RHODES UNIVERSITY

An investigation of the development and adoption of educational metadata standards for the widespread use of learning objects.

by

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A thesis submitted in fulfilment of the requirements for the degree of

Master of Commerce

Rhodes University

November 2004

Abstract

This research investigates the development and adoption of educational metadata standards for the widespread use of learning objects. Learning objects, metadata, the related IEEE standard and the various application profiles derived from the standard are discussed.

A number of standards and specifications for educational metadata used to describe learning objects are explored, namely the Dublin Core, IMS, SCORM, ARIADNE, CanCore and the UK LOM Core. Three metadata editors and the experience with using one of them, RELOAD, is described. These educational metadata specifications are used in a practical metadata implementation scenario and the experiences are extrapolated to derive a localised instance of the generic IEEE standard. A new application profile is proposed, "RU LOM Core", for the South African higher education context. Some existing results are confirmed about the complexity of using the IEEE standard and it is demonstrated that it is possible to instantiate the standard for South African conditions.

The results are largely qualitative and based on practical experience. However, the results concur with results from related research. Although the development of an application profile is certainly not new, the development of RU LOM Core illustrates that the IEEE standard, developed largely within the northern hemisphere, can be adapted to work in the South African scenario. RU LOM Core has been developed for the South African higher education environment and takes linguistic and cultural diversity and the low rate of technological literacy into consideration. The lessons learned and the proposed LOM core can be built upon in further research and collaboration to use and support the use of such standards within South Africa.

Acknowledgements

My deepest thanks and appreciation go first and foremost to my supervisors, Professor David Sewry and Brenda Mallinson, for your guidance and counsel. Your direction, advice and encouragement have helped me immeasurably. Thank you also for your patience and tireless reading of drafts.

Thank you also to everyone in the Information Systems Department for your support and for making my time in the department such an enjoyable one.

My deepest thanks and love to my family for all you have done for me. Your love and strength has enabled me to face any challenge.

Thank you to my friends, for your support and motivation.

The financial assistance from the Rhodes University Postgraduate Scholarship towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at are those of the author and not necessarily to be attributed to Rhodes University.

Declaration

I acknowledge that all references are accurately recorded and that, unless otherwise stated, all work herein is my own.

G.E. Krull

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Glossary of Terms

Application Profile: a customisation of a standard for the specific needs of particular communities of implementers with common application requirements (Friesen, Roberts and Fisher, 2002).

Learning Object (LO): the smallest element of stand-alone information required for an individual to achieve an enabling objective or outcome (Wagner, 2002).

Learning Object Metadata (LOM): provides data or any information about each learning object stored in a database (Barritt and Alderman, 2004: 162).

Learning Object Repository (LOR): an online, searchable collection of learning objects (Friesen, 2003).

Chapter 1

Introduction to the Research

Chapter One of this research introduces the research problem. This is achieved by describing the research area and showing how the research area relates to the research problem on a general level. This chapter also presents a summary of the results of the research and explains the organisation of this thesis.

1.1 Introduction

Littlejohn (2003: 1) notes that there is a growing international demand for access to education. Along with this demand for access is an expectation of lifelong learning brought about by changes in attitudes to learning and employment patterns. Developments in Information and Communication Technologies (ICT) are supporting these advancements. New technologies are beginning to transform higher education delivery both on campus and at a distance. E-learning affords new opportunities to increase flexibility in time and location of study, communication, interaction and access to resources through the Internet (Littlejohn, 2003: 1).

This chapter provides an introduction to the research. The context of the research is explored in order to provide a background to the study and is followed by the statement of the research problem and the statement of the sub-problems. The scope of the research indicates the assumptions and delimitations of the research. This is followed by a discussion of the research methodology and a summary of the results of the research. Finally, the organisation of the thesis is detailed.

1.2 Research Context

According to Clark (1998: 61), companies are increasingly transforming themselves into learning organisations in order to capitalise on the knowledge and skills held by employees. A key factor supporting this shift is the critical role of database and networking technology to tag, store and disseminate content (Clark, 1998: 61). Alavi and Leidner (2001: 2) agree that in the knowledge economy, there is increased demand for a highly educated workforce and for the continuous learning and upgrading of employees' skills. Increasingly, individuals are not prepared to wait for the next available local course to obtain the information they need and do not want to have to travel elsewhere to obtain it. Technology makes it possible for learning to be mass customised and individualised (McGreal and Roberts, 2001). Downes (2001) suggests that if educational content is available online, it is available worldwide. Accordingly, if a single piece of educational content is created, then it can potentially be accessed by each of the thousands of educational institutions teaching the same material.

The provision of e-learning involves making learning resources and instructional activities available to learners (Mashile and Pretorius, 2003: 133). Gordon (2002) postulates that if e-learning developers could adopt a common, worldwide system for labelling and describing not just e-learning courses, but individual "chunks" of a course, then those small, granular "chunks" could easily be located and reused by other developers. These chunks can be described as "learning objects". According to Kilby (2003), learning objects could significantly impact e-learning in this decade. Learning objects are at the core of a whole new courseware design paradigm requiring a radical change in instructional design strategy, technical architectures, and delivery systems in order to improve the value of learning content. In this regard, learning content should be both reusable and accessible, while the instructional units in which content is packed should be interoperable and durable (Kilby, 2003).

Meeting these criteria requires the definition of standard learning objects that are catalogued for search and reuse (Kilby, 2003). According to Gordon (2002), the descriptive language for learning objects (similar to the information in a library's card catalogue) is metadata. A universal metadata system could form the backbone for an enormous, searchable repository of learning objects - a repository like the World Wide Web, but one where finding the particular object wanted would be far easier and more efficient than conducting a standard Internet search (Gordon, 2002). There are some challenges to the provision of the necessary flexibility required to facilitate wider access and lifelong learning (Littlejohn, 2003: 2). Creating digital materials necessary for online delivery requires considerable investment. Numerous national and international initiatives have been established to investigate ways in which digital resources might be developed, shared and reused by teachers and learners around the world. Behind these initiatives lies a vision of the future where reusable resources (or learning objects) could comprise a new currency of exchange within a learning economy. Learning objects developed by publishers, educators, support staff and learners themselves would be stored in digital repositories where they could be easily accessed, recombined and reused within courses. Ideally, these learning objects would be designed so that they could be adapted to fit different pedagogical models, subject disciplines and levels of study (Littlejohn, 2003: 2).

Technical standards are vital for interoperability; they assure that the "investment in time and intellectual capital can move from one system to the next" (Connor and Hodgins, 2000). The e-Learning Consortium (2002: 11) (a collaboration of corporations, government agencies and e-learning providers focused on benchmarking and the future of e-learning) notes that, to ensure compatibility, agreement must be achieved on global standards that facilitate assembling and reusing “chunks” of content from various providers across multiple platforms. There are a number of initiatives currently engaged with developing educational metadata specifications. These include the Learning Technology Standards Committee (LTSC) affiliated to the Institute of Electrical and Electronics Engineers (IEEE), the Aviation Industry CBT (Computer Based Training) Committee (AICC), the IMS Global Consortium, the Advanced Distributed Learning (ADL) Initiative and the Dublin Core Initiative. The underlying problems fuelling the development of e-learning standards are that learners cannot easily find the courses that they need and course developers struggle to combine content and tools from different vendors due to deficiencies in interoperability (Horton and Horton, 2003: 472). The development of technical standards in educational technology can be understood as a part of the maturation of the emergent field of e-learning. Digital technologies have been widely used in education, but typically in ad-hoc and divergent forms. Numerous courses and systems for managing learning have been developed independently of each other, often at great expense (Friesen, 2004c: 1070). It is very difficult if not impossible to support their interchange and successful interoperation. E-learning standards seek to address these problems by ensuring the interoperability, portability and reusability of learning objects and of the systems (repositories) that deliver and manage their use by learners (Friesen, 2004c: 1070).

The IEEE LTSC Learning Object Metadata (LOM) 1484.12.1 data model became the first accredited educational metadata standard in June 2002 (IEEE LTSC, 2002). This standard is a conceptual data model or metadata schema that specifies the data elements of which a metadata instance for a learning object is composed (Duval, 2001: 593). The LOM standard provides a base schema that is extensible (IEEE LTSC, 2002). An organisation developing and managing learning objects can adopt (or conform to) the LOM standard or it may prefer to develop its own metadata schema based on the standard. The metadata schema that a Learning Object Repository (LOR) uses is based on the IEEE LOM standard through a process that is typically referred to as an “application profile” (Neven and Duval, 2002: 291). This enables increased semantic interoperability within a community of users, while preserving compatibility with the LOM standard (Duval and Hodgins, 2003). Wagner (2002) states that the primary reason developers are not using learning objects is that they lack the technical knowledge to interpret and apply the technical guidelines in practice. Developers are still waiting for useful, widely accepted standards definitions. In addition, educational and business communities have been slow to adopt the standards due to their complexity (Hatala and Richards, 2002: 293). The process of creating metadata is problematic. It is time-consuming for resource authors to carry out and there are problems creating metadata. While teachers and learners, as end users, need not be aware of these metadata issues, they do need to understand how resources are classified. This is a major challenge given that each discipline has its own “language and discourse structure” and that resources will be shared across cultures (Littlejohn, 2003: 4).

1.3 Statement of the Problem

An investigation of the development and adoption of educational metadata standards for the widespread use of learning objects.

1.4 Statement of the Sub-problems

1. To investigate the role of learning objects within the e-learning environment
2. To analyse the role of metadata in the use of learning objects
3. To investigate the development process of educational metadata specifications
4. To analyse the IEEE Learning Object Metadata (LOM) 1484.12 standard
5. To analyse how different educational communities use the LOM standard through the use of application profiles
6. To investigate metadata editors and use a metadata editor to test application profiles
7. To develop a LOM application profile suitable for the South African higher education context
8. To test and update the developed LOM application profile to reflect practical application within the local context

1.5 Scope of Research

The term “learning object” is not inextricably linked with e-learning. One could use learning objects to support e-learning, instructor-led training and other options (Barritt and Alderman, 2002: 19). However, this research looks at learning objects within the context of e-learning. This work is focused on digital objects that can be delivered or accessed over the Internet or across a network. This research is undertaken based on the assumption that learning objects can be designed so that they can be adapted to fit different pedagogical models and subject disciplines (Littlejohn, 2003: 2).

This study will not provide guidelines for the development of reusable learning objects or look into developing a strategy for implementing reusable learning objects.

The main focus of this research is within the context of higher education, and in particular, the South African higher education context. Although many of the issues discussed here relate to the use of learning objects relate to other fields of education and training, they will not be explored in great depth.

Although the focus of this research is on the development and reuse of learning content, it is recognised that learning content itself is not sufficient for learning to occur (Thomas and Horne, 2004: 8). Furthermore, it is recognised that learning content in many cases is copyrighted to a particular organisation and that this may limit the sharing and reuse of learning resources.

1.6 Research Methodology

This research makes use of the qualitative research methodology. The research is based on a literature survey, complemented by empirical analysis. The literature survey aims to analyse educational metadata specifications in terms of what they specify, why and how. Metadata specifications are investigated in terms of how they are developed and the relationships between them. The LOM standard is critically analysed in terms of what it specifies, how it can be used and how it can be extended. International initiatives, jointly involved in the standardisation process of educational metadata, are also critically analysed. These include:

- ARIADNE (http://www.ariadne-eu.org)
- The Canadian Core Learning Resource Metadata Protocol (CanCore) (http://www.cancore.ca)
- The Dublin Core Metadata Initiative (http://dublincore.org)
- The IMS Core (http://www.imsglobal.org)
- The Sharable Content Object Reference Model (SCORM) (http://www.adlnet.org)

These initiatives are analysed with particular reference to the adequacy of the LOM standard and how the various initiatives are making use of the standard. In addition, the analysis covers how different communities adopt and support educational metadata for their constituencies, with particular reference to higher education communities. The research also investigates several metadata editors and performs practical implementation of several metadata specifications using a metadata editor. Information from the literature survey and empirical analysis is used to develop a set of guidelines for implementing metadata within the South African higher education context. These guidelines are tested through practical implementation of learning object metadata. A survey investigating the need for metadata is developed and published using Questionmark Perception 3.2. The survey is available via the web to Southern African professionals with experience in the use of educational technologies. The survey addresses the need for, and awareness of metadata for describing learning objects in South Africa. Finally, conclusions are drawn and issues for future research are discussed.

1.7 Summary of the Results

Learning objects are small, modular pieces of learning content that facilitate and enable the use and reuse of educational content online. The metadata that describes learning objects is key in facilitating the search and retrieval of them. The use of a metadata editor can simplify and improve the process of metadata creation. Internationally accredited standards enable learning objects to be interoperable and reusable in different systems and learning environments. The development of e-learning standards is a continuously evolving and dynamic process with a variety of organisations collaboratively contributing to the process.

The IEEE Learning Object Metadata (LOM) standard became the first accredited educational standard. This useful standard allows for the description of learning objects, yet can be complex to implement because some interpretation is required. Application profiles provide a simple mechanism to implement the standard. Application profiles involve customising the LOM standard, thus maintaining interoperability with the broader international community while meeting the requirements of local applications. There are several noteworthy application profiles that have been developed to meet the needs of particular communities, such as the Dublin Core, IMS, SCORM, ARIADNE, CanCore and the UK LOM Core. However, there is no application profile that meets the particular needs of the South African higher education environment.

An application profile, "RU LOM Core", was developed to support the Southern African higher education community. This application profile takes into consideration the linguistic and cultural diversity as well as the lack of technological literacy of the South African higher education environment. The application profile was refined through a practical implementation process and a survey. Several refinements, such as the reference to South African educational policies, were made to enhance the value of the application profile. RU LOM Core adequately and suitably describes learning objects for a South African higher education context.

1.8 Thesis Organisation

This thesis is organised into several chapters.

Chapter 1: Introduction

The research area and the specific problem under investigation are introduced by providing contextual background information and the rationale for conducting the research. The specific areas to be examined are illustrated by division of the research problem into several sub-problems. The scope of the research, a summary of results and a discussion of the thesis organisation are also contained within this chapter.

Chapter 2: Introduction to Learning Objects

Chapter 2 investigates learning objects and the role of learning objects in enabling and enhancing technology-based learning. Learning objects are defined and the need for learning objects is explored. The characteristics of learning objects are investigated and the benefits and risks associated with the learning object approach are explored.

Chapter 3: The Role of Metadata

Chapter 3 investigates the role of metadata in describing learning objects. The concept of metadata is introduced, followed by a discussion of educational metadata. The purpose and value of metadata is investigated and this is followed by an analysis of metadata categories. Metadata creation and the characteristics of metadata are then explored.

Chapter 4: E-learning standards

Chapter 4 investigates the development of emerging e-learning standards. The concept of standards is introduced and the need for e-learning standards is considered. The development process of e-learning standards is investigated. This is followed by an analysis of the types of e-learning standards and the standards development organisations.

Chapter 5: IEEE LOM standard

Chapter 5 analyses the IEEE LOM standard. The various educational metadata standards are considered and the IEEE LOM standard is investigated in detail. This is followed by an analysis of the LOM standard by various authors.

Chapter 6: Application Profiles

Chapter 6 investigates relevant application profiles based on the IEEE LOM standard. The development of application profiles is considered, followed by a discussion of several application profiles. A comparison of these application profiles is conducted and shortcomings in current metadata specifications are explored.

Chapter 7: Metadata Editors and Metadata Creation

Chapter 7 investigates several metadata editors and details the experiences of implementing metadata with the use of a metadata editor.

Chapter 8: Development of RU LOM Core

Chapter 8 explores the development of the proposed application profile, RU LOM Core: an application profile for the South African higher education context. A comparison with other application profiles is also detailed.

Chapter 9: Testing of RU LOM Core

Chapter 9 tests the suitability and applicability of the proposed application profile, RU LOM Core, through practical metadata implementation. The design and results of a survey addressing the need for, and awareness of, metadata to describe learning objects in South Africa is also discussed.

Chapter 10: Conclusion

The research undertaken is summarised and the contributions of the thesis are indicated. Finally, areas for future research are briefly examined.

Appendices

Various supporting documentation in the form of metadata XML files, the survey questionnaire and the application profile specification is contained within the appendices.

1.9 Conclusion

This chapter provided an introduction and background to the research. The research problem statement and statement of the sub-problems were provided. The scope of the research was indicated and the research methodology employed was specified. A summary of results was provided and the organisation of the thesis was specified.

Chapter 2

Introduction to Learning Objects

Chapter One provided a background to the research. Chapter Two investigates learning objects and the role of learning objects in enabling and enhancing technology-based learning. Learning objects add significant value to the development of learning content and the learning process; however changes in the development processes of learning content are required.

2.1 Introduction

Shepherd (2000) suggests that learning objects promise a new era of easily accessible and individualised learning, facilitated through flexible deployment over networks of small, reusable components from multiple sources. The aim of this chapter is to investigate the role of learning objects in enabling and enhancing learning. Firstly, learning objects are defined and the evolution of the learning object movement is explored. The need for learning objects is considered and the attributes or characteristics of learning objects are examined. The structure of learning content and the issue of granularity is then investigated. The benefits and risks associated with adopting a learning object approach are considered and learning object repositories are investigated.

2.2 Learning Objects

Recent developments in e-learning have resulted in the emergence of the concept of reusable learning objects. In the old paradigm, learning was organised into lessons and courses that met specific pre-defined objectives. In the new paradigm, content for learning is broken down into smaller, self-contained pieces of informational content that can be used alone or can be dynamically assembled into learning objects to meet the “just in time” requirements of a learner (e-Learning Consortium, 2003: 42). Currier and Barton (2003), of the University of Strathclyde in Glasgow, believe that the widespread use of learning objects will create a learning object economy that will enable the sharing and reuse of digital learning materials for teaching and learning.

2.2.1. Learning Object Definitions

There is no universally accepted definition of a “learning object” as the term means different things to different parties, partly because learning objects come in a variety of shapes and formats. Educational resources range in diversity from a book chapter to a transparency slide and can be applied to a range of purposes (Australian Flexible Learning Framework, 2003: 6). There are a number of different terms used to describe learning objects, including educational objects, reusable learning objects, instructional objects and sharable content objects (Hamel and Ryan-Jones, 2002 and Horton and Horton, 2003: 473). The IEEE Learning Technology Standards committee (LTSC), in promulgating the Learning Object Metadata (LOM) standard, defines a learning object as “any entity, digital or non-digital, that may be used for learning, education or training" (IEEE LTSC, 2002). Wiley (2000) challenges the usefulness of this definition, citing it could "technically include anything and everything". Wiley (2000) narrows the definition of a learning object to "any digital resource that can be used to support learning". McGreal and Roberts (2001) describe a learning object as "any entity, digital or non-digital, that can be used or referenced in technology-supported learning". Wagner (2002) states that the general consensus among authors is that learning objects are "the smallest element of stand-alone information required for an individual to achieve an enabling objective or outcome". This is supported by the e-Learning Consortium (2003:42), who classify a learning object as a "self-standing, discrete piece of instructional content that meets a learning objective".

Smith (2004: 1) notes that most descriptions focus on how learning objects are created, used and stored, rather than on what learning objects look like. Friesen (2003) postulates that the lack of a clear definition for the term "learning object" could be a result of the juxtaposition of two words that may be incompatible. The term "object" is often appended to other computing terms, such as programming, to indicate a very specific technological paradigm, while "learning" is equally vague, general and broadly non-technical. Jacobsen (2001) believes that the lack of a clear definition is no cause for concern, provided that the concept is clear and that a clear definition will emerge with time.

According to Wagner (2002), learning objects ensure that complex content can be broken down into smaller, more meaningful "chunks" that can be assembled and reassembled to meet individual learner requirements. Hamel and Ryan-Jones (2002) state that these small, pedagogically complete segments of learning content can be assembled as needed to create larger instructional units such as courses. Heng (2003) concurs that learning objects are a form of instructional learning technology that is composed of small learning chunks which can later be re-assembled or combined to form course materials. Thomas and Horne (2004: 8) refer to learning objects as "bite-sized" pieces of digital content that can be difficult to learn from in isolation, but enable learning when placed in sequence with other learning objects. The sequencing of the learning objects as well as the mode of delivery are important concerns. Anido, Fernandez, Caeiro, Santos, Rodriguez and Llamas (2002: 359) describe an educational resource as an entity that can be used or referred to during a learning process. Multimedia content, books, manuals, programmes, tests, software applications, tools, people and organisations are examples of educational resources. Shepherd (2000) provides several examples of types of learning objects, including video demonstrations, tutorials, procedures, stories, assessments, simulations and case studies.

Clark (1998: 61) provides an example of the use of learning objects where a technology company is preparing to release a product upgrade. The engineering and marketing departments have created information objects; mostly text, photographs and specifications of the product. The sales department would like to train sales personnel about the upgrade. They create a learning object by reusing the information objects to summarise product benefits and features and how to deal with customer concerns. The learning object includes a video demonstration of skills and a self-test. This learning object could be stored in the company's repository, together with a metadata tag, to be reused for future product upgrades.

2.2.2. Evolution of Learning Objects

Learning objects are an application of object-orientated thinking to the world of learning (Shepherd, 2000; Wagner, 2002). According to Jacobsen (2001) and Friesen (2003), the term "learning object" was first popularised by Wayne Hodgins when he named the Computer Education Management Association (CedMA) working group "Learning Architectures, Application Programming Interfaces (APIs) and Learning Objects". Hodgins is credited with "coining" the term while watching his children play with Lego™ building blocks, and realising that learning development efforts may benefit from plug-and-play interoperable content that could be assembled as needed. This led to CedMA becoming involved in the development of learning objects. From 1992 to1995, several disparate groups started working with the early concept of learning objects. The Learning Object Metadata Group from the National Institute of Science and Technology and CedMA grappled with learning object issues such as modularity, database centricity and tagging objects with metadata (Jacobsen, 2001). Several other groups such as the IMS Consortium in North America and the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) began to work in the learning object arena. Tom Kelly and Chuck Barritt began working on learning objects, first at Oracle and then Cisco Systems, which culminated with the release of Cisco's white paper on Reusable Learning Objects in 1998. That paper, in conjunction with the work of the industry standards and specifications bodies, did much to move learning objects to the forefront of learning technology by 2001 (Jacobsen, 2001).

2.3 The Need for Learning Objects

According to Jacobsen (2001), the learning market is demanding a quicker and less-expensive way to build and maintain content. Duval and Hodgins (2003) note that much research has been conducted into learning objects, on the premise that the reuse of content components can lead to important savings in time and money, and enhance the quality of digital learning experiences. This would result in faster, cheaper and better learning. Hamel and Ryan-Jones (2002) agree that learning objects can be shared with other users, recombined with other objects or redesigned by other instructional developers with reasonable cost savings. Friesen (2001) adds that learning objects promise easy and low-cost multimedia course creation. New learning objects can be created by educational professionals, instructional designers, or other professionals who have an educational goal in mind, but cannot find existing learning content to meet their needs. The created learning objects may then be reused in other situations (Smith, 2004: 2).

The promise of learning objects is that they can be leveraged, copied or linked by multiple authors, placed into multiple learning or training programmes and then delivered in a range of delivery media (Barritt and Alderman, 2004: 11). Learning objects promise to take learning to new levels of personalisation and relevance. They promise to offer an environment for individualised learning that is easily accessible and enabled by the reusable components over networks (Shepherd, 2000). Learning objects allow information to be presented in several different ways (Smith, 2004: 2). The vision of the learning object economy is that learning objects will be placed in public repositories for free reuse or in commercial repositories for sale, and these objects can be used as needed by instructional developers for personalised learning. For this to occur, learning content needs to be developed as reusable, stand-alone learning objects that are tagged with metadata (Hamel and Ryan-Jones, 2002).

2.4 Learning Object Attributes/Characteristics

Friesen (2001) states that learning objects are supposed to be modular, interoperable and discoverable. Longmire (2000: 25) believes that in an environment in which context is scalable and adaptive, the ideal learning object content is non-sequential, able to satisfy a single learning objective and accessible to broad audiences. Barritt and Alderman (2004: 8) list the ideal features of learning objects:

- Objective-based – able to accomplish a single learning objective

- Context-free – able to stand-alone from the rest of the associated hierarchy
- Interactive – although not required, engaging learners is key to their achieving the objective
- Self-descriptive – have associated metadata
- Self-contained – capable of standing alone or in unison with other learning objects
- Format-free – created free of "look and feel" formatting

There are a number of additional attributes of learning objects that are further explored in this section.

2.4.1. Reusability

According to Kilby (2003), learning content is modularised into small units of instruction suitable for assembly and reassembly into a variety of courses. Course developers do not have to develop all the content for a particular project, since objects can be reused on several projects (Horton and Horton, 2003: 473). Once created, a learning object should function in different contexts, that is, they should be relevant to audiences beyond the original target audience (Polsani, 2003). Smith (2004: 2) notes that learning objects can be reused or repurposed which promotes cost-effectiveness. Duval and Hodgins (2003) distinguish between different kinds of reuse: multiple distribution formats and media, multiple purposes, multiple deliveries and multiple "disciplines". Barritt and Alderman (2004: 12) note that pure reuse is an ideal scenario. In practice, many authors adopt a repurposing approach where objects are changed to meet specific needs.

2.4.2. Interoperability

Interoperability refers to instructional units that interoperate with each other regardless of the platform, developer or Learning Management System (LMS) (Kilby, 2003). Polsani (2003) concurs that the learning object should be independent of both the LMS and the delivery media. Longmire (2000: 25) states that learning objects should be portable between applications and environments. A difficult attribute to satisfy is the notion of durability. This refers to learning content that withstands evolving delivery and presentation technologies without becoming unusable (Kilby, 2003).

2.4.3. Accessibility

Learning content should be available anywhere, anytime and be able to be reused across networks (Kilby, 2003). The learning object should be tagged with metadata so that it can be stored and referenced in a repository (Polsani, 2003). Friesen (2001) adds that it is the metadata used to describe learning objects that make them accessible or discoverable.

2.4.4. Delivery

Thomas and Horne (2004: 8) state that learning objects alone are not sufficient for learning to occur; the delivery thereof affects learning. Barritt and Alderman (2002: 19) state that delivery options include e-learning, instructor-led learning, blended learning (a combination of both), as well as other options. Thomas and Horne (2004: 8) add that learning objects can also be delivered in paper-based environments. Shepherd (2000) suggests that learning objects can be selectively applied (alone or in combination) by computer software, learning facilitators or learners themselves, to meet individual needs for learning or performance support. Learning objects can be used by course developers to develop courses and assemble them to meet the needs of individual learners (McGreal and Roberts, 2001). Teachers may deliver learning objects for whole-class or differentiated teaching (Thomas and Horne, 2004: 8). Alternatively, the choice of which learning objects to assemble into a collection can be a decision made as required by a learner. Independent learners can create their own courses by assembling learning objects relevant to their own needs, moving towards an individualised and focused approach to learning (McGreal and Roberts, 2001). Thomas and Horne (2004: 8) include delivery of learning objects by learners for individual or group work. In the future, as standards and Learning Content Management Systems (LCMS) evolve, a LCMS may adapt learning objects based on the learner's real-time performance (Kilby, 2003). Learning objects can be used in a variety of ways. For example, learners could collaborate under the guidance of an educator in a classroom situation or work at home completing an assignment or even use a simulation to perform virtual experiments. Thomas and Horne (2004: 8) note that learning objects can be delivered via Learning Management Systems (LMSs) or Virtual Learning Environments (VLEs). Learning objects may also be integrated into a course using a LMS to create and manage links between objects (Smith, 2004: 3).

2.5 Learning Object Content Granularity

Learning objects exist and interoperate at different levels of granularity (McGreal and Roberts, 2001). The e-Learning Consortium (2003:46) provides a model, depicted in Figure 2.1, of a learning object content hierarchy (also represented in Wagner (2002) and Duval and Hodgins (2003)). While there may be any number of levels in this Content Object model, the four main levels are:

1. Data or "Raw" Media Elements: consist of the "raw media" stored at a pure data level, for example, a single illustration or audio clip.
2. Information Objects: a set of data elements combined to form a media independent chunk of information. Examples include procedures and summaries.
3. Application Specific Objects: Information objects are assembled into application objects, based on a single enabling objective. Learning objects are found at this level of the hierarchy.
4. Aggregate Assemblies and Collections: The fourth and fifth levels are defined around larger terminal objectives, such as lessons or chapters, which can be assembled into courses.

When this content object model is put into operation and applied to learning, the power of the inherent flexibility and reusability of the model becomes clear. Once developed, a great mass of digital assets can be stored within a database-managed repository. With the aid of metadata to detail and describe their attributes, each is ready to be reused through mass customisation by assembly within multiple contexts and applications, and delivered within multiple delivery mediums, formats and devices (Duval and Hodgins, 2003).

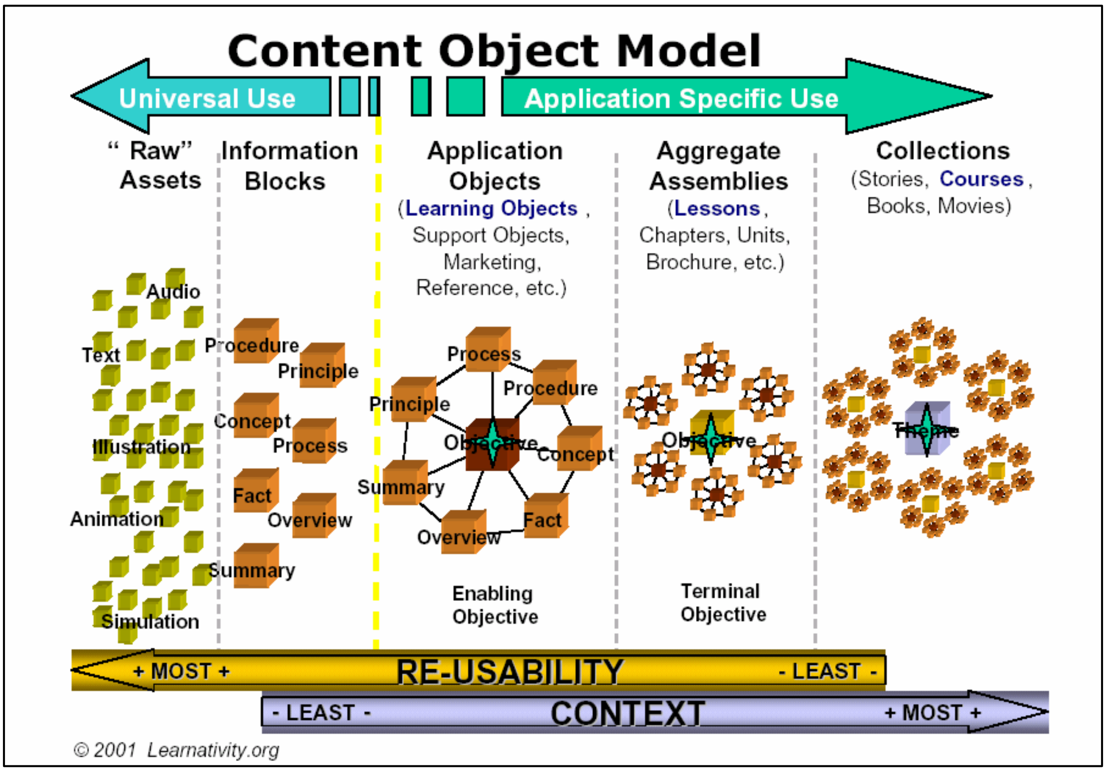

Figure 2.1: Modular Content Hierarchy (e-Learning Consortium, 2003:46)

A common issue of concern for learning object developers is the granularity at which objects are defined. It can be difficult to decide how much content to include in a single learning object. A learning object with too much content can be difficult to navigate, while too little content may result in learners finding that the outcome is not worth the time invested in using the learning object (Smith, 2004: 4). At the one end, learning objects are regarded at a micro level, as media assets. Although highly reusable at this level, helping developers in assembling content, it does little for the learner, who is not interested in how a learning component is made up, but only the functionality that it provides (Shepherd, 2000). In a Learning Object Repository (LOR), a smaller object must be provided with a proportionally higher amount of metadata to ensure that it is discoverable in the LOR, and that makes it necessary to store and manage many more objects (Thomas and Horne, 2004: 11). At the other end, a learning object can be regarded as a fully self-contained piece of instruction, including information, mechanisms for practice, and a means of assessment (Shepherd, 2000). However, not all learning objectives can be met in full by a single, integrated chunk of material. There is a danger that learning objects will become too large and inflexible, hindering reusability, personalisation and speedy, just-in-time access. Somewhere between these two extremes is a granularity level for learning objects that will place the needs of learners first, whilst recognising the wide range of potential uses for, and benefits of learning objects (Shepherd, 2000). Figure 2.1 illustrates the trade-off between context and reusability at the different levels of granularity.

Hodgins in Wagner (2002) suggests that there is no set absolute size to a learning object, since the size of the object will be relative to the needs of the learners and requirements of given learning tasks. Shepherd (2000) adds that what is really important is that the objects be short enough to be digestible and flexibly applied to a variety of situations. The time should probably take no more than 30 minutes to complete when used by a typical learner and many will last no more than a couple of minutes.

2.6 Benefits and Risks of the Learning Object Approach

There are many benefits for adopting a learning object approach to learning content development. As has been indicated, the benefits for learners are that personalised courses can be constructed to meet individual requirements, learning materials come in digestible chunks, and learning is available on a just-in-time basis (Shepherd, 2000). Additional benefits are a consistent look and feel to learning content and the potential allowance of individual learning styles (Barritt and Alderman, 2002: 18). There are also benefits for instructors. Courses can be customised to suit the needs of different audiences, courses can be constructed from components emanating from a wide range of sources, and components can be used to meet a range of learning needs (Shepherd, 2000). Instructors can also find it easier to share information across departments (Barritt and Alderman, 2002: 18). The greatest benefit for developers is the reusability of content (Longmire, 2000: 27). Barritt and Alderman (2002: 19) caution that in order for organisations to realise these benefits, they must follow a sound instructional design process.

A benefit of learning objects is flexibility; where material that is designed to be used in multiple contexts can be used much more easily than material that needs to be rewritten for each new context (Longmire, 2000: 24). Flexibility refers to the support for multiple modes of learning (Smith, 2004: 2). Another benefit is ease of updates, searches and content management. Metadata tags can facilitate rapid updating, searching and management by selecting only the relevant content for a given purpose. Another benefit is customisation, because modular learning objects maximise the potential for personalisation by permitting the delivery and recombination of material at the level of granularity required (Longmire, 2000: 24). Smith (2004: 2) adds that customisation involves various combinations of learning objects combined to support particular learning styles. Another benefit is interoperability. Organisations can set specifications regarding the development of learning objects based on organisational needs while retaining interoperability with other learning management systems. Longmire (2000: 25) suggests other benefits are the facilitation of competency-based learning (with a focus on the intersection of knowledge, skills and attitude) and the matching of learning object metadata with individual competency gaps. Also, the value of content increases every time it is reused.

Thomas and Horne (2004: 12) summarise the benefits derived from learning objects as:

- Delivering industrial economies of scale. Learning objects enable efficiency through reducing duplication of the work of educators.
- Co-production of learning object creation. Sharing and improving teaching materials between educators could improve the quality of teaching.
- Scalability and networking. Learning objects can be accessible for all and be personalised for individual needs.

There are also a number of risks associated with adopting a learning object approach. It requires a paradigm shift in the way education is viewed. Learners will require self-motivation to select learning objects. Instructors may view this approach as more work. They may have to organise or link learning objects into courses and the navigation of each object may be unique. Developers will build many small objects instead of a few larger courses, which could be perceived as counter-productive because of the additional work (e-Learning Consortium, 2003:51). Smith (2004: 4) agrees that learning objects can increase author workload. Creating a high-quality learning object is a serious undertaking and requires time to plan, gather or create assets and develop, test and deliver the final product. The idea of constructing a personalised learning environment is still relatively new and is also a complex task. The developer must select and assemble learning objects to match learning interests, performance gaps, learning style and presentation preferences (Wagner, 2002). Smith (2004: 3) notes that the lack of technical expertise is a common barrier to creating learning objects. Initially, there is a steep learning curve to using authoring tools; however, new tools which can be easy to use are constantly being developed. Another potential drawback is intellectual property and copyright issues, a common World Wide Web issue not limited to educational technology. Who owns the object? Can it be freely distributed? Is the learning object a derivative work or a redistribution of the original? Does the learning object belong to the author or institution? These questions illustrate just some of the difficulties associated with ownership and copyright of digital learning content (Smith, 2004: 3).

Friesen (2003) raises several concerns in connection with learning objects and associated technologies, notably one of which is whether objects can be simultaneously both pedagogically neutral and pedagogically valuable. Learning objects are seen to be pedagogically neutral due to the flexibility of their delivery. Critics of the learning object approach claim that the pretence of pedagogic neutrality is aimed at disguising the influence of pedagogical models where learners are “empty vessels” and wherein a computer is the “pipe that pours in the knowledge” (Thomas and Horne, 2004: 10). John Naughton, in Thomas and Horne (2004: 10), describes this as an “impoverished view of learning”, where information is confused with knowledge and information transfer confused with learning. A challenge facing developers is how to incorporate effective pedagogy into the learning object. Learning does not always occur in an intended educational experience. The educational objective can be lost when attempting to “get to grips” with the technology. It is important to keep a clear educational goal in mind when developing the learning object (Smith, 2004: 3).

A common myth is that learning objects can only support “technical-based” learning. However, they can also be used to develop “soft” skills such as sales or managerial skills. Another common myth is that learning objects can only be put together to form step-by-step learning architectures, following a page-turning metaphor. Ruth Clark (in Barritt and Alderman, 2004: 13) states that learning objects can be used for exploratory learning, guided discovery and receptive learning. However, learning objects do not solve every training problem. Although they can realise great benefits, little quantitative research has been published on the effectiveness of learning objects for a given performance problem (Barritt and Alderman, 2002: 17).

Smith (2004: 4) suggests that before educators begin to create learning objects, they should investigate:

- What educational problems they are trying to solve?
- How do they envision the learning object being used?
- What rights issues are involved?
- What are the available resources for development?

The answers to these questions enable educators to focus development efforts more efficiently. Additionally, they will keep the educational goals in focus, allow for the choice of meaningful content that directly supports the educational goal, present content in appropriate ways, select appropriate activity structures, and consider assessment issues (Smith, 2004: 21).

2.7 Learning Object Repositories

Longmire (2000: 25) states that there are two requisite components of a learning object: the object content and the metadata tag. Wagner (2002) agrees that learning objects should be stored and accessed using metadata tags. Friesen (2003) succinctly states that learning objects can be said to refer to digital educational resources and that metadata refers to their systematic description to facilitate searching and administration. Learning objects are authored in small pieces, assembled into a learning object repository and delivered to the learner through a variety of learning media (Barritt and Alderman, 2004: 8). Friesen (2003) adds that learning object repositories represent online, searchable collections of learning objects. A learning object repository stores both learning objects and their metadata, either by storing them physically together or by presenting a combined repository to the outside world, while actually storing them separately (Neven and Duval, 2002: 291). An example of a LOR is the Multimedia Educational Resource for Teaching and Online Learning (MERLOT) repository. MERLOT is an international consortium that produces an online community where staff and learners from around the world share online learning materials (McMartin, 2004). MERLOT provides free, web-based resources for higher education.

2.8 Conclusion

This chapter analysed the role of learning objects in learning, the need for learning objects and the characteristics of learning objects. Although there is no standard definition of a learning object, it is agreed that learning objects are small, reusable pieces of content that allow learners to achieve an educational objective. It is noted that the granularity of the learning object content is of key concern when developing learning objects. The benefits and risks of adopting a learning object approach and learning object repositories were examined. The literature reviewed has identified that learning objects add value to learning content development and the learning process, yet this approach does require a paradigm shift in how learning content is developed.

Chapter 3

The Role of Metadata

Chapter two investigated how learning objects can enable and enhance technology-based learning. Chapter three investigates the role of metadata in describing learning objects. Metadata is vital to the discovery and selection of suitable learning objects.

3.1 Introduction

The e-Learning Consortium (2003: 30) observes that the field of e-learning is constantly growing in association with the vast sources of e-learning information available. It is getting more and more difficult to find and use relevant information. One vital aspect of the learning object economy is the role of metadata. Currier and Barton (2003) believe that metadata is the key to enabling the discovery and selection of suitable digital learning objects.

The aim of this chapter is to analyse the role of metadata in the use of learning objects. Firstly, an overview of metadata is provided and then the role of educational metadata for learning objects is considered. The purpose and use of metadata is examined and the value provided by metadata is investigated. The research reviews metadata categories and how metadata is created, and finally explores some attributes or characteristics of metadata.

3.2 Metadata

3.2.1. Metadata Definitions

The Getty Research Institute's Anne Gilliland-Swetland (2000) notes that metadata is understood in different ways by the diverse professional communities that design, create, describe, preserve and use information. Metadata is often simply defined as "data about data" (Barritt and Alderman, 2004: 162; Duval, 2001; Horton and Horton, 2003; Pöyry, Pelto-Aho and Puustjärvi, 2002: 174; Wason, 2001). The IEEE (IEEE LTSC, 2002) refines this definition of metadata as "information about an object". Pöyry *et al* (2002: 174), of the Helsinki University of Technology, extend this view and define metadata as descriptive and classifying information about an object. Tony Gill (2000), of the Getty Research Institute, provides a more complete classification of metadata as the "structured descriptions, stored as computer data that attempt to describe the essential properties of other computer data objects". Hamel and Ryan-Jones (2002) classify metadata as "structured data about content" and tagging as "the creation of the metadata file that is to be placed within a repository". Waugh (1998: 23) describes metadata as the information associated with those objects that allow access to and manipulation of the objects. Metadata describes what the object is (such as the subject, keywords), how to use the object (where to retrieve it, how to encode it), and how the object is to be managed (its relationships with other objects) (Waugh, 1998: 23).

