authors (Oxford Eprints, 2006). For the Unversity of Cambridge at UK, its LOR is called the "Dspace@Cambridge" - a digital repository to store digital information and its descriptive "metadata", and its key purpose is to capture and preserve academic and related contents and to make them available online; (Dspace at Cambridge, 2006); and at the University of Calgary at Canada, they called it the "Dspace" and it is an institutional repository for research and publication of its academic community; (Information Resources of University of Calgary: Dspace, 2006).

Similarly, the aim of all these LORs is to collect resources that are produce by their own institution, and some are to share their resources online.

5.4.1 Example of LOR at the University of Mauritius

The University of Mauritius (UoM) has built an online learning repository called **VCILT**, a place where LOs of its university and Internet are gathered for later use. Their idea of this LOR is "*for developer, educators, and learners to collaborate in order to enhance existing learning materials and to produce new innovations*" (VCILT, 2005). Note that the VCILT is an integral part of the UoM, where all permanent lecturers working at UoM will be automatically registered with VCILT as only registered members are allow to add resources. Furthermore, searcher and tutors of UoM and other VCILT members have the possibility to add new LOs, comments and pedagogies, or to add LOs reference to existing LOs, that is with the provision of member's email address and password.

In VCILT, there are links that lead to other recognised LORs for searchers to look for alternative recourses. From the above **Figure 5.4**, it provided us the view on many ways a search could be conducted in VCILT. From this example, it is realised that a submitter of a LO might not be the author of the LO; search for LOs that are in other languages, but it has a limited list in "English" and "French", with other languages being referred as "Other"; and their LOs are ranked into different educational levels - from foundation to PhD.

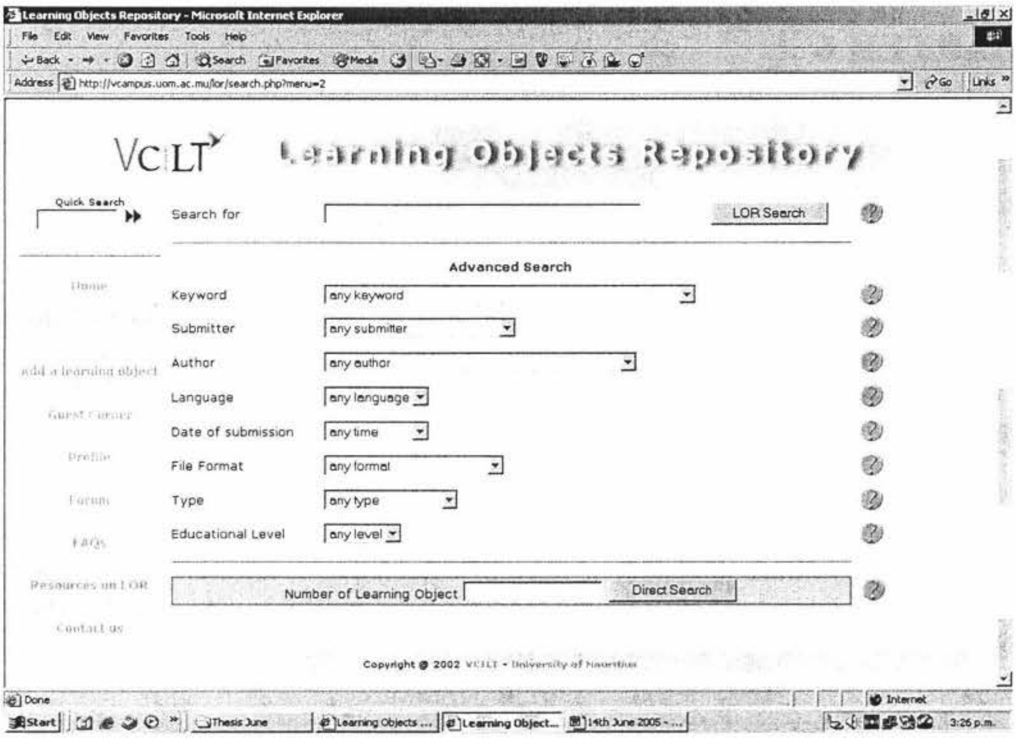

Figure 5.4: ***VCILT's LOR***

In summary, this is just a brief presentation of ideas on how our LOR should function and how it would interact with its users if it to be implemented within the ISD. Use cases are used to who (user-type) does what (interaction) with the LOR, for what purpose (objective), without dealing with the LOR internally. In general, the structured narrative taken in use case analysis would allow us to comprehend what are the possible activities are involved which might help us in defining any other requirements in the LOR. Additionally, when the instructors are to design a courseware then they need to consider how a courseware could be best discover and present to the searchers. The VCILT is being examined as it has similarity functionalities with the ISD's courseware application, so it allows us to think if something have been missed in our LOR. In future, it is hope that this LOR is able to share its content with the other departments' LORs in the university, or even with other LORs around the world that specialised in the same field.

CHAPTER 6

SELECTING METADATA ELEMENTS FOR THE LEARNING REPOSITORY

In order to develop a successful learning repository, and for it to manage the LOs efficiently, and to deliver the proper search results to its users, it is necessary to look for the metadata elements that are suitable in describing the LOs stored within the system.

In this chapter, we will attempt in creating a set of metadata elements would suit the needs for this LOR using both DC and IEEE LOM standards. Where we will analyse with the previous data modeling in the ISD and other information that might be imposed in the courseware in order to recognise what metadata elements will assist us to better discover LOs stored in this LOR.

6.1 THE DEVELOPMENT OF METADATA PROFILE USED FOR LOR

First of all, a collection of metadata elements used for a particular LOR is sometimes referred to as an "Application Profile", which is defined as "*an assemblage of metadata elements selected from one or more metadata schemas and combined in a compound schema*"; (Duval, et al., 2002). The purpose of developing one's own application profile is because the Internet is a very diversified environment, and a single metadata set will not meet the needs of all domains and purposes. Therefore, it is helpful to consider in detail of the specific applications that metadata can be used for because the information structure and content of metadata records should capture the essence of the resources they describe and facilitate the tasks for which the metadata was devised. It is known that any application can have its own application profile which specifies a set of metadata vocabulary terms used in the application as well as syntactic or structural features of the particular application; (Sugimoto, Baker & Weibel, 2002).

This LOR is intended for educational purposes, hence it is necessary to look into the learning context, levels and styles of courseware while selecting metadata elements for the application profile. With the information that obtained from the previous chapter, it is time to look into the actual learning context that are required within the ISD, and to identify how these attributes can map into the DC and IEEE LOM standards. Now, it is crucial to find out if these metadata elements will integrate with the ISD courseware's metadata elements.

6.1.1 Mapping of ISD Courseware to DC and IEEE LOM Standards

From the earlier analysis, a top down approach of HERM is used, starting from the lower level of data to identify what possible information is associated with the system.

This approach is suitable for a new project like this one, which has little dependency on other existing systems, and giving us the data concerned with the data management in the LOR.

The following is a table that used to illustrate the attributes of ISD Courseware, with an attempt to map them with the common vocabularies of both previously mentioned metadata elements of Dublin Core and IEEE LOM standards.

LEVEL ONE			
		DC	**IEEE LOM**
INSTRUCTOR	Instructor_ID		
	First_Name	**Creator** – Someone who is responsible for making the content of the LO.	**2.3.2 LifeCycle.Contribute.Entity** – The identification of and information about the entities (i.e., people, organisations) contributing to the LO. **2.3.1LifeCycle.Contribute.Role** – Kind of contribution where it has a value of "Author".
	Last_Name	Same as above.	Same as above.
	Position	Same as above.	Same as above.
	Email	**Creator** or **Creator.Email** [5] - Contact information to the Creator.	**2.3.2 LifeCycle.Contribute.Entity** – The identification of and information about entities (i.e., people, organisations) contributing to the LO.
COURSE	Course_ID		
	Course_Title		
	Description		
COURSEWARE	Courseware_ID	**Identifier** – An unambiguous reference to the LO within a given context.	**1.1.2 General.Identifier.Entry** – The value of the identifier within the identification or cataloguing scheme that designates or identifies the LO.
	Courseware_Title	**Title** – A name given to the LO.	**1.2 General.Title** – Name given to the LO.
	Category	**Type** – The nature or genre of the content of the LO.	**5.2 Educational.Learning ResourceType** – Specific kind of LO. The most dominant kind shall be first.
	Date_Create	**Date** – A date of an event in the lifecycle of the LO.	**2.3.3 LifeCycle.Contribute.Date** – The date of the contribution.
	Date_Update	**Date** – A date of an event in the lifecycle of the LO.	**2.3.3 LifeCycle.Contribute.Date** – The date of the contribution.

