ELICITING PEDAGOGICAL METADATA FOR DESCRIPTION OF LEARNING RESOURCES

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ABSTRACT

Learning object metadata standards exist to facilitate the reusability and discoverability of digital learning resources. However, without extension, these standards are ineffective to support the assembly of learning objects into coherent, larger scale structures. Ontological capture of pedagogical metadata may be critical to developing theory-aware systems capable of recommending complementary resources. In this research, scanning 74 repositories revealed that there is very little pedagogical metadata in current repositories. Software tools are needed that offer resource designers and instructors incentives to create and share pedagogical metadata. To demonstrate this concept, an online tool was developed to assist the creation of learning objectives conforming to the revised version of Bloom's taxonomy of educational objectives. The effectiveness of the tool for eliciting pedagogical metadata was assessed by collecting evaluative data from users with experience in e-learning. Participants reported positive attitudes towards the effectiveness, usefulness and necessity of the tool.

Keywords: learning object, learning object repository, educational objectives, pedagogical metadata, ontology

DEDICATION

To my parents and Lei

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3.1.3 Method for Determining Proportion of Terms Used as Pedagogical Metadata ... 31
3.2 Results ... 32
3.3 Inferences about the Frequency and Usage of Pedagogical Metadata ... 36
3.4 Conclusion ... 39

CHAPTER 4: GENERATION OF EDUCATIONAL OBJECTIVES AS PEDAGOGICAL METADATA ... 41

4.1 Introduction ... 41
4.2 A Revision of Bloom's Taxonomy of Educational Objectives as Pedagogical Metadata ... 41
4.2.1 The Knowledge Dimension ... 43
4.2.2 The Cognitive Process Dimension ... 44
4.3 A Web-Based Educational Objectives Tool ... 47
4.4 Data Importing and Representation in Pedagogical Metadata Ontology ... 51
4.4.1 Data Importing in the Pedagogical Metadata Ontology ... 52
4.4.2 Data Representation in the Pedagogical Metadata Ontology ... 55

CHAPTER 5: USER EVALUATION OF THE EDUCATIONAL OBJECTIVES TOOL ... 57

5.1 Method ... 57
5.1.1 Participants ... 57
5.1.2 Materials ... 58
5.1.3 Procedure ... 60
5.2 Results ... 61
5.2.1 Participants' Experience in Online Education ... 62
5.2.2 Perceived Effectiveness of the Tool for Constructing Learning Objectives ... 63
5.2.3 Perceived Usefulness of Learning Objectives Constructed Using the Tool ... 66
5.2.4 The Necessity of the Educational Objective Tool to Generate Pedagogical Metadata ... 69
5.2.5 The Suggestions and Overall Improvements to the Approach and the User Interface ... 72
5.3 Conclusion ... 73
5.3.1 Methodological Limitation of the Evaluation ... 73

CHAPTER 6: CONCLUSION AND FUTURE WORK ... 75

6.1 Conclusion ... 75
6.2 Limitation and Future Research Work ... 77

Reference List ... 79

Appendices ... 85

Appendix 1 ... 86
Appendix 2 ... 87
Appendix 3 ... 91

Appendix 4 99

LIST OF FIGURES

Figure 3.1 The Number Collected of Each Type of Repository 28
Figure 4.1 Cognitive Dimension 48
Figure 4.2 Knowledge Dimension 48
Figure 4.3 Category of Cognitive Procedure Dimension 50
Figure 4.4 Category of Knowledge Dimension 51
Figure 4.5 RDF Structure of Cognitive Process Dimension 52
Figure 4.6 RDF Structure for the Category in Cognitive Process Dimension 53
Figure 4.7 RDF Structure of Knowledge Dimension 54
Figure 4.8 RDF Structure of the Category in Knowledge Dimension 54
Figure 4.9 Cognitive Process Dimension in Pedagogical Metadata Ontology 55
Figure 4.10 Knowledge Dimension in Pedagogical Metadata Ontology 56

LIST OF TABLES

Table 3.1 Pedagogical metadata in 10 Repositories 34
Table 4.1 The Taxonomy of Educational Objectives 42
Table 4.2 The Knowledge Dimension 44
Table 4.3 The Cognitive Process Dimension 45
Table 5.1 Primary information about assigned three learning objects 59
Table 5.2 Participants' Experience with Online Courses 62
Table 5.3 Perceived Effectiveness of the Educational Objective Tool for Metadata Generation 64
Table 5.4 Perceived Usefulness of the Educational Objective Tool for Metadata Generation 67
Table 5.5 The Necessity of the Educational Objective Tool for Metadata Generation 70

CHAPTER 1: INTRODUCTION

1.1 Purpose of This Research

Advancing software technologies and the proliferation of information resources on the web are offering learners and educators the promise of easy access to abundant instructional materials. However, to translate these benefits into enduring and meaningful progress in teaching and learning, it may be argued that three waves of further socio-technical innovation are required, each wave consisting of a combination of technical and procedural advances motivated by immediate perceived needs. The cumulative effect of these innovations will be to profoundly change the way that teachers, instructional designers and learners think about and use learning resource materials.