Gilliland-Swetland (2000) values metadata as “the sum total of what one can say about any information object at any level of aggregation”. The concept of metadata can be applied to people, places and things. For people, this could include complex characteristics such as their learning preferences, skills, and buying habits. All these are examples of metadata (e-Learning Consortium, 2003: 30). Information objects consist of content, context and structure, all of which can be reflected through metadata. Information object metadata:

- certifies the authenticity and degree of completeness of the content
- establishes and documents the context of the content
- identifies and exploits the structural relationships that exist between and within information objects
- provides a range of intellectual access points for an increasingly diverse range of users
- provides some of the information an information professional might have provided in a physical reference or research setting (Gilliland-Swetland, 2000).

3.2.2. Importance of Metadata

Library classification systems make use of metadata to catalogue books and enable efficient discovery through the use of Machine Readable Cataloguing (MARC) and Online Public Access Catalogue (OPAC) systems (Greenberg, 2000: 5). A recognised classification system in use is the Dewey Decimal Classification (DDC) system. Metadata describes certain important characteristics of its target in a compact form. It plays a central role in improving, searching for and categorising objects within a defined context of use (Pöyry *et al*, 2002: 174). Gilliland-Swetland (2000) provides several reasons for the importance of metadata:

- Increased accessibility – effective searches across multiple collections
- Retention of context – document context and relationships between objects
- Expanding use – disseminate digital information to users around the world
- Multi-versioning – create multiple and variant versions of objects
- Legal issues – document and track rights and reproduction information
- Preservation – metadata exists independently to survive evolving computer systems
- System improvement and economics – benchmark technical data to evaluate and refine systems

3.2.3. Metadata and the World Wide Web (WWW)

Gill (2000) notes that the most common application for metadata on the Web is resource discovery, because the metadata is intended to assist Web users in discovering what they are looking for. Search engines can use meta-tags to provide more effective retrieval and relevance rankings. The availability of consistent, accurate and well-structured descriptions of Web resources enables greater search precision and a more accurate relevance ranking of retrieved information (Gill, 2000). Online retailers, such as Amazon.com, use metadata about their products to make it possible to find these goods and services. Metadata is collected about products (inventory number, price and name), customer profiles (payment methods, contact information) and web portal use (user interface) (Barritt and Alderman, 2004: 164).

The potentially dynamic and multimedia nature of learning objects makes most of them impossible to locate using text-based search engines such as Google, which in addition, return results that are difficult to assess by educators and learners (Van Assche and Massart, 2004: 316). Friesen, Roberts and Fisher (2002) assert that the problems that search engines present to users in general and educators in particular, are both familiar and manifold: thousands of "matching documents" are retrieved in response to almost any search string, appropriate educational resources are difficult to find and evaluate, and multimedia or interactive content is not directly searchable. A widely suggested solution to these problems is to turn attention to the actual meanings of the words in Web documents and to provide a textual meaning for non-text-based Web resources (Friesen, Roberts and Fisher, 2002). Attempts to capture these meanings have become the motivation for Web-based descriptive metadata. Gill (2001:7), cited in Friesen, Roberts and Fisher (2002), notes that "if there is a solution to the problem of resource discovery on the Web, it must surely be based on a distributed metadata catalogue model".

The semantic web is both a technical framework and a vision of making semantically aware applications for the Web. It is a set of universal, neutral standards and tools for publishing and processing metadata in applications (Nykänen, 2004: 896). The semantic web also establishes the technical foundation for the metadata of learning objects. Learning systems introduce additional, domain-specific semantics to the standards. The core of the semantic web is defined by a set of World Wide Web Consortium (W3C) recommendations that established the Resource Description Framework (RDF) and Web Ontology Language (OWL) (Nykänen, 2004: 896).

3.3 Educational Metadata for Learning Objects

According to the e-Learning Consortium (2003: 30), learning content is increasingly being broken down into smaller pieces so that it can be mixed, matched, and assembled into appropriate learning objects tailored to specific needs. Hamel and Ryan-Jones (2002) concur that in order to be accessible and reusable, learning objects must be tagged with metadata that provides important and descriptive information about the object. Metadata provides data about each learning object stored in a database or any information about the object (Barritt and Alderman, 2004: 162). Without metadata, there would be chaos and inefficiency resulting from an overflow of unidentified learning objects and content (e-Learning Consortium, 2003: 30). Song (2002) adds that due to the large quantity of information supplied and the ill-defined structures for learning content, it is difficult for learners to find learning resources easily. Metadata is required to support the access, search, selection, use, trade and management of learning objects (Friesen, Mason and Ward, 2002: 64).

According to Anido *et al* (2002: 359), educational metadata provides information about educational resources. Metadata refers to the collection of keywords, attributes and descriptive information that informs educators, learners and systems about a learning object (Barritt and Alderman, 2004: 8). Educational metadata can be utilised by educational and pedagogical professionals, by the institutions offering education, and by the learners searching for education. Well-designed and sufficient metadata aid the decision making process of learners and help educational institutions to provide suitable information about their educational offerings (Pöyry *et al*, 2002: 174). Metadata helps educators and learners to make decisions about the utility and functionality of a learning object (Barritt and Alderman, 2004: 163).

Harvi Singh (2000) notes that metadata provides a common set of tags that can be applied to any learning resource, regardless of who created it, what tools they used or where it is stored. Pöyry *et al* (2002: 174) agree that educational metadata may describe any class of educational objects (or learning objects), such as study courses. The level of metadata may also vary. Collection metadata relates to collections of objects, while item metadata relates to individual objects, often contained within collections (Gilliland-Swetland, 2000). The e-Learning Consortium (2003: 30) proposes that metadata can, and ideally needs to be, applied to all sizes and types of learning content, from the smallest piece of raw data, all the way up to a complete course or curriculum. Using metadata this way allows each level of content to be easily searchable and reusable. For example, it should be just as easy to find and reuse one piece of text, one page in a chapter, one chapter of a course, or an entire course. The vision of truly personalised learning and living can be achieved when metadata is used to filter, select and assemble just the right pieces of learning content, to be personalised and delivered on just the right device in just the right way (e-Learning Consortium, 2003: 30). Metadata enables a Learning Management System (LMS) to automatically compile catalogues of all the courses, lessons and other modules available (Horton and Horton, 2003: 490). High-quality metadata will be required in order to assemble the objects dynamically and adapt course materials to the learner’s needs (Mealy and Reeser, 2000, in Hamel and Ryan-Jones, 2002). The ultimate usefulness of metadata depends on having valid metadata for every object and having the search tools to use that metadata. It is possible that a LMS may automatically provide a customised learning experience based on a combination of metadata, including learner profile and learning objectives, and used to suggest learning objects that best fit a learner’s needs (Barritt and Alderman, 2004: 162). The key to sharing and reusing learning objects is not the learning objects themselves, but the successful deployment of standardised metadata specifications.

3.4 Purpose and Use of Metadata

The IEEE LTSC (2002) states that the purpose of metadata is to “facilitate [the] search, evaluation, acquisition and use” of resources. Barritt and Alderman (2004: 57) agree that the purpose of metadata is to make it easy for educators and learners to find the learning objects that they need. The purpose of metadata for educational resources is also to “facilitate the sharing and exchange of learning objects, by enabling the development of catalogues and inventories while taking into account the diversity of cultural and lingual contexts in which the learning objects and their metadata will be exploited” (IEEE LTSC, 2002). Frosch-Wilke (2004: 166) notes that metadata can be seen as a labelling system whose purpose is to describe an object’s characteristics and objectives. The purpose and usefulness of metadata in e-learning is that it provides the ability to richly describe and identify learning content so that developers can find, assemble, and deliver the right learning content to the right person at the

right time. Metadata provides the means to fully describe and identify every piece of e-learning content so that content developers can find, select, retrieve, combine, use/reuse and target it efficiently for appropriate use (e-Learning Consortium, 2003: 30).
Horton and Horton (2003: 489) describe how metadata makes e-learning content more useful to buyers, learners and instructional designers. Metadata provides a way of describing courses, lessons, topics and media components that is consistent in format and in items recorded. Descriptions can be compiled into catalogues that can be electronically searched (Horton and Horton, 2003: 489). Metadata allows for the possibility of sophisticated searches. A searcher is not limited to keyword matches, but can search for objects on a topic in a specified language with a specified duration. Metadata can also help course developers to find content that they can licence or use rather than developing it from "scratch" (Horton and Horton, 2003: 490). Smith (2004: 16) states that one purpose of metadata is the cataloguing and searching for learning objects. Cataloguing and searching allows users to enter search terms to find objects in collections. It is the metadata attached to the learning objects that is being searched, not the learning objects themselves. Standardised fields are used to describe the learning object and the search engine examines the data in those fields to come up with a list of objects to match the search criteria (Smith, 2004: 16). Another purpose is tracking ownership information and handling rights management. Ownership, attribution and rights management relates to who owns a resource, who should be credited when it is used and how it may be used. This kind of metadata assists in ensuring that resources are being used as intended and that credit is given where it is due (Smith, 2004: 17).

Metadata is the key to the discovery of existing content in a content repository (Mealy and Reeser, 2000, in Hamel and Ryan-Jones, 2002). Metadata functions in a manner similar to a card or record in a library catalogue, providing controlled and structured descriptions of resources through searchable "access points" such as title, author, date, location, description and subject. However, unlike library catalogue records, a metadata record can either be located separately from the resource it describes, or be embedded or packaged with it. Also, many visualise this metadata as being distributed across the Web, rather than collected in a single catalogue (Friesen, Roberts and Fisher, 2002). If all the metadata about learning content is recorded in a common structure or taxonomy, both the metadata and the learning content can be integrated into universally searchable and virtually centralised catalogues and databases which span multiple systems, audiences and countries (e-Learning Consortium, 2003: 31).

3.5 Value of Metadata

The ability to identify and discover appropriate content has significant benefits for organisations, the most notable being learning object reuse. The value of a learning object increases as its associated metadata increases in richness and completeness (Frosch-Wilke, 2004: 168). Singh (2000) states that metadata tagging enables organisations to describe, index and search their learning resources, which is essential for reuse. Metadata tagging also benefits individual learners, who will be able to more easily locate the information they want (Singh, 2000). There are four main uses of metadata in e-learning that emphasise the inherent value of metadata to individuals and organisations.

3.5.1. Categorisation

The e-Learning Consortium (2003: 31) declares that the most common use of metadata is to add value through organising information into categories. Finding information faster saves time, money and frustration. This significantly improves productivity and performance.

3.5.2. Taxonomies

Although it is useful to organise metadata into categories, it is more powerful to structure and organise metadata categories into ordered groups of relationships known as taxonomies. The benefits of having a taxonomy for metadata are that it can organise the content and capture the relationships between categories. Metadata taxonomies allow different systems and structures to be recognised, translated and understood (e-Learning Consortium, 2003: 31).

3.5.3. Reuse

The reusability of the content and the metadata begins to increase exponentially as content and metadata become more structured and their granular size decreases. This ability to create once and reuse multiple times can provide some of the highest multipliers and Return on Investment (ROI) levels for organisations (e-Learning Consortium, 2003: 31).

3.5.4. Dynamic Assemblies

The e-Learning Consortium (2003: 32) notes that information can only be reused in correspondence to the degree to which it can be flexibly and dynamically assembled into the "right stuff" for just the right person, in the right format, in the right language, delivered to the right location, on the right device, at the right time. For example, a Learning Content Management System (LCMS) could select the right "bits" of data for a particular learner who is using a wireless device, and assemble all of it into one or more learning objects. As the learner uses these learning objects, metadata, in the form of learner usage data is created and sent back to the repository of the LCMS for future analysis (e-Learning Consortium, 2003: 32).

3.6 Metadata Categories

3.6.1. Metadata Elements

Erik Duval (2001: 591), from the Katholieke Universiteit Leuven in Belgium, specifies that basic metadata elements include the title, author, year of publication and similar simple bibliographic data. Within any predetermined metadata schema, a limited amount of metadata or “core metadata” can capture the main idea or essence of the learning object in a coherent and unitary fashion (Longmire, 2000: 25). Richer metadata structures also include technical features, copyright properties, annotations and more (Duval, 2001: 591). Metadata may also include information such as format, size, delivery requirements, authorship, ownership, version number, instructional role, instructional characteristics and type of interactivity. Additionally, metadata can be described by a set of meta-metadata. Meta-metadata is descriptive information about the metadata record itself (Pöyry *et al*, 2002: 174). Usually, metadata elements are sorted into several metadata categories.

3.6.2. Metadata Categories

Kimberly Lightle (2003: 43), Associate Director of the Eisenhower National Clearinghouse, explains that metadata can be used to describe a digital learning object so that it can be found, managed, reused and preserved. Metadata can be categorised in many ways; Table 3.1 describes the main categories that may be used. All of the categories in Table 3.1, together with other forms of description and documentation, can be part of the metadata associated with a learning object (Lightle, 2003: 43).

Category	Description
Administrative	Metadata used in the managing and administering of information objects (Gilliland-Swetland, 2000), or supporting resource management within a collection (Lightle, 2003: 43).
Descriptive	Metadata used to describe or identify information objects (Gilliland-Swetland, 2000). It facilitates resource discovery and identification (Lightle, 2003: 43). Descriptive metadata can be further divided into: Contextual metadata and content-based semantic metadata. Contextual metadata refers to the conditions and the environment in which the metadata is created, such as the equipment required to create the object. Semantic metadata refers to the semantic characteristics of the object, or the semantic metadata that explains the meaning of the object (Pöyry *et al*, 2002: 174).
Preservation	Metadata related to the preservation management of information objects (Gilliland-Swetland, 2000), such as migrating and archiving the object (Lightle, 2003: 43).
Structural	Metadata used to describe the structural characteristics of the object, such as the form of the object, but not the content of the object (Pöyry *et al*, 2002: 174). Structural metadata describes how the components of complex learning objects are bound together (Lightle, 2003: 43).
Technical	Metadata related to how a system functions or to the behaviour of metadata (Gilliland-Swetland, 2000).
Use	Metadata related to the level and type of use of information objects (Gilliland-Swetland, 2000).
Control	Metadata created and used for controlling the flow of content for the relevant information system (Pöyry *et al*, 2002: 174).

Table 3.1: Metadata Categories

3.7 Creating Metadata

According to Barritt and Alderman (2004: 163), metadata should be rich enough to meet intended needs, but not overly burdensome to input. Some metadata is created during the development process of the learning object; other metadata will be associated with the learning object after it has been used (Barritt and Alderman, 2004: 166). The status of metadata elements may be static, dynamic or long-term. Static metadata never changes once it has been created and includes metadata elements such as title and date of creation. Dynamic metadata may change with use or the manipulation of an object, for example, changing the image resolution. Long-term metadata is necessary to ensure that the object continues to be accessible and usable and includes the technical format and rights information (Gilliland-Swetland, 2000). The more a learning object is to be used and the more granular it is, the more detailed metadata is required. Extensive metadata will add time to the development process of learning objects. Metadata guidelines, templates and an editing process will be required to facilitate the process (Barritt and Alderman, 2004: 57). A metadata editor is a software tool that may be used to support the process of metadata creation. Several metadata editors will be investigated in section 7.2.

3.7.1. Objective and Subjective Metadata

Metadata information can simply be an author's name, or the learning object title. It can also be complex, including completion criteria, access rights and costs (Barritt and Alderman, 2004: 162). The e-Learning Consortium (2003: 30) observes that metadata could be as objective and straightforward as the author of a book or the file size of an animation, or could be as complex and subjective as the learning preferences or styles of an individual. Horton and Horton (2003: 491) note that some metadata items are objective, such as size and location. These values can be easily verified. However, subjective metadata elements, such as descriptions and keywords, may provide inaccuracies. Developers may wish to make learning content more attractive to potential buyers, which may lead to embellishments of some of the metadata items. Horton and Horton (2003: 491) question who can be trusted to write subjective metadata items.

Metadata may be generated automatically by a computer (for example, keyword indexes), created manually by humans, or created through a combination of these two approaches (Gilliland-Swetland, 2000; Greenberg, 2000: 7). Learning objects can be described in considerable detail with acceptable quality through automated means (Duval and Hodgins, 2004). This can occur through exploiting the context of use and readily available information about the users involved. Metadata can be automatically generated from the content itself, while current search engine harvesting techniques can be quite powerful. For example, the title, language, reference documents and author name can be extracted from an HTML document. The authoring context can also be exploited to harvest metadata. Metadata from a course can be used as starting values for the metadata of a learning object derived from that course. Templates of reusable metadata can be created, where many of the relevant fields are pre-filled. Authors generally produce content for one domain or for a particular kind of audience. Authors could create profiles that list metadata that are common to all or most of what they do. A feedback mechanism can be provided to indicate how the learning object helped the learners achieve their goals. Learning Object Repositories could include the

"Amazon.com-like" social recommending techniques to suggest relevant content (Duval and Hodgins, 2004).

However, the creation of manual metadata is still required. A focus on the importance of context and community can minimise the current burden of metadata creation (Duval and Hodgins, 2004). The community aspect can be illustrated by websites that rely on ratings of submissions to publish or reject what they receive. Most learning objects will have multiple sets of metadata associated with them (Duval and Hodgins, 2004).

The source of the metadata may be internal, and generated at the time the object is created, such as the file name and header information. Alternatively, the metadata source may be external, which relates to metadata created later, often not by the original creator, such as rights and legal information (Gilliland-Swetland, 2000). This section outlines several alternatives to how metadata may be created and by whom.

3.7.2. Author Only

Currier and Barton (2003) suggest that the author of a learning object creates all of the metadata when uploading the resource to the Learning Object Repository (LOR). Only learning content authors may access the upload tool provided by the repository, which may be anything from highly technical, to very user friendly. The tool may incorporate some automated metadata creation, perhaps suggesting classifications based on keywords already entered and so forth. Hamel and Ryan-Jones (2002) concur that metadata is usually written by instructional designers to describe the learning objects they have created. Gilliland-Swetland (2000) notes that "lay" metadata is created by persons who are usually the original creators of the object.

3.7.3. Metadata Specialist Only

According to Currier and Barton (2003), a metadata specialist may perform the task of creating metadata. Resources may be uploaded with anything from basic information recorded by machine, to a few fields or descriptive notes entered by the depositor, which must be rewritten as conformant metadata. A trained metadata specialist assists and ensures that the remainder of the necessary fields are filled in correctly. Greenberg (2000: 6) notes that cataloguers and indexers have been recognised as expert metadata creators. Gilliland-Swetland (2000) agrees that expert metadata is created by index specialists.

3.7.4. Collaborative Metadata Creation

Currier and Barton (2003) propose that metadata may be created through a collaborative approach. The learning object author may enter data in certain fields, such as their own name, resource title, institution and digital rights information. A metadata specialist will then check these for accuracy, and add other selected fields such as subject classification, keywords and accessibility information. This process may be truly collaborative, with the parties communicating directly, or it may be that they work completely separately, perhaps with the specialist periodically checking records in batches.

3.8 Conclusion

This chapter analysed the role of metadata in the learning object economy and identified that metadata adds value through describing learning objects. Metadata can be catalogued in learning object repositories to enable learning objects to be shared and reused. Metadata allows learners and learning providers to search, evaluate, acquire and use learning content (IEEE LTSC, 2004). Metadata has an invaluable role in facilitating the widespread use of learning objects. However, metadata standards are required to provide a uniform way to describe learning objects, so that they can be discovered and accessed (Olivier and Liber, 2003: 149).

Chapter 4

E-learning Standards

Chapter Three investigated the role of metadata in describing learning objects. Chapter Four investigates the development of emerging e-learning standards. The goal of the e-learning standardisation process is to enable the sharing of learning content across different systems.

4.1 Introduction

The learning technology standardisation process is taking one of the lead roles in research efforts in e-learning, where the objective is to facilitate the reuse of learning objects and to enable interoperability among e-learning systems (Anido *et al*, 2002: 351). The aim of this chapter is to investigate the development process of e-learning standards. An overview of standards and the types of standards is provided and then the need for e-learning standards is considered. The development process of e-learning standards is investigated followed by an examination of the levels of standards. The different types of e-learning standards are discussed and then standards development organisations are explored.

4.2 Standards

Dr Norm Friesen (2002), of Athabasca University, defines standards as “documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines or definitions of characteristics, to ensure that the materials, products and services are fit for their purpose”. Compliance with a standard does not however guarantee achievement of the goal behind the standard. For example, ISO9000 does not guarantee that a factory will not consistently manufacture useless or dangerous products. All standards can do is provide reliable information upon which to base decisions, they cannot guarantee success (Horton and Horton, 2003: 475).

Horton and Horton (2003: 475) concur that a written specification is not a standard. Specifications, guidelines and recommendations are not standards unless large numbers of people follow them. Olivier and Liber (2003: 148) note that standards can only be produced by national standards bodies recognised by national governments or by international standards bodies officially recognised by many national governments. All other bodies produce specifications. Friesen (2002) also distinguishes between specifications, standards and implementations. Specifications represent standards early in their development, prior to receiving approval from standards bodies. They are experimental, incomplete and rapidly evolving (Friesen, 2002). Standards are more conclusive, complete and evolve more slowly. Implementations and reference models refer to the ways in which the standards or specifications are applied in communities. They include systems and tool development, as well as application profiles (that integrate multiple specifications or standards) or a single standard application. Friesen (2002) observes that a significant proportion of implementation and profile work mediates between the abstraction of many standards/specifications and the particularities and requirements of implementation. There are three categories of standards.

4.2.1. *De jure* Standards

De jure standards are based on written laws, government regulations or specifications issued by professional organisations. These standards are also known as accredited standards. They require a complete and unambiguous written specification, the authority of an authenticating organisation, and a certification process whereby compliance with the standard can be verified. An example of an accredited standards body is the Advanced Distributed Learning (ADL) Network, supported by the United States Department of Defence (Horton and Horton, 2003: 476; Olivier and Liber, 2003: 148).

4.2.2. *De facto* Standards

De facto standards are conventional standards that are widely followed, although they lack regulatory authority. *De facto* standards evolve when a large number of people use the same product, such as Microsoft Windows®, or when groups of people follow approximately the same rules. Adherence to such conventional standards comes about because the standard way of doing things is significantly more effective or more convenient (Horton and Horton, 2003: 476 and Olivier and Liber, 2003: 148).

4.2.3. Internal Standards

Horton and Horton (2003: 476) explain that internal standards are the rules proposed and followed by a specific team. On a multimedia development project, standards may be used for colour usage, screen layout and terminology. Such internal standards usually aim at achieving consistency of results, efficiency of production and providing quality assurance.

4.3 The Need for E-learning Standards

It was the establishment of HTML as a widely implemented, non-proprietary presentation format and the broad acceptance of the Web that allowed for the possibility of cross-platform learning content. The open cross-platform nature of web pages soon started to accumulate various proprietary additions to enable a LMS sitting behind a web server to track learner progress and other tasks. These local advantages were starting to undermine the potential for a large, open e-learning market. This led to the formation of various bodies to look into the development of e-learning specifications (Olivier and Liber, 2004: 149). Courses and systems for managing and delivering learning objects have been developed independently from one another and were created in such a way that interoperation is impossible. Standards in e-learning seek to address these shortcomings (Friesen, 2002). Horton and Horton (2003: 473) state that one of the goals of standardisation is to allow the reuse of content at all levels, not just entire courses, but smaller units as well. The main goal of standards is interoperability among authoring content, tools and management systems. Interoperability allows developers to choose the best tools, content and management systems – and to swap them without having to rework any of the others (Horton and Horton, 2003: 475). Standards promise to make it easier to migrate to another tool, course or vendor. E-learning standards are generally developed to be used in systems' design and implementation for the purposes of ensuring interoperability, portability and reusability (Friesen, 2002).

Anido, Llamas and Fernandez (2001: 86) state that standardisation is required for two reasons. Firstly, educational resources are defined, structured and presented using different formats and secondly, the functional models that are embedded in a particular learning system cannot be reused in a straightforward way. Horton and Horton (2003: 472) believe that the underlying problems causing the development of e-learning standards are that learners cannot easily find the courses that they need, course developers find it difficult to combine content and tools from different vendors, course managers cannot move courses between LMSs, and custom-built courses may only communicate with the systems on which they were developed. Standards organisations are addressing these problems through developing standards that promote building e-learning from reusable parts and that help reduce dependence on individual vendors (Horton and Horton, 2003: 473).

Horton and Horton (2003: 471) note that people who design, build, administer, sell and take e-learning courses would ideally never notice the underlying e-learning standards any more than they notice the standards for power plugs or light bulbs. As e-learning standards bodies have specified, standards are written for toolmakers, not developers and purchasers of e-learning content (Horton and Horton, 2003: 471). Developers of LMS's such as WebCT and Blackboard refer to e-learning standards when they create functions that allow content developers to track learner progress and sequence learning objects. Although the products may be different, they can interoperate with learning objects that follow the specifications (Smith, 2004: 17).

E-learning standards and specifications are not aligned with any one pedagogical approach. Thus they are frequently described as "pedagogically neutral". However, Friesen (2004c: 1070) argues that the more pedagogical neutrality is affirmed, the less relevant the standard actually becomes. These standards and instances of content need to be conceptualised in terms of their pedagogical engagement and relevance and not in terms of their neutrality (Friesen, 2004c: 1071).

4.4 The Development of E-learning Standards

Official standards for most aspects of the size, shape and function of learning objects do not currently exist. However, many specification groups are building consensus and defining specifications, reference implementations and best practices for learning objects (Barritt and Alderman, 2004: 167). The e-learning standardisation process is an active, continuously evolving process that will last for years to come, until a clear, precise and generally accepted set of standards for educational-related systems is developed (Anido, Rodriguez, Caeiro and Santos, 2003: 304).

Specifications evolve and become standards over time and go through several phases of development before they become widely adopted or *de facto*. Usually, an activity is initiated at the same time by different institutions, and links are established along the process to define the final recommendations. To achieve eventually authority, standards must be submitted to an organisation with the authority to accredit and promulgate them. In most cases, the IEEE Learning Technology Standards Committee (LTSC) collects proposals from all consortia and converts them into common recommendations after a general agreement is reached. Finally, those proposals approved by the IEEE initiate a more rigorous process to become International Standardisation Organisation (ISO) standards (Anido *et al*, 2002: 358 and Horton and Horton, 2003: 479).

Figure 4.1 depicts the development process, which is predominately linear, as cycling through iterations and feedback loops. The process moves from "Research and Development concepts" and "User Needs" to eventually arrive at approved standards (Friesen, 2002). While there is no absolute process in the creation of *de jure* standards, the e-Learning Consortium (2003: 12) has abstracted an overall and highly iterative process model where the following four stages are typical:

1. **Research and development**: R&D is conducted to identify possible solutions, based on identified stakeholder needs. Organisations involved include The Learning Federation (an Australian government initiative) and overall research at universities, companies and consortia. However, user and stakeholder needs and input often inform standards at all stages of their development (Friesen, 2002).

2. **Specification Development**: When a tentative solution appears to have merit, a detailed written specification must be documented so that it can be implemented. Various consortia or collaborations, such as AICC, ARIADNE and IMS, dedicate teams of people to focus on documenting the specifications.

3. **Testing/Piloting**: The specifications are put into use either in test situations or pilot studies to determine what works, what does not, what is missing, customer reactions and so forth. For example, the ADL plug-fests bring together early adopters of the Sharable Content Object Reference Model (SCORM) to synchronise and test evolving systems (ADL, 2003).

4. **Accredited and International Standard Status**: The tested and roughly complete specifications are reviewed by an accredited standards body and then made broadly or globally applicable by removing any specifics of given industries or originators, and taken through an open, consensus-based process to produce a working draft which is then officially balloted. If approved, the specification receives official certification by the accredited standards body and is made available to all through this body. The IEEE LTSC is an example of an accredited standards body.

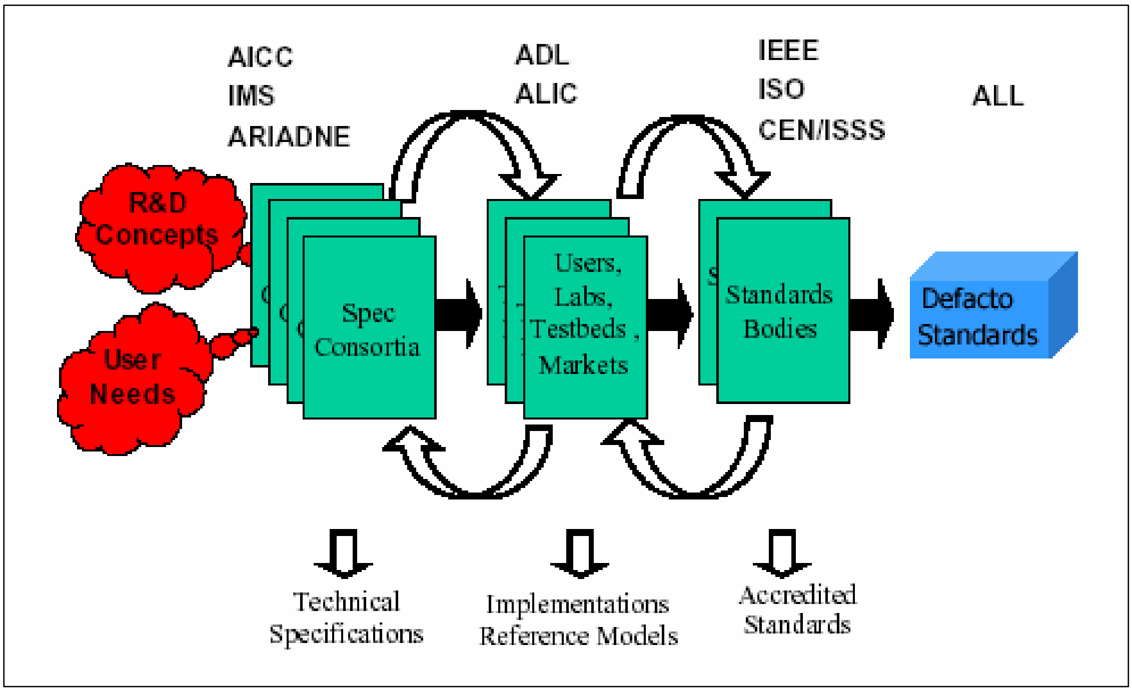

Figure 4.1: A Model for Standards Evolution (The e-Learning Consortium, 2003: 13)

Figure 4.2 illustrates a hierarchy of standards development organisations. These organisations are detailed in Section 4.7.

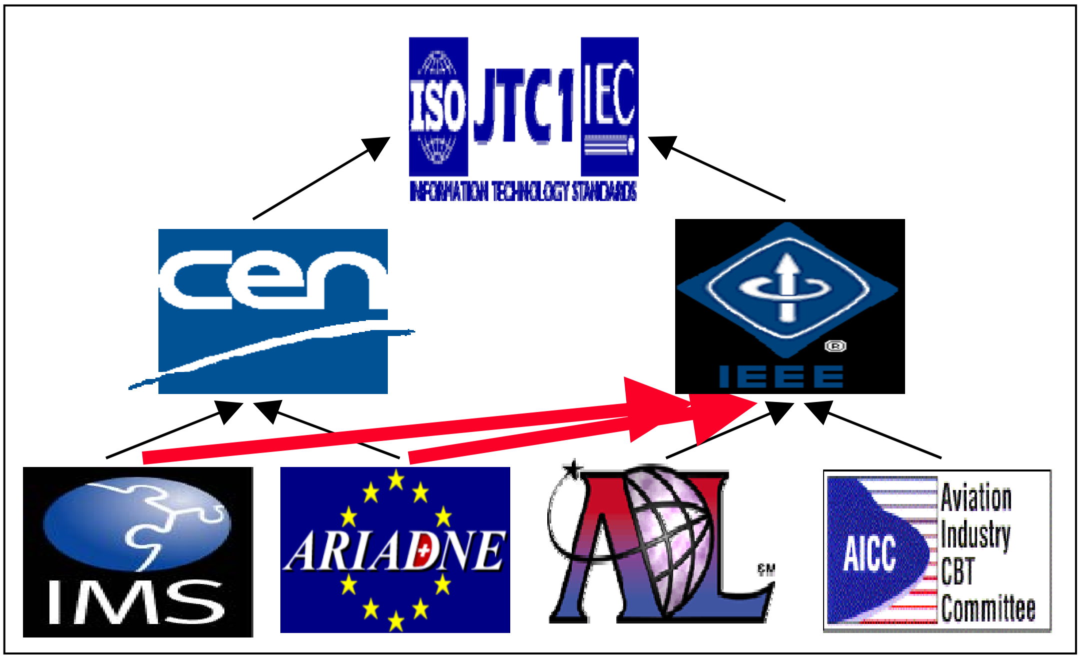

Figure 4.2: Hierarchy of Organisations Developing E-learning Standards (Duval, 2003)

4.5 Levels of Standardisation

Anido *et al* (2003: 304) separate the outcomes of these standardisation efforts into two levels.

4.5.1. Level 1: Specification of Information Models

Anido *et al* (2003: 304) explain that several proposals have been produced to specify the format, syntax and semantics of data to be transferred among heterogeneous platforms (for example, courses, learner profiles and evaluation objects). The more mature standardisation results correspond to this first level. In most cases, XML is used to define supporting information models enabling interoperability in an e-learning setting. Friesen (2002) observes that e-learning standards are often multi-part, consisting of a "data model" that specifies the standard's "normative" content in abstraction and one or more "bindings" that specify how the data model is specified in a formal idiom, which is most often XML. Standards at this level can be seen as common specifications that must be used by different vendors to produce learning objects. For example, in the car manufacturing environment, common specifications define standards to make, for example, tyres for car wheels. The standard allows different vendors to produce tyres that can be used by different cars. In the same way, common specifications for learning objects would allow their use by different educational software tools (Anido *et al*, 2003: 304). Relevant specifications at this level address metadata, learner profiles and educational content organisation.

4.5.2. Level 2: Common Software Components and Open Architectures

A multipart standard, more rarely, also includes an Application Programming Interface (API) or "service definition" that defines points of contact between cooperating systems (Friesen, 2002). According to Anido *et al* (2003: 305), standards at this level define the expected behaviour of software components responsible for managing learning objects in online environments. Revisiting the car manufacturing example, second-level standards would specify the interface for the robots that assemble tyres in a production line. These specifications let different manufacturers produce robots with the same behaviour. Performance may vary but the expected behaviour as defined by the specification must be implemented by different manufacturers' robots. Therefore, a production line could be composed of robots developed by different manufacturers provided they are compliant with the defined specification to support interoperability (Anido *et al*, 2003: 305). In the same way, software interfaces for educational components would allow new online learning systems to be built, providing interoperability among heterogeneous systems at runtime. So far, only some institutions have developed architectures that contain common components for a generic learning environment. Available proposals have not defined interfaces for the proposed architecture components or do not cover the whole functionality needed in a complete e-learning environment. Some proposals have already been identified for the development of software components responsible for managing the information models in the first level of standardisation, but so far results have been scarce (Anido *et al*, 2003: 304).

4.6 E-learning Standards

Many organisations around the world have been working diligently to create specifications for learning-related technologies and needs such as metadata, learner profiling, content sequencing, web-based courseware and computer-managed instruction (e-Learning Consortium, 2003: 11). This section details the different e-learning standards.

4.6.1. Packaging Standards

Developers create learning objects that are integrated into unified courses. Horton and Horton (2003: 476) assert that packaging standards allow the assembly of courses authored in different tools by different developers into integrated modules. These standards enable a LMS to import and organise all the components of a course. Packaging standards prescribe ways to bundle several objects, to protect them and to transport them. E-learning packaging standards specify how to bundle the separate files that make up a lesson or course. They are necessary to ensure that all the hundreds or thousands of files are included and installed in the right location (Horton and Horton, 2003: 480).

4.6.2. Communications Standards

A set of standards is necessary so that LMS's can launch individual lessons and other components, and can administer tests and other assessments. These standards are called communications standards and they specify how the consumer and LMS exchange information (Horton and Horton, 2003: 478). Communications standards define a language whereby people or other entities can communicate. E-learning communications standards define a language whereby the LMS can start up modules and communicate with them during learner engagement (Horton and Horton, 2003: 483).

4.6.3. Metadata Standards

Anido *et al* (2003: 305) specify that metadata standards describe the information used to define, as precisely as possible, educational content. This enables potential learners and developers to find the content they need (Horton and Horton, 2003: 488). Olivier and Liber (2003: 149) add that metadata standards provide a reasonably uniform way to describe learning resources, so that they can be discovered and accessed. Metadata standards specify how developers can prepare descriptions of their courses and other learning modules so that the LMS can compile catalogues of available learning content (Horton and Horton, 2003: 478).

4.6.4. Learning Design Standards

The Educational Modelling Language (EML) was developed by the Open University of the Netherlands (OUNL) to describe how learning objects should be structured and is a single, all-embracing approach to developing learning experiences (Open University of the Netherlands, 2004). The IMS Global Learning Consortium took over EML and developed the IMS Learning Design specification as a language for “modelling units of study”. A learning design captures who does what, when and using which materials and services in order to achieve particular learning objectives. The Learning Design specification is able to model single learner situations and allows multi-learner situations such as group and collaborative learning processes to be modelled (Open University of the Netherlands, 2004; Olivier and Liber, 2003: 154). The primary goal of the specification is to provide a framework that supports a wide variety of pedagogical approaches while promoting the exchange and interoperability of e-learning materials (Halm, 2003: 54; RELOAD, 2004).

4.6.5. Quality Standards

Horton and Horton (2003: 493) state that another group of standards considers the quality of modules and courses. Quality standards address the design of courses and modules as well as their accessibility by those with disabilities (accessibility specifications). Quality standards ensure that e-learning content has certain characteristics or was created using certain processes, but do not guarantee success. They ensure that objects are usable.

4.6.6. Other Standards

Learner profile or learner information standards specify information that characterise learners, their knowledge and preferences. Educational content organisation standards provide data models to describe static and dynamic course structure. Other standards address question and test interoperability, competency definitions, and include many others that are still in their early definition stages (Anido *et al*, 2003: 305). Further standards contribute to the goal of combining high-quality components in order to create richer, more effective learning solutions, such as telecommunications and media standards (Horton and Horton, 2003: 478).

4.7 Standards Initiatives/Organisations

Early standardisation work was done by such groups as ARIADNE in Europe, the Dublin Core, IEEE, the Aviation Industry's Computer Based Training Committee (AICC) and the IMS Consortium in North America. At first, these groups focused on different areas of the standards, working simultaneously, but not in coordination (e-Learning Consortium, 2003: 11). However, each of the groups involved in e-learning technology standards is greatly influenced by the others. Much of the effort of these groups has gone into "tweaking and tinkering" with standards authored by other groups or the modifications made by other groups (Horton and Horton, 2003: 478). Standards development work is usually allocated to working groups, with each working group developing a specification or standard (Friesen, 2002).

Anido *et al* (2002: 354) specify that institutions and organisations involved in the learning technology standardisation process are typically North American or European entities, both public and private, that massively use educational software products. Consequently, they are conscious of the need for recommendations and standards to simplify and promote software reuse and system interoperability. This section identifies the most active initiatives in this field, which are summarised in Table 4.1.

4.7.1. The Institute of Electrical and Electronics Engineers (IEEE)

The IEEE is an accredited international standards organisation. Within the IEEE, the Learning Technologies Standardisation Committee (LTSC) encompasses all aspects related to computer-based education. Its main objective is to develop technical standards, recommended practices and guidelines for software components, tools, technologies and design methods to facilitate the development, implementation, maintenance and interoperation of educational systems and their contents (IEEE LTSC, 2004; Anido *et al*, 2002: 354). The 15 sub-committees comprising the LTSC are organised into five working areas: general, content-related, learner-related, data and metadata, and management systems and applications (Anido *et al*, 2002:354). The LTSC coordinates with other organisations with similar interests such as the IMS and ISO/IEC (Friesen, 2002). The LTSC leads the standardisation of educational metadata models (Anido *et al*, 2002: 355).

Initiative	**Organisation**	**Acronym**
Learning Technologies Standardisation Committee	IEEE	LTSC
Joint Committee for the Standardisation of Learning Technologies	ISO and IEC	JTC1 SC36
Dublin Core Educational Metadata	DCMI	DC-ED
IMS Project and Consortium	EDUCAUSE	IMS
Advanced Distributed Learning	US Department of Defence	ADL
Aviation Industry CBT Committee	US Aviation Industry	AICC
Advanced Learning Infrastructure Consortium	Japanese Department of Defence	ALIC
Education Network Australia	Australian Government	EdNA
Alliance of Remote Instructional Authoring and Distributed Networks for Europe	European Commission	ARIADNE
Getting Educational Systems Talking Across Leading edge Techonolgies	European Commission	GESTALT
PROmoting Multimedia access to Education and Training in EUropean Society	European Commission	PROMETEUS
Learning Technologies Workshop	CEN	CEN/ISSS/LT
Gateway to Educational Materials	US Department of Education	GEM
National Science, Mathematics, Engineering and Technology Education Digital Library	NSDL	NSDL Metadata

Table 4.1: Standards Initiatives (Anido *et al*, 2002: 355)

4.7.2. International Standardisation Organisation (ISO)

The International Standardisation Organisation (ISO) is a worldwide federation of national standards bodies from 140 countries, with one member from each country. The mission of ISO is to promote the development of standardisation and related activities in the world with a view to facilitate the international exchange of goods and services, and to develop cooperation in the spheres of intellectual, scientific, technological and economic activity. Its work results in international agreements which are published as International Standards (ISO, 2003). The International Electrotechnical Commission (IEC) is a similar organisation that prepares and publishes international standards for electrical, electronic and related technologies (Friesen, 2002). The ISO occupies the top position in the hierarchy of standards organisations, as depicted in Figure 4.2.