[5] **Extensible** refers to the ability of creators of information objects to *extend* the description of their documents with the addition of other existing metadata element sets.

	Format	**Format** – The physical or digital manifestation of the LO.	**4.1 Technical.Format** – Technical datatypes(s) of the LO. This data element shall be used to identify the software to access the LO.
	Topic	**Subject** – Topic of the content of the LO.	**1.5 General.Keyword** – A keyword or phrase describes the topic of the LO.
	Courseware_Url	—	**4.3 Technical.Location** – A string that is used to access the LO.
		LEVEL TWO	
		DC	**LOM**
RESTRICTION	Equals: Course_ID		
	Equivalent: Course_ID		
PREREQUISITE	Needs: Course_ID		
	Required: Course_ID		
CONTAIN	Container: Courseware_ID	**Identifier-**	**1.1.2 General.Identifier.Entry**
	Part: Courseware_ID	**Source** – A reference to a LO from which the present LO is derived.	**7.1 Relation.Kind** – Nature of the relationship between this LO and the target LO, and has a value of "is based on". Identified by 7.2 Relation.Resource. **7.2 Relation.Resource** – The target LO that this relationship references. (***Note****: will also used* ***7.2.1 Relation.Resource.Identifier*** *– A globally unique label that identifies the target LO.*)
DESIGN	Instructor_ID		
	Courseware_ID	**Identifier**	**1.1.2 General.Identifier.Entry**
		LEVEL THREE	
		DC	**LOM**
OFFER	Offer_ID		
	Mode		
	Location		
	URL		
		LEVEL FOUR	
		DC	**LOM**
TEACH	Year		
	Semester		

Figure 6.1: ***Mapping with the Data Schemas***

The primary objective is to deliver the content of LO to the users, hence it is important to identify what other metadata elements would improve the descriptions the courseware in this repository. From the above **Figure 6.1**, it is obvious that attributes of "COURSEWARE" were able to map directly to both standards. Mainly, they are the primary characteristics that are used to describe the courseware, while other attributes are not directly related to the content of LO, hence no required in describing them and no matching metadata elements can be properly map into them.

Note that we would also consider other available metadata element from both standards to allow users of this LOR to get detailed information about a courseware from the search. For instance, where a LO has a prerequisite of other LO or LOs then it would directly point us to the metadata elements of Dublin Core's DC.Relation and IEEE LOM's 7.2.2 Relation.Rescours.Description. Eventually, this will also bring us to additional information such as publisher, ownership, description, etc. of courseware. The following are the additional metadata elements which we believe should utilise.

MOTIVATIONS	DC	LOM	EXAMPLES
Addition information on the publisher of the courseware.	**Publisher** – Someone who is responsible for making the LO available.	**2.3.2 LifeCycle.Contribute.Entity** – The identification of and information about the entities (i.e., people, organisations) contributing to the LO. **2.3.1LifeCycle.Contribute. Role** – Kind of contribution where it has a value of "Publisher".	Obviously, Massey University will be the publisher of each LO.
Information on the ownership of the LO as well as information on how this LO should be used.	**Rights** – Information about rights held in and over the LO.	**6.2 Rights.CopyrightandOtherRestriction** – If copyright or other restrictions are apply to the use of the LO. **6.3 Rights.Description**– Comment on the conditions of use of the LO.	The ownership of the LO, and how one should use it. E.g., 157.331 Database Concept of Information Systems Department, and use of this courseware in only permitted if you are students of Massey University.
Require more refined description on the LO. Information on the title, keyword, etc, they did not give us much information about the courseware.	**Description** – An explanation of the content of the LO.	**1.4 General.Description** – A textual description of the content of the LO.	Additional information about what this LO is for and what learning resources it is contains. E.g., This courseware is part of 157.331 Database Concepts, it is based on an introduction on relational calculus, and it focused on tuple relational calculus and domain relational calculus with examples being illustrated.
If the ISD wants to stored other courseware other than the primary language - English.	**Language** – A language of the intellectual content of the LO.	**1.3 General.Language** – Primary language used within the LO to communicate to the intended user.	Identify the type of Languages used in the LOR.

As a courseware may contains other courseware. Information on how a courseware is also part of another courseware, of version of a previous courseware, etc is needed.	**Relation. isPartOf** – The described LO is a physical or logical part of the referenced LO. **Relation. hasPart** – The described LO includes the referenced LO either physically or logically.	**7.2.2 Relation.Resource. Description** - Description of the target LO. (*Note: Relation mapped directly to IEEE LOM's 7.2.2. However, 7.1 and 7.2 are equally important to adopt.*) **7.1 Relation.Kind** – Natural of the relationship between this LO and the target LO, identified by **7.2 Relation.Resource** – The target LO that his relationship references.	If the instructors reuse the material of a courseware and combine into another courseware, update the courseware but also keeping the oldest version, a courseware contains other courseware and so on. (**Note**: *The **isPartOf** and **hasPart** relationships are essentially "parent/child" relationships-- hierarchical in nature. With them can be expressed both one-to-one and one-to-many types of relationships.* (DCMI, 2005a)).
If we to keep the oldest version of LOs after new update then it is necessary to have information about the version.	**Relation. isVersionOf** - The described LO is a version, edition, or adaptation of the referenced resource.	**2.1 LifeCycle.Version** – The edition of the LO.	Changes in version imply substantive changes in content rather than differences in format.
Due to the relationship between courseware, it is necessary to identify the structure of a LO.	In DC standard, this is expressed in **Relation**, depending on the composition of the LO.	**1.7 General.Struture** – The underlaying oragnizational structure of the LO.	For example, this LO could be part of the collection of a learning module, or to specify that a LO cound not derive anymore – in an "atomic" state.
As a courseware might contains another courseware, hence creating a hierarchical relationship.	——	**1.8 General.Aggregation** – The functional granularity of the LO.	To specify the level of the LO, whether it is in a smallest or largest level.
If we delete a particular LO, then we should be able to inform the users.	——	**2.2 LifeCycle.Status** – The completion status or condition of the LO.	For example, "new version will be available after semester break" or when a LO is deleted then "unavailable", or etc.

Figure 6.2: ***Motivations for other Metadata Elements***

The content of LOs should be able to incorporate with the metadata elements in both standards, the previous mapping in **Figure 6.1** is to identify which other attributes are not yet considered in the in both DC and IEEE LOM standards. **Figure 6.2** is done to recognise other necessary metadata elements which will better facilitate in describing the LOs. The decision will depend on the creators of LOR to choose the desired set of metadata schemas for their LORs, but creators will need to understand that the selected metadata elements would need to be well-suited to make the needs of the users as well as in describing the LOs.

6.2 THE APPLICATION PROFILE FOR ISD COURSEWARE

The creation of an application profile is to allow a community of users to specify which elements and vocabularies they will use. In this case, we need to make a decision on either using one of the standards or both standards where some of the metadata elements from the LOM or DC standards may be dropped. However, the key requirement is to understand the user/community needs and to express these as an application profile.

6.2.1 List of Metadata Elements for ISD Courseware

In the definition of the metadata schema of both standards, we need to consider each of the element data and their meanings. Now, we will need to choose a set of application profile based on what is required in the LOR – a small number of metadata elements as is will cut down the data entry time when loading the LOs, and at the same time to make sure the essential information from the collection of LOs are not missing, and will not limit the resource discovery in this LOR.