Driving the first wave of innovation, which is already well underway, is the widely recognized need for learning resource repositories, search tools and recommender systems to provide more precisely targeted retrieval of resources (Ma, 2005). Much of the research on learning objects over the past seven years is intended to satisfy this need. Learning objects are digital learning resources that are packaged and catalogued to afford greater reusability, generativity, adaptability, and scalability (Parrish, 2004; Wiley, 2001). In this first wave, teams of computer scientists, library scientists, and educational technology design researchers have developed databases, search and retrieval methods, and standards that allow cataloguing and technical interoperability of learning objects. In one example of this type of work by our research team, Li, Nesbit and Richards (2006) developed software capable of translating across local subject taxonomies that educators use to search for and catalogue learning resources.

A second wave of innovation has begun to emerge that is driven by the perceived need for higher quality learning resources. This wave will feature innovations in the application of instructional design theories, emphasizing the collaborative protocols, procedures, and technical infrastructure to support quality design and evaluation of individual, reusable learning resources. Toward this end, researchers at Simon Fraser University have developed and tested an instrument for evaluating learning object quality, a collaborative quality evaluation methodology, and web-based tools that support both the instrument and evaluation methodology (Nesbit, Belfer, & Vargo, 2002; Richards & Nesbit, 2004; Vargo, Nesbit, Belfer, & Archambault, 2003). The innovations in this second wave focus on the design and content features of individual objects.

The third wave of innovation will address issues related to the aggregation of learning resources to create integrated and customized learning experiences. Unlike second wave innovations, which focus on the internal design of learning objects, third wave innovations will be concerned with the fit among resources experienced by a learner, especially the alignment of instructional design elements such as assessments and activities across a set of separately produced resources. This wave may culminate, for example, in methods for automatically strengthening associations among resources that have been combined in highly rated aggregates. Designers, teachers and learners may be able to use these associative links to assemble new aggregates for specific requirements. The research conducted in this thesis, however, addresses what may be a key element in the third wave – the representation of information about the pedagogical properties of learning resources. Pedagogical metadata consist of shared terminologies in teaching, learning and instructional design to describe learning resources. They are comprised of structured data that are searchable to aid in selecting and assembling learning resources in customized instructional design and learning process.

1.2 The Research Reported in This Thesis

Working from the premise that pedagogical information has an important role in using and reusing digital educational resources, the research attempted to answer two questions: (1) How can we evaluate the quantity and quality of pedagogical metadata currently existing in learning object repositories, and (2) How can design tools foster the creation of pedagogical metadata? Separate research studies were conducted to address each of these questions.

1.2.1 Evaluation of the Quantity and Quality of Existing Pedagogical Metadata

An analysis was conducted to determine whether there exist pedagogical metadata and understand their status in current repositories. Through the analysis of the pedagogical terms used in 74 existing repositories, I found out that most of the pedagogical terms appearing in the harvested repositories are not used as pedagogical metadata. That means, although there are certain frequencies of those terms that are regarded as pedagogy terms in the repositories, they are not really applied to the contexts where instructional or learning process is expected to occur. Furthermore, I contend that, despite extensive work on the current learning object metadata standards for learning resources to aid search and retrieval, there is still very little provision in such standards to describe the ways that the resource is intended to be used, or is capable of being used, for teaching and learning. Such pedagogical information, which potentially can be rendered as metadata, may be critically important when a designer, teacher or learner is attempting to combine complementary resources and create a complete learning experience.

1.2.2 How Can Design Tools Foster Creation of Pedagogical Metadata?

By answering this question, four perspectives in terms of pedagogical metadata (PM) are considered: the need of such a tool to help generate PM, the effectiveness of this tool to help generate PM, the usefulness of the generated PM, and suggestions on improving this approach.

Functioning as metadata database, a pedagogical metadata ontology based on Bloom's revised taxonomy of educational objectives was built for further references between the communications at meta-levels among machines. Due to the complexity of ontologies for extracting data from user input, a web-based tool was developed as a friendly user interface to generate pedagogical metadata for online learning resources and collect user data. The users are allowed to add or delete the items of associated educational objectives freely. As those items exactly match the categories in the metadata ontology, they can be directly imported and stored into the ontology. This approach is evaluated by analyzing the questionnaire collected from the participants after they have used the web tool.

Ten students with teaching experiences from faculties of Education and departments of Psychology at two western Canadian universities participated the research and worked with the web tool. They also completed a questionnaire created to collect the feedback on four aspects of using such a tool to generated educational objectives. The results showed that most participants were interested in interacting with such a tool to generate educational objectives and recognized the quality and the value of the pedagogical metadata created and annotated with the learning resources.