The 36th sub-committee of the first joint ISO and IEC Committee (ISO/IEC JTC1 SC36) was launched in 1999 to cover all aspects related to the standardisation in the field of learning technologies (ISO, 2003). SC36 is also known as the sub-committee on "Information Technology for Learning, Education and Training". Its focus is on interoperability, not only at the technical level, but also taking into account social and cultural issues. This sub-committee has established explicit links with the LTSC (Anido *et al*, 2002: 355).

4.7.3. Dublin Core Metadata Initiative

The Dublin Core Metadata Initiative (DCMI) is an open forum engaged in the development of interoperable metadata standards that support a broad range of purposes and business models. DCMI is dedicated to promoting the widespread adoption of these standards and developing specialised metadata vocabularies for describing resources that enable more intelligent information discovery systems (Dublin Core, 2003). DCMI activities have been targeted to refine a core foundation of metadata elements to provide semantic information about World Wide Web resources (Anido *et al*, 2002: 355).

4.7.4. IMS

The IMS Global Learning Consortium, Inc. (IMS) project was launched by EDUCAUSE (formerly EDUCOM), a consortium of North American educational institutions and their commercial and government partners to define open technical standards for the interoperation of distributed learning applications and services (Anido *et al*, 2002: 356, e-Learning Consortium, 2003: 68 and Pöyry *et al*, 2002: 175). IMS develops and promotes open specifications for facilitating online distributed learning activities such as locating and using educational content, tracking learner progress, reporting learner performance, and exchanging student records between administrative systems (IMS, 2003). IMS is very attentive to the needs of those in the educational community generally and has the highest recognition within this community of the standards development organisations (Friesen, 2002).

The IMS initially targeted the definition of an architecture and reference model for distributed learning systems. However, its activities were redefined when it was detected that a common data model was needed to describe resources, structures and other elements handled by the intended architecture. Currently, the main results of the IMS are in the fields of metadata, content packaging, test definition, and student and group profiling and management (Anido *et al*, 2002: 356). Each one of these data models are instantiated in three different documents: model definition, XML model specification, and model implementation guide (Anido *et al*, 2002: 356).

4.7.5. Advanced Distributed Learning (ADL) Initiative

In 1997, the US Department of Defence and the White House Science and Technology Bureau launched the Advanced Distributed Learning (ADL) initiative. ADL contributes towards satisfying the needs of one of the largest software consumers in the world, and to promote better educational services (Anido *et al*, 2002: 356). ADL was targeted from the very beginning at Web-based education. Its work is coordinated with other organisations like IEEE, IMS and AICC. Coordination is of paramount importance to identify aspects of Web-based learning systems where common interface specifications are needed (Anido *et al*, 2002: 356). The purpose of the ADL initiative is to ensure access to high-quality education and training materials that can be tailored to individual learner needs and made available whenever and wherever they are required. This occurs through the development of a common technical framework for computer and Internet-based learning that will foster the creation of reusable learning content (ADL, 2003).

The ADL Initiative has taken the role of bringing the work from all the disparate standards organisations together into a common and usable “Reference Model” known as the Sharable Content Object Reference Model (SCORM) (e-Learning Consortium, 2003: 11). SCORM is not a standard itself but rather a reference model that serves to test the effectiveness and application of a collection of individual specifications and standards. SCORM allows systems to “share” data about how learners access courses, their progress in the course and their pre-test and post-test scores (e-Learning Consortium, 2003: 14). As Figure 4.3 illustrates, this includes a reference model for educational sharable software objects, a runtime environment, a metadata model and a content structure model (Anido *et al*, 2002: 357). SCORM does not directly author standards but pledges to adopt and make practical the best standards put forward by other groups (Horton and Horton, 2003: 479). Olivier and Liber (2003: 153) posit that SCORM is a content-driven model that aims to make learning content available over the Web in a format accepted by most software vendors. SCORM provides a single-user model and does not support multiple users. SCORM is a unified set of core specifications and standards for e-learning content, technologies, and services. Presently, various specification and standards bodies are working together and collaborating on SCORM, both in its current and future forms. Even at this early stage, SCORM has proven that the existing specifications and standards are able to deliver on the promises of interoperability and reusability, and provide the foundation for how organisations will use learning technologies to build and operate in the learning environment of the future. Ongoing work in this area promises to convert even more of the potential into reality (e-Learning Consortium, 2003: 11). The current version is SCORM 2004 (previously referred to as version 1.3).

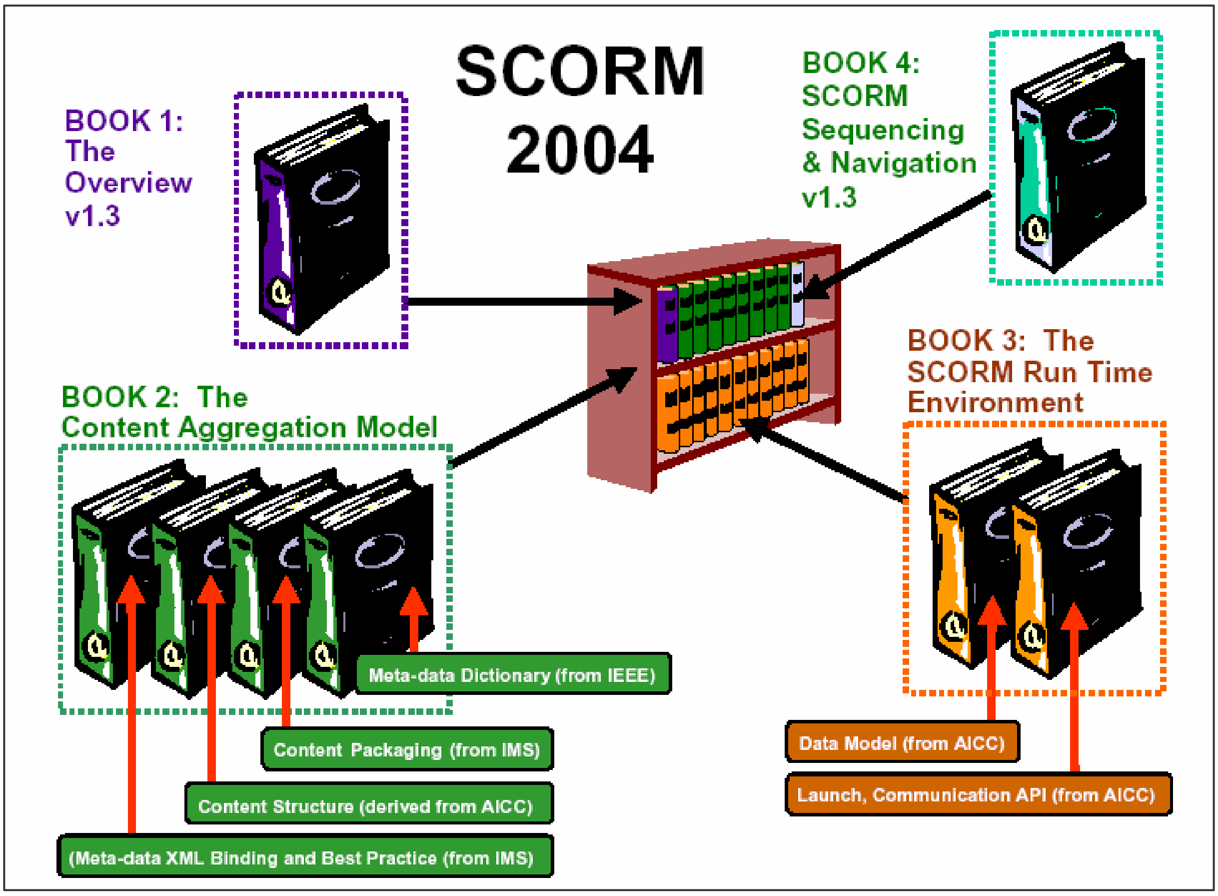

Figure 4.3: SCORM (The e-Learning Consortium, 2003: 15)

4.7.6. North American Aviation Industry

The Aviation Industry CBT (Computer Based Training) Committee (AICC) is the response to the educational standardisation challenge from one of the largest users of educational software. It is an international association of technology-based training professionals that develops training guidelines for the aviation industry. AICC is developing standards for interoperability of computer-based and computer-managed training products across multiple industries including airframe manufacturers, suppliers and buyers (e-Learning Consortium, 2003: 64). The AICC's mission is to provide information and promote guidelines and standards that result in the cost-effective implementation of CBT and Web-based training (AICC, 2003). The AICC has a close relationship with the ADL initiative (Anido *et al*, 2002: 356).

4.7.7. Advanced Learning Infrastructure Consortium (ALIC)

The Advanced Learning Infrastructure Consortium (ALIC) from Japan has the objective to establish an active society by reasonably and effectively providing a learning environment, that enables anyone to learn anytime, anywhere, and according to the goals, pace, interests and understanding of individuals and groups (ALIC, 2003).

4.7.8. Education Network Australia

Education Network Australia (EdNA) is targeted to promote the Internet as a supporting tool for computer-based learning among the Australian educational community, from students to content providers. EdNA's main objective is to offer access to educational resources and services (Anido *et al*, 2002: 357). EdNA Online is a service that aims to support and promote the benefits of the Internet for learning, education, and training in Australia (EdNA, 2003).

4.7.9. ARIADNE

The Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) has developed under the auspices of the European Commission. The main working fields of this alliance are: computer networks for education and learning; methodologies for the development, management and reuse of educational contents; syllabus definition for computer based training; and educational metadata (Anido *et al*, 2002: 358). The ARIADNE project focuses on the development of tools and methodologies for producing, managing, and reusing computer-based pedagogical elements and telematics-supported training curricula. Validation of the project's concepts is currently taking place in various academic and corporate sites across Europe (ARIADNE, 2003).

4.7.10. GESTALT

Another European initiative is the Getting Educational Systems Talking Across Leading edge Technologies (GESTALT) project. GESTALT establishes a reference framework for the development of distributed, heterogeneous, scalable and compatible educational systems. The general objective of this framework is to enable users to discover educational resources, and to provide access to the discovered resources through a conveniently managed network infrastructure (Anido *et al*, 2002: 358). Additionally, GESTALT has made important contributions to the definition of data models for networked educational systems, specifically for the definition of educational metadata and learner profiles and preferences (Anido *et al*, 2002: 358).

4.7.11. PROMETEUS

PROmoting Multimedia access to Education and Training in European Society (PROMETEUS) is an open initiative launched in March 1999 under the sponsorship of the European Commission with the aim of building a Common Approach to the Production and Provision of e-learning technologies and content in Europe. It brings together more than 400 institutions involved in computer-based education (PROMETEUS, 2003).

4.7.12. CEN-ISSS

The European Committee for Standardisation (*Comitè Europèeen de Normalization* (CEN)) hosts the Information Society Standardisation System (ISSS) subcommittee. Educational standardisation activities at ISSS take place within the Learning Technologies Workshop (CEN/ISSS/LT). Their main efforts are devoted to the reuse and interoperation of educational resources, educational collaboration, metadata for educational content, and learning process quality, taking into account European cultural diversity (Anido *et al*, 2002: 358). The mission of CEN-ISSS is to provide market players with a comprehensive and integrated range of standardisation-oriented services and products, in order to contribute to the success of the Information Society in Europe (CEN, 2003).

4.7.13. Other Initiatives

The Gateway to Educational Materials (GEM) Project provides a unified framework for the publication and location of educational resources available through the Internet. This project was promoted by the US Department of Education, and was created in 1997 as a special project within the ERIC Clearinghouse on Information and Technology (Anido *et al*, 2002: 357). GEM is a consortium effort to provide educators with quick and easy access to thousands of educational resources found on various government, university, non-profit, and commercial Internet sites (GEM, 2003).

Starting in 1996, the National Science Foundation (NSF) addressed the development of a US digital library for science, mathematics, engineering and technology education. Building on work supported under the multi-agency Digital Libraries Initiative, the National Science Foundation developed the National Science, Mathematics, Engineering and Technology Education (SMETE) Digital Library (NSDL) programme to create a national digital library that will constitute an online network of learning environments and resources for SMETE at all levels (Anido *et al*, 2002: 357).

Another organisation that generates normative guidelines is the World Wide Web Consortium (W3C). The W3C develops interoperable technologies (such as specifications and guidelines) for the Web to realise its full potential. It has been responsible for developing XML and other specifications that form the foundation upon which e-learning and other standards and specifications are being built (Friesen, 2002).

4.8 Conclusion

The development process of e-learning standards was investigated and found to be a continuously evolving and dynamic process with a wide variety of organisations collaboratively contributing to the process. The main goal of the e-learning standardisation process is interoperability among authoring content, tools and management systems (Horton and Horton, 2003: 474). Although many e-learning standards are still in the development phase and not yet fully completed, the value of implementing e-learning standards in the learning object economy cannot be overlooked.

Chapter 5

The IEEE LOM Standard

Chapter Four investigated the development of various e-learning standards. Chapter Five analyses the first accredited educational metadata standard, namely the IEEE Learning Object Metadata standard. This standard aims to facilitate the search for and use of learning objects.

5.1 Introduction

The IEEE Learning Object Metadata (LOM) data model has recently been approved as a standard and has achieved the level of stability and international recognition needed for it to be implemented in large-scale e-learning infrastructures (Friesen, 2004d). The aim of this chapter is to analyse the IEEE Learning Object Metadata standard. Firstly, educational metadata standards are considered. The LOM standard is investigated and then an analysis of the LOM standard by various authors is presented.

5.2 Educational Metadata Standards

Anido *et al* (2002: 358) describe educational metadata as one of the most prolific fields in the standardisation of education technologies. Most of the standards initiatives have made proposals in this area. Research groups, such as the Dublin Core, have developed standard lists of metadata fields and guidelines for the type of information to be included in each field. These standards do not specify which fields should be used for any given object or whether the metadata should be included inside the learning object or attached externally. However, they provide a reference for authors to use when creating or accessing metadata (Smith, 2004: 16). These data models provide important reference points for implementers who are building and managing systems that support e-learning (IMS, 2004c).

One of the main contributors to the definition of educational metadata is the Learning Technology Standards Committee hosted by the IEEE. The first officially approved standard for learning object metadata, “IEEE Learning Object Metadata” (or the “LOM”), has received widespread support from major players in the educational technology industry. The metadata specification in particular is being used or referenced in international repository efforts like ARIADNE and MERLOT, as well as in the ADL SCORM initiative (Friesen, Roberts and Fisher, 2002).

The only other accredited metadata standard is the Dublin Core Metadata Element Set, which was accredited in February 2003. The Dublin Core set represents a core metadata element set and consists of 15 elements (Dublin Core, 2003). According to Anido *et al* (2002: 359), the LOM will probably become the *de jure* standard for educational metadata. Most other educational metadata specifications are based on the LOM, or are extensions or specific instantiations of the LOM, or try to remain compatible with it.

5.3 The IEEE Learning Object Metadata (LOM) Standard

The development of the LOM was initiated in response to the practical needs of those developing online collections of learning objects (Friesen, 2002). Pöyry *et al* (2002: 175) explain that the IEEE Learning Object Metadata (LOM) Working Group developed the LOM for the specific purposes of education, especially Web-based education. In 1998, IMS and ARIADNE submitted a joint proposal to the IEEE, which formed the foundation of the IEEE LOM specification. IMS and ARIADNE found that some 75 percent of their proposed models could be "cross-walked", with little difficulty, which led to a signing of "Memorandum of Understanding" (Olivier and Liber, 2003: 150). The convergence of these two specifications, through multiple drafts and revisions, gradually developed into an official IEEE standard (Friesen, 2002). While this was taking place, IMS developed further documents in order to provide a stable, publicly accessible version of the specification to implementers and other interested parties (Hodgins, 2001, in Anido *et al*, 2002: 359). IEEE 1484.12.1 (Learning Object Metadata Data Model) was approved as a new standard by the IEEE-SA Standards Board on 13 June 2002 (IEEE LTSC, 2004).

The LOM focuses on the description of modular, reusable and specifically educational resources (or learning objects) to facilitate their use by educators, authors, learners and managers (IEEE LTSC, 2002). The LOM undertakes this task through what has been called a "structuralist" rather than a "minimalist" approach to metadata (Weibel, Ianella and Cathro 1997, in Friesen, 2004d). Instead of presenting a relatively simple data model that defines a minimal number of elements like the Dublin Core, the LOM identifies 76 data elements (covering a wide variety of characteristics attributable to learning objects) and places these elements in interrelationships that are both hierarchical and iterative (Friesen, 2004d). According to Shen, Shi and Xu (2002), of Tsinghua University, the schema contains every category of the Dublin Core and extends it to a set of attributes that can adequately describe a learning object.

5.3.1. Scope and Purpose of LOM

The Learning Object Metadata standard (IEEE 1484.12) is a multi-part standard that specifies learning object metadata and comprises:

- IEEE 1484.12.1 Learning Object Metadata Data Model (LOM)
- IEEE 1484.12.2 ISO/IEC 11404 binding for LOM
- IEEE 1484.12.3 XML binding for LOM
- IEEE 1484.12.4 RDF binding for LOM (IEEE LTSC, 2002).

IEEE 1484.12.1 specifies a conceptual data schema or model that defines the structure of a metadata instance for a learning object. This part of the standard specifies the data elements which compose a metadata instance; it does not define how a LMS represents or uses the metadata instance for a learning object (IEEE LTSC, 2002). The other parts of the 1484.12 standard are currently in the drafting stage. The purpose of the multi-part standard is to facilitate the search, evaluation, acquisition and use of learning objects. Through specifying a common conceptual data schema, this part of the standard ensures that bindings of learning object metadata have a high degree of semantic interoperability (IEEE LTSC, 2002).

5.3.2. LOM Overview

LOM specifies the syntax and semantics of learning object metadata, defined as the attributes required to fully and adequately describe a learning object. This includes element names, definitions, data types, taxonomies, vocabularies, and field lengths. Relevant attributes of learning objects to be described include type of object, author, owner, terms of distribution and format. Generic informational items are included such as title, author, description, and keywords, technical aspects such as file size and type, and also include educational and interpretive aspects like “typical learning time” (Friesen, Roberts and Fisher, 2002). Where applicable, learning object metadata may also include pedagogical attributes such as teaching or interaction style, grade level, mastery level, and prerequisites (Anido *et al*, 2002: 360). The LOM is described using the ISO/IEC 11404 data structure specification (Anido *et al*, 2002: 360).

IEEE LOM elements inhabit a hierarchical space. Some elements are aggregates of sub-elements. Aggregates do not have values directly, only data elements with no sub-elements have direct values. The sub-elements describe the attributes of the aggregated element. For example, the aggregate element <7.2 Resource> has two sub-elements, <7.2.1 Identifier> and <7.2.2 Description> (Duval, 2001:597 and Friesen, Mason and Ward, 2002: 67). This entire hierarchical conceptual data model can be referred to as the “tree structure” of a document. At the base of the hierarchy is the “root” element. The root element contains many sub-elements. If a sub-element itself contains additional sub-elements it is called a “branch”. Sub-elements that do not contain any sub-elements are called “leaves” (IMS, 2004c). The relationship between the root, branches, and leaves is depicted in Figure 5.1 using sample elements from the IEEE LOM standard.

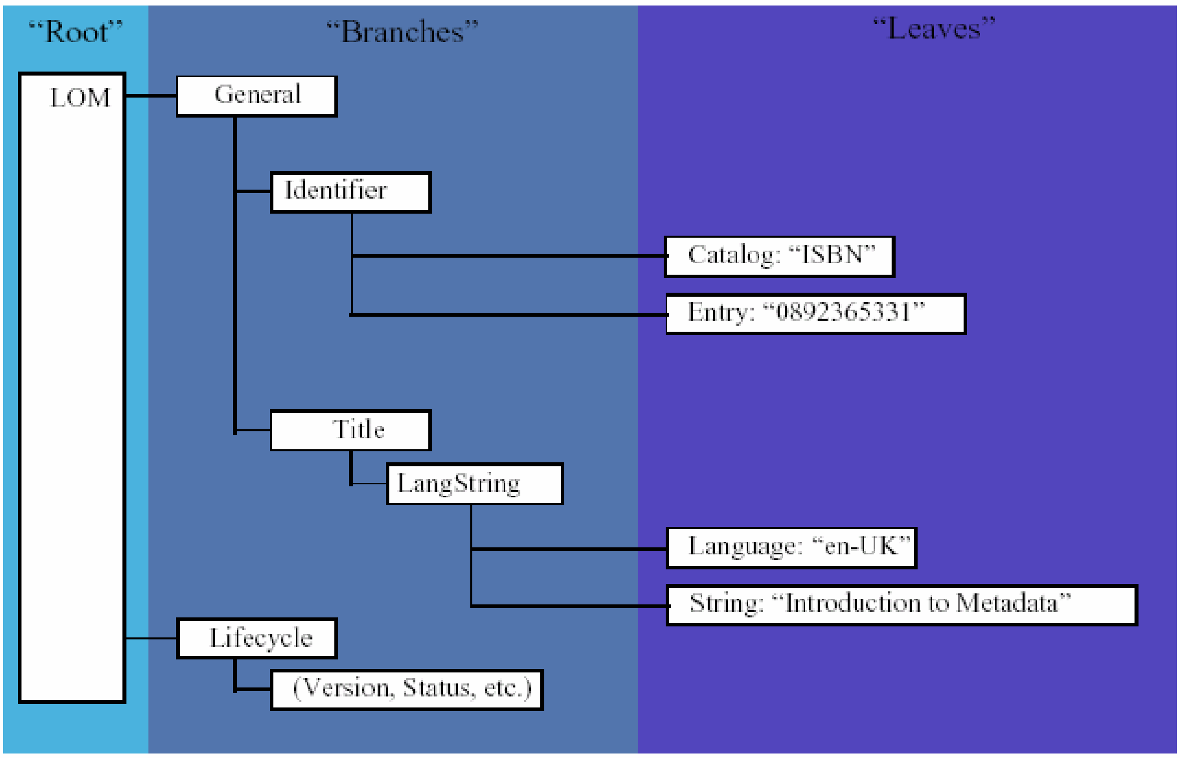

Figure 5.1: Tree View of Learning Object Metadata (IMS, 2004c)

5.3.3. Metadata Structure

The LOM conceptual model describes learning objects with a hierarchical metadata structure that is grouped into nine top-level categories. Within these categories, more detailed descriptions are provided further down in the hierarchy (Friesen, 2004d; Pöyry *et al*, 2002: 175). Shen *et al* (2002) state that each category is relatively independent and characterises the learning object from a separate aspect.

The IEEE LTSC (2002), Friesen, Roberts and Fisher (2002) and Duval (2001: 596) provide more detailed descriptions of the categories.

1. The *General* category groups information that describes the learning object as a whole. This category includes the elements <1.1 Identifier>, <1.2 Title> and <1.3 Language>.
2. The *Lifecycle* category groups the features related to the history and current state of the learning object. It also describes the individuals or organizations that have affected the learning object during its evolution. Data elements in this category include <2.1 Version> and <2.2 Status>. The Lifecycle category uses the hierarchical <2.3 Contribute> element construction along with the “Electronic Business Card” (or vCard) data model and encoding format to record the roles and identities of various contributors (authors, publishers).
3. The *Meta-metadata* category groups information about the metadata, rather than about the learning object that they describe. This includes an identifier for the metadata instance, contributors to the metadata and the language used in the metadata. In the Meta-metadata category, the <3.2 Contribute> element construction recurs in slightly modified form, for the attribution of the creation and validation of the metadata record itself.
4. The *Technical* category groups the technical requirements and characteristics of the learning object. This category describes the size and location of the learning object, and other so-called “objective” characteristics of the learning object. This element category also provides a <4.4 Requirement> element construction that allows for the formulation of machine-readable statements about specific technical supports needed for the use of the object.
5. The *Educational* category groups the educational and pedagogic characteristics of the learning object. The Educational category focuses on the more “subjective” characteristics of the object, indicating audience attributes such as age, institutional context and role. This category also provides elements that can be understood as falling into complex interrelationships, describing type and level of interactivity provided by the object, as well as the conciseness of its contents.
6. The *Rights* category groups the intellectual property rights and conditions of use for the learning object. For this category, the LOM adopted a fairly simple approach, indicating whether or not any cost is involved, and whether copyright and other

restrictions apply. The idea is to refer to other standards for more complex modelling of rights management metadata.

7. The *Relation* category groups features that define the relationship between this learning object and other ones, with an indication of the type of the relationship (for instance “based on” or “part of”).
8. The *Annotation* category provides comments on the use of the learning object and information on when and by whom the comments were created. The Annotation category employs only four elements to enable educators to share their assessments, suggestions and other comments on the educational use of the learning object.
9. The *Classification* category describes where the learning object can be classified within a particular classification system. As any classification can be referenced, this category provides for a simple extension mechanism. Classification provides nine intricately structured elements (such as <9.2 Taxon Path>, <9.2.2.1 Identifier> and others) that can be adapted to the use of almost any classification or taxonomic purpose. Among the specific purposes recommended for this element group (as suggested by the recommended vocabulary values) are “ideas”, “prerequisites”, “educational objectives”, “educational levels” and “competencies”.

Friesen, Roberts and Fisher (2002) note that the LOM standard defines approximately 80 separate aspects or “elements” for the description and management of learning resources. Figure 5.2 illustrates all the data elements.

5.3.4. Data Elements

Duval (2001: 597) and IEEE LTSC (2002) stipulate that for each data element, the base scheme defines:

• *name* - the name by which the data element is referenced;

• *explanation* - the definition of the data element;

• *size* - the number of values allowed;

• *order* - whether the order of the values is significant (only applicable for data elements with multiple values);

• *value space* - the set of allowed values for the data element - typically in the form of a vocabulary or a reference to another standard (such as ISO8601 for the representation of dates);

• *data type* - a set of distinct values;

• *example* - an illustrative example.

In the size field, a value of smallest permitted maximum refers to the smallest number of occurrences of an element that an application (such as a LMS) must be able to manage. This is the maximum number of occurrences that an element can be guaranteed to pass from one system to another. Taxonomies and vocabularies referred to in the standard are structured collections of terms that can serve as values for metadata elements (IEEE LTSC, 2002).

For each of the data elements, the specification includes the data type from which it derives its values, such as Date or Character string. The notion of "LangString" is used to represent a phrase in a human language. A value of this type can consist of multiple (Language, String) "tuples" where Language indicates the human language (according to the ISO639 standard) and String holds the actual character string (according to ISO/IEC 10646-1). As an example of this concept, two titles can be defined for the learning object: one in English and one in Dutch (Duval, 2001:597).

The vocabulary data type consists of two parts: the first part identifies the source of the vocabulary; the second part identifies the values of the vocabulary or list (IMS, 2004c). Vocabularies are recommended lists of appropriate values that define the value space of a data element. Other values, not present in the list, may be used as well. However, metadata that rely on the recommended values will have the highest degree of semantic interoperability, or the likelihood that such metadata will be understood by other end users is the highest. As an illustration, the data element <5.2 Learning Resource Type> may have a value from the LOM vocabulary, such as "Questionnaire". This option is preferred if the values in the vocabulary can adequately express the intended meaning. If the indexer wants to assign a value that is not part of the list given in the LOM document for that data element, then the indexer may designate the value as, for instance, ("http://www.vocabularies.org/LearningResourceType", "MotivatingExample"). This option provides more flexibility to the indexer of learning objects, at the expense of semantic interoperability (Duval, 2001:597).

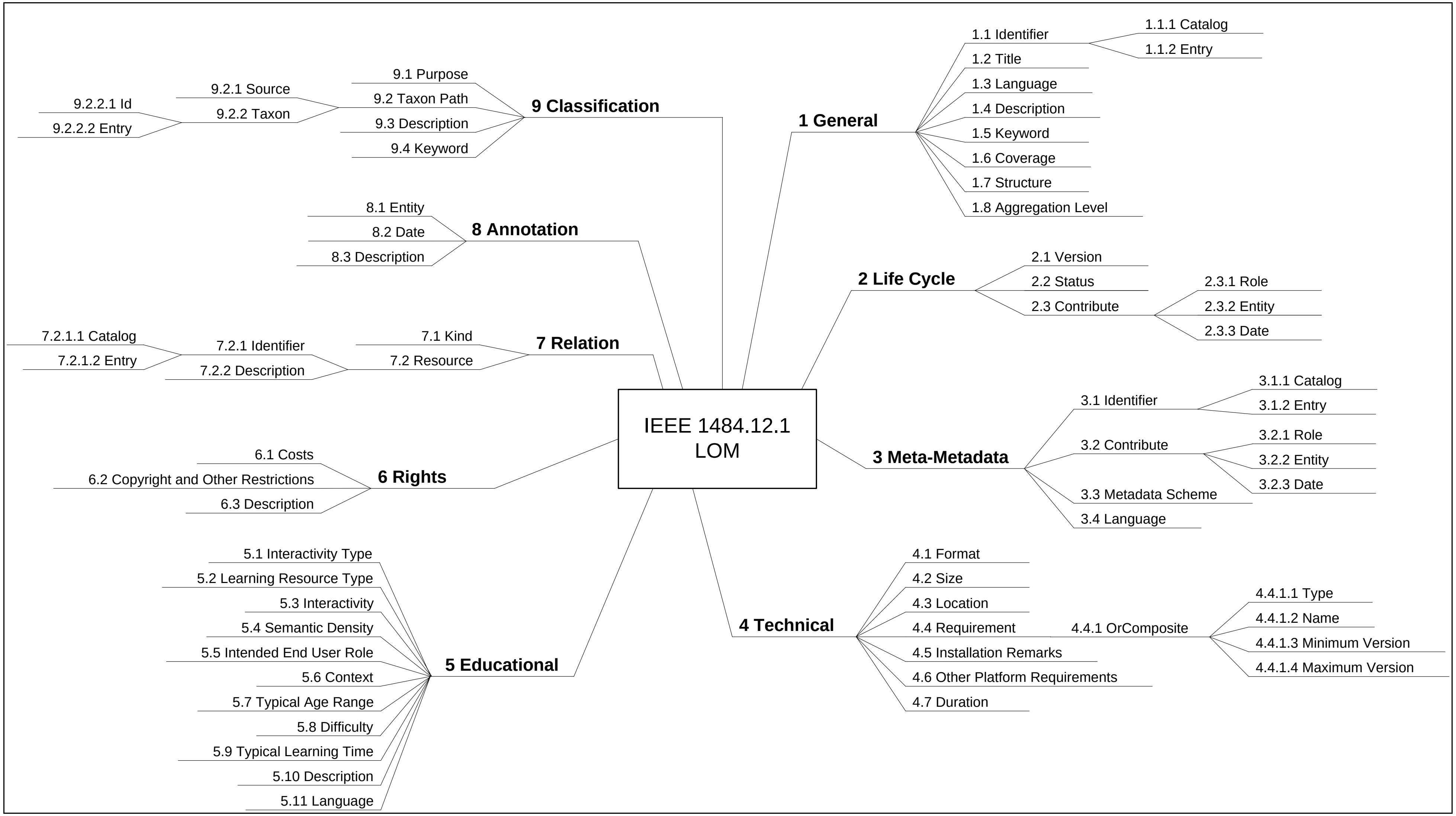

Figure 5.2: IEEE LOM Diagram (Adapted from Herrmann in Duval, 2003)

The LOM conceptual data schema intentionally provides elements and element groups that can be adapted for different purposes. It is recommended that elements be adapted to the LOM conceptual data schema rather than added as extensions. For example, instead of adding an element to accommodate thumbnail images of full size images, the Relationship category can be used to meet this requirement. It is also recommended that the Classification category should be used to accommodate requirements that may otherwise be addressed by extensions (IMS, 2004c). If certain requirements cannot be accommodated within the LOM schema, extensions may be created. Extensions may be needed to fill in metadata specific to organisational needs (Barritt and Alderman, 2004: 169). However, it must be noted that extensions are community specific and will have an impact on interoperability.

5.4 IEEE LOM Bindings

The IEEE LOM standard addresses the critical need for independence between the semantics of metadata and their syntactic representation (Duval, Hodgins, Sutton and Weibel, 2002). LOM is a “multi-part standard” where the semantic data model is an independent standard and each syntactic representation is an independent standard developed as a specific binding of the LOM data model (Duval *et al*, 2002). A binding document is a machine-readable description of a specification (Van Assche and Massart, 2004: 317). The IEEE LOM conceptual data schema contains nothing about storing and managing metadata within a standalone environment. However, in order to facilitate interoperability, it is necessary for machine readable instances of metadata to be exposed. The IEEE LTSC will be publishing standards for binding LOM in various instances as part of the LOM standard. XML is the preferred encoding syntax for binding conceptual data schemas in the IMS community (IMS, 2004c).

The eXtensible Markup Language (XML) is a method for putting structured data in a text file (McGreal and Roberts, 2001). XML consists of a set of rules for designing text formats and producing files that are easy to generate and readable by machines and humans. It is the underlying syntax for the transmission of structured data across the Internet. XML can handle various levels of complexity. It is server- and vendor-independent and can be extended by the user (McGreal and Roberts, 2001). Most learning technology specifications for metadata define metadata using XML document instances to enable flexibility and extensibility

(Nilsson, Palmér and Naeve, 2002). Duval *et al* (2002) agree that XML is the choice for the encoding and exchange of structured data. The IEEE P1484.12.3 Draft Standard for Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata has not yet been ratified (IMS, 2004c).

The Resource Description Framework (RDF) promises an architecture for web metadata and has been advanced as the primary enabling infrastructure of the semantic web activity in the World Wide Web Consortium (W3C) (Duval *et al*, 2002). RDF is an additional layer on top of XML that is designed to support the reuse and exchange of vocabulary terms across namespaces (sets of names in which all names are unique) (Duval *et al*, 2002). RDF is an infrastructure that enables the encoding, exchange and reuse of structured metadata and supports the exchange of knowledge on the Web (McGreal and Roberts, 2001).

5.5 LOM Analysis

Prior to the LOM, there was no standard method for vendors to ensure that their objects' metadata was stored in a sharable location. The LOM standard ensures that when applied correctly, metadata about an organisation's learning objects can be used by any other IEEE LOM-compliant learning system (Barritt and Alderman, 2004: 169). Shen *et al* (2002) note that the LOM schema has several features, including:

- Allowing for linguistic diversity of both learning resources and the metadata instances that describe them;
- The separation of semantic model and its bindings;
- Consistent description ensured by the recommended vocabularies of some metadata elements;
- Accommodating extension mechanism for localisation.

Educational resources are heterogeneous in nature and this diversity should be reflected in metadata descriptions. Among other tasks, LOM metadata descriptions support version management and maintenance, resource storage and recovery (searching, locating, instantiation, packaging, editing), and resource sharing. Although not explicitly stated by the LOM proposal, LOM metadata may also be useful for other related tasks like intellectual property rights management or electronic commerce (Anido *et al*, 2002: 360). Authoring tools and systems may automatically capture some elements, such as owner or structure, while others will need to be created and maintained (Barritt and Alderman, 2004: 169).

The LOM standard ambitiously defines approximately 80 separate elements for the description and management of learning resources. However, the sheer number and variety of elements in this metadata specification has created widely recognised difficulties for its implementers. The IMS Global Consortium (2000 in Friesen, Roberts and Fisher, 2002) explains that many vendors have expressed little or no interest in developing products that are required to support a set of metadata with over 80 elements. Most have existing products that they hope could support a minimum baseline of elements that the learning resource community would agree to be essential. They also want to be able to make marketing statements such as a "IEEE/IMS metadata conforming document".

As LOM is optional, various implementations may look completely different (Barritt and Alderman, 2004: 167). Developers could choose to implement all, some or none of the elements. A LOM metadata instance may contain extension data elements. Such elements cannot replace data elements in the LOM structure (Duval, 2001: 598). The LOM data elements are repeatable in different combinations, and on different levels within their hierarchical constructions. For example, on the lowest level in the hierarchy of elements in the classification category, all elements are repeatable as a group or category at least 40 times. For each repetition on this level, at least 15 different taxon paths can be specified; and for each of *these* repetitions, it should be possible to accommodate up to 15 particular taxon identifiers and entries. This means that as a minimum, systems storing and processing LOM-compliant records should be able to accommodate at least 9000 taxon identifier-value pairs (Friesen, 2004d).

It is no small task to decide whether to use such elements or vocabulary values and decipher what their intended purpose might be. The metadata that many of the LOM elements specifies or represents is not simply un-interpreted data that can be simply parsed and processed, as is the case with many of the variables outlined in more technically-oriented IEEE e-learning specifications. Instead, many of the elements in the LOM standard effectively require the intervention of human intelligence, and of human interpretation and understanding. Unfortunately, this is not explicitly recognised in LOM documentation, either in the form of clear and detailed element descriptions and term definitions, or in the form of general guidelines for interoperable interpretation and implementation (Friesen, Roberts and Fisher, 2002). Friesen, Roberts and Fisher (2002) add that to complicate matters, the IEEE LOM documentation provides only very brief and sometimes confusing descriptions of the purpose and character of its numerous metadata elements. For example, the <5.2 Learning Resource Type> element is described in the LOM documentation only as the "specific kind of learning resource", and is associated with the following recommended vocabulary terms: exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative text, exam, experiment, problem statement, self assessment, and lecture (IEEE LTSC, 2002). A quick look at this listing reveals terms whose meanings overlap (e.g., diagram, figure, graph), and terms that describe content (table, slide) as opposed to the education application for which this same content can be used (exercise, lecture, exam). For the purposes of clarifying these and other ambiguities related to vocabulary terms, the LOM refers implementers to existing practice in general, and to the 1989 edition of the Oxford English Dictionary (an historical and etymological reference) in particular (Friesen, Roberts and Fisher, 2002).

Consequently, using the LOM metadata element set in a project or indexing task is a complex, resource-intensive undertaking, requiring elements to be chosen, interpreted, used, and then possibly reinterpreted by each group or individual collecting or developing learning objects. Additionally, varying implementations of this element set threaten to create problems for the effective searching and exchange of metadata records between projects and communities (Friesen, Roberts and Fisher, 2002). Friesen (2004d) asserts that given the complex and demanding character of the LOM, the task of adapting it to meet the specific and concrete needs of implementers and users requires interpretation, elaboration, extension, and perhaps especially, the simplification of both the technical demands and the myriad interpretive possibilities it presents.

5.6 Accessibility Metadata

The IMS Global Consortium (2004a) defines a disability as a mismatch between the needs of the learner and the education offered. Accessibility is the ability of the learning environment to adjust to the needs of all learners. It is determined by the flexibility of the education environment (with respect to presentation, control methods, access modality, and learner supports) and the availability of adequate alternative-but-equivalent content and activities. Accessible systems adjust the user interface of the learning environment, locate needed resources and adjust the properties of the resources to match the needs and preferences of the user (IMS, 2004a). The IMS Global Consortium has developed several "AccessForAll" specifications. The purpose of the AccessForAll specifications is to facilitate the discovery and use of the most appropriate content for each user. The specifications represent an open collaboration between working group members from IMS, Dublin Core, IEEE, CEN-ISSS and others (IMS, 2004a).

Currier and Barton (2003) state that it is important to include accessibility metadata in order to assist those with special educational needs or disabilities. Current metadata specifications do not provide adequate support for accessible delivery of educational resources. As a result, it is difficult for current systems to match their resources with specific accessibility requirements. The AccessForAll Metadata specification (ACCMD) defines accessibility metadata that is able to express a resource's ability to match the needs and preferences of a user's Learner Information Package (ACCLIP) profile. Prior to this specification, IMS released the ACCLIP which is a model for describing and recording learner preferences regarding content, display, and control of learning resources. As a result, systems are able to select the appropriate resource(s), when available, for a learner, thereby providing experiences that adapt to individual needs (IMS, 2004a). The purpose of the ACCLIP is to allow information to be gathered from learners regarding their needs and preferences so that the user interface and content can be appropriately adapted (Halm, 2003: 56).

The two AccessForAll specifications (AccessForAll Metadata and Accessibility for LIP) address several challenges:

- Initial discovery of material having appropriate accessibility support;
- Adjustment of control and display of resources to meet learner accessibility needs and preferences;
- Discovery of appropriate alternative or augmentative representations of desired learning resources.

Users of alternative access systems need to know whether a resource is compatible with their required access method. For example, a blind learner may need audible access to a resource as opposed to visual access. Used in combination, the AccessForAll specifications offer a significant foundation for providing support to learners in expressing their accessibility needs and preferences, and to learning facilitators for declaring the suitability of resources to specific learner needs (IMS, 2004a).

The AccessForAll Metadata specification is a proposed unified approach to matching learner needs and preferences with the objects that address those needs and preferences across participating specifications bodies (IMS, 2004a). The AccessForAll Metadata specification describes the content properties and characteristics of an object. An encoding of Accessibility Metadata that harmonises with the AccessForAll Metadata specification and is suitable for use in an IEEE LOM Application is under construction by CEN-ISSS Learning Technologies Workshop (IMS, 2004a). The CEN-ISSS (Accessibility Properties for Learning Resources) (APLR) Project is developing an accessibility application profile of the IEEE LOM standard that will work with the IMS AccessForAll Specifications.

5.7 Conclusion

This chapter investigated educational metadata standards for the description of learning objects. The IEEE Learning Object Metadata (LOM) data model was the first accredited e-learning standard that defines metadata for describing a learning object. It consists of a base schema of nine categories with 76 data elements. Although the standard is undoubtedly necessary and useful, there are still some practical issues regarding vocabularies, interpretation and complexity that need to be considered before the standard is widely implemented.

Chapter 6

Application Profiles

Chapter Five analysed the IEEE LOM standard, which can be highly complex and require interpretation to implement. Chapter Six considers the use of application profiles in describing learning objects for specific communities. Application profiles represent a customisation of the LOM standard for local application.