Although the DC metadata standard is much simple to exploit and adopt, and there is no need for us to utilise all the 15 metadata elements set to fully described these LOs. Furthermore, users could adopt the extensions using the Element Refinements[6] to further extend the descriptions. On the other hand, IEEE LOM has a large schema with more expressive vocabularies which are used for their metadata elements, and IEEE LOM is developed to "*provide a schema with more educaiton information for* LOs in a standardised way"; (Edvardsen 2005). In this case, this corresponds to part of our purpose which is to deliver educational materials taught in our community to the users. Secondly, the hierarchy of IEEE LOM is explicit and easy to comprehend, especially the names of all elements are straightforward where users could understand what values to assign to them by looking at the names, because a sub-element name will always include its previous element name or names, such as the root element name. Lastly, we could use IEEE LOM to further express the structure of the LOs in the LOR with1.7 General.Stucture, and to state the granularities of LOs with 1.8 General.AggregationLevel. With these extra metadata elements, they provide detail on the arrangements on the courseware, where instructors would have a better idea on how a courseware is consist of and how it is being modularise. As a result, instructors would also need to use their best judgement to label the structure and aggregation level of their courseware, as these information would allow other instructors to know if a particular courseware is suitable for reuse or not. These metadata elements would provide a sense of guidelines on how the instructors should position their courseware

[6] **Element Refinement** is a property of a resource which shares the meaning of a particular DCMI Element but with narrower semantics, (DCMI, 2005a).

within the LOR. Thus, it is opted that IEEE LOM will be best to be employed using just the following set of metadata elements: -

Application Profile		
1. General		
1.1 General.Identifier		
	1.1.1 General.Identifier.Catalog	
	1.1.2 General.Identifier.Entry	
1.2 General.Title		
1.3 General.Language		
1.4 Genral.Description		
1.5 General.Keywords		
1.7 General.Structure		
1.8 General.AggregationLevel		
2. LifeCycle		
2.1 LifeCycle.Version		
2.2 LifeCycle.Status		
2.3 LifeCycle.Contibute		
	2.3.1 LifeCycle.Contribute Role	
	2.3.2 LifeCycle.Contribute.Entity	
	2.3.3 LifeCycle.Contribute.Date	
4. Technical		
4.1 Technical.Format		
4.3 Technical.Location		
5. Educational		
5.2 Educational.LearningResourceType		
6. Rights		
6.2 Rights.CopyrightandOtherRestriction		
6.3 Rights.Description		
7. Relation		
7.1 Relation.Kind		
7.2 Relation.Resource		
	7.2.1 Relation.Resource.Identifier	
		7.2.1.1 Relation.Resource.Identifier.Catalog
		7.2.1.2 Relation.Resource.Identifier.Entry
	7.2.2 Relation.Resource	

Figure 6.3: ***The Metadata Schema of ISD Courseware***

So far, we would like to keep this metadata schema as simple as possible because we do not want the instructors to go through whole list of metadata elements to identify what are the correct values is belong to which metadata elements. In this case, a set of guidelines is needed to guide the instructors on how to record the metadata for their courseware.

6.2.2 Use of the Application Profile

This selected set of metadata schema is intended to assist users to discover the information they are looking for; and having the availability of consistent, accurate and well-structured descriptions of courseware could enable much greater precision. Hence, the more metadata elements are being utilised, the greater the opportunity for users to find the courseware. It is essential for the application profile schema to have its requirements about which metadata elements are mandatory and which are optional, a set of procedures as how one should use the metadata elements: - **Appendix V: Guidelines in Writing the Metadata Records**.

Note that the IEEE LOM categories group related metadata elements together. The IEEE LOM data model is a hierarchy of metadata elements, which includes aggregate metadata elements and simple data elements. In IEEE LOM, only the sub-elements or simple metadata elements in the hierarchy have separate values defined through their associated value space and datatype. Aggregates do not have separate values and they are referred as container elements. Based on IEEE LOM version 1.0 that each of the database schemas usually should have the following characteristics: -

- ***Name:*** the name of each metadata element.
- ***Explanation:*** the definition of each metadata element
- ***Size:*** the number of values allowed in each metadata element
- ***Order:*** whether the order of the value needs to verify.
- ***Value space:*** the set of allowed values for the metadata element. Primarily, the list of vocabularies or a reference to another standard used.
- ***Datatype:*** indicate whether the values are DataTime, LangString, CharacterString, Vocabulary, Undefined or etc.
- ***Guide/Example:*** Guidelines or example given as on how to apply the value.

Subsequent to the above, the category of **1.2 General.Title** in IEEE LOM is in the following example, the complete table is in **Appendix VI: The ISD Courseware Application Profile Schema Properties**: -

Name: Title
Description: Name given to this learning object.
Size: 1
Order: unspecified
Value Space: -
Datatype: LangString (Smallest permitted, maximum: 1000 char).
Guide/Example: This metadata element is not repeatable, it is to facilitate titles through the use of the language string. E.g., "157250 Administrative Guide "

Each category is a grouping of metadata elements that will describe the LOs, and IEEE LOM specifies name, size, data type, description, and other key details. We need to recognise that the adoption of international metadata standards is important if this repository is to go on interoperable in the later stage, however this action should not affect ISD own educational priorities. Lastly, it is essential to select appropriate metadata standards to label the LOs because it could give a scalable measure which permit integration with future tools, and as well as how well a learning repository is going to perform.

CHAPTER 7

DISCUSSION

In order to reuse LOs, they must be made available to the potential users and the use of learning repository is an approach to house these LOs. With proper usage of metadata, it will allow the users to retrieve relevant resources more efficiently and effectively. As described by Currier et al. (2004) that the poor quality metadata can cause a LO being undetectable within the repository and remain unused, therefore in order to have quality courseware in the LOR, the selected metadata schema for this application is important.

In this chapter, it will discuss about the use of IEEE LOM in this LOR; reasoning on why these IEEE LOM metadata elements are selected and proposes that they will serve; general guidelines on how metadata should be recorded; as well as brief discussion on the trends that are taking place in the LORs.

7.1 USE OF IEEE LOM IN COURSEWARE APPLICATION

In this paper, it is about how to find a set of suitable metadata elements that would describe the ISD courseware. Being from the data modeling to recognise the data which are involved, and mapping them with both DC and IEEE LOM standards to examine what are the essential information in describing the courseware. It is also about understand the needs within the ISD courseware application and expressed these as an application profile.

Basically, the used of metadata is to encourage best practice within the instructors if they wish for their courseware to be found then they will need to describe their courseware; help end users to understand the courseware by providing required information and to encourage students to look for extra learning resources at their own pace; assist instructors to prepare new courseware and avoid extra work in the ISD.

7.1.1 Why using IEEE LOM

Selecting a set of required metadata elements from the IEEE LOM standard would be ideal than to locally develop a set of metadata schema. The reasons are IEEE LOM metadata elements are better suited to our needs compared to DC metadata standard; its metadata elements provide more emphasis in educational context; it is a well recognised which will also support interoperability with other LORs, and if ISD courseware application has decided to share and exchange their courseware with others in the later future than it is easier to implement. It is described by Edvardsen (2005) that "*IEEE LOM has the support and potential to be the standard for learning object metadata exchange in the years to come*". Other well-known LORs that use

IEEE LOM as part of their metadata schemas are CANCORE, CAREO, SCORM, and more.

Most importantly, it is pointed out by Dalziel (2002) in the IEEE Draft Standard for Learning Object Metadata that a LO as "*an aggregation of one or more digital assets, incorporating meta-data, which represents an educationally meaningful stand-alone unit*". This is very much related to what happened if a courseware is composed by two or many other courseware, which is aiming to provide a better learning outcome by modularisation. This is also applied if the instructors want to storage all the related courseware of a same course together, for example, modularised courseware that fit into the same topic but with different complexities for a learning purpose; all assignments of a course; reading materials for a particular topic, past year examination papers, etc.

7.1.2 Selecting the Application Profile from IEEE LOM

Basically, we only utilised 6 of the 9 categories of IEEE LOM, making the total of 32 metadata elements. From the 6 categories, mainly the metadata elements in categories of General, LifeCycle and Relation are being used. In the category of 1.General, it assemble all the general information that describes the courseware as a whole, however [IEEE LOM 1.6] General.Coverage is not being utilised because the content of our courseware would not have any relation with the time, culture, geography or region involved. The 2.LifeCycle category is crucial because its metadata elements are related to the past and current state of the courseware, and persons who have affected this courseware during its development. It mainly classifies the information about the status and version of a courseware, and the instructors that are involved in the courseware. Lastly, the category of 7.Relation will describe the relationship between the courseware and its other related courseware. This is particularly important to the courseware that is either contains of other courseware or is part of other courseware.