1.3 Thesis Structure

Chapter 2 is a literature review providing the background of key concepts appearing throughout the thesis. Concepts such as learning objects, learning object metadata, learning object repositories, pedagogical metadata, ontologies and educational objectives are covered in detail. Current trends in the development of learning object repositories and the well-known problem of learning object metadata about customized searching of learning resources are also discussed. To overcome the dilemma of use and reuse of digital learning resources, the notion of pedagogical metadata ontology is brought forward as a possible solution. The justification and advantages of applying such an ontology are also discussed at length.

Chapter 3 describes the study which examined the use of PM in 74 existing repositories harvested from Open Archive Initiatives (OAI). The result shows that there is a significant lack of pedagogical information in the metadata fields. The latter part of the chapter considers the reasons for this problem, and frames the problem as the motivation for the study reported in chapter 4.

Chapter 4 describes the design of a web-based tool for creating learning goals according to Blooms' revised taxonomy of educational objectives. Significantly, the tool also generates pedagogical metadata for digital learning resources. As an interface for generating pedagogical metadata, this web-based tool collects and stores the pedagogical metadata in the database running behind. Then, those metadata are retrieved and imported into the proposed pedagogical metadata ontology for communicating among systems.

Chapter 5 presents an evaluation of the web-based tool. It reports and interprets the results of data collected from 10 participants.

In chapter 6, I discuss the implications of this research. A design of how to make a user-friendly interface for general users to tag pedagogical metadata for learning objects is advocated. Limitations and possible improvements to the proposed ontological approach of representing pedagogical metadata and the use of a web-based interface to collect user data are discussed.

CHAPTER 2:
LITERATURE REVIEW

2.1 Introduction

Various educational technologies such as computer-based training, electronic performance support systems, computer-assisted instruction, intelligent tutors, experiential multimedia, and constructivist learning environments have been researched and sometimes implemented in educational settings. Although the emphasis may vary according to the specific approach, the learner and the educational resources remain principal parts of the equation (Konstantopoulos, Darzentas, Koutsabasis, Spyrou, & Darzentas, 2001).

The enormous changes in the access to information brought by the internet have had a significant impact on the understanding of instructional design principles and practices. Web-based support systems have introduced new instructional designs and course delivery models. Distance learning and online education have gained increasing attention because they are perceived as changing the way students interact and learn.

Networks and technologies bring learners the promise of ubiquitous access to instructional materials as well as learning support. However, these gains can be achieved only by translating technological advances into meaningful learning and instructional environments in online educational settings. The overarching question is how we should use the new digital learning resources to support learning goals in diverse settings, and effectively integrate them into everyday teaching and learning. In this chapter, I introduce ontologies as an approach to capturing and applying pedagogical metadata. Specifically, I propose an ontology for pedagogical metadata based on Bloom's revised taxonomy of educational objectives. The purpose of the ontology is to annotate learning resources with pedagogical metadata which can assist teachers and instructional designers in searching for appropriate learning objects and incorporating them in their learning designs.

The chapter is structured in the following manner. In section 2.2, the concept of learning objects, learning object metadata, and their uses in instructional design are introduced, giving special attention to the notion of learning object reusability. In section 2.3, learning object repositories and their current status are discussed in detail. In section 2.4, I introduce the concept of pedagogical metadata and its representation in ontologies, and explain the purpose of a pedagogical metadata ontology. In Section 2.5 the concept of ontology and its advantages in supporting knowledge sharing and annotating learning resources are introduced. A pedagogical ontology is proposed to support the creation of pedagogical metadata. The problem in building such a metadata ontology is also discussed.

2.2 Learning Objects

Learning objects are regarded as a new way of framing computer-based learning, grounded in the object-oriented paradigm of computer science (Sampson & Karagiannidis, 2002). With its potential for reusability, generativity, adaptability, and scalability, learning objects are considered as the leading candidate of technological choice in the next generation of instructional design (Wiley, 2000).

To facilitate the widespread deployment and interoperability of learning objects, some organizations initiated instructional and technical specifications for learning objects. The Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) defined learning objects as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning." By testing and integrating various technical specifications developed by these organizations, the Advanced Distributed Learning (ADL) Initiatives have developed a model for developing digital content based on a commonly accepted set of specifications. The model was known as Shareable Content Object Reference Model (SCORM). The SCORM model seeks to develop a system of specifications for developing learning objects based on the requirements of accessibility, interoperability, durability and reusability (Darrin, 2001). A similar project called the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) started with the financial support of the European Union Commission. At the same time, another venture called the Instructional Management Systems (IMS) Project were launched in the United States (IMS, 2000). Many of these local standards efforts have representatives on the LTSC group (Wiley, 2000).

In a broader sense, learning objects can be thought of as web pages, animations or other digital resources for learning. Parrish (2004, p. 52) proposed that "instead of trying to define learning objects as entities or particular artifacts, it may be more useful to view learning objects as a process or strategy" for object-oriented instructional design (OOID), which is "a strategy for designing digital (typically online) learning content and activities as discrete, addressable, and adaptable units." According to this view, the purpose of working with smaller-grained units such as learning objects is to afford efficient and flexible aggregation into learning resource packages.