6.1 Introduction

According to Friesen, Roberts and Fisher (2002), interoperable metadata, consistently and systematically implemented, is critical to achieving the vision of easy access to shared and reusable learning objects. The development of learning object repositories around the world, in both the private and public sectors, has led to the increased accessibility of learning content that can be shared. The development of common metadata specifications supports these efforts (Halm, 2003: 49). This chapter examines the most relevant specifications on metadata for educational resources. Firstly, the development of application profiles is considered and this is followed by a discussion of several metadata specifications that have links to the IEEE LOM standard. A comparison of the metadata elements used in each application profile is made. Shortcomings of current metadata specifications are examined and then an international survey of LOM implementations is reviewed.

6.2 Application Profile Development

In practice, organisations and communities will find it necessary to implement the LOM standard in ways that meet their specific requirements (IMS, 2004c). No single metadata element set will accommodate the functional requirements of all applications (Chatzinotas and Sampson, 2004: 876). Friesen (2004d) states that the task of interpreting and simplifying standards has generally been understood as being the responsibility of application profiling activities. Heery and Patel (2000) define application profiles as “schemas which consist of data elements drawn from one or more namespaces, combined together by implementers and optimised for a particular local application”. “Application Profiles” is a term adopted by the broader metadata community to describe metadata element sets that are either abbreviated versions of complete standards or are a heterogeneous mix of elements drawn from different metadata schemas (IMS, 2004c). Duval *et al* (2002) define an application profile as “an assemblage of metadata elements selected from one or more metadata schemas and combined in a compound schema”. Friesen, Roberts and Fisher (2002) state that an application profile represents a “customisation” of a “standard” for the specific needs of “particular communities of implementers with common application requirements”. Application profiles facilitate the “mix and match” of metadata schemas as appropriate. Heery and Patel (2000) specify that a profile may support a particular application, function, community or environment.
Application profiles are usually developed to meet the needs of a specific application, within a

specific community. For example, to exchange metadata records among higher education institutions within a country or to support the distributed development of learning resource material by learning teams within a corporation (IMS, 2004c).

The purpose of an application profile is to adapt or combine existing schemas into a package tailored to the functional requirements of a particular application, while retaining interoperability with the original base schemas (Duval *et al*, 2002). Duval *et al* (2002) add that the main goal of application profiles is to increase the "semantic interoperability" of the resulting metadata instances within a community of practice. This is achieved by going beyond the universal consensus of a single standard, yet without compromising the basic interoperability that the standard enables across the boundaries of these communities. An application profile is more easily available than the initial educational standard as it is adapted to the needs of the specific application and target user group. Application profiles facilitate the process of metadata creation because the element set and value spaces are less abstract. Additionally, application profiles offer these benefits without compromising the interoperability with the initial standard (Chatzinotas and Sampson, 2004: 876). Heery and Patel (2000) suggest that the usefulness of application profiles is that they allow the implementers to declare how they are using standard schemas. Duval *et al* (2002) add that a part of the adaptation is the elaboration of local metadata elements that have importance in the community, but which are not expected to be important in a wider context. A benefit of this approach is that communities of practice are able to focus on standardising community-specific metadata in ways that can be preserved in the larger metadata architectures. It will also be possible to snap together such community-specific modules to form more complex metadata structures that will conform to the standards of the community while preserving cross-community interoperability (Duval *et al*, 2002). Currently, there exists diverse practice relating to the definition and implementation of application profiles. While the development of application profiles provides the opportunity for implementer communities to meet their local need, balancing interoperability with local requirements can be a significant challenge (IMS, 2004c).

Friesen, Mason and Ward (2002: 63) note that with the approval of the Learning Object Metadata (LOM) data model as an IEEE standard, and the Dublin Core Metadata Element set as an ISO standard, metadata models have achieved a stability and level of community commitment requisite to their implementation in the form of application profiles and supporting infrastructure. This provides implementers and developers with a solid foundation for creating metadata to meet the needs of national, regional and local educators and learners. The task of adapting abstract standards to meet the specific and concrete needs of these stakeholders requires interpretation, elaboration, extension and in some cases, the simplification of their syntax and semantics. Friesen, Mason and Ward (2002: 63) report that, in their experience, it is not a trivial matter to retain interoperability with original base schemas and other application profiles. Adaptation and interpretation play important roles in the process of profiling metadata for the needs of particular projects and communities. These needs are also influenced by the policy and cultural environments in which these projects and communities exist.

The IMS Metadata Special Interest Group (2004c) notes that two approaches to the development of application profiles are emerging. The former approach involves combining elements from different metadata schemas while the latter constrains and extends a single schema. The Dublin Core Metadata Initiative is an example of the first approach. The LOM standard, however, is typically implemented by creating application profiles that restrict the elements used, designate certain elements as mandatory or optional, specify vocabulary usage and add organisation or community specific classification schemas (IMS, 2004c). Various application profiles are discussed in section 6.3.

Friesen (2004d) divides application profiles into four general (and not mutually exclusive) groups.

1. Those that combine elements from the LOM standard with elements from other metadata specifications and standards.
2. Those that focus on the definition of element extensions and other customisations specifically for the LOM standard.
3. Those that emphasise the reduction of the number of elements and the choices they present.
4. Those that both simplify and undertake customised extensions of the LOM standard.

The fundamental techniques or characteristics used for the definitions of application profiles include.

1. **Cardinality enforcement**. Cardinality refers to the constraints on the appearance of an element, such as mandatory or optional. The status of a data element can be made

more stringent in a given context. However, an application profile must operate within the interoperability constraints defined by the standard; it cannot relax the status of data elements (Duval *et al*, 2002). For example, an optional element can be made mandatory in an application profile. There is wide flexibility in the selection of mandatory elements in different application profiles, such as ARIADNE and SCORM (Duval and Hodgins, 2003).

2. **Value space restriction**. Communities may find LOM based vocabularies insufficient and may achieve increased specificity in describing their learning objects by using terms that have high semantic interoperability within that community (IMS, 2004c). Heery and Patel (2000) state that application profiles specify permitted schemas and values and refine standard definitions. For some elements, the value space can be made more restrictive than in the standard. This applies when a standard is very “loose” about the values for a data element. This mechanism can also apply when the standard is quite prescriptive about the value space, when the context of use allows for further restrictions (Duval *et al*, 2002). Due to the LOM standard being broadly applicable, certain available options may not be relevant in specific contexts, for example, the “educational validator” value in the <2.3.1 Role> element. Alternatively, the value space of a particular element may be fixed for a certain community. For example, the educational context may always be that of a university if the community only deals with that context (Duval and Hodgins, 2003: 662).
3. **Relationship and dependency specification**. An application profile can define interrelationships between data elements and their value spaces. Implementers may also constrain the data model by dictating the way in which elements are used and repeated (IMS, 2004c). For instance, the presence of one data element may impose the requirement that another element be present (Duval *et al*, 2002). For example, the application profile may define that if a cost is involved in using the learning object, the rights holder must be known (Duval and Hodgins, 2003). Similarly, an application profile can restrict the value set of a data element, based on the value of another data element (Duval *et al*, 2002).
4. **Exclusion of some elements**. As all LOM elements are optional, a community may decide not to make use of certain elements (Duval and Hodgins, 2003). In many cases, application profiles of the LOM are defined primarily in terms of data element subsets. These profiles simplify the complex standard by reducing the number of elements that need to be considered in subsequent implementation and record-creation

efforts (Friesen and Nirhamo, 2003). This profiling activity is commonly understood as the first stage in implementing the LOM.

5. **Identifying taxonomies and classifications**. The LOM standard allows the use of arbitrary taxonomic staircases in general classification structures which can be explicitly defined by a community (Duval and Hodgins, 2003).
6. **Declaration of namespace**. Application profiles support the use of multiple namespaces, such that designers may choose elements appropriate to their needs from different element sets. Schema designers may also add local elements through the use of a locally defined namespace (Duval *et al*, 2002).

The e-Learning Consortium (2003: 35) notes that standards implementers do not have to choose one metadata standard; it is possible to "map" standards. Although not ideal, it is possible to "cross walk" from one standard to another in order to satisfy particular metadata needs. Heery and Patel (2000) suggest that, in their experience, implementers use metadata standards in a pragmatic way; they will bend and fit metadata schemas for their own purposes. Heery and Patel (2000) also add that, in order to work effectively, communities need to share information about the way they are using standards. This enables communities to start to align practice and develop common approaches by sharing their application profiles.

The IMS (2004c) suggests that to successfully create an application profile it is necessary to:

- Understand the requirements and clearly define the purpose of the profile;
- Ensure that adequate resources are available for the process of creating and maintaining the profile;
- Review existing relevant standards, specifications and application profiles. If an application profile is found that meets the implementer's community requirements, it should be used as is or if necessary modified to meet these requirements;
- Determine with which other applications the profile needs to interoperate;
- Follow recommendations for extensions, bindings and conformance, vocabularies, translations and mapping semantics;
- Publish the profile in a metadata schema registry.

6.3 Learning Object Metadata Specifications

This section looks at several metadata specifications that have links to the LOM standard. The inclusion of these metadata specifications was based on the criteria that the element sets must be publicly available, together with documentation, and that the metadata element sets must be widely used. The element sets of each metadata specification are represented in Table 6.1.

6.3.1. Dublin Core Metadata Element Set

The Dublin Core Metadata Element Set (DCMES) is a general-purpose and widely adopted metadata scheme targeted to resource location, developed within the Dublin Core Metadata Initiative (DCMI). Pöyry *et al* (2002: 174) state that the DCMES is a widely known metadata standard that has been developed since 1995 through a series of workshops. The DCMES is intended to facilitate discovery of electronic resources, especially from the World Wide Web (Dublin Core, 2003). The DCMES is a standard for cross-domain information resource description and is not limited to describing learning resources. In August 1999, the Dublin Core Advisory Committee formed the DC-Education Working Group to develop a proposal for the use of Dublin Core metadata for the description of educational resources. Essentially, its task was to propose extensions to the Dublin Core metadata set in order to describe educational resources, taking LOM and the IMS proposal as a basis (Greenberg, 2000: 6; Anido *et al*, 2002: 360).

DCMES provides an element set only, which can be used in the context of a specific project or application. It was accredited as an International Standardisation Organisation (ISO) standard in 2003 (ISO 15836) (Dublin Core, 2003). The Dublin Core standard contains 15 metadata elements that describe the content, the intellectual property rights and the instantiation of the object. In the Dublin Core, each element set is optional and repeatable. Metadata elements may also appear in any order. For each element, the standard provides a name, label, definition and comment. The 15 elements are: Identifier, Title, Language, Description, Subject, Coverage, Type, Date, Creator, OtherContributor, Publisher, Format, Rights, Relation and Source (Dublin Core, 2003). The LOM standard data elements map directly to data elements defined in the DCMES (IEEE, 2002).

Anido *et al* (2002: 360) state that the standard is compact and its elements are the result of a wide consensus, and consequently, Dublin Core has become the foundation for other initiatives. The simplicity of Dublin Core can be both a strength and a weakness. Simplicity lowers the cost of creating metadata and promotes interoperability. However, simplicity does not accommodate the semantic and functional richness supported by complex metadata schemas (Dublin Core, 2003).

6.3.2. IMS Metadata

The IMS project decided that an agreement on metadata for educational resources was one of the first tasks to be considered in the learning technology standardisation process. Since 1998, when they made a joint proposal with ARIADNE to create LOM, IMS has regularly contributed to its evolution. IMS also uses the LOM standard as its basis for metadata specification - the IMS Learning Resource Metadata Information Model (Anido *et al*, 2002: 361 and Pöyry *et al*, 2002: 175). IMS has also contributed to LOM by introducing best practice guides for metadata developers and implementers. To represent metadata, IMS has introduced the use of a XML binding specification (Pöyry *et al*, 2002:175).

Initially, IMS considered that the number of items defined for LOM was too large. Many organisations within the IMS community recommended that a reduced core of basic elements be identified to simplify initial implementation efforts. IMS metadata attempted to make LOM metadata more flexible by providing IMS Core (consisting of 19 LOM elements) (Anido *et al*, 2002: 361). However, this proved to be less than effective and IMS reverted to the full standard. The current IMS Metadata Best Practice Guide version 1.3 uses all 76 data elements from the LOM standard and all elements have optional status (IMS, 2004c).

6.3.3. SCORM Metadata

The original contribution of SCORM is a mapping of metadata elements into three learning content elements: asset, sharable content object and content aggregation. In this way, they provide the missing link between general metadata specifications and specific content models (Anido *et al*, 2002: 362). SCORM differs from other metadata schemas as it describes how to apply metadata to particular, specific systems. It also references the IMS XML binding specification to validate implementations.

SCORM identifies three types of learning object metadata.

1. Raw media metadata or Asset metadata are metadata that can be applied to assets such as illustrations, documents, or media streams and provide descriptive information

about the assets independently of learning content. These metadata are used to facilitate reuse and discoverability, mainly during learning content creation of assets within an asset repository.

2. Sharable Content Object (SCO) metadata can be applied to blocks of content or assignable units to provide descriptive information about the learning content independently of the particular content aggregation. These metadata are used to facilitate reuse and discoverability of such learning content within a learning content repository.
3. Content Aggregation metadata describe content aggregations (defined as courses), similar to the SCO structure format. These metadata are used to facilitate reuse and discoverability within a courseware repository, and to provide descriptive information about the content aggregation (Anido *et al*, 2002: 362).

Anido *et al* (2002: 362) state that SCORM has adopted the set of metadata elements described in the IMS Learning Resource Metadata Information Model, which in turn is based on the LOM standard. Elements are designated as mandatory or optional.

6.3.4. ARIADNE Metadata

ARIADNE's primary goal is to promote the sharing and reuse of electronic pedagogical material. In order to support this goal, they have built the Knowledge Pool System, a European distributed repository for pedagogical documents, with associated indexing and query tools (Anido *et al*, 2002: 363). One of the main features of these tools is the metadata schema used. ARIADNE is concerned with the development of a metadata system that works in a multilingual and multicultural environment, neutral with regard to both the language of the original document being indexed and the language used to create the metadata (Anido *et al*, 2002: 363).

Pöyry *et al* (2002: 175) state that the ARIADNE project has also used LOM as its basis. However, they have not used the final standard yet, and the metadata schema is based on LOM Draft 3.8. ARIADNE has added more educational metadata elements to the original LOM schema, such as educational pre-requisite and pedagogical classification (Pöyry *et al*, 2002: 175). Anido *et al* (2002: 363) add that the metadata is grouped into five categories: general information of the resource, semantics, technical characteristics, conditions for use, and meta-metadata information. There are 50 metadata elements in ARIADNE, which are designated as mandatory or optional.

6.3.5. CanCore Learning Object Metadata

The Canadian Core (CanCore) initiative has been developed with the support and funding of several Canadian educational institutions including the Netera Alliance (an Alberta, Canada, non-profit alliance that coordinates Alberta's provincial ICT research infrastructure), Telecampus.edu, the Electronic Text Centre at the University of New Brunswick, the University of Alberta, Abathasca University and other Canadian national projects (Friesen, Roberts and Fisher, 2002). These projects include the BELLE (Broadband-Enabled Lifelong Learning Environment) project and the POOL (Portal for Online Objects for Learning) project, both funded primarily by the government's Industry Canada department (Friesen, Mason and Ward, 2002: 65). The community that CanCore supports is constituted by public education (both traditional and distance forms) in Canada, including the primary, secondary and tertiary educational sectors. Education in Canada is highly decentralised and falls exclusively under provincial and territorial jurisdiction. Canadian educational policy forbids federal involvement and encourages education to reflect and sustain a multiplicity of languages and cultures. In this context, means of ensuring linguistic and cultural neutrality and adaptability are mandated requirements. These and other factors provide a strong inducement for collaboration and cooperation to protect interests of diversity and adaptability (Friesen, Mason and Ward, 2002: 66).

The CanCore application profile is distributed at no cost. The CanCore elements were chosen based on their likely utility for interchange and interoperation in the context of a distributed, national repository infrastructure. The CanCore elements are focused fairly exclusively on resource discovery. Those dealing with rights management and educational applications are kept to a minimum. The emphasis on resource discovery may be a function of the heterogeneity of the community that CanCore is serving, which is the different Canadian provincial education departments (Friesen, Mason and Ward, 2002: 66).

The CanCore initiative aims to interpret and refine the LOM standard for the needs of this community; it is not creating a new specification. It aims to bridge the gap between the generalities and choices in the standard and the very specific needs of implementers, projects and indexers (Friesen, Roberts and Fisher, 2002). The interest of CanCore is not to compete with or supplant other standards efforts, but to add value strategically to the widely accepted, but difficult to implement, IEEE metadata model (Friesen, Roberts and Fisher, 2002). CanCore recognises that, within the learning technology standards communities, much effort has been expended on the development of bindings and schemas for the purposes of syntactic and systems interoperability, but that generally less attention has been paid to issues of semantic interoperability. It is understood by CanCore that interoperability occurs incrementally and often as a result of deliberate and pragmatic efforts. Ultimately, there is a wide diversity in the communities of practice when adopting metadata for application and that pragmatic solutions are key to facilitating adoption (Friesen, Mason and Ward, 2002: 69).

CanCore combines best practices from existing data models, implementations, and application profiles and explicates its normative decisions and, in so doing, hopes to provide significant direction and assistance to those making decisions about educational metadata. For example, CanCore refers to the Dublin Core semantics and best practices as normative guides. Thus CanCore leverages already developed semantic consensus to promote semantic interoperability among projects referencing the IEEE LOM and also to work toward cross-domain interoperability through mutual reference to the Dublin Core data model (Friesen, Mason and Ward, 2002: 68).

According to Friesen, Roberts and Fisher (2002), the CanCore Metadata Application Profile is a streamlined and well-defined version of a sub-set of the LOM metadata elements. The CanCore element set is derived from the elements and the hierarchical structure of the LOM standard, but it greatly reduces the complexity and ambiguity of this specification. The CanCore application profile consists of 9 categories, 15 "placeholder" elements that designate sub-categories, and 36 "active" elements for which data are actively supplied in the process of creating a metadata record. All elements are optional. The 9 categories used are from the LOM standard (Friesen, Roberts and Fisher, 2002). Friesen, Roberts and Fisher (2002) note that, in providing these simplifications and recommendations, the CanCore application profile has already realised considerable economies of scale for its users. It has worked to remove redundant or inconsistent interpretations and to ensure that learning objects can be shared among their users as effectively as possible with others across Canada and with LOM implementations internationally. An example of such a project is the Campus Alberta Repository of Education Objects (CAREO), a repository initiative with a focus on post-secondary education in Alberta, Canada (Friesen, Roberts and Fisher, 2002).

Friesen, Roberts and Fisher (2002) state that to ensure further coordination and economies of scale, CanCore has developed a set of comprehensive, free guidelines. In the CanCore guidelines, CanCore has utilised every available opportunity to reference established and emerging practices as a way of grounding its normative interpretations (Friesen, Mason and Ward, 2002: 68). The guidelines provide explanations of the meaning and use of each element in the profile, vocabulary refinements, discussions of best practice, examples and detailed technical implementation notes. Additionally, CanCore is planning to provide training and other support and coordination services. Collectively, this allows for an even higher interoperability among vendors, developers and repository efforts. CanCore thus adds considerable value to the LOM standard (Friesen, Roberts and Fisher, 2002).

6.3.6. UK LOM Core

The development of the United Kingdom Learning Object Metadata Core (formerly the UK Common Metadata Framework) stems from the formation of a community of practitioners to identify common UK practice in the use of metadata in packaged e-learning content. UK LOM Core undertook a comparison of twelve metadata schemas based on the LOM standard. The twelve schemas include SCORM (Content Aggregation, SCO, Asset), CanCore, Dublin Core, Learning and Teaching Scotland, NGfL Scotland Content, Facilitating Access to Information on Learning Technology for Engineers (FAILTE), University for Industry (UfI), BECTA National Learning Network (NLN) and Curriculum Online (COL) (UK LOM, 2004b).

As a result of this comparison, a set of guidelines has been developed to inform UK practitioners on the implementation of a minimum common core of LOM elements and associated vocabularies. These guidelines seek to record common practice rather than recommending best practice. The UK LOM Core is essentially an application profile of the IEEE LOM that has been optimised for use within the context of UK education (UK LOM, 2004b). The aim of the UK LOM Core is not to be prescriptive, but rather to identify common practice and provide guidelines for metadata implementers, creators and users. In this respect, the UK LOM Core has been heavily influenced by the work of CanCore. The current draft of the UK LOM Core application profile contains an information model only and is not accompanied by a binding (UK LOM, 2004b). All elements in the UK LOM Core may have the status of mandatory or optional.

6.3.7. Other Application Profiles

There are several other application profiles that have been developed. The Education Network Australia (EdNA) application profile is based on the Dublin Core Metadata Element Set (EdNA, 2003). The purpose of the EdNA Metadata Standard is to support interoperability across all sectors of education and training in Australia in the area of online resource discovery and management.

Another Australian application profile is the Le@rning Federation Application Profile (Friesen, Mason and Ward, 2002: 65). It has been developed to meet metadata requirements in the public education sector in Australia. It references a number of metadata schemas in the including the Dublin Core Metadata Element Set, the EdNA Metadata Standard and the IEEE Learning Object Metadata standard.

Figure 6.1 illustrates a timeline of the development and evolution of the metadata specifications discussed above.

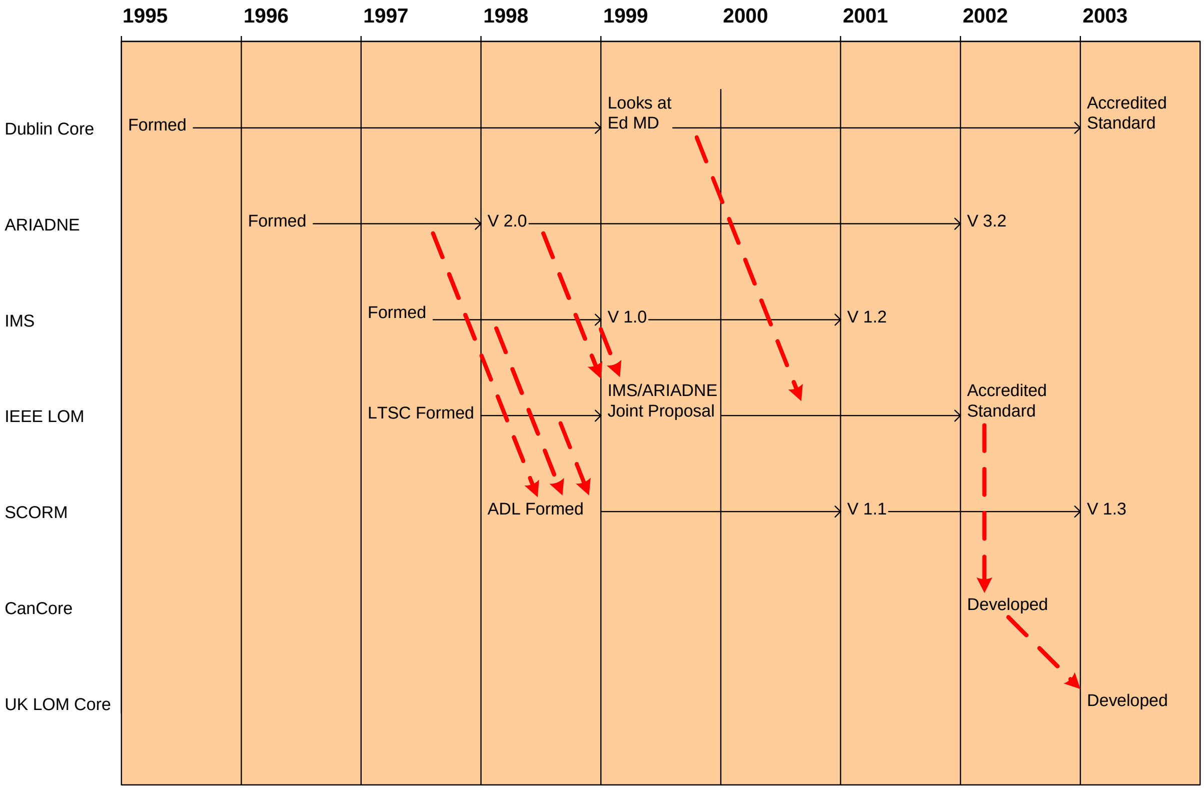

Figure 6.1: Timeline of Metadata Schema Development

6.4 Learning Object Metadata Element Comparison

The following LOM comparison is based on similar comparisons by Anido *et al* (2002: 366) and Friesen and Nirhamo's (2003) analysis of international LOM implementations. The purpose of this comparison is to provide a reference for the learning object metadata elements proposed by the organisations involved in their standardisation. Table 6.1 lists the LOM elements from the specifications discussed above, namely, the Dublin Core, the IMS, SCORM, ARIADNE, CanCore and UK LOM Core.

Table 6.1 lists the LOM elements vertically; the application profiles which include, exclude or otherwise qualify their use are listed horizontally. "M" indicates mandatory elements, while "O" indicates elements that are optional. This overview provides a simple indication of the consistency and divergence of the elements in each application profile (Friesen and Nirhamo, 2003). Unsurprisingly, there is a consistency in the inclusion of elements that have equivalents in the Dublin Core. This is due to the Dublin Core containing a core foundation of metadata elements (Anido *et al*, 2002: 360). There are several elements that are common in all. The importance of these elements, such as <1.2 Title>, <1.3 Language>, <2.3 Contribute> and <4.1 Format> is thus underscored. Similarly, many elements in categories such as <1 General>, <2 Lifecycle>, <3 Meta-metadata> and <6 Rights> have been given mandatory status, highlighting their importance in ensuring interoperability. Most application profiles surveyed have opted to use almost all of the LOM standard elements. This could be to ensure high interoperability or perhaps provide an indication of the completeness of the LOM standard.

	IEEE LOM	Dublin Core	IMS	SCORM Content Aggregate	SCORM Sharable Content Object	SCORM Asset	ARIADNE	CanCore	UK LOM Core
1	**General**		O	M	M	M	M	O	M
1.1	Identifier		O	M	M	M		O	M
1.1.1	Catalog		O	O	O	O	M	O	M
1.1.2	Entry	O	O	O	M	M	M	O	M
1.2	Title	O	O	M	M	M	M	O	M
1.3	Language	O	O	O	O	O	M	O	M
1.4	Description	O	O	M	M	M	O	O	M
1.5	Keyword	O	O	M	M	O			O
1.6	Coverage	O	O	O	O	O		O	O
1.7	Structure		O	O	O	O			O
1.8	Aggregation Level		O	O	O	O	O	O	O
2	**Life Cycle**		O	O	M	O	M	O	M
2.1	Version		O	O	M	O	O	O	O
2.2	Status		O	O	M	O			O
2.3	Contribute		O	O	O	O		O	M
2.3.1	Role	O	O	O	O	O	M	O	M
2.3.2	Entity	O	O	O	O	O	M	O	M
2.3.3	Date	O	O	O	O	O	O	O	M
3	**Meta-metadata**		O	O	M	M	M	O	M
3.1	Identifier		O	O	M	M		O	M
3.1.1	Catalog		O	O	O	O		O	M
3.1.2	Entry		O	O	M	M		O	M
3.2	Contribute		O	O	O	O		O	M
3.2.1	Role		O	O	O	O	M	O	M
3.2.2	Entity		O	O	O	O	M	O	M
3.2.3	Date		O	O	O	O	M	O	M
3.3	Metadata Schema		O	O	M	M		O	M
3.4	Language		O	O	O	O	M	O	M
4	**Technical**		O	O	M	M	M	O	M
4.1	Format	O	O	O	M	M	M	O	O
4.2	Size		O	O	O	O	M	O	O
4.3	Location		O	O	O	O	M	O	M
4.4	Requirement		O	O	O	O			O
4.4.1	orComposite		O	O	O	O			O
4.4.1.1	Type		O	O	O	O	M		O
4.4.1.2	Name		O	O	O	O	M		O
4.4.1.3	Minimum Version		O	O	O	O	O		O
4.4.1.4	Maximum Version		O	O	O	O			O
4.5	Installation Remarks		O	O	O	O	O		O
4.6	Other Platform Requirements		O	O	O	O	O	O	O
4.7	Duration		O	O	O	O		O	O
5	**Educational**		O	O	O	O	M	O	O
5.1	Interactivity Type		O	O	O	O	M		O
5.2	Learning Resource Type	O	O	O	O	O	M	O	O
5.3	Interactivity Level		O	O	O	O	O	O	O
5.4	Semantic Density		O	O	O	O	O		O
5.5	Intended End User Role		O	O	O	O	M	O	O
5.6	Context		O	O	O	O	O	O	O
5.7	Typical Age Range		O	O	O	O		O	O
5.8	Difficulty		O	O	O	O	O		O
5.9	Typical Learning Time		O	O	O	O	M	O	O
5.1	Description		O	O	O	O			O
5.11	Language		O	O	O	O		O	O
6	**Rights**		O	O	M	M	M	O	M
6.1	Cost		O	O	M	M	M	O	O
6.2	Copyright and Other Restrictions		O	O	M	M	M	O	M
6.3	Description	O	O	O	O	O	M	O	M
7	**Relation**		O	O	O	O	O	O	O
7.1	Kind		O	O	O	O	O	O	O
7.2	Resource	O	O	O	O	O		O	O
7.2.1	Identifier		O	O	O	O		O	O
7.2.1.1	Catalog		O	O	O	O		O	O
7.2.1.2	Entry		O	O	O	O		O	O
7.2.2	Description	O	O	O	O	O	O		O
8	**Annotation**		O	O	O	O	O	O	O
8.1	Entity		O	O	O	O	M	O	O
8.2	Date		O	O	O	O	M	O	O
8.3	Description		O	O	O	O	M	O	O
9	**Classification**		O	O	O	O	M	O	O
9.1	Purpose		O	O	O	O	M	O	O
9.2	Taxon Path		O	O	O	O		O	O
9.2.1	Source		O	O	O	O	M	O	O
9.2.2	Taxon		O	O	O	O		O	O
9.2.2.1	Identifier		O	O	O	O		O	O
9.2.2.2	Entry		O	O	O	O	M	O	O
9.3	Description		O	O	O	O			O
9.4	Keyword		O	O	O	O		O	O

Table 6.1: Application Profile LOM Element Comparison

6.5 Analysis of Current Metadata Specifications

The adoption of metadata specifications as part of broad national initiatives, such as SCORM, CanCore and the MERLOT repository, have energised the research and development of learning object repository infrastructure. However, just having learning resources available in standard format does not in itself leverage all the potential of these objects for interoperability and reuse (Halm, 2003: 50). There are a few areas where existing learning object metadata technologies need additional work.

Firstly, Halm (2003: 50) believes that the metadata creation process needs to be less onerous for those contributing resources to learning object networks. Without progress in this area, adoption of these technologies will be slow. Halm (2003: 50) suggests initiatives such as harvesting metadata from files or objects and the use of templates. Secondly, qualitative information about learning objects is still largely missing. This information is critical for making judgements on using a particular resource. Qualitative information needs to be linked directly to the object to help potential educators to make decisions on the incorporation of such materials into a learning experience. MERLOT has used the academic peer review model, where experts individually rate new resources. However, this model is restrictive in that the process of creating qualitative information is limited to how quickly experts can evaluate new resources. The ability to rate the quality of an object, comment on its usefulness or provide specifics on how it is integrated into a learning experience would increase the immediate usability and adoption of repositories and learning objects. Anyone should be able to rate learning objects, but the process needs to be streamlined in order to be successful. Furthermore, Halm (2003: 50) believes that metadata about content quality is not adequately supported in existing metadata specifications.

Halm (2003: 50) adds that there is a need for better methods allowing communities of practice to identify and create their own metadata structures specific to their particular community. This user-created metadata has meaning within the community and is better suited for the community to locate and manage common resources. Metadata schemas need to be more flexible to accommodate this community specific metadata strategy (Halm, 2003: 50). Duval and Hodgins (2003) concur that concerns remain about the best ways to define application profiles and how to translate from one profile to another. Additionally, it can be unclear what kind of community an application profile tries to serve and how the characteristics and requirements of that community have influenced the definition of the profile.

Halm (2003: 50) notes that the same learning object may be used in multiple contexts. Much can be learned about the usefulness of an object if there is an understanding of the many contexts in which the object is used. To enable this, metadata associated with the object would need to articulate its relationship with surrounding objects and report that relationship to the repository. This has the potential to make learning objects more universally useful (Halm, 2003: 50).

The true effectiveness of application profiles will be tested when mechanisms for sharing or exchanging learning objects are put into place. It seems likely that further refinement and collaboration between application profiles will be necessary for them to meet the needs of their stakeholders and of broader, cross-domain interoperability requirements. This is necessary to realise the vision of interoperable and effective resource sharing (Friesen, Mason and Ward, 2002: 69).

6.6 International Survey of LOM Implementations

Friesen and Nirhamo (2003) conducted an international survey of Learning Object Metadata (LOM) implementations on behalf of the ISO/IEC JTSC1 36 Subcommittee for Information Technology for Learning, Education and Training. The survey focused on the semantics of metadata tags - what “goes between” the tags rather than the structure or format of the tags themselves. The survey focused on which elements were used and on what types of values were assigned to them (Friesen, 2004a).

The initial response to a call for metadata records resulted in records from the CAREO repository, ARIADNE, Telecampus, Metakka, Eisenhower National Clearinghouse and LearnAlberta.ca (Friesen and Nirhamo, 2003). Further records were received from the Learning and Teaching Support Network for Economics, Chinese E-Learning Technology Standard (CELTS) and METALAB (France) (Friesen, 2004a). The survey provides an overview of each of these contributing projects. This resulted in a large collection of records from three collections and very small sets from the others. Additionally, records were structured using different versions of the LOM standard. Friesen and Nirhamo (2003) thus decided to follow the approach of randomly choosing a small number of records from each set. Each record was subject to a careful, manual inspection and conspicuous characteristics were noted.

Friesen and Nirhamo (2003) grouped the characteristics revealed in the survey into general element use, employment of element vocabularies and the implementation of the vCard specification (referenced in certain LOM elements). Friesen and Nirhamo (2003) found the following relating to general element use:

- Some complex structures are utilised very effectively and precisely. Some of the more complex aggregate structures including the classification element group and the technical requirements aggregate are used carefully and effectively.
- A small number of the available LOM elements are used. The survey found that only half to a third of "active" elements were populated in a given record.
- Few of the element iterations and field lengths are put to use. In the surveyed records, descriptive information was easily accommodated within the capacity specified for each LOM element.
- Many of the elements used are in the Dublin Core Metadata Element Set (DCMES). The elements chosen for use in the records surveyed had frequent equivalents in the DCMES.
- The use of Educational elements is not necessarily high. Despite the LOM being specifically designed for learning objects, the use of educational elements is sometimes low. This is evident in application profiles such as UK LOM Core and SCORM where all educational elements are left as optional. The educational elements utilised frequently pertain to audience characteristics (such as <5.6 Context> and <5.7 Typical Age Range>).
- Multilingual requirements are accommodated well through element iterations. The use of multiple human languages such as French, English and German were easily accommodated.
- A single title element is utilised for sub-titles and title qualifiers. The LOM allows for only one title for each human language used. Challenges arise with the use of sub-titles, series titles and other titular variations.

Additionally, Friesen and Nirhamo (2003) made several findings regarding the reference and use of vocabularies. Local vocabularies are used frequently, especially for <5.2 Learning Resource Type> and the <4.4 Requirement> aggregate. Sometimes the source of a local vocabulary is not specified, which can cause interoperability problems. Some records displayed inconsistencies in which they referenced local vocabularies and these vocabularies appeared to provide little potential for semantic interoperability. In one case, both local and LOM vocabularies were used in separate iterations to overcome this problem. There are also problems with implementing the vCard specification. Very few instances provided conformant vCard records. Friesen (2004a) believes that this is partly because the vCard syntax is erroneously presented in the IEEE LOM Standard.

Friesen and Nirhamo (2003) conclude that the findings of their survey require further interpretation and speculation about the LOM and its implementation. They, however, do believe that fewer and better defined elements might be more effective than the range of choice and interpretive possibilities currently allowed by the LOM. This is especially true regarding Educational elements, which are surprisingly underutilised for educationally relevant metadata. The need for a smaller number of elements is further supported by the common identification of Dublin Core element equivalents. There are also a number of findings that support the conclusion that a clear and easily supported means of working with local, customised vocabularies would also be very valuable; the means of retaining a minimum of interoperability between these variant vocabularies would also be very valuable. Friesen and Nirhamo (2003) also suggest that it would be useful to ensure that structures are provided to accommodate complex but more conventional aspects of resource description such as multiple title versions and multilingual descriptions.

In the second phase of the investigation, Friesen (2004a) surprisingly found that the LOM is not able to provide easy data portability across collections using conventional database and data-processing technologies. This is due to the variance in the precise data model and bindings upon which they were based. Some record sets and the tools used were based on earlier drafts of the LOM data model. Invalid constructions of vCard bindings resulted in invalid and unparsable vCard records. Additionally, LOM data structures, their number and iteration can be difficult to represent using tabular and relational structures of common database technologies. Native XML databases are usually the best for metadata storage, although these can be costly. The fact that it was found that LOM structures make data portability and reuse difficult using conventional and low cost technologies is of great concern to the educational community.

When analysing which LOM elements are made use of, Friesen (2004a) found that the most frequently used elements are <9.1 Purpose>, <1.2 Title>, <4.1 Format>, <1.3 Language>, <2.3.1 Role> and <5.2 Learning Resource Type>. The highest level of use for a set of elements were the <1 General> and <9 Classification> categories. The use of the <8 Annotation> category and the elements: <1.6 Coverage>, <4.4.1.3 Minimum Version>, <4.4.1.4 Maximum Version>, and <5.4 Semantic Density> were notably absent. Low use was made of the <7 Relation> and <3 Meta-metadata> categories.

When analysing the values assigned to LOM elements, Friesen (2004a) found that the <1.2 Title> element displays distinct patterns in its use in that nearly a third of records examined, used multiple title components. The LOM standard only allows one Title element per record. The vocabulary namespace for <2.3.1 Role> allows the choice of 15 terms including "validator", "editor" and "publisher", however only three of these were used, namely "author", "publisher" and "validator". A variety of the "MIME" types in the <4.1 Format> category are used. However, there is some inconsistency in the manner in which these values are formulated. A variety of local or custom vocabularies were used for the <5.2 Learning Resource Type> element. Most of these refer to the genre or intellectual type of resource such as hypertext or video, rather than to a specific educational application such as assignment or exam. The value space of the classification element <9.1 Purpose> was widely used, with the majority referring to the classification purpose as "Discipline".

Friesen (2004a) concludes that LOM structures need to be revised so that they are not as dependent on costly, native-XML storage and processing technologies. The benefit of using the vCard specification is outweighed by difficulties of implementation. Elements describing intellectual content such as <1.5 Keywords> and the characteristics of the resources such as <4.1 Format> and <5.2 Learning Resource Type> are well-utilised. Elements that attempt to associate an educational context or level such as <1.8 Aggregation Level> and <5.4 Semantic Density> are used much less frequently. Friesen (2004a) notes that elements that are "abstract" like <5.4 Semantic Density> are used less frequently than "tangible" elements like <5.2 Learning Resource Type>. Friesen (2004a) recommends refining the intellectual content and file characteristics of the resource and considering the depreciation of less-used values. Due to the small number of potential element iterations and vocabulary values being used, the complexity and frequency of their occurrence needs to be reviewed. Fewer and more narrowly defined vocabulary values could result in higher semantic interoperability. Friesen (2004a) states that an assumption that the research is based upon is that the way in which the LOM is currently being implemented serves an important basis for defining future metadata requirements and approaches. An analysis of how the LOM is currently used can provide valuable and verifiable evidence for the utility or inadequacy of its components and characteristics.

Godby (2004) performed a LOM application profile analysis retaining all the data from the Friesen (2004a) study and added six other application profiles from different countries. Godby (2004) identified a composite record that would support interoperability across repositories of learning object metadata to provide some measure of confidence that the LOM-defined elements are perceived as useful. This composite record matched the impressions of Friesen (2004a). This included most of the recommended elements mapping to Dublin Core equivalents and the regional variations in application profiles. This composite record lacks many elements to describe the educational, social and technical contexts required for a successful interaction with a learning object. Godby (2004) proposes that the best prospects for interoperability are local application profiles and that interoperability downgrades as institutional, linguistic and cultural boundaries are crossed. Godby (2004) believes that it is premature to assess the prospect for interoperability of LOM records, especially those created by geographically and culturally distant insititutions. Godby (2004) concludes by proposing the notion of two layers of metadata, one defined to be core to maximize interoperability and harvesting, and the other with more local data.

6.7 Metadata for Collaborative Learning Environments

Tamura, Okamoto, Friesen and McGreal (2004) specify that the tacit assumption of LOM standard is that curriculum and learning objects will first be designed and developed by different organisations and professionals, and provided to learners in managed, networked contexts. Each learning object needs to be described through various attributes in systematic and consistent ways to be used and reused. However, LOM appears to focus on individual learning. Collaborative learning incorporates different learning activities whereby learners are able to exchange their opinions and information. Learning materials are not necessarily provided by learning experts or organisations. Instead, learners create the resources themselves and the creation of these resources is part of the learning process. Additionally, the creation of these resources involves the creation of corresponding metadata. Discussions normally include titles, authors, times and dates of composition. This metadata should be captured and structured in the form of standardised metadata to allow for the portability, analysis and reuse of the materials that have been generated in the course of collaborative learning activities (Tamura *et al*, 2004).