Other selected categories are Technical, Educational and Rights. The primary aim of 4.Technical category is to identify the format and location of the courseware. The 5.Educational category is solely for users to know the learning resource type that they are getting from the courseware. As for 6.Rights category is to provide rights of the courseware, with description describing how one can use the courseware.

Because there are more than 60 metadata elements in IEEE LOM, hence sometime it is tough to come to a decision on which metadata element is actually suited for describing a particular property of the courseware. It is believed these current 32 metadata elements are adequate for what we want to convey to the end users about our courseware. Furthermore, we want to limit ourselves on a simple metadata schema for the courseware application.

7.2 THE GENERAL GUIDELINES IN USING METADATA ELEMENTS OF ISD COURSEWARE

In our case, this LOR will be a "metadata repository" where courseware metadata records are stored outside of the courseware. The reason is most of the courseware have been established under the courses' own Web-pages, a collection of URIs with descriptions of each courseware will assist users to find their desire courseware through search. Note that metadata records that are stored in this way can still be shared and accessed with other LORs, this is done by mapping of the metadata schema where metadata records can be uploaded to another LOR or other metadata records to our repository.

One of the disadvantages of use of linkage of data and metadata, metadata needs to be tightly bound to resources it is described. The instructors (or administrator) of the courseware must make sure that the metadata would be generated at the same time (or immediately) as the resource, and modified when the courseware is being changed or it deleted.

7.2.1 Recording the Metadata Records

General guidelines have been written in the Appendix VI to assist the instructors to overcome any problems with recording the metadata records. It allows instructors to determine which metadata element is mandatory and which is optional. For mandatory elements, they are the basic information about the courseware and without them then the courseware will seem meaningless to the end users. Optional metadata elements are to give emphasis to the courseware, known as the additional information that might be helpful to the users about the courseware.

In order to be systematic, unique catalog names can also be assigned by organisations to handle resources developed for specific purpose. It is suggest to establish a catalog name to assign to the courseware, and the value of the element can be automated to a catalog name is pre set when metadata records are being created. The outcome of the value will be the identifier for the courseware, and another catalog name to be established would be all the course numbers of the paper in ISD. This will assist users if they want to search for courseware by the course numbers, for this reason the instructors should record this identifier whenever a courseware is relate to a course in the ISD, if it is applicable.

Note that the instructors need to keep with the consistency in using the metadata schema. For example, the identifier for URIs of courseware, both General.Identifier [IEEE LOM 1.1] and Technical.Location [IEEE LOM 4.3] are suitable to employ. However, we are using Technical.Location as the metadata element for URIs because it appears to be more appropriate and straightforward, and we do not want to confuse the instructors for using both metadata elements. Instructors need to take note of the maximum permitted character string allow for a particular field, if the limit is exceeded then the information typed in maybe lost in the data exchange process with other LORs.

7.2.2 Other Feathers which assist the Metadata Recording

Other features will be a friendly user interface is required when we need to create a service application that is intended for the instructors, where this interface will make the creation of quality metadata simple and time efficient. Note that tools such as templates and data entry forms are developed to facilitate the entry of metadata. As for the data-type that is in a vocabulary (state or enumerated) in the IEEE LOM, a dropdown list is recommended to select the appropriate value. With those values that required scripting then a field is given for instructors to type in the descriptions.

In addition, there is increasing number of LORs are using automatic processing to limit the number of metadata elements which require the creators of LOs need to manually fill out. As explained by Edvardsen (2005), use of automatic processing can be crucial in order to achieve time efficient metadata labelling solution, especially if the application involved with a size like the IEEE LOM collections. In our case, with 32 metadata elements hence there is no need for such innovation, and with the expertise of the instructors we are expecting to have accurate records with manually filling the metadata records. Also agreed by Iannella and Waugh (1997) that "*the author-generated metadata or even semi-automated will add a higher level of quality in LOs*".

The above is a couple of concerns that we need to pay attention when creating a courseware. As mentioned by Milstead and Feldman (1999) that to have a successful metadata schema, the creator must also establish standard structure and terminology used. Metadata can be embedded within a learning object, and it also can be created and stored separately from the learning objects in a metadata repository. With proper usage of metadata, it will allow the users to retrieve relevant resources more efficiently and effectively.

CHAPTER 8

FUTURE WORK & CONCLUSION

Reuse of the LOs has been become an alternative for people that are looking for a new form of sharing learning materials. LOs are often stored in a repository in order for us to manage them, and individuals or organisations often prefer a custom metadata schema instead of using the ready made LOR applications, this is especially when they want to gather a more specialised collection of learning items. With a custom repository, organisations are able to design their own repositories that comply to their needs and objectives.

Long (2004) remains that "*the amount of work that required to produce LOs is more visible, often involves effort beyond that which would have been expended to prepare the traditional course content, and frequently engages more people, however its values has appreciated over its former paper and chalk board counterparts*". Although the concept of sharing and reusing the LOs not only save time and cost, but to promote one's work in the e-learning environment. However, there is much preparation and groundwork to be done before this concept can come true.

8.1 WORKING WITH METADATA OF THE COURSEWARE APPLICATION

Besides letting the instructors to share and reuse courseware, part of the purpose of this LOR is also for students to find the learning materials that they need for their studies. In order for a LOR to be organized, there are couples of issue that we need to take note when dealing with metadata: -

- **Using Metadata Elements that Suit Our Purposes**
  Most of all, before using metadata it is necessary to identify the need in define the set of characteristics that we want to describe, especially in we actually need to describe in order for students to fully understand the content of the courseware. While in creating the metadata schema and guidelines, we need to make sure that we are in compliance with the chosen standard. Also, we need to define and describe why metadata elements are chosen for our own purposes.

- **Good Metadata Practices**
  (i) To use the mandatory metadata elements for a courseware to be fully described.
  (ii) Using standard controlled vocabularies to reflect the characteristic of the LOs, where values for the metadata record must be structured as defined by the IEEE LOM specification. Also, instructors need to be consistent in using the terminology used in this LOR.

(iii) Note that as more resources are collected in the repository, there is a likelihood of new metadata element is required. If there is a need for new metadata elements, then it should be a recognised metadata element from IEEE LOM. Note that if the instance contains extensions to the IEEE LOM structure, then the extension should not replace metadata elements in the IEEE LOM structure.

(iv) It is necessary to state how metadata schema is being used; refer to **Appendix IV** and **Appendix V** for using the metadata schema of courseware application.

- **Maintain Accuracy of LOs**
  This repository is a metadata repository when metadata is created and stored separately from the LOs, where it will contain metadata and provides access to LOs that located on remote locations. Therefore in order to achieve accuracy, instructors will need to update their metadata if changes are taking place for the LOs. Like what Tannenbaum (2002) said "*the accuracy of metadata depends on an accurate definition of instance data*", (p. 91). It is important that we give thought to the management of the metadata. Otherwise, we are likely to find the metadata becomes out-of-date.

Note that the creation of and agreement on common vocabularies for the description of LOs have been complicated. That is if all organisation create their metadata schemas according to the same standard, then searching with productive results and effective interoperability can happen across repositories. It is obvious that there is no standard to apply to all communities of interest, furthermore we need to think what would fulfil the need of our local community before the others.

8.2 POSSIBILITY OF FUTURE WORKS

With the completion of the application profile for the courseware, then the next appropriate step is to create a standardisation to direct how one should create a LO, this will lead to more superior LOs. At the moment, most instructors work differently in the ISD, where each instructor has his/her own pattern of work behaviours, such as how their courseware is created; how they arrange their courseware; and how the courseware is delivered to the students. With a standardisation in hand then the created courseware is able to use as individual learning unit or combined into a larger learning unit, this is to focus the aspect of reusability of learning modules in different contexts and how easily modules may then be reused in different teaching and learning situations. This standardisation is to provide a mechanism to ensure the quality and consistency of resources being adopted in the LOR.