The fundamental idea behind learning objects is reusability in multiple contexts. Learning objects can be broken down as small instructional units so that they can be used and reused in distinctive learning context and educational settings for several times, thus the quality of the learning can be enhanced for those people who reuse those learning objects and integrate them into their learning or course design (Wiley, 2000). Moreover, as learning objects are digital pieces of instruction that are context independent and transportable, they have great potentials to be deployed in customized learning models and forms (Herridge Group, 2006a).

Learning objects represent a completely new conceptual model for the content used in the context of learning. They will permanently transform the form of learning in an innovative manner in the field of learning content design, development, and delivery (Hodgins, 2000).

Reusability in multiple contexts is fundamental to the learning objects paradigm (Ma, 2005). To achieve this goal, cooperating professional organizations have formalized standards for describing or labelling learning objects so that they can be discovered by search engines with greater ease and efficiency (Frosch-Wilke, 2004). The international Learning Objects Metadata (LOM) standard introduced by the IEEE Learning Technology Standards Committee defines 81 descriptor fields or elements categorized as general, life cycle, meta-metadata, technical, educational, rights, relation, annotation or classification (IEEE LTSC, 2002).

The Learning Objects Metadata (LOM) specification for the description of learning objects includes a hierarchical structure of nine categories of metadata:

1. General: general features of learning objects;

2. Lifecycle: the status of learning objects from past to the current situation;

3. Meta-metadata: Features of the metadata that describe learning objects;

4. Technical: Technical aspects of learning objects;

5. Educational: Educational or pedagogic aspects of learning objects;

6. Rights: Conditions and copyright of using learning objects;

7. Relation: Relationship of learning objects to other learning objects;

8. Annotation: Comments on the educational use of learning objects;

9. Classification: Classifications of learning objects in relation to a classification system.

Each of those nine categories of metadata is composed of data elements that cover specific aspects of a learning object. For example, the entry coverage describes the situation such as time, culture and regions where the learning objects apply. One element in the LOM educational category is difficulty, which means the level of the audience that this learning object can apply to.

2.2.1 Reusable Learning Objects

Supporting the notion of small, reusable chunks of instructional media, Reigeluth and Nelson (1997) suggests that teachers prefer to divide instructional materials into smaller units and reassemble those components in ways that best support their individual instructional and educational goals. As Wiley (2000, p.3) mentioned, with regard to such an instructional procedure, "reusable instructional components, or learning objects, may provide instructional benefits" because "this initial step of decomposition could be bypassed, potentially increasing the speed and efficiency of instructional development."

In more detail, a learning object is a collection of components covering a topic or complex task and meeting one or more learning objectives (Herridge Group, 2006b). Traditionally, many courses are made up of modules and lessons of various topics. According to the specific instructional design principles to apply, learning activities to perform, and learning goals to achieve, instructors can choose and define learning objects with a commensurate size. Defined as a meaningful division of learning that can be accomplished in one sitting, the appropriate size of a learning object is based on "the amount of information that can be digested by a learner at the time the learning is occurring" (Mills, 2002, p. 2). This leaves it open for instructors to incorporate right learning objects into their instructional design.

Learning objects are also self-contained and context-independent units (Herridge Group, 2006b). In separating content from structure, learning objects are disconnected from concrete learning contexts. In order to reused in the new context for learning, learning objects should be annotated with certain types of pedagogical information such as earning strategies, learning processes or sequences and learning goals (Allert, Dhraief, & Nejdl, 2002). As Wiley indicated, instructional design theory and strategies "must play a large role in the application of learning objects if they are to succeed in facilitating learning "(Wiley, 2001, p.9).

Thus, in the procedure of aggregating suitable learning objects with specific pedagogical purpose, learning objects need to contain contextual pedagogical information for the web-based systems to successfully find and compile them. It is widely understood that the primary purpose of the LOM standard is to facilitate search and retrieval rather than support coherent aggregation. In addition to being rarely used, these elements in LOM provide insufficient information to instructional designers who assemble learning objects to form courses or other larger scale learning packages and there is a lack of related pedagogical information of pedagogy in LOM. Thus, unless extended, the standard offers very little support for the description of the pedagogical or learning design properties of learning objects (Brsetti, Dettori, Forcheri, & Ierardi, 2004; Frosch-Wilke, 2004; Mwanza & Engeström, 2005).

Assigning instructional objectives information as part of the metadata for learning objects is a possible solution to provide for instructionally grounded use and assembly of learning objects into useful, learner-centred instructional materials (Martinez, 2001; Wiley, 2001). Rather than randomly enclosing together a series of learning objects from a general category into an online course, an instructional design-centric approach will consider the scope, role, audience, level of complexity and adaptability of particular digital resources. This will be done in part by referencing the instructional-related metadata previously assigned to the objects, to ensure the most effective, learner-centered learning course material. By incorporating pedagogical metadata within learning objects, even dynamic learning content development systems can help avoid assembling content that lacks instructional value (Darrin, 2001). As such, reusability of learning materials can be achieved both at the domain level and the instructional level (Sampson & Karagiannidis, 2002).