The IMS Global Consortium has released a specification for a type of metadata for collaborative learning entitled "IMS Learning Design". This specification is based on Educational Modelling Language (EML) developed at the Open University of the Netherlands. Learning Design represents an integrated view of learning materials, participants, processes and outcomes. Another proposed metadata specification is Collaborative Learning Entity of Metadata (CLEM), which describes collaborative entities as learners, teachers, outcomes and environment (Tamura *et al*, 2004). The features of these specifications introduce a variety of pedagogical strategies to the learning experience, supporting collaboration and adaptability, and leading to new requirements, specifications and improved standards (Halm, 2003: 57).

6.8 Conclusion

Application profiles are a customisation of the LOM standard that maintains interoperability with the broader standard while meeting the requirements of local applications (Friesen *et al*, 2002). This chapter looked at several metadata specifications, namely Dublin Core, IMS, SCORM, ARIADNE, CanCore and UK LOM Core. A comparison of these specification element sets revealed a general consistency in the use of metadata elements. Shortcomings of current metadata specifications were discussed and an international survey of LOM implementations was reviewed which concluded that a lesser number of better-defined LOM elements would be beneficial.

Chapter 7

Metadata Editors and Metadata Creation

Chapter Six reviewed various application profiles based on the IEEE LOM standard. Chapter Seven reviews several metadata editors and implements learning object metadata with the use of one of the metadata editors.

7.1 Introduction

Rehak, Pasini and Blackmon (2003) note that various computer-based tools have been developed to support the process of learning object creation with the aim of simplifying the creation of learning objects. Metadata editors are examples of these tools. The aim of this chapter is to investigate metadata editors and to create learning object metadata using a metadata editor. Firstly, three metadata editors are investigated, namely RELOAD, Metadata Generator Pro and ALOHA. The RELOAD Editor is used to explore the creation of metadata for learning objects. The experiences of creating metadata and the issues encountered are then considered.

7.2 Metadata Editors

A metadata editor is a software tool that supports the process of metadata creation. Chatzinotas and Sampson (2004: 876) classify metadata software tools into two categories.

1. **Generic XML Editors**. This category includes software tools designed to support the creation and editing of files in XML. The user must possess a sound knowledge of XML structure, syntax and namespaces, and as such, these tools are ineligible for most educational metadata authors.

2. **Specific Educational Metadata Authoring Tools**. These tools produce educational metadata compatible with a specific standard. Further software development is required in order to incorporate a new standard. An example of this type of tool is Metadata Generator Pro.

There is a need for a software tool that combines a graphical user interface for easy metadata authoring and at the same time can incorporate new educational metadata standards or application profiles. Chatzinotas and Sampson (2004: 876) have developed eMAP, a tool that incorporates all these features. Another example of such a tool is the RELOAD Editor. The following metadata editors were considered based on their availability and support for various LOM specifications.

7.2.1. RELOAD

Reusable e-Learning Object Authoring and Delivery (RELOAD) is a project funded under the Joint Information Systems Committee (JISC) Exchange for Learning Programme (X4L) in the

United Kingdom. The project focuses on the development of tools that are based on emerging learning technology interoperability specifications. RELOAD tools will be of significant value to JISC and the wider community, since they provide the crucial “missing link” which allows users to author and transfer learning objects, in specification-compliant format, between authoring and design tools, local and distributed digital repositories, and LMS’s (RELOAD, 2004).

Phillip Beauvoir and Paul Sharples from the Bolton Institute of Higher Education in the United Kingdom developed the RELOAD Editor (RELOAD, 2004). The RELOAD Editor offers a definitive content package editor and viewer as well as a metadata editor. It is free, open source and written in Java. The tool will support all aspects of the latest and previous versions of IMS Content Packaging, including IMS Metadata with IEEE LOM (Learning Object Metadata) vocabulary. The current version supports IMS Content Packaging1.1.3, ADL SCORM 1.2 and IMS Metadata 1.2.2. RELOAD Editor also supports the IMS Metadata 1.2.2 XML binding due to the absence, currently, of an IEEE LOM XML binding. IMS Simple Sequencing and Learning Design support will be added later. The RELOAD Editor enables content to be aggregated into different structures and tagged with metadata for exchange between systems and delivery to learners. A package viewer is incorporated to enable both authors and learners to interact with packages produced (RELOAD, 2004).

The IMS Content Package is depicted in Figure 7.1 and consists of a special XML file (known as a manifest file) describing the content organisation and resources in a Content Package and also the physical files being described by the XML. Once a package has been incorporated into a manifest file for transportation, it is called a Package Interchange File (PIF) (IMS, 2004b).

Figure 7.2 provides a screenshot of the RELOAD Editor. The RELOAD workspace consists of three panes: a resources pane (left), a manifest view pane (top right) and an attribute pane (bottom right). The resources pane depicts a tree structure of the files and folders. The manifest pane represents the structure of the content package - containing Metadata, Organisations and Resources. The attribute pane provides information about the individual elements and includes a section with context sensitive information on the currently selected element as well as a table of values and a space for data entry.

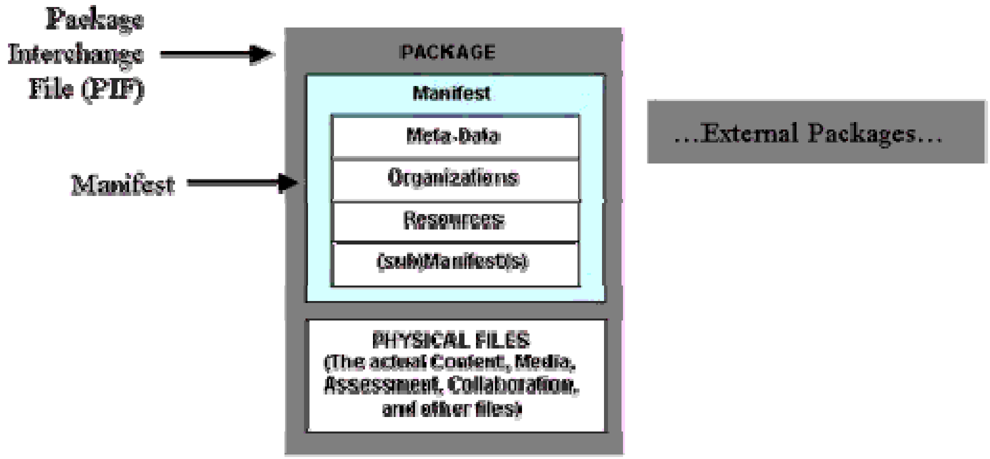

Figure 7.1: IMS Content Package (IMS, 2004b)

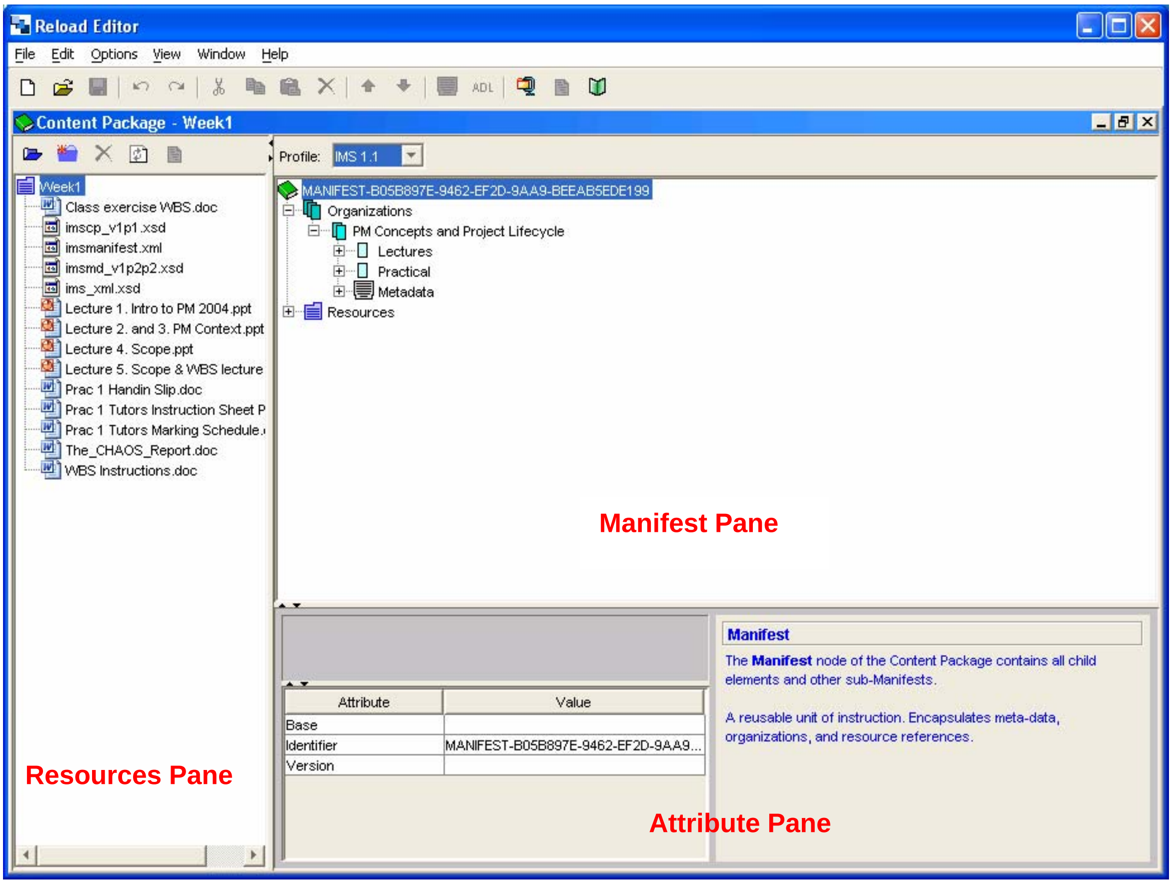

Figure 7.2: RELOAD Editor Screenshot

Rehak *et al* (2003) analysed the RELOAD Editor as an example of the current generation of learning object creation tools. The approach and structure of RELOAD is similar to many other tools. The RELOAD Editor is aimed at simplifying the entry of metadata and exporting the results as an XML file. The tool allows the user to see the actual XML. Rehak *et al* (2003) state that the tool does an adequate job of adding an abstraction layer to hide the XML representation from the user. This helps to eliminate intermediaries and lets users create metadata records directly.

However, Rehak *et al* (2003) believe that RELOAD is less successful in separating the meaning of the metadata and the process of creating metadata from the underlying standard. Firstly, it uses jargon taken directly from the standard and may require someone with cataloguing expertise to use it consistently and effectively. Rehak *et al* (2003) suggest that the vocabulary and terms should be appropriate for and understandable by the user; matched to the domain and their process, and not matched to the standard. Secondly, it structures the data in the linear order used in the standard and implies a linear entry. Some tools go further in imposing more structure such as one sub-form for each metadata category. An ordering is used in the standard simply because the standard must be expressed in a linear form. There is no requirement to carry this linearization forward for data entry. Rehak *et al* (2003) suggest that data should be structured in a meaningful way for the user. According to Rehak *et al* (2003), RELOAD, like many other tools, focuses on how to hide the standard from the user, not how to create, manage and deliver learning objects. Metadata standards are meant to enable developers to realise interoperable technical components. Duval and Hodgins (2004) agree that too many tools and implementations of LOM use the exact same terminology as in the LOM standard document. Terms such as “semantic density” are unlikely to be familiar to communities creating and using such metadata. Although understandable that early implementations of new standards focus on the implementation of the required functionality, the evaluations of the actual experience of end users with these tools will show the failure of this approach (Duval and Hodgins, 2004). Tools should not expose detailed Learning Object Metadata or unnecessarily burden the end user. In order to be successful, metadata should become invisible for end users. The “visibility” of metadata has caused limited penetration of metadata, despite the enormous amount of available digital content. Large communities of practice are required to provide critical elements of relevance and applicability to their disciplines and constituents (Duval and Hodgins, 2004).

RELOAD’s new focus of development is on Learning Design specification tools. RELOAD has handed over the future development of the RELOAD Editor to the Technology Enhanced Learning Conformance - European Requirements and Testing (TELCERT) project.

TELCERT is a major EU-funded project (http://www.opengroup.org/telcert/) which seeks, amongst other things, to build on the RELOAD tools to provide further tools specialised for specific user groups. Amongst its primary activities of relevance to RELOAD will be providing support for application profiles, vocabularies, internationalisation and validation (RELOAD, 2004).

7.2.2. Metadata Generator Pro

JCA Solutions, Inc. is based in Florida, United States and develops software tools for developing distributed learning content. They developed Metadata Generator Pro, a tool used to create SCORM (Sharable Content Object Reference Model)-conformant metadata. Metadata Generator Pro assists users in creating Metadata files which meet the ADL SCORM 1.2 specification (JCA, 2004).

Metadata Generator auto-populates metadata files using a wizard style interface which frees a content developer from knowing XML, and for those who do, Metadata Generator Pro expedites the process of hand coding. JCA Solutions promises that Metadata Generator Pro makes generating metadata quick and easy and contains easy to understand explanations for SCORM metadata categories. This means that Web-based courseware developers who need to meet SCORM specifications can output their courses and course descriptions more rapidly. JCA Solutions declares that using Metadata Generator Pro can cut development time by as much as 60 percent (JCA, 2004). Metadata Generator Pro is an example of a tool imposing increased structure through the deployment of one sub-form for each metadata category as described by Rehak *et al* (2003) and is thus is subject to the same criticisms. Figure 7.3 provides a screenshot of Metadata Generator Pro.

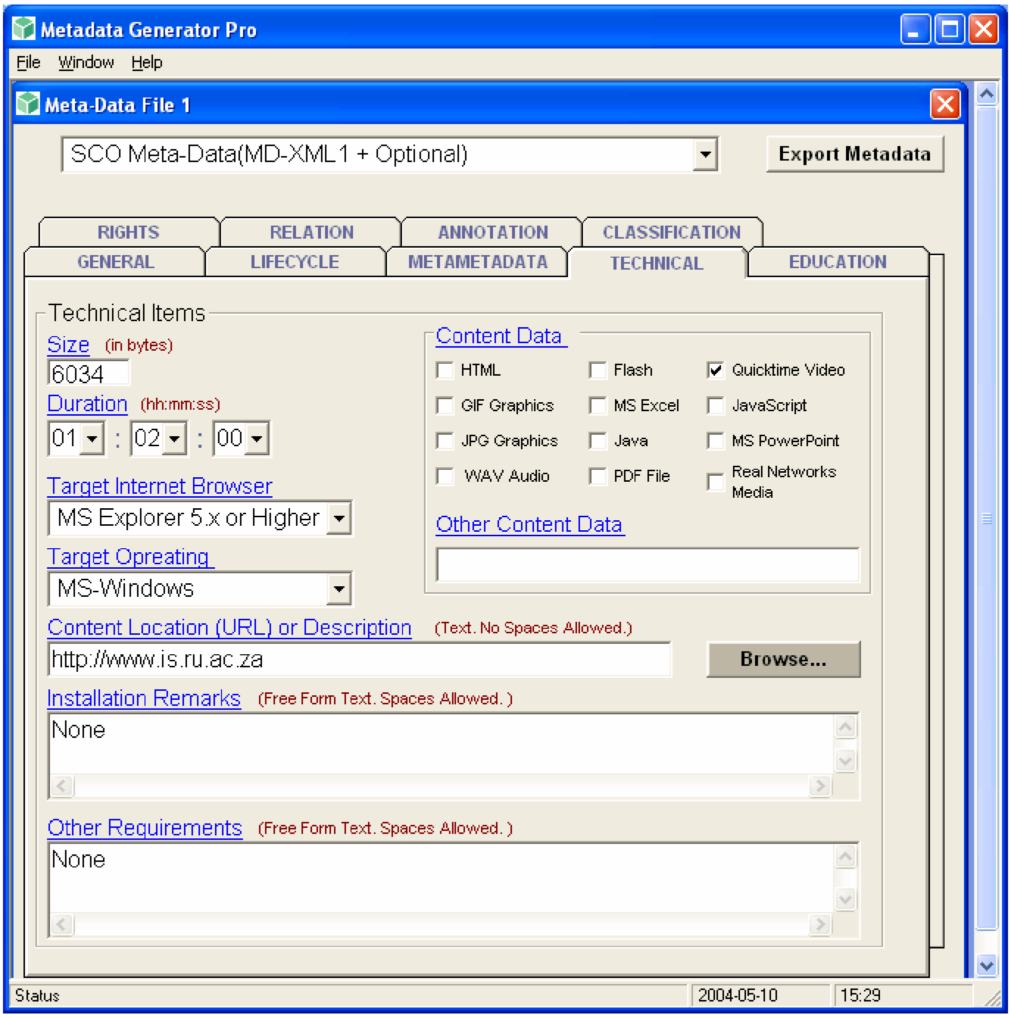

Figure 7.3: Metadata Generator Pro Screenshot

7.2.3. ALOHA

ALOHA (Advanced Learning Object Hub Application) II is a Java-based software project that is being undertaken by the Netera Alliance and the University of Calgary's Learning Commons, in partnership with the Bolton Institute in the United Kingdom (developers of RELOAD). The project represents part of a suite of tools in the eduSource project. The tool has been designed for indexing, aggregating, sharing, multi-purposing, and re-purposing learning objects. It was created to meet the needs of indexers, educators and learners and includes versatile and powerful indexing tools and flexible searching of multiple educational object repositories (ALOHA, 2004). ALOHA II is based on the educational standards of IMS and SCORM. Currently, it is designed to author IMS Learning Object Metadata (IMS LOM), build IMS Content Packages (IMS CP 1.22), build SCORM Sharable Content Objects (SCORM 1.2), and read IMS Vocabulary Definition Exchange (IMS VDEX) files. All of the metadata and packages created by this tool can be placed in online learning object repositories so they can be shared among colleagues and institutions (ALOHA, 2004).

One of the focuses of the second version of ALOHA was to make it much more user-friendly so that educators and content experts could spend more time filling in valuable information about the learning object and less time just trying to understand the educational standards. The new profile builder allows users to build custom forms for their metadata that can be tailored to their individual needs. The creation of simplified and easily understood input forms was seen as crucial to the adoption of these standards by the educational community (ALOHA, 2004). ALOHA II uses the interface and some functionality developed by the developers of the RELOAD Editor. Figure 7.4 provides a screenshot of ALOHA II.

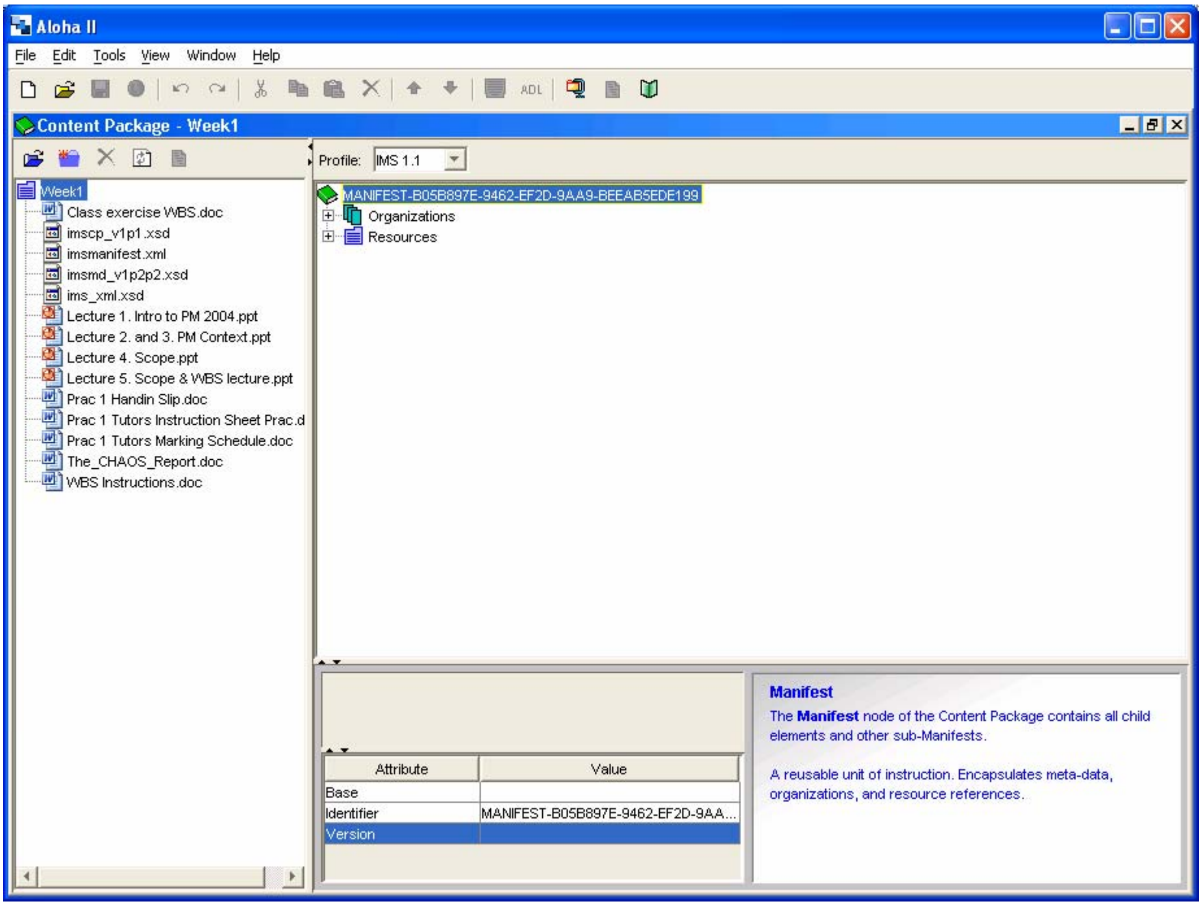

Figure 7.4: ALOHA II Screenshot

The metadata editors were analysed in terms of conformance to the IEEE LOM standard and various application profiles, functionality, ease of use and customisation abilities. Table 7.1 provides an overview comparison of the metadata editors.

Criteria	**Tool**		
	RELOAD	*Metadata Generator*	*ALOHA*
Availability	Available at no charge	Commercially available	Available at no charge
Open Source	Yes	No	No
LOM standard	IEEE	IEEE	IEEE
Application Profiles	All	SCORM	All
Metadata Forms	One	Sub-forms	Both
Current version	1.3	2.0	2.0
Customisable	Yes	No	No

Table 7.1: Comparison of Metadata Generators

7.3 Creating Metadata

This section discusses the process of metadata creation using a metadata editor. It must be noted that, at present, no finalised XML or RDF binding exists for the LOM standard, and consequently no metadata editors exist that comply with IEEE LOM. Thus, the author has used the IMS metadata 1.2.1 XML binding as a practical solution for creating metadata records. The process of creating metadata using a metadata editor was conducted as follows: the learning object content or learning objects were selected or created. Local examples were used in this case. The selection of a metadata editor was required. The author evaluated the metadata editors discussed in the previous section and chose the RELOAD Editor, based on the use of IMS metadata and the availability of the tool.

7.3.1. Analysis of metadata implementation experiences

Learning content was taken from a third-year Information Technology (IT) Project Management module presented in the Information Systems Department at Rhodes University. The module is four weeks in length and is made up of traditional face to face teaching and an online component. The traditional component consists of five lectures and one practical per week. Four of the lectures are devoted to more theoretical concepts while the fifth lecture deals with the practical aspects. The online component consists of the resources that are available for the module, quizzes and forum discussions. The module content comprised: module information, lecture slides, practicals and additional resources. The content was structured into learning objects and metadata was created for each learning object. The learning content was structured into learning content packages using the RELOAD Editor.

The metadata was created based on the IMS Metadata specification (IEEE LOM standard). The content package in RELOAD is demonstrated in Figure 7.5. Figure 7.6 depicts an extract of the RELOAD Editor Metadata form. Appendix A contains an XML metadata file for one of the Project Management learning objects namely, “Risk Management”. Several annotations have been made in the appendix in order to highlight certain features.

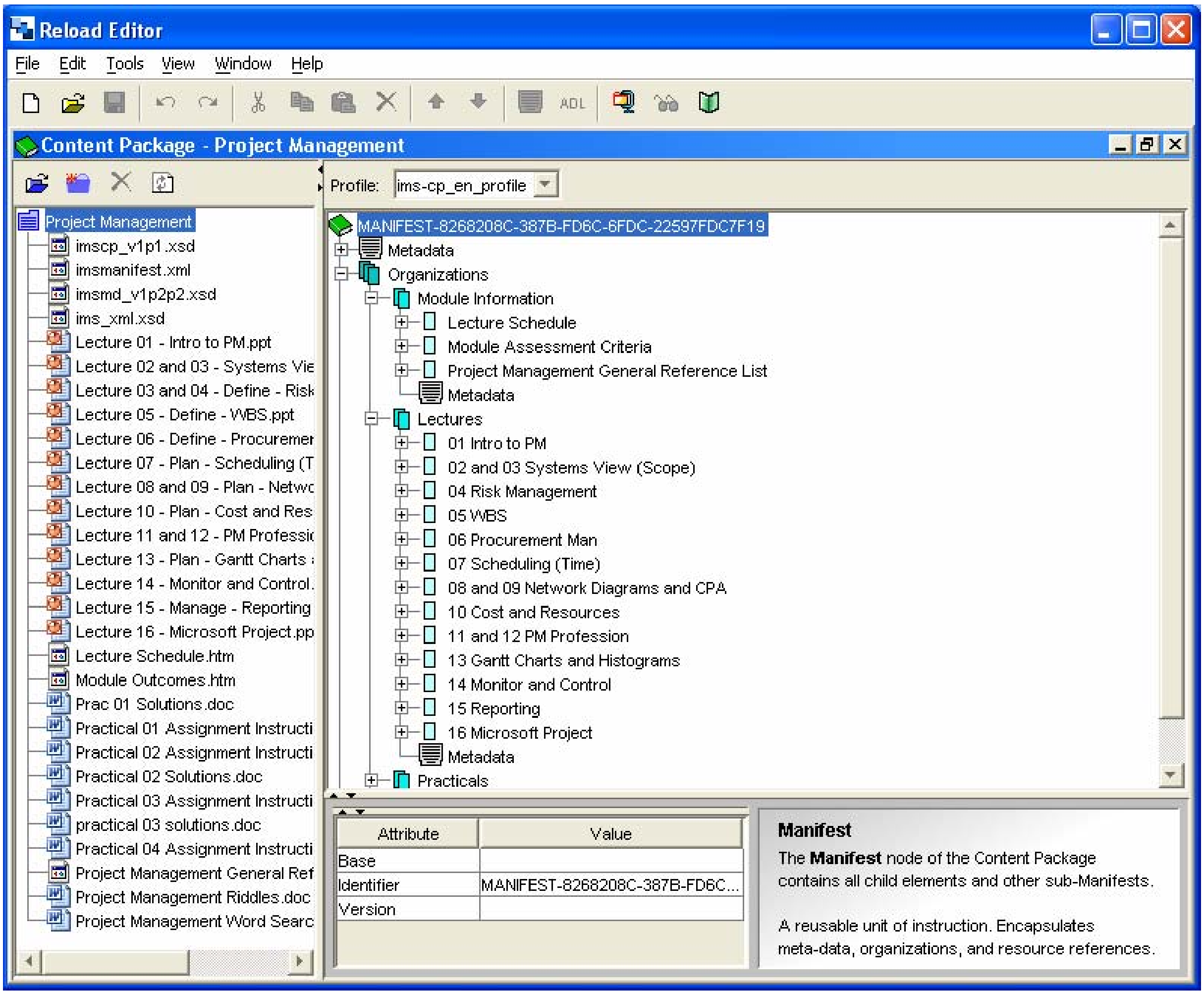

Figure 7.5: Project Management Content Package

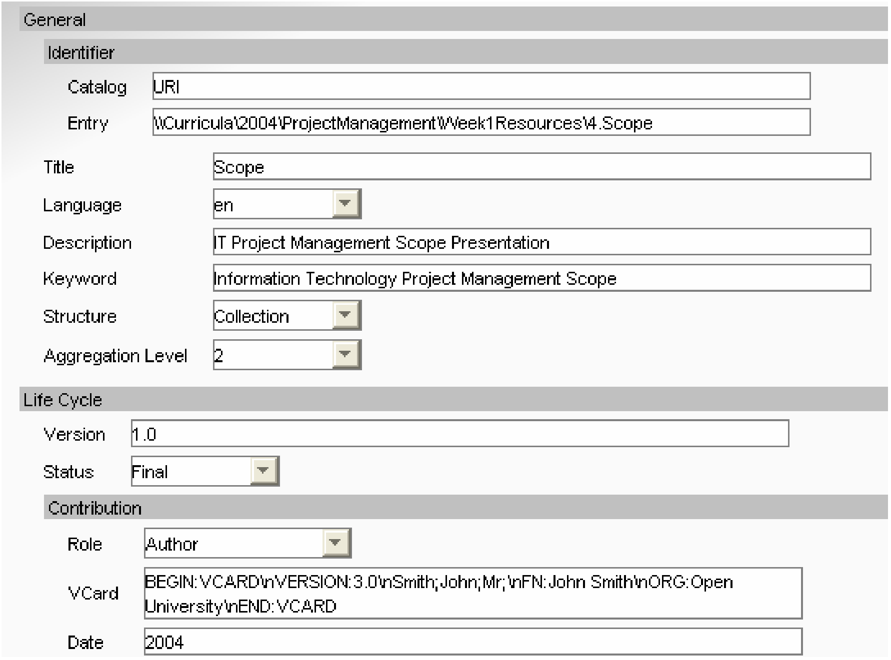

Figure 7.6: RELOAD Metadata Form

As it was found to be very time consuming to create the metadata record for each object, eventually a stand-alone metadata XML file was created. This file could be imported into other metadata records to make the metadata creation a less onerous task. This stand-alone "template" metadata file consisted of elements that did not change from record to record, such as <3.2 Contribute> and elements that could be easily modified, such as <1.5 Keyword>. This rapidly improved the speed of the cataloguing process. The metadata creator applied the guidelines set out in UK LOM Core v0.1, which is based on the IEEE LOM Standard. Reference was made to the CanCore Metadata Guidelines (CanCore, 2003) for further guidance or clarification when required.

7.3.2. Analysis of Experiences using Application Profiles and RELOAD

The experiences of implementing metadata were generally in accordance with the literature reviewed (see Chapter 6: Application Profiles). The experiences can be categorised into two areas: issues arising from using LOM application profiles and issues arising from using the metadata editor.

LOM Application Profiles

1. **Not the author of the content**. As the metadata creator was not the author of the content, it was difficult to describe the content accurately as the intended learning was

not clear in certain cases. For example, the general description of the learning object provided in <1.4 Description> may be divergent to the author's own description. This perhaps supports Currier and Barton's (2003) view of the metadata creator (technical specialist) working together with the content creator (author) to generate the metadata.

2. **Subjective elements**. Related to the previous issue, some fields were found to be unduly subjective and difficult to quantify, for example, <5.8 Difficulty>. However, this may be due to the inexperience of the implementer and may improve with practice. Duval and Hodgins (2003) believe that it is the subjective metadata, rather than the objective metadata, that is more valuable for identifying relevant learning objects.
3. **Elements not used:**

   Certain elements were not used during the implementation process. These are:

   - <1.6 Coverage>
   - <4.4.1.4 Maximum Version>
   - <4.5 Installation Remarks>
   - <4.6 Other platform requirements>
   - <5.1 Interactivity Type>

   It must be noted that these elements may be used for other learning objects or in particular circumstances. For example, <4.5 Installation Remarks> may be required for a ".exe" learning object (such as executable software). All other LOM elements were used.
4. **Classification**. Initially, the implementer used the UK LOM Core and CanCore Guidelines v2.0 recommended usage of the Dewey Decimal Classification (DDC) System for the Classification category. This, however, was found to have limited classification usefulness. As a second attempt, the categories of the current international Information Systems Curricula Guidelines (IS2002) (IS 2002, 2002) were used. This proved to be more useful as the learning content was able to be classified in a more detailed manner. Further (more detailed) classifications using other classification systems seems to be unlikely. However, the Information Systems Curricula Guidelines are very context-specific and may have limited interoperability. Additionally, not all disciplines may be governed by similar curricula guidelines and such additional classification may not always be feasible.

RELOAD Editor

1. **Inserting multiple elements.** RELOAD does not provide simple mechanisms with which to insert multiple elements, for example, inserting multiple technical requirements. Inserting multiple requirements involves moving from Form View to Tree View and then copying and pasting the required element. This quickly proved to require additional and unwelcome effort. However, there were very few data elements that required multiple entries.
2. **Automatic entry**. It is preferable to minimise the number of elements that require manual entry. The use of a metadata "template" helped to minimise manual entry. Additionally, the use of auto-populated metadata fields that do not change within a community would be beneficial. Examples of these elements include <1.3 Language>, <6.1 Cost> and <6.2 Copyright and Other Restrictions>.
3. **Validation.** Most data elements had little or no data validation. This meant that virtually anything could be entered. Although this does allow for greater flexibility, this is most problematic. It is of particular concern for interoperability. Data validation would have been most useful for the vCard and Date value spaces. Currently, data elements can only be validated through manual inspection.

The use of the RELOAD Editor simplified the process of metadata creation and allowed the value space of certain elements to be customised. It must be noted that it may be possible to implement some of the suggested changes above in RELOAD in future versions developed by the TELCERT project. This is a first generation tool and extra functionality will probably be incorporated in future releases.

7.4 Conclusion

The metadata editors investigated all aid in the process of metadata creation and simplified the process of the metadata implementation. However, the editors had certain limitations. It is recognised that these tools are early generation tools and future versions may include greater functionality. The issues encountered from creating metadata can be categorised as those relating to the use of the LOM standard (or application profiles) and those relating to the use of a metadata editor. The experiences and lessons learned from this process can be applied when it comes to developing an application profile based on the IEEE LOM standard for the South African higher education context.

Chapter 8

Development of RU LOM Core

Chapter Seven reviewed metadata editors and described practical experiences of implementing metadata. Chapter Eight describes the development of an application profile for the South African higher education context, namely RU LOM Core.

8.1 Introduction

Friesen, Roberts and Fisher (2002) state that application profiles represent a "customisation" of a standard for the specific needs of "particular communities of implementers with common application requirements". Presently, a Learning Object Metadata (LOM) Application Profile that can be used to describe learning objects within the context of South African higher education does not exist. This chapter introduces and describes the development of the "RU LOM Core" application profile and provides a comparison to other application profiles. The development of RU LOM Core involves the exclusion of metadata elements, a refinement of certain vocabularies (value space restriction) and the enforcement of cardinality in certain LOM data elements.

8.2 RU LOM Core Application Profile

8.2.1. The South African Higher Education Context

Djamen (1995), cited in Lelliott, Pendlebury and Enslin (2001), notes the prevailing viewpoint that the African continent, along with the rest of the developing world, needs widespread access to ICT if it is to compete in a global economy. Much of the African continent remains under-developed and poverty stricken and universal basic education is a long way from occurring (Lelliott *et al*, 2001). However, Lelliott *et al* (2001) state that South Africa is the most technologically advanced of all African countries. Mashile and Pretorius (2003: 133) concur that South Africa is in a unique position with regard to the rest of the developing countries in Africa.

South African universities have been confronted with numerous changes in their external and internal environments since the 1990s. They have been forced to respond to emerging challenges such as continual developments in ICT, shifts in learner expectations, changing demographics of learners and the rapid development of subject knowledge and decreasing financial support (Engelbrecht, 2003a: 38). South African higher education has undergone enormous change in the past few years in order to redress the inequalities of the past and meet the reconstruction and development challenges in South Africa. This includes the transformation and restructuring of many institutions in order to address social and structural inequalities, effectively utilise limited resources and address globalisation challenges (South African Department of Education, 2002).

E-learning increases access and embraces institutional transformation. In developing countries, such as South Africa, academic institutions and educators still experience many challenges. For example, the percentage of individuals with access to higher education is low (Mashile and Pretorius, 2003: 138). South African academic institutions face the challenges of implementing e-learning projects and the associated operational costs as well as the costs involved in training lecturers and providing access to students (Engelbrecht, 2003b: 29). The lack of educator skills is another limiting factor. Most lecturers do not have the skills to develop their own online course materials and depend on ICT support staff and content developers to convert content into digital format for the Internet. Teachers who use educational technology often lack confidence because they have no formal training in using the technology (Mashile and Pretorius, 2003: 133). Lecturers need to change the way they teach and develop learning materials and in the process embrace a new learning model that is appropriate for online teaching and learning (Engelbrecht, 2003b: 29). Teachers require a model to follow in implementing the paradigm shift from transmitters of knowledge to mediators of learning and other roles prescribed by South Africa’s new Outcomes-Based Curriculum.

Mashile and Pretorius (2003: 132) explain that the digital divide is a widespread problem in Africa, and as a result, the lack of technology is the main problem with implementing e-Learning. The digital divide in a developing country constitutes unequal and disproportionate access to digital infrastructure and services (Paul, 2002, in Mashile and Pretorius, 2003: 137). Students in developing countries face challenges that include the lack of computer and Internet access. They are also dependent on an Internet Service Provider (ISP) for the performance of the network. Low speed connections, especially from homes, can cause problems when downloading large files. Additional factors such as computer viruses, technical problems and limited computer skills may inhibit their studies (Engelbrecht, 2003b: 28). Africa has limited connectivity, usually confined to capital cities, with just one Internet user for every 750 people, compared with the world average of one in every 35 (Jensen, 2000, in Lelliott *et al*, 2001). The cost of access to the Internet is high and the usage is relatively limited, while international bandwidth is insufficient due to the high cost and lack of digital circuits.

Opponents of e-learning in developing countries argue that low socio-economic individuals are being disadvantaged by ICT driven education programmes, contributing to the lack of the implementation of these programmes. Academics question the rationale of using sophisticated technology when students stand to be “disadvantaged” by the technology (Mashile and Pretorius, 2003: 132). They believe that South Africa lacks the necessary infrastructure to sustain e-learning as it is a developing country (Mashile and Pretorius, 2003: 133). However, low socio-economic status individuals are disadvantaged by their status and not by ICT. Education and training must create a need for learners to experience ICT and not rely on access to ICT to improve learning (Mashile and Pretorius, 2003: 137).

Lelliott *et al* (2001) warn that e-learning content has the ability to exclude those who are already disadvantaged and increase the education gap and, for this reason, the content and style of the materials produced need to be suited to the social and cultural traditions within the developing country. Dagada and Jakovljevic (2003) investigated e-learning initiatives that were introduced in South Africa and noted that most courses are designed and developed in other countries. Although they comply with the quality standards of international associations, they do not always meet the requirements of South African educational policies, such as Outcome-based Education (OBE), and the qualifications bodies, such as the South African Qualifications Authority (SAQA) and the National Qualifications Framework (NQF) (Dagada and Jakovljevic, 2003). In Africa and the rest of the developing world, patterns of inclusion and exclusion, and empowerment and disempowerment have differed from those of Europe and Northern America. Patterns of educational provision and styles of teaching have also differed (Lelliott *et al,* 2001). Lelliott *et al* (2001) note that much of the content and style of materials produced in developed countries is unsuited to social and cultural traditions in developing countries and may have the effect of excluding people who are already severely disadvantaged. Mansell and When (1998), cited in Lelliott *et al* (2001), warn of major difficulties associated with ICT use in the least developed countries. These include conflicting agendas in curriculum content and the cultural and linguistic dominance of the western English-speaking world.

ICT educational applications have failed in the past due to unsuitability to the technological and organisational infrastructure of the countries concerned. They have been over-specified in terms of their technological sophistication and they have been insufficiently focused on the problem-solving environment (Mansell and Wehn, 1998, in Lelliott *et al*, 2001). It may be relevant that "tangible" metadata elements are used to describe learning objects in developing countries. The educational possibilities of ICT are constrained or enabled both by the technology and the curriculum they transmit and by the context in which they are received. One challenge is to ensure that the "world's stocks of information" are combined effectively with local knowledge (Mansell and Wehn, 1998, in Lelliott *et al*, 2001). Another challenge is to transcend mere information and to transform it into a range of learning activities that meet educational ends. Significant institutional changes are required, otherwise ICT is likely to be used within traditional educational programmes by traditional and often poorly qualified teachers (Lelliott *et al*, 2001). Further challenges are experienced by the cultural and linguistic diversity in South Africa. These issues will all influence the development of RU LOM Core which needs to take cognisance of the current situation in South Africa.

8.2.2. Motivation for RU LOM Core

As part of this study, the development of the Rhodes University Learning Object Metadata Application Profile (known as "RU LOM Core v1.0") was undertaken by the author. It stems from the comparison of several metadata schemas based on the IEEE Learning Object Metadata (LOM) Standard. This comparison has resulted in the development of an application profile to inform learning object practitioners in South Africa on the implementation of a minimum common core of LOM elements. Essentially, RU LOM Core is an application profile of the IEEE LOM that has been optimised for use within the context of higher education in South Africa. The RU LOM Core application profile is thus designed to support the South African higher education community.

RU LOM Core aims to provide guidelines for metadata implementers, creators and users. It has been heavily influenced by the work of the Canadian Core Learning Object Metadata Application Profile (CanCore) and the UK LOM Core.

The descriptions for each metadata element were compiled from the IEEE LOM standard (IEEE LTSC, 2002), the CanCore Guidelines v2.0 (CanCore, 2004) and the UK LOM Core Element and Implementation Guidelines v0.2 (UK LOM, 2004a). Additionally, other metadata schemas were reviewed including ARIADNE, SCORM, DCMES and IMS. All metadata elements included in the IEEE LOM standard and CanCore are optional, while the UK LOM Core categorises some elements as mandatory. CanCore and the UK LOM Core provide metadata implementation guidelines. Figures 8.1, 8.2 and 8.3 provide an extract of each one of these metadata schemas.