If this LOR is well-organised then the program and curriculum within the ISD can be built and reused from the available courseware over and over again. Because the search result is not visible to us, hence it is necessary to produce a prototype using the current selected metadata elements from IEEE LOM to test the outcome of the search function. That is to demonstrate and test this system application to its competence in complies with the desired requirements set. As such, we could also implement the other features such as drop-down list for easy entering of metadata records; feedback and evaluation for students or other users to leave valuable comments on the courseware; features that would help instructors to ease the process metadata recordings or enhance the LOR as a whole.

8.3 CONCLUSION

It is believed that with the used of metadata, searching of LOs will become more specific; managing of LOs will become more easy and manageable; and sharing of LOs with others will become more efficient. Hence, it is undeniable that metadata is an important aspect in describing the LOs as it can significantly assist in the discoverability, and allow use and reuse of LOs.

In this paper, a courseware is a self-contained piece of learning material which has an associated of learning objective, it can be of any size and in a range of media permitted in ISD. The selected metadata elements are to serve the purpose of reuse courseware within the ISD, and it is believed that a good metadata schema should support the long-term management of LOs, and should be appropriate to the contents in stored in the LOR and provide the information to the users of the LOs; and current and likely use of the LOs in the future.

The importance of recording and maintaining accurate metadata for courseware should not be undervalue, as information cannot be effectively managed or used without metadata. In future, it is in hope this learning repository could co-operate with other departments in the Massey University, so more instructors could take of advantage of using and sharing of courseware, and students are able to access to greater information of other interests. Lastly, it should support interoperability with other LORs in the future so the instructors could exchange their learning materials, expertise and experience with others.

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APPENDIX I: The Relational Database Schema: Relation Types

Level 1: -

INSTRUCTOR

Attributes:	Instructor_ID, First_Name, Last_Name, Position, Email
Primary key:	Instrcutor_ID

COURSE

Attributes:	Course_ID, Course_Title, Description, Point
Primary key:	Course_ID

COURSEWARE

Attributes:	Courseware_ID, Courseware_Title, Category, Date_Create, Date_Update, Format, Topic, Courseware_URL
Primary key:	Courseware_ID

Level 2: -

RESTRICTION

Attributes:	Course_ID
Primary key:	Course_ID
Foreign key:	[Course_ID] ⊆ COURSE [Course_ID]

PREREQUISITE

Attributes:	Course_ID
Primary key:	Course_ID
Foreign key:	[Course_ID] ⊆ COURSE [Course_ID]

CONTAIN

Attributes:	Courseware_ID
Primary key:	Courseware_ID
Foreign key:	[Courseware_ID] ⊆ COURSEWARE [Course_ID]

DESIGN

Attributes:	Instructor_ID, Courseware_ID
Primary key:	Instructor_ID, Courseware_ID
Foreign key:	[Instructor_ID] ⊆ INSTRUCTOR [Instructor_ID] [Courseware_ID] ⊆ COURSEWARE [Courseware_ID]

Level 3: -

OFFER

Attributes:	Courseware_ID, Instructor_ID, Offer_ID, Mode, Point, URL
Primary key:	Courseware_ID, Instructor_ID, Offier_ID
Foreign key:	[Course_ID] ⊆ COURSE [Course_ID] [[Courseware_ID] ⊆ COURSEWARE [Courseware_ID]; [Instructor_ID] ⊆ INSTRUCTOR [Instructor_ID]] ⊆ DESIGN [Courseware_ID, Instructor_ID]

Level 4: -

TEACH

Attributes:	Instructor_ID, Offer_ID, Year, Semester
Primary key:	Instructor_ID, Offer_ID
Foreign key:	[Instructor_ID] ⊆ INSTRUCTOR [Instructor_ID] [Offer_ID] ⊆ OFFER [Offer_ID]

RETURN

APPENDIX II: Definition of the Entities and Attributes

For this ISD example, a course named the "Database Concepts" is selected to exemplify what are the data is contained in the relational database. A description of the data schema for this course is as follows: -

LEVEL 1: - *** = primary key**

	ATTRIBUTES	DEFINITION	EXAMPLE
INSTRUCTOR: Person who involves in the course is called the instructor, he or she could be a course controller, lecturer, tutor and etc. Someone who have the authorities to post, update or delete the resources in the learning repository.	Instructor_ID*	A unique key used to identify each individual instructor, which contains 5 numbers.	14892
	First_Name	First name of the instructor.	Schewe
	Last_Name	Last name of the instructor.	Klaus-Dieter
	Position	Not the position held in the department, instead the position in a particular course; e.g. lecturer, tutor and etc.	Course coordinator
	Email	Email address of the instructor.	K.D.Schewe@massey.ac.nz

	ATTRIBUTES	DEFINITION	EXAMPLE
COURSE: Course which is offer by the university, ranges from 100 level to 800 level.	Course_ID*	A unique key used to identify each course offered by the university. For example, 157.331 - the first 3 digits identify the nature of the course and the last 3 digits represent the level of the course.	157.331
	Course_Title	Name given to the course.	Database Concepts
	Description	General description used to describe the content of the course.	An advanced study of database management systems involving concepts of data models and query languages, physical architecture, distribution and design. The study includes the critical use of commercial database management systems
	Point	Point or credit awarded to student who completed the course.	12.5

	ATTRIBUTES	DEFINITION	EXAMPLE
COURSEWARE: Learning objects which are prepared by instructors, it could be a file that contain the learning materials, lecture notes, study guide, assignment information of the course, and etc.	Coursewar_ID*	A unique key used to identify each available courseware.	157331_2005_A003
	Courseware_ Title	Title of the courseware.	157331 Assignment 3
	Category	Category of the courseware; e.g. Lecture Note, Study Guide, Assignment and etc.	Assignment
	Date_Create	Date when the courseware is created.	04-12-2004
	Date_Update	Date when the courseware is updated.	18-02-2005
	Format	Format of the courseware; e.g. Pdf file, text document, and etc.	pdf
	Topic	Keywords used within the courseware, such as the topic or subject.	Relational Calculus
	Courseware_ URL	Location of the courseware.	http://is157331/ assignments/ass_3.pdf

LEVEL 2: -

	ATTRIBUTES	DEFINITION	EXAMPLE
RESTRICTION: Students are not allowed to take this course if they have taken one or more courses listed in the restriction section.	Equals: Course_ID	Using this Equals:Course_ID to check what courses are equivalent to this particular course.	157.331
	Equivalent: Course_ID	From this Equals:Course_ID, it is found that it is equivalent to these Equivalent:Course_ID; e.g. Any student who has taken any of these Equivalent:Course_ID then they cannot take Equals:Course_ID or vice versa.	157.337

	ATTRIBUTES	DEFINITION	EXAMPLE
PREREQUISITE: Students are allowed to take this course if they have not taken one or more courses listed in the prerequisite section.	Needs: Course_ID	Using this Needs:Course_ID to check what courses are required to this particular course.	157.331
	Required: Course_ID	From this Needs:Course_ID, it is found that it is required to these Required:Course_ID; e.g. Any student who has taken any of these Required:Course_ID then they can take Needs:Course_ID or vice versa.	157.223 o 159.254 or 160.212

	ATTRIBUTES	DEFINITION	EXAMPLE
CONTAIN: Used to describe if a courseware might contain one or more courseware.	Container: Courseware_ID	Using this Container:Courseware_ID to check if this particular courseware contain any other courseware.	157331_2005_A003
	Part: Courseware_ID	From this Container:Courseware_ID, it will check if this particular courseware contain any other Part:Courseware_ID.	Ø

	ATTRIBUTES	DEFINITION	EXAMPLE
DESIGN: To identify which instructor has designed a particular courseware, using Courseware_ID and Instructor_ID.	Courseware_ID	A unique key used to identify each available courseware	157331_2005_A003
	Instructor_ID	A unique key used to identify each individual instructor.	14892

LEVEL 3: -

	ATTRIBUTES	DEFINITION	EXAMPLE
OFFER: Able to understand what course will be offered	Offer_ID*	A unique key used to identify what courses are being offer in the university.	157331_2005_In_01
	Mode	Deliver mode of the course; e.g. internal, extramural or block.	Internal
	Location	Location where the course is offered; e.g. Palmerston North, Wellington or Albany.	PNTH
	URL	Location that provided the information of the course.	http://is157331/massey.ac.nz

LEVEL 4: -

	ATTRIBUTES	DEFINITION	EXAMPLE
TEACH: Used to identify the "particular time" the course is available to students.	Year	The academic year when the course is offered; e.g. 2004 or 2005.	2005
	Semester	The semester when the course is offered; e.g. double semester, semester 1, summer semester and etc.	One

RETURN

APPENDIX III: Relational Database for Courseware Application

In this relational database, real data are being extracted from the courses' Web-page of ISD. This is just an example of how the database would look like, so we can have a better understanding of what sort of information are being captured.