While a number of technical challenges remain to be solved, in the future the goals of learning content accessibility, interoperability, durability and reusability will be realized. As digital content sharing for learning becomes commonplace, designers for online courses, will experience new opportunities to increase content quality and course development efficiency, with the goal of improving the availability and value of educational content for all learners (Darrin, 2001).

2.3 Learning Object Repositories

Educational resources have a wide variety of forms, such as textbooks, digital images, audio and video clips, simulations and so on. As more and more digital educational content are delivered and incorporated into web-based curricula, many issues have to be addressed to overcome problems such as: How to properly archive and manage the ever-increasing amount of electronic content? How to support customized access to high-quality, structured learning resources (Hatala & Nesbit, 2001)? How to sustain the reusability and interoperability of learning objects (Paquette, 2004)?

A learning object can be seen as "a unit of instructional content for which a metadata record describing its characteristics and intended educational usage is provided" (Sicilia, Garcia, Pages, Martinez, & Gutierrez, 2005, p.411). The ability to retrieve, use and reuse learning objects has driven the creation of learning objects in a standard fashion that can not only benefit the course designers within their target audience, but also has the potential for greater knowledge sharing among organization and research and institutions for education and training, providing a tangible return on investments (AFLF, 2005). Consequently, this situation requires learning object warehouses to play a central role by storing large collections of learning objects or learning object metadata, enabling "independence of content from the delivery system and dynamic rendering of content" (Hatala & Nesbit, 2001).

Some organizations have initiated projects to aggregate collections of learning objects for long-term storage, search, and utilization in a similar way to digital libraries, which are the prototype of Learning Object Repositories (LOR). LORs function like portals with a web-based user interface, a service engine for searching and a catalogue of the resources (Guzmán & Peñalvo, 2005). Although LORs are built by utilizing database technology, they differ essentially from the digital libraries with regard in their goal to support instructors and a broad variety of services provided to encourage the discovery, exchange, and reutilization of learning objects (Richards, McGreal, Hatala, & Friesen, 2003), targeting both humans and software agents and other web-based systems. Therefore, LORs are regarded as "key enablers for bringing increased value to learning resources by providing opportunities for reuse, repurposing, or reengineering to suit a variety of purposes and end-user needs" (Porter, Curry, Muirhead, & Galan, 2002, p. 5).

2.3.1 The Functionality of Learning Object Repositories

The learning object paradigm plays a fundamental role in meeting the pedagogical needs for ubiquitous and lifelong learning, and for more flexible, adaptive learning opportunities realized inside and outside the public education system (Paquette, 2004). LOR functionality is designed to support such educational activities and purposes. In general, LOR functionality can be identified at two levels.

The first level provides services for learning object storage, retrieval and maintenance – the functions of the classical database. At this level, LORs are designed to preserve technical quality of a large amount of multimedia and hypermedia materials, manage the storage, access, retrieve content and provide the services of searching, browsing and utilization of learning materials for various learner communities and educational settings (Kleinberger, Schrepfer, Holzinger, & Müller, 2001).

The second level of LOR functionality is to support the reuse and interoperability of learning objects among interdisciplinary programs and re-purposing of learning objects in various educational contexts. To achieve the goal of reusability, learning objects must adhere to a standard format to be "sufficiently structured or sufficiently granular to allow educators to swap components to adapt the learning object to a specific curriculum requirement, local context or background knowledge" (TILE, para. 2), and support interoperability between repositories and other content management systems. As a result of this, several standards for describing learning objects, such as the IEEE Learning Object Metadata (IEEE LTSC, 2002), the Dublin Core Metadata (DCMI) and IMS Core (IMS, 2006), have been developed through collaboration of public and private organizations (Hatala & Nesbit, 2001). The completeness of these standards for describing learning objects plays a crucial role as quality indicators for the evaluation of reusability of learning objects, since "reusability requires precise enough descriptions to be able for a human or a software module to retrieve the appropriate items, and also to be able to decide its appropriateness for the usage context at hand" (Sicilia et al., 2005, p. 11).

The next trend for the development of LORs is from currently centralized repository structures to a distributed repository architecture. Such a federated architecture model will provide a unifying structure, compliant to coherent technology standards and metadata schemas, and deploy an enlarging practice of connecting resources of provinces, communities and individuals with those of federation members (Porter et al., 2002).

2.3.2 Major Initiatives of Learning Objection Repositories

Many large-scale initiatives for building LORs have emerged in Canada, the United States, Europe and Australia. Some recent repository projects in Canada include LORNET (The Learning Object Repository Research Network), CLOE (Cooperative Learning Object Exchange) and CAREO (Campus Alberta Repository of Educational Objects).