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
1	General	This category groups the general information that describes this learning object as a whole.	1	unspecified	-	-	-
1.1	Identifier	A globally unique label that identifies this learning object.	smallest permitted maximum: 10 items	unspecified	-	-	-
1.1.1	Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	"ISBN", "ARIADNE", "URI"
1.1.2	Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies this learning object. A namespace specific string.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	"2-7342-0318", "LEAO875", "http://www.ieee.org/documents/1234"
1.2	Title	Name given to this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	("en", "The life and works of Leonardo da Vinci")

Figure 8.1: Extract from the IEEE LOM Standard

1.1:Identifier *Explanation*	*Size*	*Order*	*Value Space*	*Datatype*
A globally unique label that identifies this learning object.	Smallest permitted maximum: 10 items	unspecified	-	-

Using sub-elements 1.1.1 and 1.1.2, provide a name for the identification scheme and a unique value to identify the learning resource.

1.1:Identifier consists of:

1.1.1:Catalog
1.1.2:Entry

Recommendations for the formulation of globally unique, location-independent, persistent identifiers are available from CanCore at: http://www.cancore.ca/documents/Resourceids.doc.

- This element aggregate refers explicitly to the learning resource being described by the metadata record. It does not refer to the metadata record itself. To supply an identifier for the metadata record, refer to the 3.1:Meta-Metadata.Identifier aggregate element.
- If the resource is non-electronic, use any globally unique identification system for identifying the resource such as an ISBN or ISSN.

Figure 8.2: Extract from the CanCore Guidelines

Nr	Name	Explanation	Size	Order	Value space	Data type	Mandatory Or Optional	UK LOM Core Implementation Guidelines
1	**General**	This category groups the general information that describes this learning object as a whole.	1	unspecified		Container element	Mandatory	
1.1	**Identifier**	A globally unique label that identifies this learning object.	Smallest permitted maximum=10	unspecified		Container element	Mandatory	Use a formal identification system where possible. E.g. DOI, ISBN. Refer to the IMS "Persistent, Location-Independent, Resource Identifier Implementation Handbook" http://www.imsglobal.org/implementationhandbook/imsrid_handv1p0.html for further guidance.
1.1.1	Catalog	The name or designator of the identification or cataloguing scheme fir this entry. A namespace scheme.	1	unspecified	Repetoire of ISO/IEC 10646-1:2000	CharactersString (minimum-maximum: 1000 char)	Mandatory	If the originating organisation has a cataloguing system in place then it should be used, otherwise use the notation of the repository the learning object resides in. Publishers are advised to register with DOI.
1.1.2	Entry	The value of the identifier within the identification or cataloguing scheme that designates or identifies this learning object. A namespace specific string.	1	unspecified	Repetoire of ISO/IEC 10646-1:2000	CharacterString (minimum-maximum: 1000 char)	Mandatory	If the originating organisation has a unique identification system in place then it should be used, otherwise use a GUID following IMS guidelines. http://www.imsglobal.org/implementationhandbook/imsrid_handv1p0.html

Figure 8.3: Extract from the UK LOM Core Element and Implementation Guidelines

The final version of RU LOM Core (v1.1) can be found in Appendix E and consists of a list of metadata elements structured in a tabular format. For each data element, the following are defined.

- *Number* and *Name*: number referencing the LOM and the name by which the element is referenced
- *Explanation*: definition of the data element
- *Size*: number of values allowed
- *Order*: whether the order of the values is significant
- *Value space*: set of allowed values for the data element
- *Data type*: indicates whether the values are LangString, DateTime, Duration, Vocabulary, CharacterString or Undefined
- *Cardinality*: whether the data element is mandatory or optional
- *Guidelines*: metadata implementation guidelines that provide recommendations for using RU LOM Core

8.3 Development of RU LOM Core

As proposed in Duval *et al* (2002) and discussed in Chapter 6: Application Profiles, the development of this application profile has taken place through the exclusion of certain LOM data elements, the restriction of some value spaces, cardinality enforcement and restriction of the order of multiple records. A new element was also added to the application profile. Each of these is detailed in this section. Additionally, examples have been reworked to reflect the new application profile.

8.3.1. LOM Data Elements Excluded

Based on the findings of their international survey, Friesen and Nirhamo (2003) believe that fewer and better defined elements might be more effective than the range of choice and interpretive possibilities currently allowed by the LOM. Thus the development of RU LOM Core has been predicated on providing fewer and better defined elements for the RU LOM Core community of users. The LOM elements excluded from this application profile were excluded based on their exclusion in other application profiles, challenges presented in their implementation or exclusion in the implementation process. The excluded elements are:

<4.4 Requirement>
This data element refers to the technical capabilities necessary for using the learning object. This aggregate element can specify the type, name, and permissible version numbers for the required technology. This element is optional in UK LOM Core. CanCore does not recommend the use of this aggregate element due to the challenges presented in the implementation of this aggregate element. These challenges can be avoided by exploiting other LOM elements. CanCore (2004) notes that it may be difficult to establish and maintain vocabulary values for <4.4.1.2 Name> because browsers and operating systems are developing rapidly and proliferating as they move into wireless devices and information appliances. It is difficult to indicate that certain software is optimal or preferred. Additionally, general software requirements information is already implied in the MIME type values supplied in <4.1 Format>. CanCore recommends the use of <4.6 Other Platform Requirements> for the description of all technical requirements not already indicated by <4.1 Format> and RU LOM Core follows this recommendation. As such, all elements under <4.4 Requirement> are excluded from the RU LOM Core.

<4.4.1 OrComposite>
This data element refers to the grouping of multiple requirements. The composite requirement is satisfied when one of the component requirements is satisfied, that is, the logical connector is "OR".

<4.4.1.1 Type>

This data element refers to the technology required to use this learning object.

<4.4.1.2 Name>

This data element refers to the name of the required technology to use this learning object.

<4.4.1.3 Minimum Version>

This data element refers to the lowest possible version of the required technology to use this learning object.

<4.4.1.4 Maximum Version>

This data element refers to the highest version of the technology known to support the use of the learning object.

<4.5 Installation Remarks>

This data element refers to the description of how to install the learning object. This element is optional in the UK LOM Core and is not used by CanCore. CanCore (2004) refers to the usefulness of this element only in exceptional circumstances where a learning object is stand-alone software requiring special installation procedures. Additionally, these learning objects usually include a "read-me" file or other such installation information, negating the need for this data element. This element was not used during the implementation process.

<5.1 Interactivity Type>

This data element indicates whether the object requires action on the part of the user. The vocabulary ('active', 'expositive', 'mixed') is fairly obscure and not well understood (CanCore, 2004; UK LOM Core, 2004a). Further work is required to develop an understanding of this element and its common usage. Additionally, these characteristics can be described by other elements such as <5.2 Interactivity Level> and <4.1 Type>. This element is optional in UK LOM Core, CanCore excludes it and it was not used during the implementation process.

8.3.2. LOM Data Elements Added

<4.8 Alternative Delivery Formats>

Shen *et al* (2002) note that the LOM standard can accommodate extension mechanisms for localisation. This element is been added to RU LOM Core, in the Technical category, based on the need for such an element in a developing country. In South Africa and other developing countries, there is limited access to technology as noted by Mashile and Pretorius (2003) and others. Additionally, many educators and learners have limited skills in using educational technologies. This element can be used to specify that a learning object, such as an animation file or similar object, may be delivered in an alternative format. For example, a learning object may be printed out for reading purposes or used as an overhead transparency slide.

8.3.3. Value Space Restrictions

Communities may find LOM based vocabularies insufficient and may achieve increased specificity in describing their learning objects by using terms that have high semantic interoperability within that community (IMS, 2004c). The elements with restricted value spaces in RU LOM Core are:

<1.3 Language>

The IEEE LOM standard recognises that to “facilitate the sharing and exchange of learning objects”, the diverse lingual contexts in which learning objects and their metadata will be applied must be taken into account (IEEE LTSC, 2002). This element is enforced as mandatory as South Africa is a multi-lingual society with 11 official languages. Thus several languages are allowed. The default entry for this element is ‘en-ZA’, while allowing for a number of other languages. This is typical of application profiles that support multi-lingual societies such as CanCore’s (2004) support for English and French.

<1.6 Coverage>

Additionally, the IEEE LOM standard also recognises the diversity of cultural contexts in which learning object metadata will be used (IEEE LTSC, 2002). In the LOM standard, this data element refers to the time, culture, geography or region to which the learning object applies. This element is optional in UK LOM Core and it is not used in CanCore. The value space of this element has been limited in RU LOM Core to reflect the cultural context of the object. This element can be used to specify where the learning object has been developed and how it is affected by social and cultural traditions. Conflicting agendas in curriculum content and cultural and linguistic issues may be described. Thus this element can be used to specify that the learning object has been developed for use in Western countries, such as the United Kingdom and whether it is suitable to the social and cultural traditions in developing countries such as South Africa.

<2.3.1 Role>

This element has a value space in LOM that allows 15 possible elements such as “validator”, “editor” and publisher”. Only three of these terms were used during the implementation process and in the international implementation survey conducted by Friesen (2004a). The value space in RU LOM Core comprises:

- Author
- Publisher
- Editor

<5.2 Learning Resource Type>

The use of the IEEE LOM vocabulary is problematic as it includes terms that describe both the form (such as diagram) and the function (such as exam) of the object. In recognition of this, a customised vocabulary is used to describe this element in conjunction with IEEE LOM. This follows the LOM recommendations for element <5.6 Context>: “Suggested good practice is to use one of the values of the value space and to use an additional instance of this data element for further refinement”. The RU LOM Core vocabulary reflects the higher education context through the use of values such as “tutorials” and “lecture presentations”, and is based on the vocabulary used in UK LOM Core. The value space comprises:

- Assessment
- Case Study
- Course Lecture Notes
- Course Module
- Curriculum Syllabus
- Demonstration
- Examination/Test
- Glossary
- Lecture Presentation

- Lesson Plan
- Reading List
- Resource Pack
- Simulation
- Study Guide
- Tutorial/Practical

<5.6 Context>
Similarly to <5.2 Learning Resource Type>, a customised vocabulary is used to describe this element in conjunction with LOM v1.0. The recommended vocabulary for the educational context is now RU LOM Core v1.0. This contains values relevant to the South African educational context, such as "university undergraduate", and is based on the vocabulary used in UK LOM Core. The vocabulary comprises:

- Primary education
- Secondary education
- University undergraduate
- University postgraduate
- Professional development
- Continuing education

8.3.4. Cardinality Enforcement

LOM elements that have been given a mandatory status must be included in all metadata records and can thus ensure greater interoperability between the users of RU LOM Core. All data elements in the UK LOM Core with a mandatory status have been given mandatory status in RU LOM Core v1.0. Additionally, one data element that has optional status within the UK LOM Core has been given mandatory status in RU LOM Core v1.0. This element is <1.5 Keywords>. Although the data element has an optional status within UK LOM Core, it is a recommended data element. It is expected that when educators or learners conduct searches to find learning objects, the keyword field will be an important, often-used search string and will facilitate resource location. Thus, the <1.5 Keywords> element requires mandatory status in RU LOM Core.

8.3.5. Changed Order

The IEEE LOM standard specifies that multiple element records require specification about whether the ordering of the records is significant or not. Where possible, the order status has been changed from “unspecified” to either “ordered” or “unordered” in order to refine the application profile. This is to ensure greater interoperability among the users of RU LOM Core. Additionally, this enables the application profile to be more specific for the relatively unsophisticated user base.

8.4 LOM Application Profile Element Comparison

Table 8.1 lists the LOM elements in the various application profiles. It is an extension of Table 6.1 and adds the elements of RU LOM Core for comparison.

8.5 Conclusion

The development of RU LOM Core serves as a starting point for the description of learning objects in South African higher education and will be refined with use and evaluation by practitioners. This chapter reviewed the development of the RU LOM Core and provided a comparison of application profile LOM data elements. RU LOM Core was developed as an application profile based on the IEEE LOM standard and CanCore, UK LOM Core and other application profiles. An application profile was created that restricted the elements used, designated certain elements as mandatory or optional and specified vocabulary usage (IMS, 2004c). The reason for the development of this application profile is to provide a minimum LOM core for metadata implementation within the context of higher education in South Africa, taking into account the current South African issues. This ensures greater interoperability within the South African higher education context, while retaining flexibility with the LOM standard and wider community.

The application profile will need to be tested through practical use of the application profile. This should provide valuable information for improving RU LOM Core and will enable the refinement of the guidelines and the controlled vocabularies. This will allow for the building up of a community of practitioners.

	IEEE LOM	Dublin Core	IMS	SCORM Content Aggregate	SCORM Sharable Content Object	SCORM Asset	ARIADNE	CanCore	UK LOM Core
1	**General**		O	M	M	M	M	O	M
1.1	Identifier		O	M	M	M		O	M
1.1.1	Catalog		O	O	O	O	M	O	M
1.1.2	Entry	O	O	O	M	M	M	O	M
1.2	Title	O	O	M	M	M	M	O	M
1.3	Language	O	O	O	O	O	M	O	M
1.4	Description	O	O	M	M	M	O	O	M
1.5	Keyword	O	O	M	M	O			O
1.6	Coverage	O	O	O	O	O		O	O
1.7	Structure		O	O	O	O			O
1.8	Aggregation Level		O	O	O	O	O	O	O
2	**Life Cycle**		O	O	M	O	M	O	M
2.1	Version		O	O	M	O	O	O	O
2.2	Status		O	O	M	O			O
2.3	Contribute		O	O	O	O		O	M
2.3.1	Role	O	O	O	O	O	M	O	M
2.3.2	Entity	O	O	O	O	O	M	O	M
2.3.3	Date	O	O	O	O	O	O	O	M
3	**Meta-metadata**		O	O	M	M	M	O	M
3.1	Identifier		O	O	M	M		O	M
3.1.1	Catalog		O	O	O	O		O	M
3.1.2	Entry		O	O	M	M		O	M
3.2	Contribute		O	O	O	O		O	M
3.2.1	Role		O	O	O	O	M	O	M
3.2.2	Entity		O	O	O	O	M	O	M
3.2.3	Date		O	O	O	O	M	O	M
3.3	Metadata Schema		O	O	M	M		O	M
3.4	Language		O	O	O	O	M	O	M
4	**Technical**		O	O	M	M	M	O	M
4.1	Format	O	O	O	M	M	M	O	O
4.2	Size		O	O	O	O	M	O	O
4.3	Location		O	O	O	O	M	O	M
4.4	Requirement		O	O	O	O			O
4.4.1	orComposite		O	O	O	O			O
4.4.1.1	Type		O	O	O	O	M		O
4.4.1.2	Name		O	O	O	O	M		O
4.4.1.3	Minimum Version		O	O	O	O	O		O
4.4.1.4	Maximum Version		O	O	O	O			O
4.5	Installation Remarks		O	O	O	O	O		O
4.6	Other Platform Requirements		O	O	O	O	O	O	O
4.7	Duration		O	O	O	O		O	O
5	**Educational**		O	O	O	O	M	O	O
5.1	Interactivity Type		O	O	O	O	M		O
5.2	Learning Resource Type	O	O	O	O	O	M	O	O
5.3	Interactivity Level		O	O	O	O	O	O	O
5.4	Semantic Density		O	O	O	O	O		O
5.5	Intended End User Role		O	O	O	O	M	O	O
5.6	Context		O	O	O	O	O	O	O
5.7	Typical Age Range		O	O	O	O		O	O
5.8	Difficulty		O	O	O	O	O		O
5.9	Typical Learning Time		O	O	O	O	M	O	O
5.1	Description		O	O	O	O			O
5.11	Language		O	O	O	O		O	O
6	**Rights**		O	O	M	M	M	O	M
6.1	Cost		O	O	M	M	M	O	O
6.2	Copyright and Other Restrictions		O	O	M	M	M	O	M
6.3	Description	O	O	O	O	O	M	O	M
7	**Relation**		O	O	O	O	O	O	O
7.1	Kind		O	O	O	O	O	O	O
7.2	Resource	O	O	O	O	O		O	O
7.2.1	Identifier		O	O	O	O		O	O
7.2.1.1	Catalog		O	O	O	O		O	O
7.2.1.2	Entry		O	O	O	O		O	O
7.2.2	Description	O	O	O	O	O	O		O
8	**Annotation**		O	O	O	O	O	O	O
8.1	Entity		O	O	O	O	M	O	O
8.2	Date		O	O	O	O	M	O	O
8.3	Description		O	O	O	O	M	O	O
9	**Classification**		O	O	O	O	M	O	O
9.1	Purpose		O	O	O	O	M	O	O
9.2	Taxon Path		O	O	O	O		O	O
9.2.1	Source		O	O	O	O	M	O	O
9.2.2	Taxon		O	O	O	O		O	O
9.2.2.1	Identifier		O	O	O	O		O	O
9.2.2.2	Entry		O	O	O	O	M	O	O
9.3	Description		O	O	O	O			O
9.4	Keyword		O	O	O	O		O	O

Table 8.1: Application Profile LOM Elements including RU LOM Core v1.0

Chapter 9

Testing RU LOM Core

Chapter Eight described the development of RU LOM Core. Chapter Nine aims to test the adequacy and suitability of this application profile through practical implementation and a survey.

9.1 Introduction

The aim of this chapter is to report on the evaluation of the RU LOM Core application profile. The profile was tested in terms of suitability for describing learning objects in a South African higher education context as well as interoperability with the IEEE LOM standard. A survey was also conducted that sought to rate the importance of metadata elements. The RELOAD Editor and a LOM Validator tool were used for the testing process. Firstly, the customisation of RELOAD for RU LOM Core is detailed and then the experiences of creating RU LOM Core-conformant metadata in RELOAD are analysed. This is followed by discussion of the testing of the interoperability of RU LOM Core conformant metadata with the IEEE LOM standard. The design and results of the metadata survey are examined and this is followed by a discussion of the modifications to RU LOM Core, based on the testing process.

9.2 RELOAD Customisation for RU LOM Core

The first step in the testing process was to include the RU LOM Core application profile in the RELOAD Editor. By default, RELOAD supports the IMS Metadata v1.2.2 specification and this is the standard application profile. However, RELOAD is able to tailor the metadata form it displays based on any profile with which it is supplied. Developers are offered the choice of loading one of the supplied alternative profiles. These are UK LOM Core v1.0 and LTSN v1.0. Developers may also create their own application profile through the metadata helper structure (RELOAD, 2004).

The RU LOM Core application profile was implemented using the metadata helper structure. There are three directories in this structure: “profile”, “schemahelper” and “vocab”. The profile directory holds the application profiles themselves and these refer to a schemahelper file (which provides help text) and a vocabulary file (which provides the correct vocabulary for a given profile). To add a new profile, one needs to create three XML files: the profile itself, a schemahelper and a vocabulary (RELOAD, 2004). Due to RU LOM Core being based on the UK LOM Core (an existing profile in RELOAD), the relevant UK LOM Core files were copied, renamed and edited. The editing process consisted of going through the elements and sub-elements and making the necessary changes to create the new profile. These changes were based on the development of RU LOM Core (see Chapter 8). The order in which the elements appear can also be changed, as the order in the profile XML file defines the order on the metadata form. This is usually in the order of the LOM standard. The created "RU LOM v 1.0" profile was then set as the default profile in the Metadata Preferences Tab in the RELOAD Editor.

9.3 Analysis of RU LOM Core testing using RELOAD

RU LOM Core was tested through practical use of the application profile in describing learning objects. The process was conducted in the same manner as the previous implementation (see Chapter 7: Metadata Editors and Metadata Creation). This involved creating metadata using the RELOAD Editor for two different sets of learning objects. Firstly, metadata was created describing a second-year Accounting Information Systems (AIS) Theory module presented by the Information Systems Department at Rhodes University in the second semester of 2004. The course consists of several lecture presentations, readings and assessments. Secondly, metadata was created for learning objects for Computer Science 102 (a first year course presented in the second semester by the Computer Science Department at Rhodes University) for the Academic Development Programme (ADP). The ADP is a university-wide programme providing academic support and assistance for students through individual consultations, workshops and extra materials. The ADP objects consist of Java applets or interactive tutorials developed in Flash.

The content was structured into learning objects and metadata was created for each learning object. The learning content was structured into learning content packages using the RELOAD Editor. The metadata was created based on RU LOM Core application profile in order to test the efficacy of the application profile. The AIS Theory content package in RELOAD is demonstrated in Figure 9.1. The Computer Science 102 ADP content package in RELOAD is demonstrated in Figure 9.2.

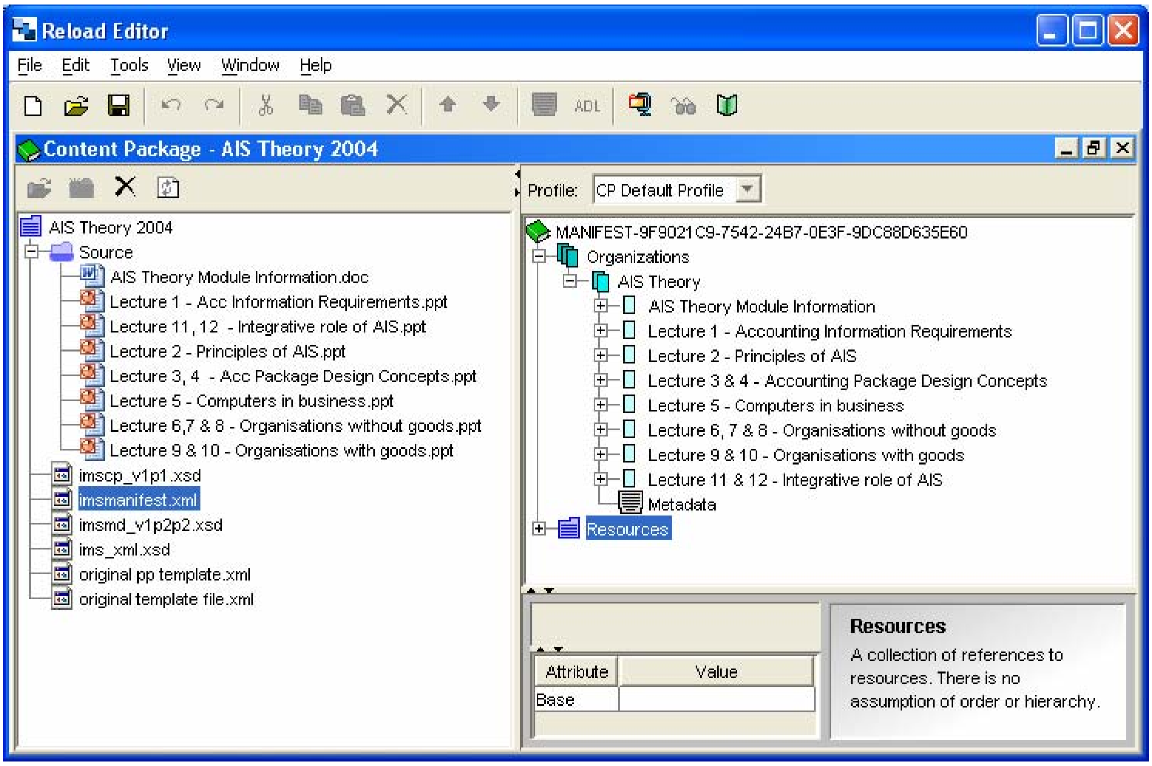

Figure 9.1: Accounting Information Systems Theory Content Package

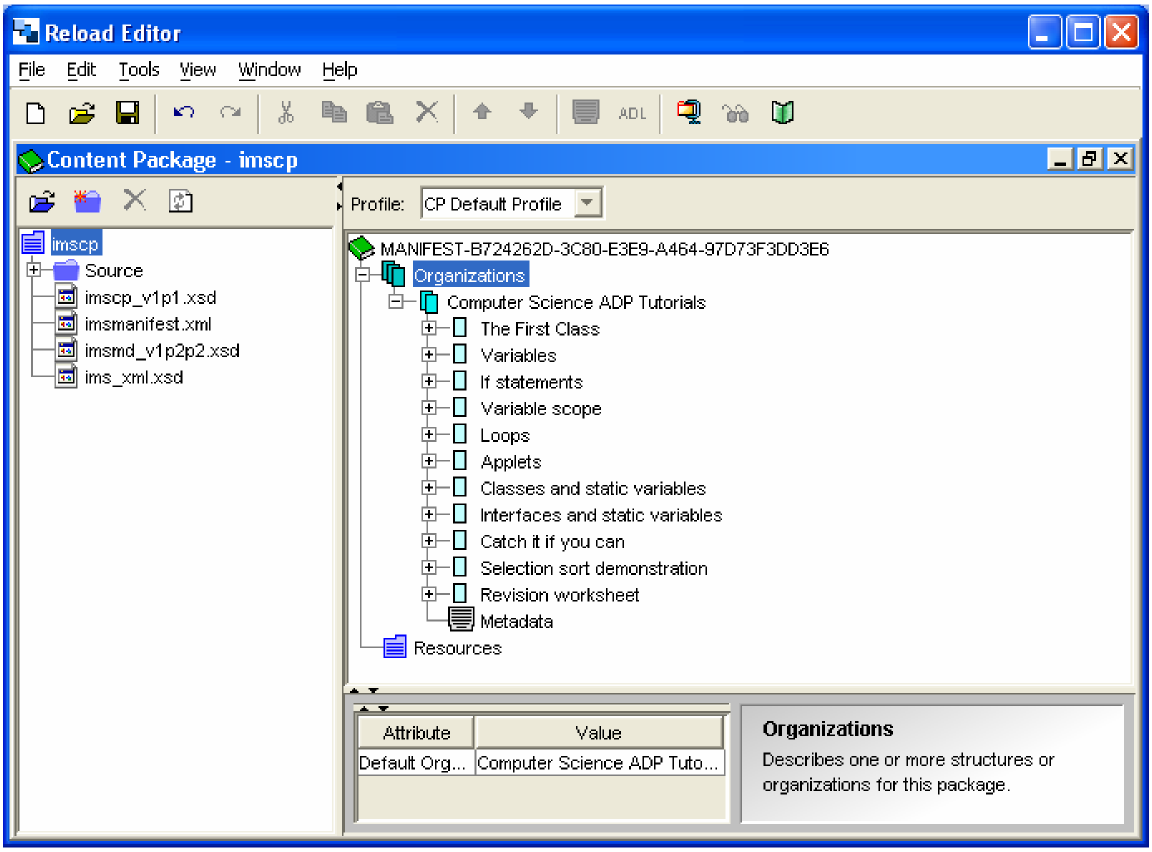

Figure 9.2: ADP Computer Science Tutorials Content Package

As was discovered during the initial implementation process (Chapter 7: Metadata Editors and Metadata Creation), the creation of a metadata record for each learning object proved to be time-consuming. Thus, a stand-alone metadata XML file was again created. This file could be imported into other metadata records to improve the efficiency of the implementation process. This stand-alone ‘template’ metadata file consisted of elements that did not change from record to record, such as <3.3 Metadata Schema> and elements that could be easily modified, such as <1.5 Keyword>. The metadata creator applied the guidelines set out in RU LOM Core v1.0, which is based on the IEEE LOM Standard and the CanCore Metadata Guidelines (CanCore, 2004).

Figure 9.3 depicts an extract of the RELOAD Editor Metadata form, using the RU LOM Core application profile.

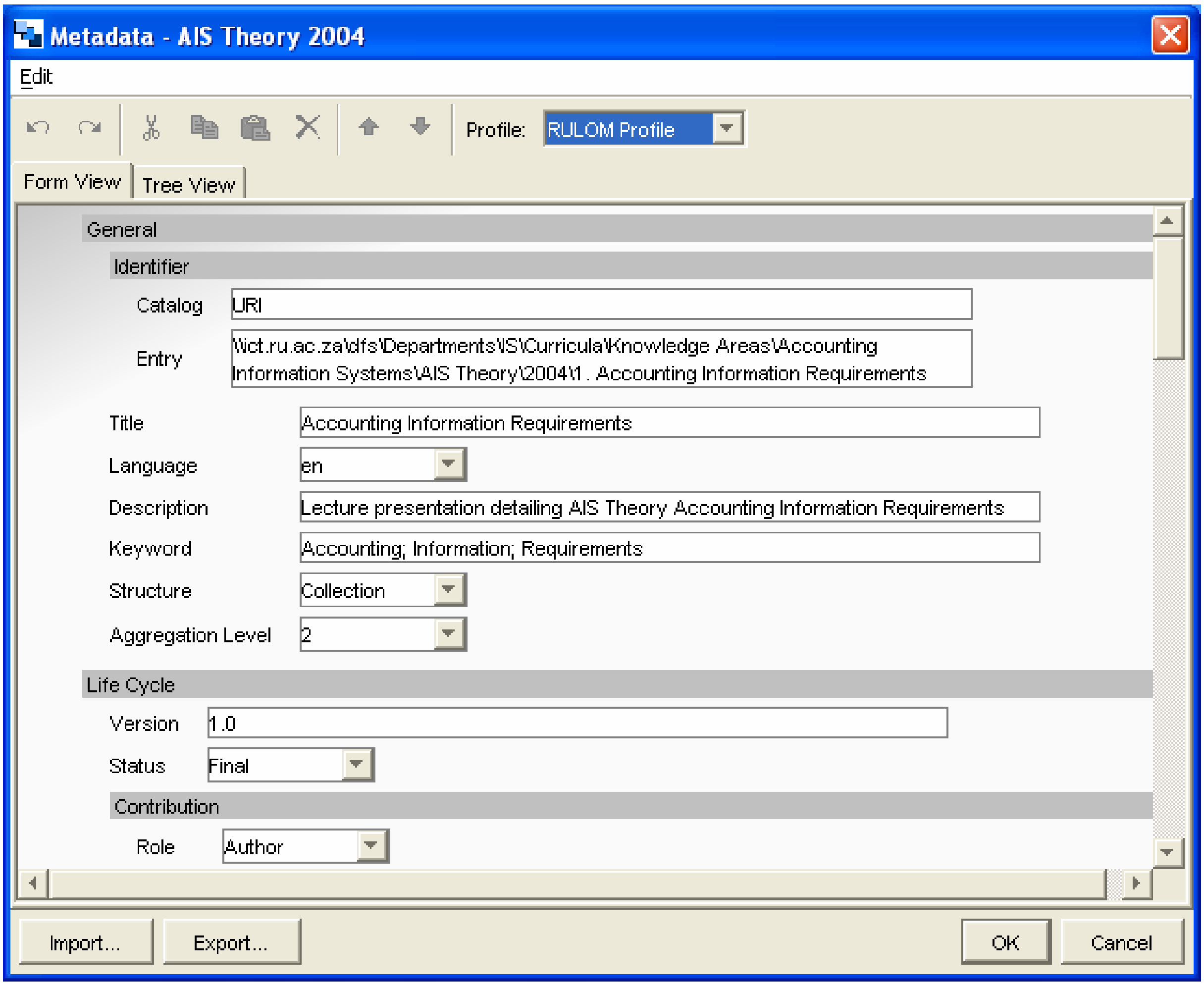

Figure 9.3: RELOAD Editor Metadata Form

The main findings of this testing process were:

- All elements given mandatory status in RU LOM Core were used in the metadata creation process.
- There are problems with the vCard specification as it is incorrectly specified in the IEEE LOM Standard. The vCard properties should be delimited using real line breaks and not the "/n" format. This may cause a lack of interoperability with other application profiles.
- Although some subjective elements are still difficult to quantify accurately, the experience of the previous metadata implementations helped in this regard. Examples of such elements are <1.8 Aggregation Level> and <5.8 Difficulty>.
- Information regarding platform requirements was minimal and the element <4.6 Other Platform Requirements> was found to be sufficient for this task.
- The element <5.4 Semantic Density> was not used in the testing process. It has an optional status in RU LOM Core. CanCore does not recommend the use of this element and UK LOM Core has advised implementers not to use this element due to the relative obscurity of the vocabulary.
- Only the vocabulary items "Teacher" and "Learner" were used during the process for element <5.5 Intended End User Role>. The vocabulary items "Manager" and "Author" were not used.
- The element <5.9 Typical Learning Time> was not used in the testing process. It has an optional status in RU LOM Core. UK LOM Core has advised implementers not to use this element due to the difficulties in defining it.
- The elements <9.3 Description> and <9.4 Keyword> were not used in the Classification process. These elements were detailed sufficiently in <1.4 Description> and <1.5 Keyword>. The elements <9.3 Description> and <9.4 Keyword> have been excluded from RU LOM Core. The learning objects were classified according to the Dewey Decimal Classification (DDC) system, which proved to be a sufficient classification system.

Appendices B and C represent a sample of the exported XML metadata files for a learning object from RELOAD. The metadata file in Appendix B represents a metadata instance for the "Accounting Information Requirements" learning object. The metadata file in Appendix

C represents a metadata instance for the “Computer Science 102 ADP Tutorial” learning object.

9.4 Testing the Interoperability of RU LOM Core

This section discusses testing the interoperability of RU LOM Core with other application profiles and the IEEE LOM Standard. It must be noted that the IEEE standard for Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata is still in draft form (IEEE LTSC, 2004). This standard allows the creation of LOM instances in XML. Thus current systems may make use of different versions of the standard, leading to interoperability problems.

Chris Hubick (2004), of Athabasca University in Canada, has made available a preliminary version of a Learning Object Metadata (LOM) validator. This service can be used to validate IEEE LTSC LOM XML conformant metadata against the LOM-XML Schema, and the vCard data can be run through a vCard (VCard4J) parser. The Java software behind this service is provided under the terms of the GNU LGPL Free Software License (Hubick, 2004). Metadata documents can be validated via an upload form or by providing a URL address and are validated against the LOM-XML Schema. The vCard data is run through a vCard parser. If validation fails, an error message is returned, otherwise the service returns the valid metadata document. Metadata documents developed using RELOAD were validated and returned errors. There are a number of common validation problems experienced in using a LOM validator (Hubick, 2004). These may include:

- The LOM XML must use the “http://ltsc.ieee.org/xsd/LOM” namespace.
- VCard properties must be delimited using real line breaks (ASCII code pair (10,13), XML Entities
), not “\n”.
- VCards must contain N, FN, and VERSION properties.

Although the RELOAD Editor uses the correct namespace and uses all the required vCard properties, the RELOAD-created metadata documents cannot be validated as RELOAD does not yet follow the vCard specification as used by the LOM Validator (properties delimited using real line breaks). It is expected that when the final version of the XML binding standard is released, RELOAD will update its XML schema accordingly. This is supported by the findings of the international survey conducted by Friesen (2004a), where very few instances provided conformant vCard records.

9.5 Metadata Survey

9.5.1. Introduction

An electronic survey was conducted with the purpose of investigating the need for and awareness of metadata for describing learning objects in Southern Africa and as an evaluation mechanism for RU LOM Core. The respondents of the survey were people interested in deploying educational technologies in the Southern African region.

9.5.2. Survey Design

The survey can be found in Appendix D. The structure of the questionnaire consists of numerous questions categorised into three sections. Section A concerns respondents' demographics (home region, experience with educational technologies, education sector), Section B concerns the respondents' awareness of metadata and Section C details metadata elements. Section C makes use of a five-point Likert scale (Very important, Somewhat Important, Neutral, Little importance, and No importance) to rate the importance of different metadata elements. These elements were derived from the metadata elements in RU LOM Core v.1.0.

A pilot study was performed. The survey was piloted in the Department of Information Systems, before being published on the web. As a result of the pilot, questions were reformulated in order to increase their clarity. A demographic question was added that asked respondents to indicate their experience with using educational technologies.

The administration of the survey was facilitated through the use of Questionmark Perception 3.2 and was conducted electronically, via the web. Respondents had to click on a hyperlink to access and complete the survey online. The survey responses were saved on the Perception-server located in the Department of Information Systems at Rhodes University.

The population of the survey consists of people interested in deploying educational technologies in the Southern African region. A request for participation in the survey and a hyperlink was e-mailed to two relevant mailing lists. The survey was sent to the SANTEC and CATTS mailing lists. This section provides an overview of these organisations.

Southern African Network for Educational Technology and eLearning (SANTEC)

The purpose of SANTEC is to provide an enabling network of educational technology and e-learning practitioners with an interest in developing environments in order to facilitate and support collaborative ventures amongst members (SANTEC, 2004). SANTEC draws together individuals, institutes of higher education, industrial organisations and other institutions in Southern Africa and beyond, as a community of practice in a financially sustainable programme of research, training and professional services in educational technology and e-learning. SANTEC began its operations on 5 June 2003 and now has more than 550 members both within SADC and internationally (SANTEC, 2004).

Computer Assisted Teaching and Training Society (CATTs)

CATTs is a society comprising current and past students of the Masters degree in Computer-Assisted Education class at the University of Pretoria, in South Africa, most of whom work in the computer-assisted education environment (CATTs, 2001).

9.5.3. Survey Results

Unfortunately, the response to the calls for participation in the survey was limited. A total of sixteen responses were received for the survey.

SECTION A: DEMOGRAPHICS

1. Region of residence

13 respondents are from a Southern African Development Community (SADC) country, while 2 respondents are from a non-SADC Country. 81% of the respondents are thus involved within the field of educational technology within Southern Africa.

	Count	Percent
SADC Country	13	81
Non-SADC Country	2	13
No response	1	6
Total	**16**	**100**

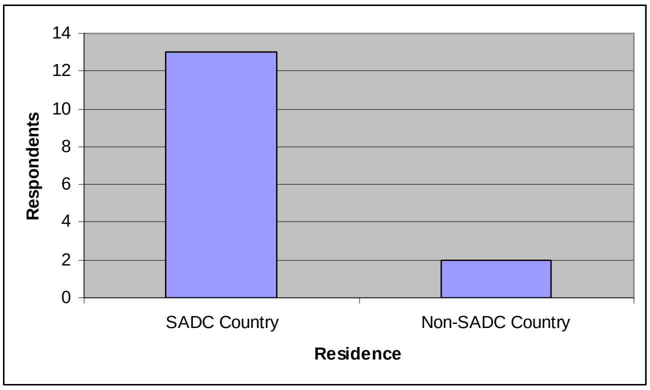

Figure 9.4: Respondents by Country of Residence

2. Number of years experience working with educational technologies

3 respondents have fewer than two years' experience, 3 have between three to five years' experience, 8 have between six and ten years' experience, while 2 have more than ten years' experience. Several participants have therefore some, or considerable experience in working with educational technologies.

	Count	Percent
Fewer than 2 years	3	19
3 - 5 years	3	19
6 - 10 years	8	50
More than 10 years	2	12
Total	**16**	**100**

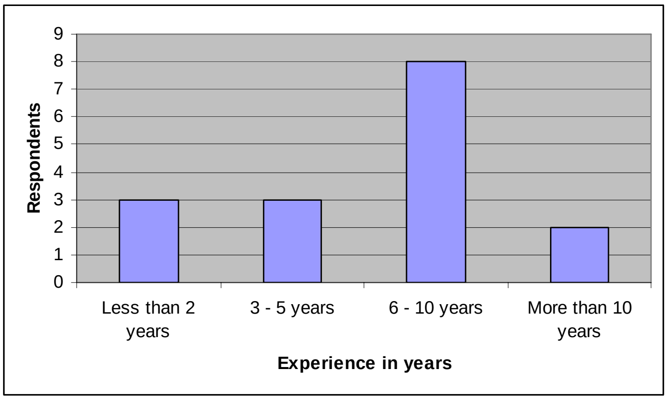

Figure 9.5: Respondents by Experience with Educational Technologies

3. Educational sector

None of the respondents work in primary education, 3 work in secondary education, 7 work in tertiary education, 3 work in corporate training, while 3 others work in a cross-section of most, or all, of these fields. Most of the respondents thus work within the field of higher education.

	Count	Percent
Primary Education	0	0
Secondary Education	3	19
Tertiary Education	7	43
Corporate Training	3	19
Other	3	19
Total	**16**	**100**

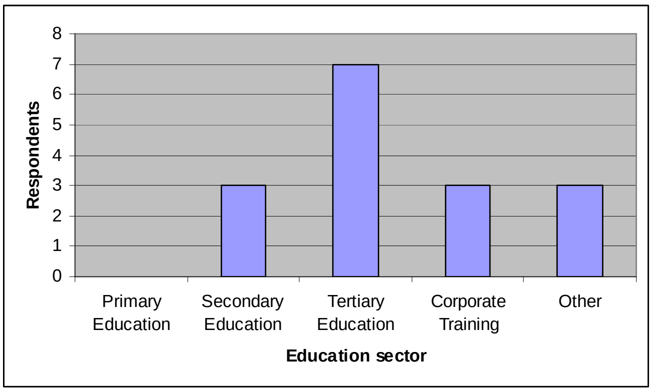

Figure 9.6: Respondents by Education Sector

SECTION B: METADATA AWARENESS

1. Perceived Need for Metadata

5 respondents are currently involved in projects where the need for metadata has been identified. These projects include developing a Learning Management System and the development of a digital repository. 8 respondents are not currently involved in any such projects. However, several respondents aim to develop such projects, including developing a repository, and reusable objects. Other respondents indicated that metadata could be used for the development of product documentation and objects used in different modes of learning. One respondent cited a lack of information as a barrier to adoption.