*** = Primary key**

Instructor

Instructor_ID*	First_Name	Last_Name	Position	Email
25685	Hui	Ma	Assistance Lecturer	H.Ma@massey.ac.nz
14892	Klaus_Dieter	Schewe	Professor	K.D.Schewe@massey.ac.nz
21007	Roland	Kaschek	Associate Professor	R.H.Kaschek@massey.ac.nz
19665	Sven	Hartmann	Associate Professor	S.Hartmann@massey.ac.nz
14513	Alexei	Tretiakov	Lecturer	A.Tretiakov@massey.ac.nz
02384	Sergiy	Zlatkin	Assistant Lecturer	S.Zlatkin@massey.ac.nz
10992	Madre	Chrystall	Senior Tutor	M.P.Chrystall@massey.ac.nz

Course

Course_ ID*	Course_Title	Description	Point
157.331	Database Concepts	An advanced study of database management systems involving concepts of data models and query languages, physical architecture, distribution and design. The study includes the critical use of commercial database management systems	12.5
157.250	Design and Development of Web-based Information Systems	A fundamental study of modelling principles and techniques used to develop Internet sites and applications in E-Business, learning, entertainment and information sites. A practical approach is taken focusing on development methodology, underlying modelling principles and realisation techniques.	12.5
157.223	Information Systems Design	A study of the design, re-design, and development of information systems leading to systems specifications. This study is combined with the hands-on critical use of tools employed in industry.	12.5

Courseware

Courseware_ ID*	Courseware_ Title	Category	Data_ Create	Date_ Update	Format	Topic	Courseware_URL
157223_ 2005_ L002	Lecture Slide: Part 2	Leacture Notes	16-11 2004	15-01-2005	ppt	"Lecture Slide Part 2" or "Lecture Note"	http://is157223/course/ lecture_notes/Part_II.ppt
157223_ 2005_ A003	Oracle Designer: Tutorial 1, (Assignment 3)	Assignment	12-10-2004	23-03-2005	html	"Data Model"; "ERD" or "RON"	http://is157223/assignments/ Oracle_component/dt01_ datamodel_erd.html
157331_ 2005_ A003	Assignment 3	Assignments	04-12-2004	18-02-2005	doc	"Relational Calculus"	http://is157331/ assignments/ass_3.pdf
157331_ 2005_ C001	Study Guide 1	Study Guide	12-01-2005	15-02-2005	Pdf	"Study Guide; Study Guide – Internal"	http://is157331/course/ Study_Guide_05.pdf
157331e_ 2005_ SL002	Self Learning: SQL LAB 2	Self Learning	07-12-2004	27-01-2005	doc	"Data Definition Language"; "Creating tables" or "Inserting/ Deleting	http://is157331e/SQL_labs/ SQL%20Lab2.doc

						data".	
157250_ 2005_ A001	157250_2005_ Assignment_1.doc	Assignments	02-1-2004	12-02-2005	doc	"Strategy Statement or Use Cases"	http://is157250.massey.ac.nz Assignments/157250_2005 _Assignment_1.doc
157250_ 2005_L001	Week01_Motivation _and_Overview.ppt	Lecture Notes	14-11-2004	21-02-2005	ppt	"Motivation; Overview; WIS or Internet; WWW"	http://is157250.massey.ac.nz /h/Lecture_Notes/Week01_ Motivation_and_Overview.ppt
157250_ 2005_SL	HTML_Exercises	Self Learning	23-10-2004	05-02-2005	url	"Self Learning or HTML Exercises"	http://is157250.massey.ac.nz /h/Self_Learning/
157250_ 2005_SL001	HTML_Lab_1.doc	Self Learning	27-10-2004	11-11-2004	doc	"Introduction to HTML; Notepad; HTML document; CSS; Colours, Paragraph or Style sheets"	http://is157250.massey.ac.nz /h/Self_Learning/HTML_ Exercises/HTML_Lab_1.doc

Restriction

Equals:Course_ID*	Equivalent:Course_ID*
157.223	Ø
157.250	Ø
157.331	157.337

Prerequisite

Needs:Course_ID*	Needed:Course_ID*
157.223	157.226
157.250	**157.1xx or 159.1xx**
157.331	157.223 o 159.254 or 160.212

Contain

Container: Courseware_ID*	Part: Courseware_ID*
157223_2005_L002	Ø
157223_2005_A003	Ø
157331_2005_A003	Ø
157331_2005_C001	Ø
157331e_2005_SL002	Ø
157250_2005_A001	Ø
157250_2005_L001	Ø
157250-2005_SL	157250_2005_SL001
157250_2005_SL001	Ø

Design

Courseware_ID*	Instructor_ID*
157223_2005_L002	21007
157223_2005_A003	21007
157331_2005_A003	14892
157331_2005_C001	14892
157331e_2005_SL002	25685
157250_2005_A001	19665
157250_2005_L001	19665
157250_2005_SL	14513
157250_2005_SL001	14513

Teach

Instructor_ID*	Offer_ID*	Year	Semester
14513	157331_2005_In_01	2005	One
25685	157331_2005_Ex_01	2005	One
19665	157223_2005_In_02	2005	Two
02384	157250_2005_In_01	2005	One
14513	157250_2005_Ex_01	2005	One
02384	157250_2005_In_01	2005	One

Offer

Offer_ID*	Mode	Location	URL
157331_2005_In_01	Internal	PNTH	http://is157331/massey.ac.nz
157331_2005_Ex_01	Extramural	PNTH	http://is157331e/massey.ac.nz
157223_2005_In_02	Internal	PNTH	http://is157223/massey.ac.nz
157250_2005_In_01	Internal	PNTH	http://is157250/massey.ac.nz
157250_2005_Ex_01	Extramural	PNTH	http://is157250/massey.ac.nz
157250_2005_In_01/W	Internal	WGTN	http://is157250/massey.ac.nz
157250_2005_In_01	Internal	PNTH	http://is157250/massey.ac.nz

RETURN

APPENDIX IV: DCMI Refinement and Scheme

Please Note:-

Dublin Core qualifiers have the following properties:
Name: The unique token assigned to the qualifier.
Label: The human-readable label assigned to the qualifier.
Definition: A statement that represents the concept and essential nature of the qualifier.
Comment: Additional information associated with the qualifier (if available).
See Also: A link to more information about the qualifier (if available).

DCMES Element	Element Refinement(s)	Element Encoding Scheme(s)
Title	Alternative	-
Creator	-	-
Subject	-	LCSH MeSH DDC LCC UDC
Description	Table Of Contents Abstract	-
Publisher	-	-
Contributor	-	-
Date	Created Valid Available Issued Modified Date Accepted Date Copyrighted Date Submitted	DCMI Period W3C-DTF
Type	-	DCMI Type Vocabulary
Format	-	IMT
	Extent	-
	Medium	-
Identifier	-	URI
	Bibliographic Citation	-
Source	-	URI
Language	-	ISO 639-2RFC 3066
Relation	Is Version Of Has Version Is Replaced By Replaces Is Required By Requires Is Part Of Has Part Is Referenced By References Is Format Of Has Format Conforms To	URI

Coverage	Spatial	DCMI Point ISO 3166 DCMI Box TGN
	Temporal	DCMI Period W3C-DTF
Rights	Access Rights	-
	License	URI
Audience	Mediator Education Level	-