LORNET is a pan-Canadian research network supported by Science and Engineering Research Canada aiming at concrete deliverables for society, universities, as well as public and private organizations across Canada. CLOE, founded at the University of Waterloo and consisting of 17 university partners in Ontario, proposes a collaborative model for the creation, development, use, and reuse of learning objects. CAREO is a project supported by the Universities of Alberta, Calgary and Athabasca University in cooperation with BELLE (Broadband Enabled Lifelong Learning Environment), CANARIE (Canadian Network for the Advancement of Research in Industry and Education), and the Campus Alberta initiative.

Funded by National Science Foundation (NSF) in the United States, the SMETE project (Universal Access to Academic Excellence in Science, Mathematics, Engineering of federated repositories," promoting the "teaching and learning of science, mathematics, engineering and technology" for educators and students of any age, any level at any time and any place (SMETE, para. 1).

The UK's NLN (National Learning Network) is a national partnership program providing infrastructure for a wide ranging of interactive learning materials for teaching and learning to support users across the learning and skills sector.

By empowering individual as well as community users of learning and teaching practices, the development of digital libraries, centralized repositories and federated repository networks have aimed at quality education by changing the ways in which learning technologies are used in either online or traditional classrooms.

2.3.3 The Problems in Current Learning Object Repositories

LORs provide interoperability infrastructure for a great variety of users to share and reuse of desirable learning objects in diverse online educational environments. Successful online instruction depends essentially on the extent to which the learning object can be searched, utilized and re-purposed appropriately in a new learning context (Richards & Hatala, 2003). Learning object metadata records consist of descriptions of learning objects' characteristics that can be used for searching and locating learning objects. Hence, the completeness and consistency of metadata records becomes a critical requirement for effective search and retrieval of learning objects stored and registered in LORs (Sicilia et al., 2005).

According to an empirical study of the completeness of metadata records on the MERLOT repository and CAREO repository by Sicilia et al. (2005), the amount of metadata information in both repositories is low, relative to the large number of learning object records in them. This study indicates that many repositories may have similar problems of not having complete metadata records for learning objects.

2.4 Pedagogical Metadata

Pedagogical metadata use the vocabularies of teaching, learning and instructional design to describe learning resources. They are comprised of searchable, structured information created by the object's designers and users. Such metadata are created to aid teachers, learners and designers in assembling learning resources to form coherent sets of instructional materials.

Pedagogical metadata may describe the theoretical rationale for a learning activity. For example, if the learning resource allows the learner to step through an animation of a worked mathematics problem, the metadata might refer to the cognitive load theory that studying worked problems is more beneficial for novices than solving problems (Kalyuga & Sweller, 2004). Pedagogical metadata may also identify the learning objectives of a resource, the type of feedback it offers learners and so on.

Working from an activity theory perspective, Mwanza and Engeström (2005) proposed pedagogical metadata consisting of seven activity theory concepts. For example, they specified a "division of labour" element that a designer could use to indicate the differing roles played by participants in a computer-supported collaborative activity. They concluded that "metadata abstraction methods based on specific theories have a role to play in facilitating the conceptualization of contextually and pedagogically grounded insights about learning resources" (Mwanza & Engeström 2005, p. 463).

In many educational settings, web resources and their applications are not always used in productive, instructionally relevant ways (Wallace, Kupperman, Krajcik, & Soloway, 2000). To make effective instructional design a more tractable problem for busy teachers, computer scientists have begun to develop semi-automated systems capable of assembling pedagogically matching objects (e.g., Del Corso, Ovcin, & Morrone, 2005). By relying on pedagogical metadata, it is expected that such systems can assist users to combine materials using criteria such as quality, relevance and mutual suitability. For example, such systems may be able to recommend a simulation object and an assessment object that address the same learning objectives.

2.5 Ontologies

Computer scientists define an ontology as a specification of a representational vocabulary for a shared domain of discourse. An ontology is a specification of a conceptualization, consisting of definitions of classes, relations, functions, and other objects (Gruber, 1993). It serves as metadata schemas, providing a controlled vocabulary of concepts, each with explicitly defined and machine-processable semantics. By defining shared and common domain theories, ontologies help people and machines to communicate concisely-supporting exchange of semantics, not just syntax (Madche & Staab, 2001).

In the contexts of knowledge sharing and reuse, ontologies serve as metadata schemas providing a controlled vocabulary of concepts such that each term is fully labelled with explicitly defined and machine-processable semantics. Generally, ontologies provide a framework for building knowledge, and set the foundation for developing reusable web-contents, web-services, and applications (Devedžić, 2003).

2.5.1 Why an Ontology for Pedagogical Metadata?

Generally speaking, "ontologies provide the necessary armature around which knowledge bases should be built, and set grounds for developing reusable web-contents, web-services, and applications" (Devedžić, 2003, p. 3). While the advancement of technologies made it promising to support increasingly complicated instructional design processes, many technical and conceptual issues remain unresolved.