	Count	**Percent**
Yes	5	31
No	8	50
No response	3	19
Total	**16**	**100**

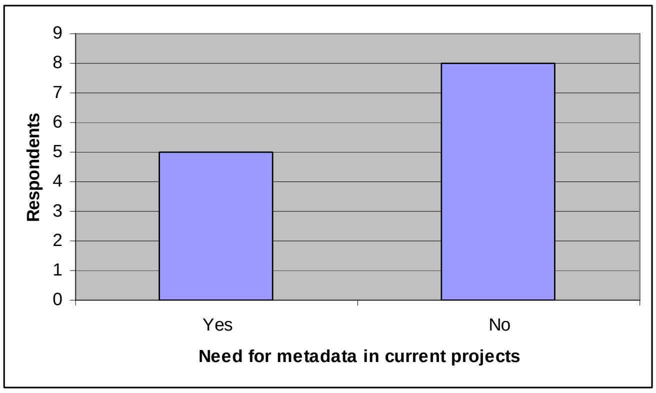

Figure 9.7: Respondents by Need for Metadata in Current Projects

2. Awareness of metadata specifications

Respondents were asked to indicate their awareness of metadata specifications. More than one specification could be selected. The awareness of international metadata specifications was found to be generally limited. 8 respondents are aware of SCORM, 4 of the Dublin Core, 6 of IEEE LOM, 4 of IMS metadata. No other metadata specifications were suggested. One respondent is involved in facilitating SCORM-training courses.

	Count	Percent
ADL SCORM	8	37
Dublin Core	4	18
IEEE LOM	6	27
IMS Metadata	4	18
Other	0	0
Total	**22**	**100**

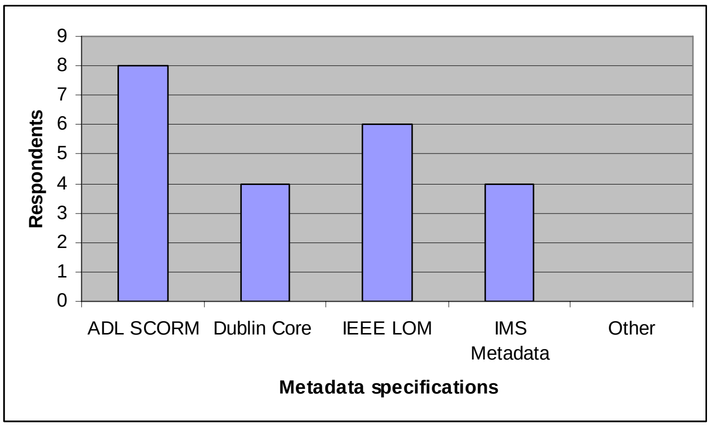

Figure 9.8: Respondents by Metadata Specifications

SECTION C: METADATA ITEMS

In this section, respondents had to rate the priority of metadata items considered to be important when searching or browsing for digital learning content. The metadata elements were grouped into the nine categories of the IEEE LOM standard (IEEE LOM, 2002). The elements were derived from the elements in the RU LOM Core application profile. Certain aggregate elements such as in the <9 Classification> category were represented as one element in order to simplify the survey.

1. General Category

This category was found to be very important, particularly the <Description>, <Keywords> and <Accessibility> elements. The rating of <Accessibility> as “Very important” by all respondents indicates the relevance of including accessibility in e-learning specifications. Although <Accessibility> is not a metadata element included in RU LOM Core, it was included in the survey to assess the relevance of including accessibility considerations in e-learning specifications. It is noted that the CEN-ISSS (Accessibility Properties for Learning Resources) (APLR) Project is developing an accessibility application profile of the IEEE LOM standard that will work with the IMS AccessForAll Specifications (IMS: 2004b). Thus accessibility considerations will be included in future such specifications.

	Very important	Somewhat important	Neutral	Little importance	No importance	No response
Unique Identifier	7	0	2	0	0	7
Title	4	4	1	1	0	6
Language	5	3	1	0	0	7
Description	4	5	0	0	0	7
Keywords	7	2	0	0	0	7
Coverage	3	3	1	1	0	8
Accessibility	9	0	0	0	0	6

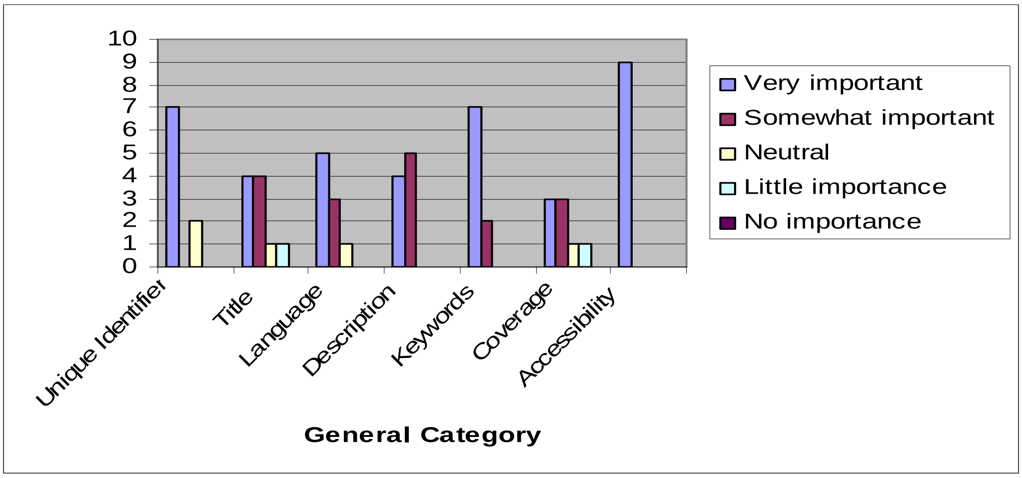

Figure 9.9: General Category Element Ratings

2. Life Cycle Category

The elements in the Life Cycle category were found to be somewhat important.

	Very important	Somewhat important	Neutral	Little importance	No importance	No response
Version	0	3	1	1	0	11
Status	0	3	1	1	0	11
Contributor	0	4	0	1	0	11

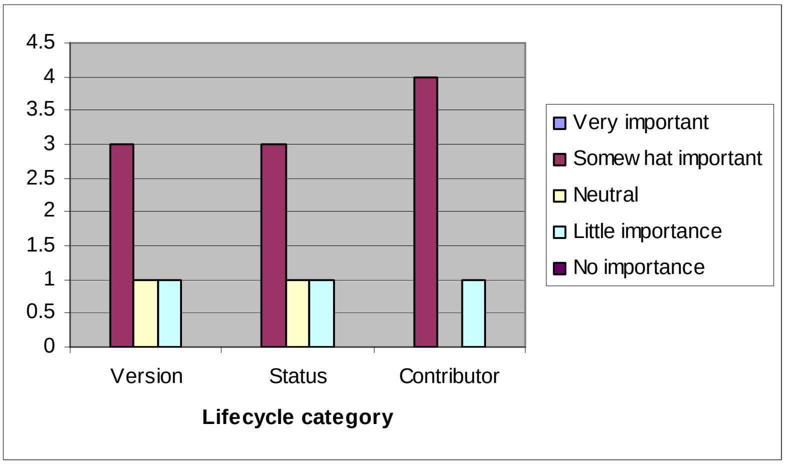

Figure 9.10: Life Cycle Category Element Ratings

3. Meta-metadata Category

The elements in the meta-metadata category were found to be of mixed importance. The metadata identifier was found to be the most important element in this category.

	Very important	Somewhat important	Neutral	Little importance	No importance	No response
Metadata identifier	5	2	1	0	0	8
Contributor	2	4	1	1	0	8
Metadata language	1	5	2	0	0	8
Metadata schema	0	4	3	1	0	8

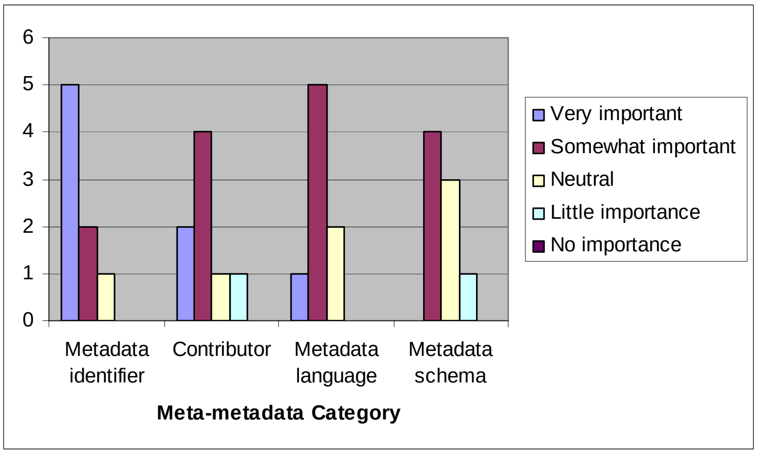

Figure 9.11: Meta-metadata Category Element Ratings

4. Technical Category

The elements in the Technical category were rated as considerably important. The <Format>, <Size> and <Location> elements were considered to be the most important in this category. The unique RU LOM Core element, <Alternative Delivery Format> was found to be somewhat important. However, the vocabulary of this element may be used for accessibility considerations, thus enhancing the value of this element.

	Very important	Somewhat important	Neutral	Little importance	No importance	No response
Format	8	0	1	0	0	7
Size	6	3	0	0	0	7
Location	6	2	1	0	0	7
Other requirements	3	5	0	1	0	7
Alternate delivery	2	4	2	1	0	7

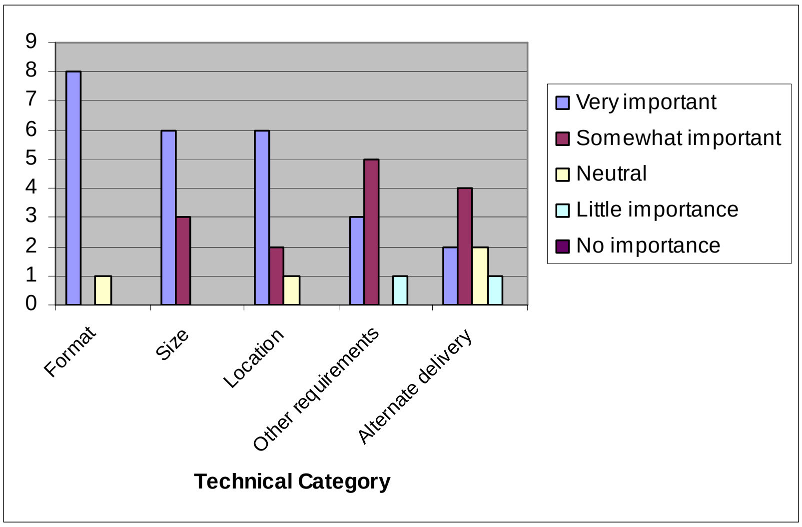

Figure 9.12: Technical Category Element Ratings

5. Educational Category

The elements in the educational category were found to be of mixed importance. More easily quantifiable elements such as <Resource Type> and <Context> were considered to be more important than subjective elements such as <Difficulty>. This supports the findings of Friesen (2004b), where "abstract" elements are used much less frequently.

	Very important	**Somewhat important**	**Neutral**	**Little importance**	**No importance**	**No response**
Resource type	4	4	1	0	0	7
Interactivity level	2	5	1	1	0	7
End user	2	5	1	1	0	7
Context	5	2	1	1	0	7
Age range	1	4	0	3	1	7
Difficulty	2	1	4	2	0	7

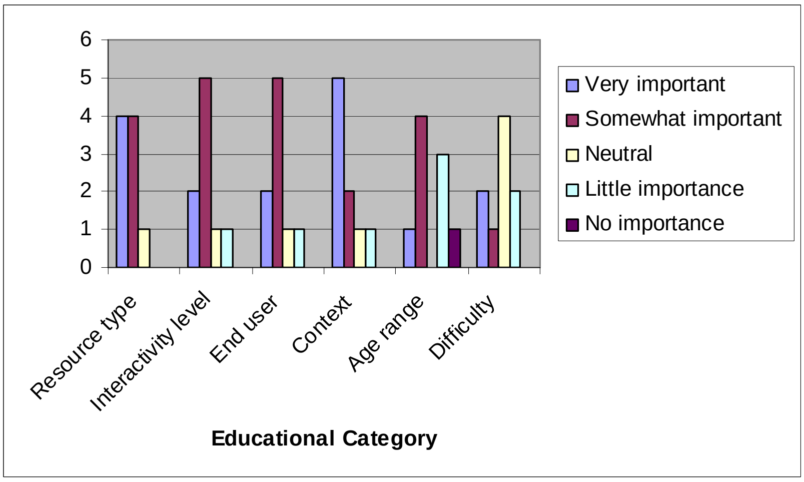

Figure 9.13: Educational Category Element Ratings

6. Rights Category

The elements in the rights category were rated as being considerably important.

	Very important	Somewhat important	Neutral	Little importance	No importance	No response
Cost	7	2	0	0	0	7
Copyright	5	3	0	0	0	8

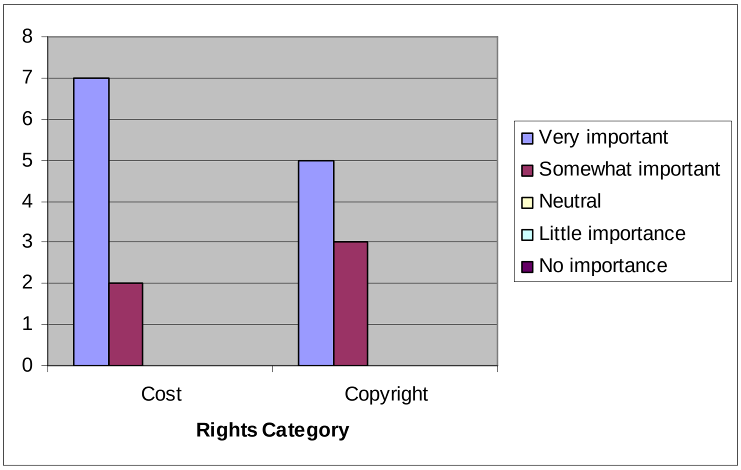

Figure 9.14: Rights Category Element Ratings

7. Relation Category

The elements in this category were aggregated into one element for the purposes of this survey. The relationship to other learning objects was rated as being mostly "somewhat" important.

	Very important	Somewhat important	Neutral	Little importance	No importance	No response
Relation	2	4	2	1	0	7

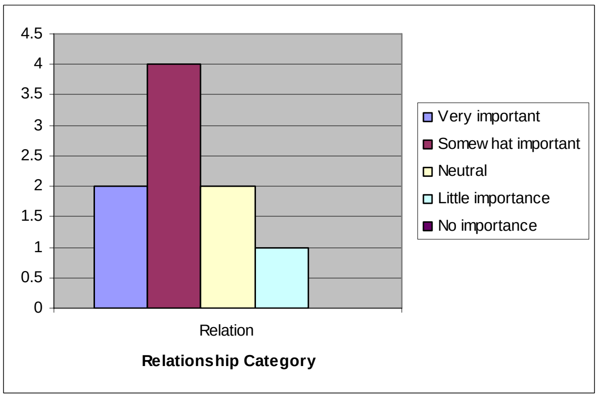

Figure 9.15: Relation Category Element Ratings

8. Annotation Category

The elements in this category were aggregated into one element for the purposes of this survey. The actual educational experience of using the learning object was found to be mostly "somewhat important".

	Very important	Somewhat important	Neutral	Little importance	No importance	No response
Educational experience	1	5	2	1	0	7

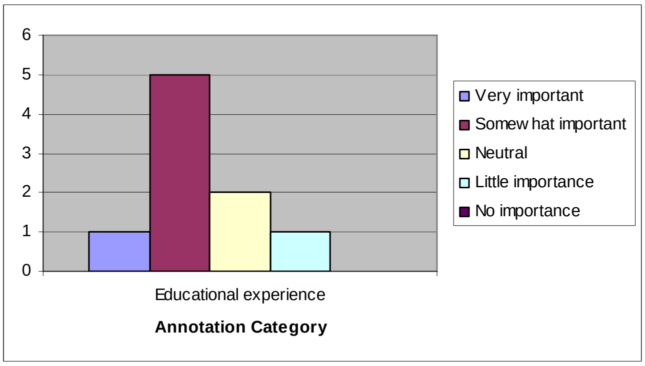

Figure 9.16: Annotation Category Element Ratings

9. Classification Category

The elements in the complex aggregate set of <Classification> elements in this category were aggregated into one element for the purposes of this survey. Most of the respondents considered that the <Purpose> and the Classification elements to be very important.

	Very important	Somewhat important	Neutral	Little importance	No importance	No response
Purpose	6	1	1	1	0	7
Classification	5	1	1	2	0	7

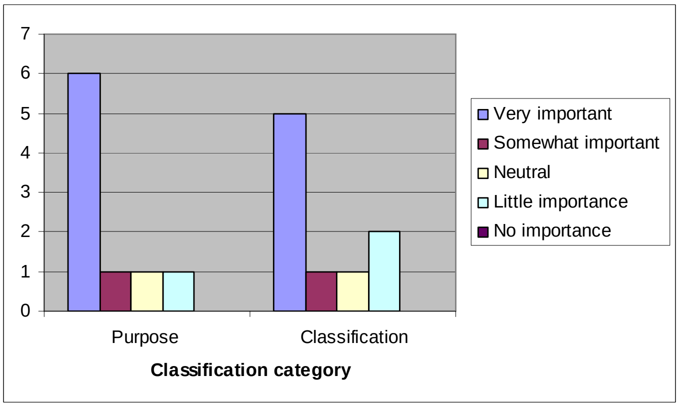

Figure 9.17: Classification Category Element Ratings

10. Other metadata elements

Most respondents did not suggest any other elements that they may consider to be useful in searching for learning materials. Three respondents indicated that it may be useful to include that a learning object has been developed in accordance with a South African Unit Standard or NQF level. This can be indicated in the RU LOM Core application profile, within the <9 Classification> category of elements.

11. Unique Southern African higher education factors

Two respondents indicated that the South African education situation needed to be taken into account, such as the National Qualifications Framework (NQF) levels and Unit Standards. Another respondent indicated that the technical local infrastructure also needed to be taken into account. The NQF is essentially a quality assurance system in which the development and registration of standards and qualifications is carried out by Standards Generating Bodies (SGBs), while the quality assurance is looked after by Education and Training Quality Assurance bodies (ETQAs) that carry out their function in co-operation with providers and moderating bodies (Council of Higher Education, 2001). The South African Department of Education has recently gazetted a Higher Education Qualifications Framework policy. The purpose of this policy is to provide a framework for the development and provision of higher education qualifications within a single, coordinated higher education sector (South African Department of Education, 2004: 6). The policy also provides the basis for integrating all higher education qualifications into the NQF and its structures for standards generation and quality assurance.   The NQF has 10 levels, of which the higher education qualifications framework occupies six. Levels 5-7 are undergraduate and levels 8-10 are postgraduate. For example, NQF level 7 refers to material contributing towards a Bachelors Degree or Advanced Diploma. Similarly, vocational oriented qualifications are based on unit standards. Unit standards are units of learning which are standardised through the SAQA standards generation process and then registered on the NQF. These may be offered in the education and training system either as “stand-alone” discrete units of learning, or they may be combined in a purposeful manner to form a qualification (Council of Higher Education, 2001).

Ranking of Importance

Further analysis involved combining the results for each element in the "Very important" and "Somewhat important "options. This yielded the fifteen most important elements, as shown in Figure 9.18. Most of these elements have mandatory status in RU LOM Core.

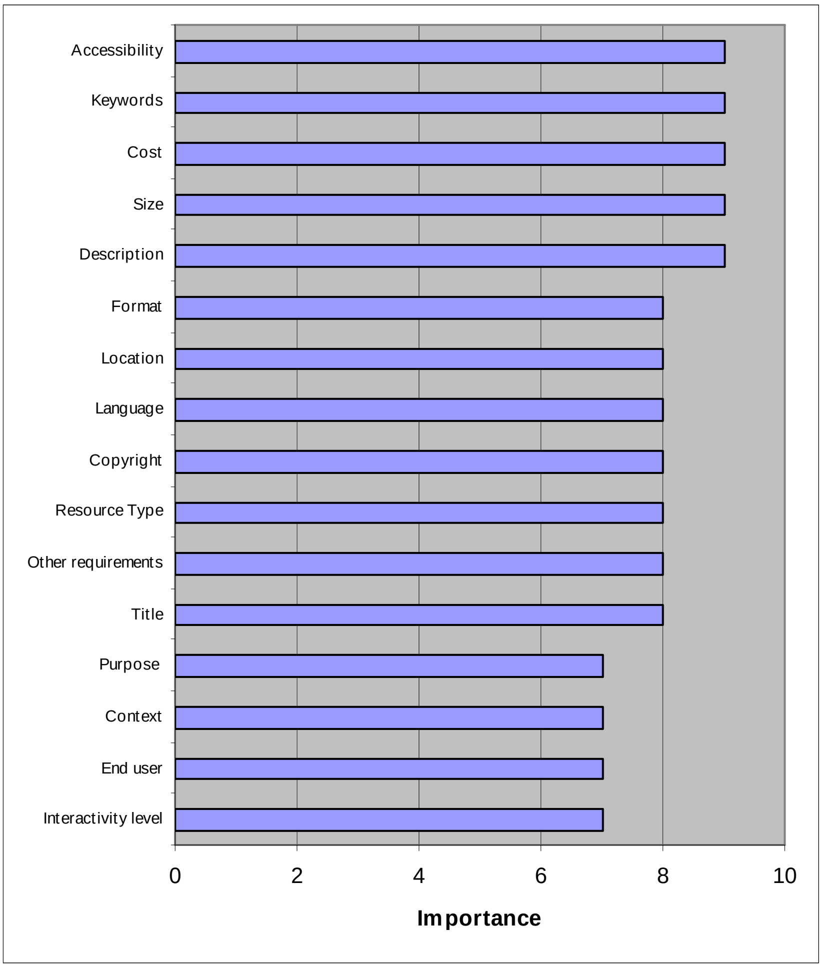

Figure 9.18: Top Fifteen Rated Elements

9.6 Modifications to RU LOM Core

The purpose of metadata for learning objects is to "facilitate the sharing and exchange of learning objects, by enabling the development of catalogues and inventories while taking into account the diversity of cultural and lingual contexts in which the learning objects and their metadata will be exploited" (IEEE LTSC, 2002). Based on the results of the testing process and the survey, several modifications have been made to enhance the value of RU LOM Core.

9.6.1. Modifications indicated by the testing process

Firstly, the vocabulary of element <5.5 Intended End User Role> has been restricted to just "Teacher" and "Learner". These were the only two vocabulary items made use of during the testing process. The testing process also revealed several elements that were highly complex or extraneous to the purpose of RU LOM Core. In order for RU LOM Core to be a streamlined and useful application profile for the South African higher education environment, several elements have been removed from RU LOM Core. These elements are:

- <5.4 Semantic Density>
- <5.9 Typical Learning Time>
- <9.3 Description>
- <9.4 Keyword>

9.6.2. Modifications indicated by the survey

RU LOM Core allows educators to describe learning objects with reference to South African educational qualifications and policies. Based on the results of the metadata survey, RU LOM Core recommends the use of the Dewey Decimal Classification system and the NQF/Unit Standard levels as the classification systems to be used in the <9 Classification> Category. Additionally, the following elements have had their cardinality enforced. This will lead to increased interoperability within the community of RU LOM Core users. These elements were rated as being "very important" and have thus been given a mandatory status in RU LOM Core (they were previously given optional status). The elements are:

- <4.1 Format>
- <4.2 Size>
- <5.2 Learning Resource Type>
- <6.1 Cost>

It must be noted that these results form part of the initial testing of RU LOM Core and that further research and testing is required to ensure the suitability of the application profile. Table 9.1 reflects the updated RU LOM Core (v1.1) in the application profile element comparison. Appendix E contains the RU LOM Core v1.1 specification.

9.7 Conclusion

As Wagner (2002) has specified, the primary reason developers are not using learning objects is that they lack the technical knowledge to interpret and apply the technical guidelines in practice. Additionally, Hatala and Richards (2002: 293) note that educational and business communities have been slow to adopt the standards due to their complexity. RU LOM Core provides a useful standard definition for describing learning objects for the South African (developing country) environment. The RU LOM Core application profile was tested to determine its suitability for describing learning objects in a South African higher education context. This was achieved through the creation of metadata records for higher education learning content. Additionally, a metadata survey was conducted to assess the importance of different metadata elements for searching purposes. With a few modifications to enhance the value of the application profile, it was found that RU LOM Core can adequately describe learning objects within the South African higher education context. Thus RU LOM Core serves as a starting point for learning object description in South African higher education and can be refined with further use. This will enable the refinement of the vocabularies and guidelines and ensure the appropriateness and suitability of the application profile for widespread use.

	IEEE LOM	Dublin Core	IMS	SCORM Content Aggregate	SCORM Sharable Content Object	SCORM Asset	ARIADNE	CanCore	UK LOM Core	RU LOM Core
1	**General**		O	M	M	M	M	O	M	M
1.1	Identifier		O	M	M	M		O	M	M
1.1.1	Catalog		O	O	O	O	M	O	M	M
1.1.2	Entry	O	O	O	M	M	M	O	M	M
1.2	Title	O	O	M	M	M	M	O	M	M
1.3	Language	O	O	O	O	O	M	O	M	M
1.4	Description	O	O	M	M	M	O	O	M	M
1.5	Keyword	O	O	M	M	O			O	M
1.6	Coverage	O	O	O	O	O		O	O	O
1.7	Structure		O	O	O	O			O	O
1.8	Aggregation Level		O	O	O	O	O	O	O	O
2	**Life Cycle**		O	O	M	O	M	O	M	M
2.1	Version		O	O	M	O	O	O	O	O
2.2	Status		O	O	M	O			O	O
2.3	Contribute		O	O	O	O		O	M	M
2.3.1	Role	O	O	O	O	O	M	O	M	M
2.3.2	Entity	O	O	O	O	O	M	O	M	M
2.3.3	Date	O	O	O	O	O	O	O	M	M
3	**Meta-metadata**		O	O	M	M	M	O	M	M
3.1	Identifier		O	O	M	M		O	M	M
3.1.1	Catalog		O	O	O	O		O	M	M
3.1.2	Entry		O	O	M	M		O	M	M
3.2	Contribute		O	O	O	O		O	M	M
3.2.1	Role		O	O	O	O	M	O	M	M
3.2.2	Entity		O	O	O	O	M	O	M	M
3.2.3	Date		O	O	O	O	M	O	M	M
3.3	Metadata Schema		O	O	M	M		O	M	M
3.4	Language		O	O	O	O	M	O	M	M
4	**Technical**		O	O	M	M	M	O	M	M
4.1	Format	O	O	O	M	M	M	O	O	M
4.2	Size		O	O	O	O	M	O	O	M
4.3	Location		O	O	O	O	M	O	M	M
4.4	Requirement		O	O	O	O			O	
4.4.1	orComposite		O	O	O	O			O	
4.4.1.1	Type		O	O	O	O	M		O	
4.4.1.2	Name		O	O	O	O	M		O	
4.4.1.3	Minimum Version		O	O	O	O	O		O	
4.4.1.4	Maximum Version		O	O	O	O			O	
4.5	Installation Remarks		O	O	O	O	O		O	
4.6	Other Platform Requirements		O	O	O	O	O	O	O	O
4.7	Duration		O	O	O	O		O	O	O
5	**Educational**		O	O	O	O	M	O	O	O
5.1	Interactivity Type		O	O	O	O	M		O	
5.2	Learning Resource Type	O	O	O	O	O	M	O	O	M
5.3	Interactivity Level		O	O	O	O	O	O	O	O
5.4	Semantic Density		O	O	O	O	O		O	
5.5	Intended End User Role		O	O	O	O	M	O	O	O
5.6	Context		O	O	O	O	O	O	O	O
5.7	Typical Age Range		O	O	O	O		O	O	O
5.8	Difficulty		O	O	O	O	O		O	O
5.9	Typical Learning Time		O	O	O	O	M	O	O	
5.1	Description		O	O	O	O			O	O
5.11	Language		O	O	O	O		O	O	O
6	**Rights**		O	O	M	M	M	O	M	M
6.1	Cost		O	O	M	M	M	O	O	M
6.2	Copyright and Other Restrictions		O	O	M	M	M	O	M	M
6.3	Description	O	O	O	O	O	M	O	M	M
7	**Relation**		O	O	O	O	O	O	O	O
7.1	Kind		O	O	O	O	O	O	O	O
7.2	Resource	O	O	O	O	O		O	O	O
7.2.1	Identifier		O	O	O	O		O	O	O
7.2.1.1	Catalog		O	O	O	O		O	O	O
7.2.1.2	Entry		O	O	O	O		O	O	O
7.2.2	Description	O	O	O	O	O	O		O	O
8	**Annotation**		O	O	O	O	O	O	O	O
8.1	Entity		O	O	O	O	M	O	O	O
8.2	Date		O	O	O	O	M	O	O	O
8.3	Description		O	O	O	O	M	O	O	O
9	**Classification**		O	O	O	O	M	O	O	O
9.1	Purpose		O	O	O	O	M	O	O	O
9.2	Taxon Path		O	O	O	O		O	O	O
9.2.1	Source		O	O	O	O	M	O	O	O
9.2.2	Taxon		O	O	O	O		O	O	O
9.2.2.1	Identifier		O	O	O	O		O	O	O
9.2.2.2	Entry		O	O	O	O	M	O	O	O
9.3	Description		O	O	O	O			O	
9.4	Keyword		O	O	O	O		O	O	

Table 9.1: Application Profile LOM Elements including RU LOM Core v1.1

Chapter 10

Conclusion and Future Research

Chapter Nine described the testing process of the developed application profile. Chapter Ten provides a conclusion to the research by reviewing the contributions of the research and discussing areas for future research.

10.1 Introduction

Emerging e-learning technologies enable learning to be customised and individualised. The promise of the learning object economy is the interoperability and reuse of learning content in education. However, learning objects have not been widely used due to the lack of technical knowledge to interpret and apply current technical guidelines. This research investigated the development and adoption of educational metadata standards for the widespread use of learning objects. In order for organisations and individuals to reuse learning objects they require descriptive data or metadata to facilitate the search and retrieval of learning content. A metadata editor may be used to simplify the process of implementing metadata. Learning object metadata standards ensure global interoperability and enable potential learners and developers to find the content that they need. The first accredited educational metadata standard is the IEEE Learning Object Metadata (LOM) standard. This highly complex standard requires interpretation in order to implement it. Application profiles provide a way to simplify implementation through customising the standard. This retains interoperability with the standard, while meeting the needs of local communities. There is a need for a local, context-sensitive application profile. A new application profile, RU LOM Core, was developed for the South African higher education environment as a solution to the issues discussed above.

This chapter concludes the research by considering the contributions of the thesis and by discussing areas for future research.

10.2 Contributions of the Thesis

The investigation of learning objects and metadata reveals that learning objects are small, reusable pieces of content that allow learners to achieve an educational objective. Learning objects can add considerable value to the learning process through the creation of reusable, interoperable and accessible content. However, a paradigm shift is required from developing entire courses to creating smaller, modular pieces of learning content that can be assembled and reused as needed. Metadata adds value to learning objects through describing their properties. This allows learners and learning providers to search, evaluate, acquire and use learning objects (IEEE LTSC, 2004).

The investigation of e-learning standards indicates that the development of e-learning standards is a continuously evolving and dynamic process with a variety of organisations and consortia collaboratively contributing to the process. The goal of the e-learning standardisation process is interoperability among learning content and learning tools and systems. Although many e-learning standards are still in the development phase, these standards promise interoperability, portability and reusability in the learning object economy. The IEEE LOM data model was the first accredited e-learning standard and defines metadata for describing learning objects. It consists of a base schema of nine categories with 76 data elements. This standard is beginning to be widely implemented, although it can be highly complex and requires concentrated interpretation to implement it.

Application profiles provide an alternative mechanism for implementing the IEEE LOM standard and are developed through element exclusion, value space restriction and cardinality enforcement. The foremost application profiles include the Dublin Core, IMS, SCORM, ARIADNE, CanCore and the UK LOM Core.

The study and use of metadata editors shows that these software tools, such as RELOAD, Metadata Generator Pro and ALOHA II, greatly facilitate the production of metadata. The limitations of the metadata editors such as over-reliance on the standard, significant manual entry and limited validation may be overcome with future generations of the tools. The experiences and lessons learnt from the implementation process such as content author and metadata specialist working together, quantifying subjective elements, not using particular elements (such as Maximum Version and Interactivity Type) and the use of different classification schemas have been applied to the creation of a application profile for the South African higher education context.

An application profile for the South African higher education context, RU LOM Core, was developed. The distinctive features of this application profile are that it allows for linguistic and cultural diversity and the lack of technological literacy in the South African higher education environment. The development of this application profile enables greater interoperability within this community, while retaining flexibility with the wider LOM community.

The RU LOM Core application profile was refined through an implementation process and survey. Several modifications were made to enhance the value of RU LOM Core, such as reference to South African educational policies and the removal of the extraneous elements. RU LOM Core adequately describes learning objects.

The development of RU LOM Core confirms some existing results about the complexity of using the IEEE standard. Implementers have to interpret the standard in order to implement it and there is a need to take local factors into account. RU LOM Core demonstrates that it is possible to instantiate the standard for the South African environment.

10.3 Future Research

A number of issues remain unexplained by this thesis. Future research includes the following:

The ISO/IEC JTC1 SC 36 committee Working Group 4, “Management and Delivery for Learning, Education and Training” has been explicitly charged with the task of contributing to future standardisation work on the LOM. This work is currently taking place through the development of a new international multipart standard entitled “Metadata for Learning Resources” (Friesen, 2004b). RU LOM Core needs to take into account the development and changes of this specification in order to remain interoperable with other application profiles.

As suggested by the IMS (2004a), once an application profile has been developed, it should be published in a metadata schema registry. If RU LOM Core is to be followed and extended in the future, it will have to be published in a recognised metadata schema registry.

RU LOM Core requires further validation in order to be widely used. Analysis of how RU LOM Core is used can provide valuable and verifiable evidence of the utility or inadequacy of its components and characteristics. Future research involves the development and description of learning content by different institutions and educational sectors. This involves implementing metadata for numerous contexts and for numerous learning objects. An analysis of these experiences would be most useful. Godby (2004) reports that projects with significant investment in LOM need to mature and report on their experiences. The learning object community would benefit if such projects could share missing pieces of the formal standard such as syntactic bindings, extensions to controlled vocabularies and protocols for communicating with similar projects.

Another area for future research is how the LOM standard and the derived application profiles can be integrated with other e-learning specifications and standards. For example, mechanisms need to be explored on how best to integrate the IMS Learning Design specification for metadata for collaborative learning and the Collaborative Learning Entity of Metadata (CLEM) specifications with the LOM. RU LOM Core has been implemented using the RELOAD metadata editor. TELCERT is going to develop RELOAD further to include support for application profiles, vocabularies, internationalisation and validation (RELOAD, 2004). Investigation is required of how these features will affect and can be incorporated into RU LOM Core.

10.4 In Closing

The use of metadata enables the description of learning objects that facilitates the sharing and reuse of learning content. The proposed RU LOM Core can be used to support the development of a learning object economy within South Africa. However, as Mayes (2003: 11) notes, once all the technical and pedagogical issues are completely dealt with, it is the cultural, social and organisational factors that determine the extent to which learning objects are actually used and reused. RU LOM Core contributes towards this goal.

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Appendix A

Project Management Metadata XML File

```
<?xml version="1.0"?>
<!--This is a Reload version 1.1.3a Metadata document-->
<!--Spawned from the Reload Metadata Generator - http://www.reload.ac.uk-->
<lom xmlns="http://www.imsglobal.org/xsd/imsmd_v1p2"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.imsglobal.org/xsd/imsmd_v1p2 imsmd_v1p2p2.xsd">
  <general>
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    </title>
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xml:lang="en">http://www.is.ru.ac.za/courses/2003/IS301/ProjectMan/Lecture%20Slides
/Lecture%2003%20and%2004%20-%20Define%20-%20Risk%20Management.ppt</langstring>
      </entry>
    </catalogentry>
    <language>en</language>
    <description>
      <langstring xml:lang="en">Set of slides detailing IT Project Management Risk
Management</langstring>
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    <keyword>
      <langstring xml:lang="en">Information Technology Project Management Risk
Management</langstring>
    </keyword>
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        <langstring xml:lang="x-none">2</langstring>
      </value>
    </aggregationlevel>
  </general>
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    </version>
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      <value>
        <langstring xml:lang="x-none">Final</langstring>
      </value>
    </status>
    <contribute>
      <role>
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        </source>
        <value>
          <langstring xml:lang="x-none">Author</langstring>
        </value>
      </role>
      <centity>
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Stott\nORG:Rhodes University\nEND:VCARD</vcard>
```

Created using RELOAD
LOM Namespace
Element Name
Element Data Type
Element Value
Vocabulary source
Vocabulary value
vCard specification

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      </date>
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  </lifecycle>
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    </catalogentry>
    <contribute>
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        </source>
        <value>
          <langstring xml:lang="x-none">Creator</langstring>
        </value>
      </role>
      <centity>
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Krull\nORG:Rhodes University\nEND:VCARD</vcard>
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      </date>
    </contribute>
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    <language>en</language>
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    <format>application/mspowerpoint</format>
    <size>648192</size>
    <location
type="URI">http://www.is.ru.ac.za/courses/2003/IS301/ProjectMan/Lecture%20Slides/Le
cture%2003%20and%2004%20-%20Define%20-%20Risk%20Management.ppt</location>
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        <value>
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        </source>
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    <duration>
      <datetime>0:45</datetime>
    </duration>
  </technical>
  <educational>
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      <value>
        <langstring xml:lang="x-none">low</langstring>
      </value>
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      <value>
        <langstring xml:lang="x-none">medium</langstring>
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    </semanticdensity>
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        <langstring xml:lang="x-none">Learner</langstring>
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      <source>
        <langstring xml:lang="x-none">LOMv1.0</langstring>
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        <langstring xml:lang="x-none">Higher Education</langstring>
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    <typicalagerange>
      <langstring xml:lang="en">3rd year, University (19-20 years)</langstring>
    </typicalagerange>
    <difficulty>
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        <langstring xml:lang="x-none">LOMv1.0</langstring>
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      <value>
        <langstring xml:lang="x-none">easy</langstring>
      </value>
    </difficulty>
    <typicallearningtime>
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    </typicallearningtime>
    <description>
      <langstring xml:lang="en">IT Project Management Risk Management</langstring>
    </description>
    <language>en</language>
  </educational>
  <rights>
    <cost>
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```

```
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    <copyrightandotherrestrictions>
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      </source>
      <value>
        <langstring xml:lang="x-none">yes</langstring>
      </value>
    </copyrightandotherrestrictions>
    <description>
      <langstring xml:lang="en">Copyrighted to Rhodes University</langstring>
    </description>
  </rights>
  <relation>
    <kind>
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        <langstring xml:lang="x-none">LOMv1.0</langstring>
      </source>
      <value>
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      </value>
    </kind>
    <resource>
      <description>
        <langstring xml:lang="en">Part of IS301 Project Management Course Lecture
series (3 of 16)</langstring>
      </description>
      <catalogentry>
        <catalog>URL</catalog>
        <entry>
          <langstring
xml:lang="en">http://www.is.ru.ac.za/courses/2003/IS301/ProjectMan</langstring>
        </entry>
      </catalogentry>
    </resource>
  </relation>
  <annotation>
    <person>
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Krull\nORG:Rhodes University\nEND:VCARD</vcard>
    </person>
    <date>
      <datetime>2004-01-03</datetime>
    </date>
    <description>
      <langstring xml:lang="en">Recommended for managing risk for IT project
management</langstring>
    </description>
  </annotation>
  <classification>
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      <value>
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      </value>
    </purpose>
    <taxonpath>
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        <langstring xml:lang="x-none">IS 2002</langstring>
      </source>
      <taxon>
        <id>IS 2002.10</id>
        <entry>
          <langstring xml:lang="en">Project Management and Practice</langstring>
```

```
        </entry>
      </taxon>
    </taxonpath>
  </classification>
</lom>
```