RETURN

APPENDIX V: Guidelines in Writing the Metadata Records

1. GENERAL			
		Requirement:	Guidelines
1.1 General.Identifier		Mandatory	
	1.1.1 General.Identifier.Catalog		1. A unique catalog name is assigned to the courseware and the value of the element can be automated to a catalog name is pre set when metadata records are being created. 2. A unique catalog name is created based on all the course numbers of the ISD, to identify the courseware is related to which course. If a courseware is not related to any of the courses in ISD then it should set to "Nil". 3. Courseware will probably have other identification number know by the instructors before it is recorded in the repository, will need to take into consideration. 4. For multiple identifiers then repeat the field.
	1.1.2 General.Identifier.Entry		1. Value of this element matches the catalog identified in 1.1.1. 2. A running number in sequence that automatically generated when a record is created.
1.2 General.Title		Mandatory	1. Using the title that is most obvious on the courseware. They will usually appear at the top of the courseware. 2. Avoid using initial articles such as A, An, The, etc. 3. Additional title can be created if it would assist the users.
1.3 General.Language		Optional	1. Default value for this element is "en-NZ". 2. An option to enter other values as needed.
1.4 Genral.Description		Optional	1. Short description on the courseware if the instructors think this description will help users to understand the courseware better.
1.5 General.Keywords		Mandatory	1. Words or abbreviation that could be related to the courseware. 2. Could use the thesaurus but need to avoid using broad terms that might provide little assistance. 3. For multiple keywords then repeat the field. *Note*: Maximum size of this field is 2000.
1.7 General.Structure		Mandatory	1. Using the value space that is available: "atomic", "collection", "networked", "hierarchical", and "linear" – using a dropdown list.

		Note: Instructors would need to have a strong sense on how their courseware is structured in the repository.
1.8 General.AggregationLevel	Mandatory	1. Using the value space that is available: "1", "2", "3", and "4" – using a drop down list.

2. LIFECYCLE			
		Requirement:	**Guidelines**
2.1 LifeCycle.Version		Mandatory	1. A dropdown list from version 1.0 to version 10.0. This is to set a control on how long a courseware should not be stored in the repository. 2. Should be able to revise this field whenever a courseware is being updated.
2.2 LifeCycle.Status		Mandatory	1. Information on the status of the courseware - which is either "completed", "unavailable", etc. – using a dropdown list for values.
2.3 LifeCycle.Contibute		Mandatory	
	2.3.1 LifeCycle.Contribute Role		1. Information about the creator, a dropdown list to select the value: whether a "author", "publisher", "editor" and etc.
	2.3.2 LifeCycle.Contribute.Entity		1. Names of the instructors, where three properties are declared mandatory in vCard specification: FN, N and version.
	2.3.3 LifeCycle.Contribute.Date		1. This data format is set at "yyy-mm-dd".

4. TECHNICAL		
	Requirement:	**Guidelines**
4.1 Technical.Format	Mandatory	1. Using the registered MIME types – using a dropdown list of all the possible format types. 2. For possible of other formats then repeat the field.
4.3 Technical.Location	Mandatory	1. Using this element to capture of location of the courseware rather than 1.1.1 General.Identifier.

5. EDUCATIONAL		
	Requirement:	**Guidelines**
5.2 Educational.LearningResourceType	Mandatory	1. Using the recommended value space by IEEE LOM, select values that are relevance to our courseware – using dropdown list for values.

6. RIGHTS		
	Requirement:	**Guidelines**
6.2 Rights.CopyrightandOtherRestriction	Mandatory	1. Using a dropdown list to set default to "Yes" or "No" to see if a courseware

		required rights or any other restriction.
6.3 Rights.Description	Optional	1. Short description on how one can use the courseware. If required no restriction then the instructors will not need to complete this field.

7. RELATION		
	Requirement:	**Guidelines**
7.1 Relation.Kind	Mandatory	1. Using the recommended value space in IEEE LOM. 2. If there is more than one relation then repeat the field.
7.2 Relation.Resource	Mandatory	
7.2.1 Relation.Resource.Identifier		
7.2.1.1 Relation.Resource. Identifier.Catalog		1. Using the same unique catalog name is assigned to the courseware. 2. Also to use the unique catalog name is created based on all the course numbers of the ISD. 3. Courseware will probably have other identification number know by the instructors before it is recorded in the repository, will need to take into consideration. 4. For multiple identifiers then repeat the field. Note: Similar to 1.1.1 General.Catalog
7.2.1.2 Relation.Resource. Identifier.Entry		1. Value of this element matches the catalog identified in 7.2.1.1.
7.2.2 Relation.Resource		1. Short description on the target courseware that is related to this courseware.

NOTE: - Refer to the **Appendix V:** for other information on the metadata schema of the courseware application.

RETURN

APPENDIX VI: The ISD Courseware Application Profile Schema Properties
(With some adoptation from the IEEE LOM Final Draft Standard, 2002)

Element Number in IEEE LOM	Name	IEEE LOM Explanation	Size	Order	Value Space	Datatype	Guide/Example
1.	General	This category groups the general information that describes this learning object as a whole.	1	unspecified	-	-	Categories and aggregates (element with sub-elements), hence do not have value space or datatype constraints.
1.1	Identifier	A globally unique label that identifies this learning object.	Smallest permitted maximum: 10 items	unspecified	-	-	This is a container element with catalog and entry as its sub-elements.
1.1.1	Catalog	The name or designator of the identification or cataloguing scheme for this entry. A namespace scheme.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (Smallest permitted maximum: 1000 char)	The following are unique catalog identifier, URI, ISBN, ISSN, etc. Unique catalog names can also be assigned by organisations to handle resources developed for specific purpose. The catalog name and entry value form the unique resource identifier. Organisations can establish a catalog name to assign to their resources and the value of the element can be automated to a catalog name is pre set when metadata records are being created – using a dropdown list of values. E.g., To create a catalog based on the courseware number and the course number.
1.1.2	Entry	The value of the identifier within the	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (Smallest	The value of this element matches the catalog identified in 1.1.1. This could be a

		identification or cataloguing scheme that designates or identifies this learning object. A namespace specific string.				permitted maximum: 1000 char)	running number in a sequence that automatically generates when a record is being created. E.g., "157331_2005_A003", "157331".
1.2	Title	Name given to this learning object.	1	unspecified	-	CharacterString (Smallest permitted maximum: 1000 char)	This element is not repeatable but facilitates multi-language titles through the use of the language string. E.g., "157331 Assignment 3"
1.3	Language	Primary language used within the LO to communicate to the intended user. *Note 1*: An indexation or cataloguing tool may provide a useful default. *Note 2*: If the learning object had no lingual content (as in the case of a picture), then the appropriate value for this data element would be "none". *Note 3*: This data (metadata) element concerns the language of the learning object.	Smallest permitted maximum: 10 items	unordered	LanguageID=Langcode. Language code as defined by the code set ISO 639:1988. *Note 4*: The language code should be given in lower case and the country code (if any) in the upper case. However, the values are case insensitive. *Note 6*: "none" shall also be an acceptable value.	CharacterString (Smallest permitted maximum: 100 char)	Default value for this element is "en-NZ" for many cases, but with an option to enter other values as required. Language code can be selected from ISO 639-2:1988. Country code from ISO 3166-1:1997.

		Data element 3.4:Meta-Metadata.Langauge concerns the language of the metadata instance.					
1.4	Description	A textual description of the content of this learning object. This information is usually displayed in search results. *Note 1*: This description need not be in language and terms appropriate for the users of the learning object being described. The description should be in language and terms appropriate for those that decide whether or not the learning object being described is appropriate and relevant for the users.	Smallest permitted maximum: 10 items	unordered	-	CharacterString (Smallest permitted maximum: 2000 char)	This element is repeatable. *Note 2*: The maximum size for this field is 2000. If the limit is exceeded the information maybe lost in a data exchange process with other repositories. E.g., ("en", In this assignment 3, the questions set are to prepare students of the course to have a understand the subject in relational calculus …")
1.5	Keyword	A keyword or phrase describes the topic of this learning object. This data element	Smallest permitted maximum: 10 items	unordered	-	CharacterString (Smallest permitted maximum: 1000 char)	The best practice recommends is a new string should be used for each keyword or phrase. E.g., "relational calculus", "tuple relational calculus", "domain relational calculus".

		should not be used for characteristics that can be described by other data elements.					
1.7	Structure	Underlying organisational structure of this learning object.	1	unspecified	**Atomic**: an object that is indivisible (in this context). **Collection**: a set of objects with no specified relationship between them. **Networked**: a set of objects with relationships that are unspecified. **Hierarchical**: a set of objects whose relationships can be represented by a tree structure. **Linear**: a set of objects that are fully ordered. Example, A set of objects that are connected by "previous" and "next" relationships.	Vocabulary (State)	*Note*: - A learning object with Structure = "atomic" with typically have 1.8 General.AggregationLevel = 1. A learning object with Structure = "collection", "linear", "hierarchical", or "networked" will typically have 1.8 General.AggregationLevel = 2, 3, or 4.
1.8	Aggregation Level	The functional granularity of this learning object.	1	unspecified	**1**: the smallest level of aggregation, e.g., raw media data or fragments. **2**: a collection of level 1 learning objects, e.g., a lesson.	Vocabulary (Enumerated)	*Note 2*: A learning object with AggregationLevel = 1 will typically have 1.7 General.Structure = "atomic". A learning object with AggregationLevel = 2, 3, or 4 will typically have 1.7 General.Structure = "collection", "linear", "hierarchical", or "networked".