First, there is a large conceptual gap between courseware authoring systems (Intelligent instructional system, IIS) and authors. As there is a lack of a common vocabulary or terminologies for understanding, knowledge and components embedded in systems are usually not sharable or reusable (Mizoguchi & Bourdeau, 2000). For example, learning objects are not well annotated with the context of use and data of surrounding activities, which made them difficult to be shared, reused in any course design.

In addition, the wide range of models and practices within the domain of instructional design and learning science has also led to a lack of shared terminology (Allert et al. 2002), and yet a unified and well-defined set of pedagogical concepts and principles is fundamental to the development of instructional design support systems. Although many instructors are well aware of instructional theories, they encounter difficulties in implementing systems that can rely on a unified set of concepts and principles. Furthermore, most web-based systems today use different formats and languages for representing and storing the course material, as well as the teaching strategies, the learning goals and the assessment procedures. Ontologies can support those systems by explicitly representing of the conceptualization of each system. These terms enables us to share the specifications of components' functionalities, tutoring strategies and so on (Devedžić, 2003). Therefore, such systems will be able to communicate with users and support them by manipulating concepts according to their design rationale.

Moreover, authoring tools are mostly non-intelligent. In common, it is not easy for authors (instructors) to acquire personalized recommendations or support from the system itself.

Ontologies are a potential solution to overcome such drawbacks. Firstly, ontologies can assist the sharing and reusing of learning materials between different systems. In addition, ontologies can provide supports to annotate learning materials and the higher-level interaction between systems and users.

Another role of an ontology is to act as a meta-model. An ontology specifies the models to build by giving guidelines and constraints that must be followed. Specifically, in the domain of instructional design, ontologies can help cataloguing and annotating learning objects, which can provide descriptive summaries intended to convey the semantics of the object (Devedžić, 2003). Together, these tags (or data elements) usually comprise what is called a metadata structure (LTSC, 2000). Metadata structures are searchable and thus provide a means for discovering learning objects of interests, even when they are non-textual (Recker, Walker, & Wiley, 2000).

Applications of ontologies make systems intelligent and interactive with users at a higher level. For instance, in the context of recommender systems (Middleton, Shadbolt, & Roure, 2003), ontological user profiling helped capture knowledge about user interests and made inferences over similar users to seek implicit items that are interesting to users.

2.5.2 Pedagogical Metadata Ontology

The creation of a pedagogical metadata ontology provides a solution by explicitly representing a shared vocabulary with attendant relations. A pedagogical metadata ontology would consist of terms and relations for instructional design theories, learning goals or objectives, learning tasks and activities, assessments, and other aspects of teaching and learning. It could accommodate the divergent vocabularies of different theoretical domains, and could explicitly represent connections across domains where they exist. An important advantage of ontologies is that they flexibly accommodate knowledge expansion. Thus, in principle, changes in learning design knowledge or the meaning of educational terminology can be incorporated into an existing ontology.

The ontology would support the retrieval of pedagogically relevant resources according to situationally driven design rationale and eliminate or give lower attention to the irrelevant resources often returned by search engines and recommender systems. For instance, a high school instructor teaching Newtonian mechanics might need resources for a problem-based learning unit on photosynthesis. She may place a query that specifies "instructional method = problem-based learning" and "topic = photosynthesis." The search engine would return materials about photosynthesis, first listing those that are suitable for use in problem-based learning.

In addition to supporting coherent recommendation of learning resources, such an ontology would also allow users to browse and visualize pedagogical concepts in relation to the resources they are creating, tagging, or assembling. Moreover, a pedagogical ontology could support inferences using explicitly related concepts and vocabularies. Such inferences would allow, for example, a set of search terms to be extended to include terms semantically linked to those entered by a user.

2.5.3 Problems in Building Pedagogical Metadata Ontology

However, there remain significant challenges in establishing an adequate ontology for pedagogical metadata. As evidenced by the many unused elements in the existing metadata standard, the mere definition and provision of metadata fields does not ensure that users will expend effort to populate them with useful information. Thus, devising a feasible way to motivate users to pedagogically describe the resources they design and use becomes a key element in pedagogical metadata creation.

2.6 Conclusion

This chapter introduced the concepts of learning objects, learning object metadata, learning object repositories and presented their current trends and advancements. Problems that instructors confront in the field of online education were discussed with regard to the transformations from physical classrooms to online environments. The notion of ontology is advocated as a possible solution to overcome those drawbacks with its capabilities to representing and sharing domain terminologies. In chapter 4, I propose a pedagogical metadata ontology utilizing Bloom's revised educational objectives as a feasible approach to generating, storing, and applying pedagogical metadata for digital learning resources in diverse instructional contexts. Before that, in chapter 3, I report an empirical investigation on the pedagogical metadata available in current LORs.