Appendix B

Accounting Information Metadata XML File

```
<?xml version="1.0" encoding="UTF-8"?>
<!--This is a Reload version 1.2 Metadata document-->
<!--Spawned from the Reload Metadata Generator - http://www.reload.ac.uk-->
<lom xmlns="http://www.imsglobal.org/xsd/imsmd_v1p2"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.imsglobal.org/xsd/imsmd_v1p2 imsmd_v1p2p2.xsd">
  <general>
    <title>
      <langstring xml:lang="en">Accounting Information Requirements</langstring>
    </title>
    <catalogentry>
      <catalog>URI</catalog>
      <entry>
        <langstring
xml:lang="en">\\ict.ru.ac.za\dfs\Departments\IS\Curricula\Knowledge
Areas\Accounting Information Systems\AIS Theory\2004\1. Accounting Information
Requirements</langstring>
      </entry>
    </catalogentry>
    <language>en</language>
    <description>
      <langstring xml:lang="en">Lecture presentation detailing AIS Theory
Accounting Information Requirements</langstring>
    </description>
    <keyword>
      <langstring xml:lang="en">Accounting; Information; Requirements</langstring>
    </keyword>
    <structure>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">Collection</langstring>
      </value>
    </structure>
    <aggregationlevel>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">2</langstring>
      </value>
    </aggregationlevel>
  </general>
  <lifecycle>
    <version>
      <langstring xml:lang="en">1.0</langstring>
    </version>
    <status>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">Final</langstring>
      </value>
    </status>
    <contribute>
      <role>
        <source>
          <langstring xml:lang="en">LOMv1.0</langstring>
        </source>
        <value>
          <langstring xml:lang="en">Author</langstring>
        </value>
      </role>
      <centity>
        <vcard>BEGIN:VCARD\nVERSION:3.0\nKrull;Greig;Mr;\nFN:Greig
Krull\nORG:Rhodes University\nEND:VCARD</vcard>
```

```
      </centity>
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        <datetime>2004</datetime>
      </date>
    </contribute>
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      <catalog>URI</catalog>
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Areas\Accounting Information Systems\AIS Theory\2004</langstring>
      </entry>
    </catalogentry>
    <contribute>
      <role>
        <source>
          <langstring xml:lang="en">LOMv1.0</langstring>
        </source>
        <value>
          <langstring xml:lang="en">Creator</langstring>
        </value>
      </role>
      <centity>
        <vcard>BEGIN:VCARD\nVERSION:3.0\nKrull;Greig;Mr;\nFN:Greig
Krull\nORG:Rhodes University\nEND:VCARD</vcard>
      </centity>
      <date>
        <datetime>2004-07-26</datetime>
      </date>
    </contribute>
    <metadatascheme>LOM v1.0</metadatascheme>
    <language>en</language>
  </metametadata>
  <technical>
    <format>application/mspowerpoint</format>
    <size>158000</size>
    <location
type="URI">http://www.is.ru.ac.za/Courses/2004/IS203/AIStheory</location>
    <otherplatformrequirements>
      <langstring xml:lang="en">MS Powerpoint</langstring>
    </otherplatformrequirements>
    <duration>
      <datetime>0:45</datetime>
    </duration>
  </technical>
  <educational>
    <learningresourcetype>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">LecturePresentation</langstring>
      </value>
    </learningresourcetype>
    <interactivitylevel>
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      </source>
      <value>
        <langstring xml:lang="en">very low</langstring>
      </value>
    </interactivitylevel>
    <semanticdensity>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
```

```
      <value>
        <langstring xml:lang="en">low</langstring>
      </value>
    </semanticdensity>
    <intendedenduserrole>
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        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">Learner</langstring>
      </value>
    </intendedenduserrole>
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      </source>
      <value>
        <langstring xml:lang="en">University Undergraduate</langstring>
      </value>
    </context>
    <typicalagerange>
      <langstring xml:lang="en">first or second year undergraduate</langstring>
    </typicalagerange>
    <difficulty>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">very easy</langstring>
      </value>
    </difficulty>
    <description>
      <langstring xml:lang="en">Introduction to AIS, presentation on requirements
for Accounting Information Requirements: users of accounting information,
characteristics of accounting information, how it affects profitability and the
financial position of the business, management needs for information for decision
making, management reports.</langstring>
    </description>
    <language>en</language>
  </educational>
  <rights>
    <cost>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">no</langstring>
      </value>
    </cost>
    <copyrightandotherrestrictions>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">yes</langstring>
      </value>
    </copyrightandotherrestrictions>
    <description>
      <langstring xml:lang="en">Copyright to Rhodes University</langstring>
    </description>
  </rights>
  <relation>
    <kind>
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```

```
      </value>
    </kind>
    <resource>
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series</langstring>
      </description>
      <catalogentry>
        <catalog>URI</catalog>
        <entry>
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xml:lang="en">\\ict.ru.ac.za\dfs\Departments\IS\Curricula\Knowledge
Areas\Accounting Information Systems\AIS Theory\2004\1. Accounting Information
Requirements</langstring>
        </entry>
      </catalogentry>
    </resource>
  </relation>
  <annotation>
    <person>
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University\nEND:VCARD</vcard>
    </person>
    <date>
      <datetime>2004-07-26</datetime>
    </date>
    <description>
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the Information Systems Department. Well-received.</langstring>
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  </annotation>
  <classification>
    <purpose>
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        <langstring xml:lang="en">Discipline</langstring>
      </value>
    </purpose>
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(http://www.oclc.org)</langstring>
      </source>
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        <id>657</id>
        <entry>
          <langstring xml:lang="en">Accounting</langstring>
        </entry>
      </taxon>
    </taxonpath>
  </classification>
</lom>
```

Appendix C

ADP Tutorial Metadata XML File

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!--This is a Reload version 1.2 Metadata document-->
<!--Spawned from the Reload Metadata Generator - http://www.reload.ac.uk-->
<lom xmlns="http://www.imsglobal.org/xsd/imsmd_v1p2"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.imsglobal.org/xsd/imsmd_v1p2 imsmd_v1p2p2.xsd">
  <general>
    <title>
      <langstring xml:lang="en">The First Class</langstring>
    </title>
    <catalogentry>
      <catalog>URI</catalog>
      <entry>
        <langstring
xml:lang="en">http://www.cs.ru.ac.za/courses/CSc102/ADP/index.php</langstring>
      </entry>
    </catalogentry>
    <language>en</language>
    <description>
      <langstring xml:lang="en">Tutorial detailing what a class is</langstring>
    </description>
    <keyword>
      <langstring xml:lang="en">Class</langstring>
    </keyword>
    <structure>
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      </source>
      <value>
        <langstring xml:lang="en">Collection</langstring>
      </value>
    </structure>
    <aggregationlevel>
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        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
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        <langstring xml:lang="en">2</langstring>
      </value>
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  </general>
  <lifecycle>
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      <langstring xml:lang="en">1.0</langstring>
    </version>
    <status>
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        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">Final</langstring>
      </value>
    </status>
    <contribute>
      <role>
        <source>
          <langstring xml:lang="en">LOMv1.0</langstring>
        </source>
        <value>
          <langstring xml:lang="en">Author</langstring>
        </value>
      </role>
      <centity>
        <vcard>BEGIN:VCARD\nVERSION:3.0\nLobb;Adele;Mrs;\nFN:Adele
Lobbl\nORG:Rhodes University\nEND:VCARD</vcard>
      </centity>
      <date>
        <datetime>2004</datetime>
```

```
      </date>
    </contribute>
  </lifecycle>
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      <catalog>URI</catalog>
      <entry>
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xml:lang="en">\\ict.ru.ac.za\dfs\Departments\CS\Curricula\Knowledge Areas\Computer
Science 102\ADP\First Class</langstring>
      </entry>
    </catalogentry>
    <contribute>
      <role>
        <source>
          <langstring xml:lang="en">LOMv1.0</langstring>
        </source>
        <value>
          <langstring xml:lang="en">Creator</langstring>
        </value>
      </role>
      <centity>
        <vcard>BEGIN:VCARD\nVERSION:3.0\nKrull;Greig;Mr;\nFN:Greig
Krull\nORG:Rhodes University\nEND:VCARD</vcard>
      </centity>
      <date>
        <datetime>2004-09-26</datetime>
      </date>
    </contribute>
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    <language>en</language>
  </metametadata>
  <technical>
    <format>application/x-shockwave-flash</format>
    <size>3700000</size>
    <location
type="URI">http://www.cs.ru.ac.za/courses/CSc102/ADP/index.php</location>
    <otherplatformrequirements>
      <langstring xml:lang="en" />
    </otherplatformrequirements>
    <duration>
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  </technical>
  <educational>
    <learningresourcetype>
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      </value>
    </learningresourcetype>
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        <langstring xml:lang="en">medium</langstring>
      </value>
    </interactivitylevel>
    <semanticdensity>
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      </source>
      <value>
        <langstring xml:lang="en">low</langstring>
      </value>
```

```
    </semanticdensity>
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      <value>
        <langstring xml:lang="en">Learner</langstring>
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    <context>
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      </source>
      <value>
        <langstring xml:lang="en">University Undergraduate</langstring>
      </value>
    </context>
    <typicalagerange>
      <langstring xml:lang="en">first year undergraduate</langstring>
    </typicalagerange>
    <difficulty>
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        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">very easy</langstring>
      </value>
    </difficulty>
    <description>
      <langstring xml:lang="en" />
    </description>
    <language>en</language>
  </educational>
  <rights>
    <cost>
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        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
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    <copyrightandotherrestrictions>
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        <langstring xml:lang="en">LOMv1.0</langstring>
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      <value>
        <langstring xml:lang="en">yes</langstring>
      </value>
    </copyrightandotherrestrictions>
    <description>
      <langstring xml:lang="en">Copyright to Rhodes University</langstring>
    </description>
  </rights>
  <relation>
    <kind>
      <source>
        <langstring xml:lang="en">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="en">IsPartOf</langstring>
      </value>
    </kind>
    <resource>
      <description>
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introductory course</langstring>
      </description>
```

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      <catalogentry>
        <catalog>URI</catalog>
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xml:lang="en">\\ict.ru.ac.za\dfs\Departments\CS\Curricula\Knowledge Areas\Computer
Science 102\ADP\First Class</langstring>
        </entry>
      </catalogentry>
    </resource>
  </relation>
  <annotation>
    <person>
      <vcard />
    </person>
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    </date>
    <description>
      <langstring xml:lang="en" />
    </description>
  </annotation>
  <classification>
    <purpose>
      <source>
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      </source>
      <value>
        <langstring xml:lang="en">Discipline</langstring>
      </value>
    </purpose>
    <taxonpath>
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(http://www.oclc.org)</langstring>
      </source>
      <taxon>
        <id>005</id>
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data</langstring>
        </entry>
      </taxon>
    </taxonpath>
  </classification>
</lom>
```

Appendix D

Metadata Survey

Request to respondent: If you are an eLearning practitioner, I would be grateful if you could please take a 10-minute break and fill out this online questionnaire. Please note that your responses to this survey will remain completely confidential and will be used solely for the purposes of the author's research. This survey is part of a Masters thesis by Greig Krull in the Department of Information Systems at Rhodes University.

Context: Imagine that you were able to access a vast repository (database) of learning materials that you can use and reuse for your learning needs. The repository would consist of reusable pieces of digital learning content (known as "Learning objects" or learning resources). In order to easily and efficiently search and find these materials, descriptive language (known as metadata) is required about each piece of learning content.

Current Standards: There are several international metadata standards available. These standards are very broad and require interpretation. These Learning Object Metadata standards can be customised through the process of "application profiling" to meet the needs of particular communities.

Aim: The aim of this research is to develop a metadata application profile that is customised for the potential needs in Southern African higher education. The purpose of this survey is to identify trends that will affect the development of a unique application profile for Southern African higher education.

SECTION A: DEMOGRAPHICS

Country of Residence:

- ☐ SADC Country
- ☐ Non-SADC Country

Please indicate the number of years of experience you have in working with Educational Technologies.

- ☐ less than 2 years
- ☐ 3 to 5 years
- ☐ 6 to 10 years
- ☐ more than 10 years

Educational sector:

- ☐ Primary Education
- ☐ Secondary Education

- Tertiary Education
- Corporate Training
- Other (please specify):

SECTION B: METADATA AWARENESS

Are you currently involved in any projects where the need for describing learning content using metadata has been identified?

- Yes
- No

If you answered yes to the previous question, please provide a brief description of the project. If you answered No, please provide a brief description of where you think you may be able to use these technologies.

Are you aware of any of the following international metadata standards or specifications? (Please tick the ones that you are aware of)

- ADL SCORM
- Dublin Core
- IEEE LOM
- IMS Metadata
- Other (please specify):

SECTION C: METADATA ITEMS

The international IEEE Learning Object Metadata Standard is the pervasive metadata standard and has grouped metadata items into nine broad categories. The items listed below have been adapted from this standard. Please respond to the questions below by rating the priority of items considered to be important if you were to search or browse for digital learning content. The options range from **Very important** on the left to **No importance** on the right.

General Category

Unique Identifier	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Title	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Language(s)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
General Description	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Keywords	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Coverage - cultural context (e.g. developed in USA)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Accessibility Considerations (e.g. for disabled learners)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

Life cycle Category

Version (e.g 1.0)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Status (final, draft etc)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Contributor (Author, Publisher, Organisation etc)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

Meta-metadata Category

Unique Metadata Identifier	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Metadata contributor (Creator, Editor etc)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Metadata Language	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Metadata specification/schema	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

Technical Category

Format (e.g. .doc, .jpeg, html etc)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Size (in megabytes)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Location (e.g. URL)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Other requirements (e.g. software required)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Alternative delivery formats	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

(e.g. print out for reading)

Educational Category

Learning Resource Type (reading, simulation, tutorial etc)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Interactivity level (high or low)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Intended End user (teacher, learner etc)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Context (primary, tertiary, professional etc)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Typical age range	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Difficulty (easy, difficult etc)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

Rights Category

Cost or Free	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Copyright and other restrictions	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

Relationship Category

Relation to other Learning Objects	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

Annotation Category

Actual educational experiences using the Learning Object (comments)	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

Classification Category

Educational Purpose	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None
Classification system	☐ Very	☐ Somewhat	☐ Neutral	☐ Little	☐ None

Are there any other elements/items that you might like to include? If so, please specify:

Are there any factors that need to be taken into account regarding Southern African higher education that will affect the development of a local application profile? If so, please specify:

General Comments:

Thank you for completing this survey. Please do not hesitate to email Greig Krull to request to be kept informed of the results, should you so desire.
Additionally, should you wish to share any experiences of working with learning objects with the authors of the study, your further comments would be most gratefully appreciated.

Submit

Appendix E

RU LOM Core

RU LOM Core Element and Implementation Guidelines v1.1

The development of the Rhodes University Learning Object Metadata Application Profile ("RU LOM Core") stems from the comparison of several metadata schemas based on the IEEE Learning Object Metadata (LOM) Standard. This comparison has resulted in an application profile to inform learning object practitioners in South Africa on the implementation of a minimum common core of LOM elements. Essentially, RU LOM Core is an application profile of the IEEE LOM that has been optimised for use within the context of higher education in South Africa. RU LOM Core aims to provide guidelines for metadata implementers, creators and users. It has been heavily influenced by the work of the Canadian Core Learning Object Metadata Application Profile (CanCore) and the UK LOM Core.

The application profile is depicted in tabular format and describes the nine metadata categories in the IEEE LOM standard:

1. General
2. Lifecycle
3. Meta-metadata
4. Technical
5. Educational
6. Rights
7. Relationship
8. Annotations
9. Classification

For each data element, the following is defined:

- Number and Name: number referencing the LOM and name by which the element is referenced
- Explanation: definition of the data element
- Size: number of values allowed
- Order: whether the order of the values is significant
- Value space: set of allowed values for the data element
- Data type: indicates whether the values are LangString, DateTime, Duration, Vocabulary, CharacterString or Undefined
- Cardinality: whether the data element is mandatory or optional
- Guidelines: metadata implementation guidelines that provide recommendations and guidelines for using RU LOM Core

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1. General	This category groups the general information that describes this learning object as a whole.	1	-	-	Container element	Mandatory	-

Guidelines
This category provides a reasonable first point of contact with a learning object.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.1 Identifier	A globally unique label that identifies this learning object.	Smallest permitted maximum=10 items	unordered	-	Container element	Mandatory	-

Guidelines
The identifier provides a name for the identification scheme and a unique value to identify the learning object. Use a formal identification system where possible.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.1.1 Catalog	The name or designator of the identification or cataloguing scheme for this entry. A namespace scheme.	1	-	Repertoire of ISO/IEC 10646-1:2000[1]	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"URI"

Guidelines
Use the common abbreviation or the standard name for the identification scheme that is used to reference the learning object, such as URI (Uniform Resource Identifier) or URL (Uniform Resource Locator) or DOI (Digital Object Identifier). Non-electronic objects may be identified through the use of globally unique identification systems such as ISBN (International Standard Book Number) or ISSN (International Standard Serial Number). RU LOM Core recommends the use of a URI. See CanCore at: ttp://www.cancore.ca/documents/Resourceids.doc and for specific examples see UKOLN/CETIS "Guidelines for encoding identifiers in Dublin Core and IEEE LOM metadata" http://www.ukoln.ac.uk/metadata/dcmi-ieee/identifiers/

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.1.2 Entry	The value of the identifier within the identification or cataloguing scheme that designates or identifies this learning object. A namespace specific string.	1	-	Repertoire of ISO/IEC 10646-1:2000[1]	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"http://www.is.ru.ac.za/"
Guidelines Provide the actual value of the identifier as derived from any specified identification scheme.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.2 Title	Name given to this learning object	1	-	-	LangString (smallest permitted maximum: 1000 char)	Mandatory	"en", "Project Risk Management"
Guidelines Transcribe the title preserving the original wording, order and spelling. Only capitalise proper nouns. Punctuation need not reflect the usage of the original. Subtitles should be separated from the title using a colon.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.3 Language	The primary human language or languages used within this learning object to communicate to the intended user.	smallest permitted maximum: 10 items	unordered	ISO 639-1:2002 and ISO 3166-1:1997[2]	CharacterString (smallest permitted maximum: 100 char)	Mandatory	“en-ZA”

Guidelines
If the object is multi-lingual, list all languages that apply in any convenient order. This element is mandatory as RSA is multi-lingual. The appropriate two character ISO 3639-1 country code should also be used. The default entry for this element is ‘en-ZA’, which may be provided by the repository tool.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.4 Description	A textual description of the content of this learning object.	Smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 2000 char)	Mandatory	“Lecture slides detailing risk, sources and elements of risk, monitoring and control”

Guidelines
The description should be a concise, keyword-intensive description of the object. If the learning object has an abstract or table of contents, that information can be included here. The general description should not be confused with the educational description of the object. Please note that 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.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.5 Keywords	Keywords or phrases describing this learning object. This data element should not be used for characteristics that can be described by other data elements.	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	Mandatory	“risk, project management”

Guidelines
These keywords should ideally be created by the author of the learning object and not through a classification process. In general, choose the most significant and unique words for keywords, avoiding those too general to describe a particular object. If the subject of the learning object is a person, enter their name using the 'lastname, firstname' format. For example: Shakespeare, William
For multiple free-text keywords, repeat the element for each term.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.6 Coverage	The cultural context or other considerations that apply to this object.	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	Optional	“risk, project management”

Guidelines
This element indicates the cultural aspects or context that applies to this learning object. It is recommended that this element is be used with a customary, maintained vocabulary.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.7 Structure	Underlying organisational structure of this learning object.	1	-	atomic collection networked hierarchical linear	Vocabulary (State)	Optional	“collection”

Guidelines

Structure refers to the way in which individual objects are logically related to form aggregate or composite objects.

Atomic:An object that is indivisible (raw media)

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

The use of this element is not recommended by CanCore. The basis for this that objects incorporating multiple levels of aggregation will likely include more than one kind of structure. The expressive power of this element is consequently limited in that it does not accommodate more than one value, and does not recommend a value that indicates that a multiplicity of structures are incorporated into a single aggregate object. It is also not clear how the underlying structure of a resource might relate to learning styles or user preferences.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
1.8 Aggregation Level	The functional granularity of this learning object.	1	-	1 2 3 4	Vocabulary (Enumerated)	Optional	“2”

Guidelines

This refers to the number of times an object can be decomposed into still smaller component parts, independent of the kind of relationships between them. Refers to the “logical” size of the learning object.

1: the smallest level of aggregation (raw media data or fragments)
2: a collection of level 1 learning objects
3: a collection of level 2 learning objects
4: the largest level of granularity

UK LOM Core does not recommended that this element is used as part of the basic element set as there is no generally agreed consensus as to how this element can be used appropriately.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
2. Life Cycle	This category describes the history and current state of this learning object and those who have affected this learning object during its evolution.	1	-	-	Container element	Mandatory	-

Guidelines
This category describes the development of and contributions to the learning object, accommodating the roles associated with collaborative development.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
2.1 Version	The edition of this learning object.	1	-	-	LangString (smallest permitted maximum: 50 char)	Optional	“en”, “1.2”

Guidelines
This element is understood as describing software versioning conventions (e.g. alpha, beta) as well as document publication conventions. If no version information is provided, do not use this field.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
2.2 Status	The completion status or condition of this learning object	1	-	draft final revised unavailable	Vocabulary (State)	Optional	“final”

Guidelines
The meanings of the vocabulary values provided for this element are most appropriate for written objects, not multimedia or software objects. This element may prove useful for resources held in repositories that are not yet publicly available, or resources that have previously been available but have subsequently been withdrawn.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
2.3 Contribute	Those entities (i.e., people, organisations) that have contributed to the state of this learning object during its life cycle (e.g., creation, edits, publication).	smallest permitted maximum: 30 items	ordered	-	Container element	Mandatory	-
Guidelines This category describes who has contributed to the learning object, indicating the nature and date of the contribution. Rank important contributors and contributions either by order of significance or alphabetically.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
2.3.1 Role	Kind of contribution.	1	-	author publisher validator	Vocabulary (State)	Mandatory	“author”
Guidelines For commercially sourced learning objects or those created by institutions or projects the minimum madatory requirement is “publisher”. For objects created by teachers or lecturers “author” should be used to denote the person who created the object and/or 'publisher' for their institution/employer. Multiple authors may be recorded.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
2.3.2 Entity	The identification of and information about people or organisations contributing to this learning object, most relevant first.	smallest permitted maximum: 40 items	ordered	vCard[3]	CharacterString (smallest permitted maximum: 1000 chars)	Mandatory	"BEGIN:VCARD\n VERSION:3.0\nFN:John Smith\nORG:Rhodes University\nEND:VCARD\n"
Guidelines The mandatory minimum set of vCard elements is "version", "name" and "organisation name". Use this element to provide information about the author and/or publisher of the learning object by setting '2.3.1 role' to 'author' or ''publisher' as appropriate. Multiple authors may be recorded. See vCard[3]							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
2.3.3 Date	The date of the creation or publication of the learning object.	1	-	-	DateTime[4]	Mandatory	2004-02-10
Guidelines This element could be used to identify a specific version of a resource in the absence of a formal method of version control. See DateTime[4]							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3. Meta-Metadata	This category describes this metadata record itself (not the learning object that this record describes).	1	-	-	Container element	Mandatory	-

Guidelines
This category describes how the metadata instance can be identified, who create it, how, when and with what references.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.1 Identifier	A globally unique label that identifies this metadata record.	1	-	-	Container element	Mandatory	-

Guidelines
The metadata identifier is in the domain of the system in which the metadata record is created. For example a digital repository system would be responsible for populating the meta-metadata values.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.1.1 Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	1	-	Repertoire of ISO/IEC 10646-1:2000[1]	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"URI"

Guidelines
If the originating organisation has a cataloguing system in place then it should be used, otherwise use the notation of the repository the metadata record resides in, such as URI (Uniform Resource Identifier) or URL (Uniform Resource Locator) or DOI (Digital Object Identifier).

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.1.2 Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies this metadata record. A namespace specific string.	1	-	Repertoire of ISO/IEC 10646-1:2000[1]	LangString (smallest permitted maximum: 1000 char)	Mandatory	“http:www.is.ru.ac.za”

Guidelines
Provides the actual value of the identifier as derived from the specified identification scheme.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.2 Contribute	Those entities (i.e., people or organisations) that have affected the state of this metadata instance during its life cycle (e.g., creation, validation).	smallest permitted maximum: 10 items	ordered	-	Container element	Mandatory	-

Guidelines
This category describes who is responsible for the metadata record, the nature of their responsibility (either “creator” or “validator”), and any dates that are affiliated with the record’s creation.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.2.1 Role	Kind of contribution.	1	-	creator validator	Vocabulary (State)	Mandatory	“creator”

Guidelines
It is important to trust the validity of information contained in a metadata record therefore the creator of the record is mandatory. Exactly one instance of creator should exist.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.2.2 Entity	The identification of and information about the people or organisations contributing to this metadata instance, most relevant first.	smallest permitted maximum: 10 items	ordered	vCard[3]	Characterstring (smallest permitted maximum: 1000 char)	Mandatory	“BEGIN:VCARD\n VERSION:3.0\nFN:John Smith\nORG:Rhodes University\nEND:VCARD\n”
Guidelines The mandatory minimum set of vCard elements is “version”, “name” and “organisation name”. It would be preferable for this information to be generated automatically by the system from its record of registered users.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.2.3 Date	The date of the contribution.	1	-	-	DateTime[4]	Mandatory	“2004-04-12”
Guidelines The date should be generated automatically by the repository system and recorded in the YYYY-MM-DD format.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.3 Metadata Schema	The name and version of the authoritative specification used to create this metadata instance.	smallest permitted maximum: 10 items	unordered	Repertoire of ISO/IEC 10646-1:2000[1]	CharacterString (smallest permitted maximum: 30 char)	Mandatory	“RULOMCorev1.0”
Guidelines This element can refer either to a formal standard metadata scheme e.g.LOMv1.0, or an application profile of a scheme e.g. RULOMCorev1.0. This element may be selected by the user or system generated.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
3.4 Language	Language of this metadata instance.	1	-	ISO 639-1:2002 and ISO 3166-1:1997[2]	CharacterString (smallest permitted maximum: 100 char)	Mandatory	“en”

Guidelines
This is the default language for all LangString values in this metadata instance. If a value for this data element is not present in a metadata instance, then there is no default language for LangString values. The default value for this element is “en”. This value should be generated automatically by the system. If the language requires an additional country identifier, ISO 3166-1:1997 should be used.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
4 Technical	This category describes the technical requirements and characteristics of this learning object.	1	-	-	Container element	Mandatory	-
Guidelines -							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
4.1 Format	Technical data type(s) of (all the components of) this learning object.	smallest permitted maximum: 40 items	unordered	MIME types based on IANA[5] registration or 'non-digital'	CharacterString (smallest permitted maximum: 500 char)	Mandatory	"application/mspowerpoint"
Guidelines Identifies software needed to access the learning object. Use MIME types only. LOM stipulates that the technical data types of all components are recorded. For example, for a Flash animation in an HTML Web page, repeat this element to encode both 'text/html' and 'application/x-shockwave-flash'. If it is not possible to accurately determine the MIME type(s) of an object use 'application/x-unknown'.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
4.2 Size	The size of the digital learning object in bytes (octets).	1	-	ISO 646:1991[6], but only the digits '0'..'9'	CharacterString (smallest permitted maximum: 30 char)	Mandatory	"36000"
Guidelines The size is represented as a decimal value. Consequently, only the digits '0' through '9' should be used. The unit is bytes, not MB, GB, etc. Ideally, the size of the learning object should be generated automatically by the packing tool or repository system. Although LOM stipulates that the number is stored in bytes, it should be displayed to the user in the most appropriate format e.g. Kb, Mb etc. The size must refer to the uncompressed size of the object.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
4.3 Location	A string that is used to access this learning object.	smallest permitted maximum: 10 items	Ordered	Repertoire of ISO/IEC 10646-1:2000[1]	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	“http://www.is.ru.ac.za”

Guidelines
The string used for access may be a location (e.g. Universal Resource Locator, URL), or a method that resolves to a location (e.g. Universal Resource Identifier, URI). If the resource is held in a repository system this element would refer to the location of the object in the repository and should be generated automatically. For non-bibliographic physical resources (e.g. VHS videos), provide the URL of a Web page or service that describes how to obtain the resource. The first element of this list shall be the preferable location. This refers to the location of the object rather than the location of the metadata record.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
4.6 Other Platform Requirements	Information about other software and hardware requirements.	smallest permitted maximum: 10 items	ordered	-	LangString (smallest permitted maximum: 1000 char)	Optional	“This object requires Adobe Acrobat Reader”

Guidelines
Use as a general comment element to describe any technical information the user may require in order to use the object that has not already been described in 4.1 technical format.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
4.7 Duration	Time a continuous learning object takes when played at intended speed.	1	-	-	Duration[7]	Optional	“PT1H20”

Guidelines
Should only be used to describe time-based media files, e.g. sound, video or animation.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
4.8 Alternative delivery formats	Alternative options for the delivery format of the learning object.	smallest permitted maximum: 10 items	unordered	-	CharacterString (smallest permitted maximum: 1000 char)	Optional	“Printed”

Guidelines

This element describes alternative delivery options for the learning object. For example, an animation can be printed out as a set of diagrams.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
5. Educational	This category describes the key educational or pedagogic characteristics of this learning object.	Smallest permitted maximum: 100 items	-	-	Container element	Optional	-
Guidelines 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.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
5.2 Learning Resource Type	Specific kind of learning object. The most dominant kind shall be first.	Smallest permitted maximum: 10 items	ordered	*LOMv1.0* Exercise Simulation Questionnaire Diagram Figure Graph Index Slide Table Narrative Text Exam Experiment Problem statement Self assessment Lecture *RU LOM Core* Course Module Resource Pack Case Study Simulation Study Guide Examination/Test Assessment Lecture Presentation Glossary Course Lecture Notes Demonstration Tutorial/Practical Reading List Curriculum Syllabus Lesson Plan	Vocabulary (State)	Mandatory	“slide”

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example

Guidelines
Use of the LOMv1.0 vocabulary is problematic as it includes terms that describe both the form (e.g. diagram) and the function (e.g exam) of the object. In recognition of this, a customised vocabulary is used to describe this element in conjunction with LOMv1.0. This follows the LOM recommendations for element 5.6 Educational. Context: “Suggested good practice is to use one of the values of the value space and to use an additional instance of this data element for further refinement.”

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
5.5 Intended End User Role	Principal user(s) for which this learning object was designed, most dominant first.	smallest permitted maximum: 10 items	ordered	teacher learner	Vocabulary (State)	Optional	“learner”

Guidelines
Until the vocabulary for this element is used more widely by educators it will remain relatively obscure and therefore can not be mandatory. Further work is required to develop an understanding of this element and its common usage (UK LOM Core).
Teacher – uses a learning object to teach something
Learner – works with a learning object in order to learn something

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
5.6 Context	The principal environment within which the learning and use of this learning object is intended to take place.	smallest permitted maximum: 10 items	unordered	primary education secondary education university undergraduate university postgraduate professional development continuing education	Vocabulary (State)	Optional	“higher education”
Guidelines Indicate the institutional environment or the level of education appropriate for use of the learning object. The recommended vocabulary for this element is now RU LOM Core v1. This contains terms relevant to the South African educational context.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
5.7 Typical Age Range	Age of the typical intended user.	smallest permitted maximum: 5 items	unordered	-	LangString (smallest permitted maximum: 1000 chars)	Optional	“18-”
Guidelines This element should only refer to the chronological age of a user and not their developmental age. Therefore the element is used to indicate the appropriateness of the object for a particular age group. Developmental ‘age’ or level should be described using 9.1 Purpose “'Educational Level”.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
5.8 Difficulty	How difficult it is to work through this learning object for the typical target audience.	1	-	very easy easy medium difficult very difficult	Vocabulary (Enumerated)	Optional	“easy”
Guidelines Educators routinely make judgements on the appropriateness of learning resources based on a subjective notion of ‘difficulty’, even though they may not use this term. It is difficult to see how this element could be used in the context of learning objects without more objective methods of determining the value. Until the vocabulary in this element is used more widely by educators it will remain relatively obscure and therefore cannot be mandatory. Work is required to develop an understanding of this element and its common usage (UK LOM Core). CanCore does not recommend the use of this data element.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
5.10 Description	Comments on how this learning object is to be used.	Smallest permitted maximum: 10 items	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Optional	This object can be very effective when utilised as an introduction to the topic”
Guidelines This element describes possible educational uses for an object. For example, “use as an introduction to the topic”. This element should not be confused with 1.4 Description.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
5.11 Language	The human language used by the typical intended user of this learning object.	smallest permitted maximum: 10 items	unordered	See 1.3 Language	CharacterString (smallest permitted maximum: 100 char)	Optional	“en”
Guidelines This is distinct from 1.3 Language. For example, an object designed to support the teaching of Afrikaans for English speakers could have 1.3 = 'af' and 5.11 = 'en', that is, it is a resource in Afrikaans designed to be used by a student who’s first language is English.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
6 Rights	This category describes the intellectual property rights and conditions of use for this learning object.	1	-	-	Container element	Mandatory	-
Guidelines This category provides a minimal description of the legal and/or ethical conditions associated with the use, reuse, modification and/or distribution of the learning object.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
6.1 Cost	Whether use of this learning object requires payment.	1	-	yes no	Vocabulary (State)	Mandatory	"no"
Guidelines If "yes", details of the actual cost should be included in 6.3 description.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
6.2 Copyright and Other Restrictions	Whether copyright or other restrictions apply to the use of this learning object.	1	-	yes no	Vocabulary (State)	Mandatory	"yes"
Guidelines If "yes", details of the restrictions sould be included in 6.3 description.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
6.3 Description	Comments on the conditions of use of this learning object.	1	-	-	LangString (smallest permitted maximum: 1000 char)	Mandatory	"Copyrighted to Rhodes University"
Guidelines A description of costs, copyright restrictions, conditions of use or where to find further information regarding usage rights.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
7 Relation	This category defines the relationship between this learning object and other learning objects, if any.	smallest permitted maximum: 100 items	unordered	-	Container element	Optional	-

Guidelines
Appropriate use of these elements can be labour intensive. When creating guidelines for the use of the Relation element group, keep in mind the functionality of the metadata in both a local and interoperable environment. In a local environment, it may be desirable and possible to exert a tight control over the relationships among learning resources. In an interoperable environment, there may not be the same controls in place for associating one learning object with another. Relational associations will likely not be implemented comprehensively or may be implemented with a degree of redundancy in a distributed environment. Furthermore, remote resources that an indexer may wish to point at may not be maintained thus necessitating ongoing maintenance of a metadata record (CanCore).

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
7.1 Kind	Nature of the relationship between this learning object and the target learning object, identified by 7.2.Resource.	1	-	Note: Based on Dublin Core: is part of has part is version of has version is format of has format references is referenced by is based on is basis for requires is required by	Vocabulary (State)	Optional	“is part of”

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example

Guidelines
This element provides the context for the relationship between the learning resource described by the metadata record and another learning resource. CanCore recommends the use of the DC.Relation Qualifier vocabulary. Refer to this vocabulary and not that of LOM 1.0 in the vocabulary data structure of this element (http://www.dublincore.org/documents/dcmes-qualifiers/#relation).

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
7.2 Resource	The target learning object that this relationship references.	1	-	-	Container element	Optional	-

Guidelines
Using sub-elements 7.2.1.1 and 7.2.1.2, this element provides a name for the identification scheme and a unique value to identify the related object. This element group should be used to refer to the related object itself and not to any accompanying metadata record.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
7.2.1 Identifier	A globally unique label that identifies the target learning object.	Smallest permitted maximum: 10 items	unspecified	-	Container element	Optional	-

Guidelines
The identifier provides a name for the identification scheme and a unique value to identify the learning object.Use a formal identification system where possible, e.g. DOI, ISBN.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
7.2.1.1 Catalog	The name or designator of the identification or cataloguing scheme for this entry. A namespace scheme.	1	-	Repertoire of ISO/IEC 10646-1:2000[1]	CharacterString (smallest permitted maximum:1000 char)	Optional	"URI"

Guidelines
If the originating organisation has a cataloguing system in place then it should be used, otherwise use the notation of the repository the learning object resides in.
Use the common abbreviation or the standard name for the identification scheme that is used to reference the learning object, such as URI (Uniform Resource Identifier) or URL (Uniform Resource Locator) or DOI (Digital Object Identifier).

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
7.2.1.2 Entry	The value of the identification or cataloguing scheme that designates or identifies the target learning object. A namespace specific string.	1	-	Repertoire of ISO/IEC 10646-1:2000[1]	LanString (smallest permitted maximum: 1000 char)	Optional	"http://www.is.ru.ac.za"

Guidelines
Provides the actual value of the identifier as derived from any specified identification scheme.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
7.2.2 Description	Description of the target learning object.	1	-	-	LangString (smallest permitted maximum: 1000 char)	Optional	"This object forms part of the project management module"

Guidelines
This element should contain just enough information to provide the end-user with a context for what the related resource is. A short title or simple phrase description is all that is necessary.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
8. Annotation	This category provides comments on the educational use of this learning object, and information on when and by whom the comments were created.	smallest permitted maximum: 30 items	unordered	-	Container element	Optional	-

Guidelines
This category enables educators to share their assessments of learning objects, suggestions for use, etc. Implementers and educators should aspire to using the annotation category elements as they have the potential to significantly enhance the richness of the metadata record by recording additional qualitative information about the object and its usage.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
8.1 Entity	Entity (i.e. people, organisation) that created this annotation.	1	unspecified	vCard[3]	CharacterString (smallest permitted maximum: 1000 char)	Optional	"BEGIN:VCARD\n VERSION:3.0\nFN:John Smith\nORG:Rhodes University\nEND:VCARD\n"

Guidelines
The recommended minimum set of vCard elements is "version", "name" and "organisation name". It would be preferable for this information to be generated automatically by the system from its record of registered users.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
8.2 Date	Date that this annotation was created.	1	-	-	DateTime[4]	Optional	2004-01-01

Guidelines
The date should be generated automatically by the repository system and recorded in the YYYY-MM-DD format.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
8.3 Description	The content of this annotation.	1	-	-	LangString (smallest permitted maximum: 1000 char)	Optional	"Used this object with great success in a third year class environment"

Guidelines

This element can be used to enable educators to describe the experience of using the learning object in a teaching and learning situation. This element could provide an example of a successful use of the object in a particular educational context, also indicating specific challenges or strengths presented by the object in that context.

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
9 Classification	This category describes where this learning object falls within a particular classification system.	smallest permitted maximum: 40 items	unordered	-	Container element	Optional	-
Guidelines To define multiple classifications there may be multiple instances of this category.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
9.1 Purpose	The purpose of classifying this learning object.	1	-	discipline idea prerequisite educational objective accessibility restrictions educational level skill level security level competency	Vocabulary (State)	Optional	"discipline"
Guidelines Classification may be used for multiple purposes. The UK LOM Core recommends the usage of discipline and idea. discipline - formal subject classification or identification in use by the institution or sector. E.g. Dewey Decimal Classification (Summary Levels 1-2) idea - relates to the concept contained in the resource. It is possible to use vocabularies already used for Discipline but to a deeper level e.g. LDSC, DDC. educational level - the cognitive/grade level for which the object is intended							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
9.2 Taxon Path	A taxonomic path in a specific classification system. Each succeeding level is a refinement in the definition of the preceding level.	smallest permitted maximum: 15 items	unordered	-	Container element	Optional	-
Guidelines There may be different paths, in the same or different classifications, which describe the same characteristic.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
9.2.1 Source	The name of the classification system. This data element may use any recognised “official” taxonomy or any user-defined taxonomy.	1	-	Repertoire of ISO/IEC 10646-1:2000[1]	LangString (smallest permitted maximum: 1000 char)	Optional	-
Guidelines An indexation, cataloging or query tool may provide the top-level entries of a well established classification, such as The Library of Congress Classification (LOC), Universal Decimal Classification (UDC), Dewey Decimal Classification (DDC), etc. CanCore recommends the use of the DDC to provide a minimal level of systematic subject description. Further subject description may then be provided by relevant vocabularies. Additionally, the use of South African Educational policies, such as NQF levels and Unit Standards may be used.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
9.2.2 Taxon	A particular term within a taxonomy. A taxon is a node that has a defined label or term.	smallest permitted maximum: 15 items	ordered	-	Container element	Optional	-
Guidelines A taxon may also have an alphanumeric designation or identifier for standardised reference. Either the label and the entry or both the may be used to designate a particular taxon. An ordered list of taxons creates a taxonomic path, i.e. "taxonomic stairway": this is a path from a more general to more specific entry in a classification.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
9.2.2.1 Id	The identifier of the taxon, such as a number or letter combination provided by the source of the taxonomy.	1	-	Repertoire of ISO/IEC 10646-1:2000[1]	CharacterString (smallest permitted maximum: 100 char)	Optional	-
Guidelines Use a notation from the chosen classification scheme described by 9.2.1 source.							

Name	Explanation	Size	Order	Value space	Data type	Cardinality	Example
9.2.2.2 Entry	The textual label of the taxon.	1	-	-	LangString (smallest permitted maximum: 500 char)	Optional	-
Guidelines Use a term from the chosen classification scheme described by 9.2.1 source.							

Notes

1. Repertoire of ISO/IEC 10646-1:2000
This value space allows the use of an extensive international letters, glyphs and other characters. This international Standard for Universal Multiple-Octet Coded Character Set (UCS) specifies a character set that relies on 32 bits.

2. ISO 639-1:2002 and ISO 3166-1:1997
ISO 639-1:2002 is an international standard for the representation of languages. A “LangCode” is a language code as defined by ISO 639-1:2002. For example, “en” for English.
ISO 3166-1:1997 is an international standard for the representation of country codes. A “Subcode” is a country code as defined by ISO 3166-1:1997. For example, “za” for South Africa.
Also available in RFC 2045:1996 (http://ietf.org/rfc/rfc1766.txt)

3. vCard (Virtual Business Card)
vCard is a standard that defines how contact details for people and organisations can be represented (http://www.ietf.org/rfc/rfc2426.txt), similar to the information found on a business card. Structure the value according to vCard, using the ‘FN’ and ‘ORG’ vCard elements for “name” and “organisation name” and “VERSION” for the version of the vCard specification used (the LOM states that the value of this property must be 3.0), enclosed between 'BEGIN:VCARD' and 'END:VCARD'. Additional vCard elements may be used but it is recommended that the total number of elements used should be kept to a minimum for the sake of simplicity. Separate vCard components with '\n' and escape ';' and ',' using '\;' and '\,' where these characters appear in a component value. The mandatory minimum set of vCard elements is “version”, “name” and “organisation name”. For example: BEGIN:VCARD\nVERSION:3.0\nFN:John Smith\nORG:Rhodes University\nEND:VCARD\n
Further information is available at http://www.imc.org/pdi/.

4. DateTime
The preferred method for recording a date is the YYYY-MM-DDThh:mm format. In most instances it is sufficient to record year and month, in which case use the first day of the month. For example, 2004-01-01. Partial dates are permitted. Based on ISO 8601:2000.

5. MIME types based on IANA (Internet Assigned Numbers Authority) registration (see RFC2048:1996)
Multipurpose Internet Mail Extensions (MIME) types allow the encoding of the digital format of the resource. RFC 2048:1998 specifies various IANA registration procedures (http://ietf.org/rfc/rfc2048.html or http://www.isi.edu/in-notes/iana/assignments/media-types/media-types). Additional types may be added, using the convention “‘type’ x-‘application name’”, where ‘type’ equals a MIME category type and ‘application name’ equals the name of the format needing description. E.g. “application x-flash”.

6. ISO 646:1991
This is an international standard that defines the international 7-bit coded character set with national variants.

7. Duration
An interval in time in the format PThHnMsS, where h = number of hours, n = number of minutes, s = number of seconds. For example, PT1H30M is one hour and 30 minutes).