					3: a collection of level 2 learning object, e.g., a course. **4**: the largest level of granularity, e.g., a set of courses that lead to a certification. *Note*: - Level 4 objects can contain level 3 objects, or can recursively contain other level 4 objects,		
2.	Life Cycle	This category describes the history and current state of this learning object and those entities that have affected this learning object during its evolution.	1	unspecified	-	-	Container
2.1	Version	The edition of this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 50 char)	Should be able to revise this field. E.g., ("en", "version 1.0")
2.2	Status	The completion status or condition of this learning object.	1	unspecified	Draft final revised unavailable.	Vocabulary (State)	If using a local vocabulary to identify the status of a learning object maps the values to the IEEE LOM's vocabulary to maintain interoperability - could use a dropdown list.
2.3	Contribute	Those entities that have contributed to the state of this learning object	Smallest permitted maximum: 30 items	ordered	-	-	Container

		during its life cycle. *Note 1*: This data element is different from 3.3 Meta-Metadata.Contribute. *Note 2*: Contributors should be considered in a very broad sense here, as all actions that affect the state of the learning object.					
2.3.1	Role	Kind of contribution. *Note 1*: Minimally, the Author(s) of the learning object should be described.	1	unspecified	Author Publisher Unknown Editor Content provider Graphical designer Technical implementer Instructional designer *Note 2*: We will only used the vocabularies that applied to our courseware.	Vocabulary (State)	Depending on what contribution which we want to be recognised, using a default value be set for role – using a dropdown list. E.g., In our case, main roles are "Author", "Publisher", "Editor", "Content provider", "Unknown", etc.
2.3.2	Entity	The identification of and information about entities (i.e., people, organisations) contributing to this learning object. The entities shall be	Smallest permitted maximum: 40 items	ordered	vCard, as defined by IMC vCard 3.0 (RFC 2425, RFC 2426)	LangString (smallest permitted maximum: 1000 char)	vCard specifications can be found at http://www.imc.org/pdi/ For example, Three properties are declared mandatory in vCard specification, FN, N, and Version. FN (formatted name), the name by which the person is known. E.g., FN: Professor

		ordered as most relevant first.					Sven Hartmann N (structured name) is entered Family first then followed by given name and other names and separated by a semi-colon. E.g., Hartmann; Sven Version of vCard specification used is 3.0. E.g., Version 3.0
2.3.3	Date	The date of the contribution.	1	unspecified	-	DateTime	Specified format for this entry is "yyyy-mm-dd". E.g., "2005-02-07"
4	Technical	This category describes the technical requirements and characteristics of this learning object.	1	unspecified	-	-	Container
4.1	Format	Technical datatye(s) of (all the components of) this learning object.	Smallest permitted maximum: 40 items	unordered	MIME types based on IANA registration (see RFC2048:1996) or "nono-digital".	LangString (smallest permitted maximum: 500 char)	This element is repeatable for each type. The officially registered MIME types are available at http://www.iana.org/assignments/media-types/ E.g., "text/html", "video/mpeg".
4.3	Location	A string that is used to access this learning object. If may be a location (e.g., Universal Resource Locator), or a method that resolves to a location (.g., Universal Resource Identifier).	Smallest permitted maximum: 10 items	ordered	Repertoire of ISO/IEC 10646-1:2000	LangString (smallest permitted maximum: 1000 char)	Value for this element should be captured by an electronic system whenever possible, e.g., file name or URL. E.g., "http://is157331/ assignments/ass_3.pdf" *Note*: Instead of using 1.1. Identifier to create a record of URL of courseware, this metadata element will provide that

							information.
5.	Educational	This category describes the key educational or pedagogical characteristics of this learning object. Note: This is the pedagogical information essential to those involved in achieving a quality learning experience. The audience for this metadata includes teachers, managers, authors, and learners.	Smallest permitted maximum: 100 items	unspecified	-	-	Container
5.2	Learning Resource Type	Specific type of learning objects. The most dominant kind shall be first.	Smallest permitted maximum: 10 items	ordered	Lecture Assignment Exercise Exam Self assessment Questionnaire Diagram Figure Graph Index Slide Table	Vocabulary (State)	In order to achieve interoperability, it is best to create a crosswalk from the preferred vocabulary to IEEE LOM. E.g., "Lecture", "Exam", etc – using a dropdown list for IEEE LOM's values. *Note*: "Assignment" is not a controlled vocabulary from IEEE LOM, if there is any other vocabulary in future then we must declare it.
6.	Rights	The category describes the	1	unspecified	-	-	Container

		intellectual property rights and conditions of use of this learning object.					
6.2	Copyright and Other Restrictions	Whether copyright or other restrictions apply to the use of this learning object.	1	unspecified	Yes No	Vocabulary (State)	Set default to "yes" or "no" – could use a dropdown list.
6.3	Description	Comments on the conditions of use of this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Statement of copyright, licensing and use condition to this learning object. E.g., ("en", "use of this courseware is only permitted after confirmation with the course coordinator".)
7.	Relation	This category defines the relationship between these learning objects, if any. To define multiple relationships, there may be multiple instances of this category. If there is more than one target learning object, then each target shall have a new relationship instance.	Smallest permitted maximum: 100 items	unordered	-	-	Container
7.1	Kind		1	unspecified	Based on Dublin Core: ispartof: is part of haspart: haspart isversionof: is version of	Vocabulary (State)	This element is repeatable for each different relation. E.g., Based on the courseware that might contain other courseware. Such as this

					hasversion: has version isformatof: is format of hasformat: has format references: references isreferenceby: is reference by isbasedon: is based on isbasedfor: is based for requires: requires isrequiredby: is required by		learning object is ispartof a courseware which contains all the assignments, and isversionof another courseware created in the previous year, 2004.
7.2	Resource	This target learning object that this relationship references.	1	unspecified	-	-	This is a container element with catalog and entry as its sub-elements.
7.2.1	Identifier	A globally unique label that identifier the target learning object.	Smallest permitted maximum: 10 items	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (Smallest permitted maximum: 1000 char)	This is a container element with catalog and entry as its sub-elements.
7.2.1.1	Catalog	The name or designator of the identification or cataloguing scheme for this entry. A namespace scheme.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (Smallest permitted maximum: 1000 char)	Similar to 1.1.1, the catalog name and entry value form the unique resource identifier. Organisations can establish a catalog name to assign to their resources and the value of the element can be automated to a catalog name is pre set when metadata records are being created – using a dropdown list of values. E.g., To create a catalog based on the courseware number and the URI of the learning object.
7.2.1.2	Entry	The value of the identifier within the identification or cataloguing scheme	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (Smallest permitted maximum:	The value of this element matches to the catalog identified in 7.2.1.1. This could be a running number in a sequence that automatically generates when a record is

		that designates or identifies the target learning object. A namespace string.				1000 char)	being created. E.g., If this learning object is related to study guide of 157331: - "157331_2005_C001", "157331"
7.2.2	Description	Description of the target learning object.	Smallest permitted maximum: 10 items	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Description on the target learning object that is related to this learning object. E.g., ("en", "The chapter 3 of this study guide provide the topic on relational calculus – will assist in completing this assignment 3".)

RETURN

Acknowledgements

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