CHAPTER 3: ANALYSIS OF PEDAGOGICAL METADATA IN CURRENT LEARNING OBJECT REPOSITORIES

The standards of learning object metadata have been widely deployed in many learning object repositories and educational systems. Teachers need such information when they access repositories and search for learning objects for particular pedagogical purposes. I hypothesize, however, that in many learning object repositories learning objects are not tagged with adequate pedagogical information, which is a key element for retrieving and reusing learning objects in different learning contexts. To assess the hypothesis that pedagogical information is absent, I measured the amount of pedagogical metadata in the current repositories by harvesting metadata from 74 learning object repositories at Open Archive Initiatives (OAI). The result shows that most repositories analyzed have little or no pedagogy information in the metadata fields. At the end of this chapter, the reasons why there is a lack of such important information in many digital learning resources are attributed to the lack of the precision with which current metadata categories describe pedagogical features, as well as the time-consuming nature of metadata annotation. Later chapters describe how a web-based tool informed by Bloom's revised taxonomy of educational objectives was designed and implemented as a possible solution to assist in eliciting and generating pedagogical metadata.

3.1 Method

In this section, I describe the techniques used to examine whether the pedagogical terms appeared in the learning object metadata are used for pedagogical purpose in current learning object repositories. When instructors search for appropriate learning materials in LORs for an online curriculum, usually they already have certain pedagogical or instructional approaches and objectives in mind. Therefore, they would probably use certain associated pedagogical terms as the key words to locate the matching learning objects. Thus, it is reasonable to examine the actual metadata records in repositories to see if pedagogical terms are used, which should help to identify problems that instructors may encounter in building up their online curriculum. This study includes three phases: (1) metadata harvesting in the repositories, (2) calculation of term frequencies in the repositories and (3) examination of sample terms.

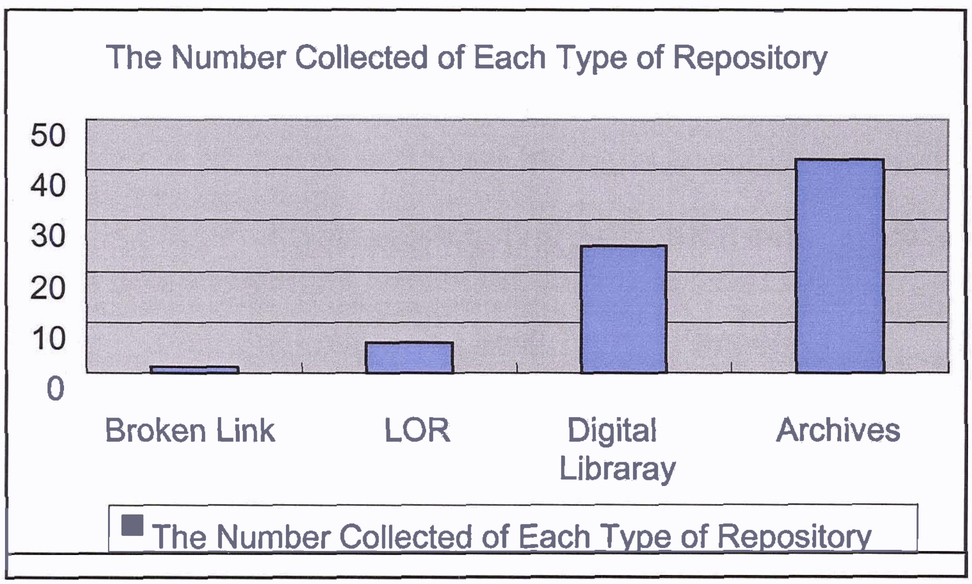
3.1.1 Repositories Used in This Analysis

The metadata records were collected from repositories indexed by the Open Archive Initiative (OAI). OAI is an organization aimed at promoting the accessibility and interoperability standards of online archives. It was originally designed to enhance the sharing of scholarly papers in the E-Prints community. Later, OAI became committed to offering broader access to learning object repositories maintained by other organizations. More detailed information can be found on the OAI website.

Altogether, metadata records from 94 repositories were collected. Among those repositories, some are registered in OAI while others simply are repositories that support the OAI protocol, namely, Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). The OAI-PMH protocol allows the public to harvest all xml-formatted metadata from the OAI repositories. For more convenient access, those metadata are associated with related contents for users by providing an identifier in Dublin Core format. The URLs of the repositories are found through searching the OAI repositories.

I found that, in addition to conventional learning object repositories, the OAI repositories include digital libraries and archives of publications, theses and dissertations from universities on a variety of subjects and topics. Figure 3.1 shows the number collected of each type of repository.

Figure 3.1 The Number Collected of Each Type of Repository



There were six conventional learning object repositories existing in the harvested repositories. Conventional learning object repositories are those repositories where users register learning objects such as a simulation of a chemical lab, or an interactive geometric animation. Some of them also register user reviews of learning objects. They are open to users from different places, at different learning levels and with different learning objectives. For example, the repository "LearningOnline Network with CAPA" (http://www.lon-capa.org/) is a free open-source system to shares and use online learning and assessment materials across institutions and disciplines.

There were 34 digital libraries harvested. The digital libraries contain a great amount of text and non-text collections. For example, the "Indiana University Digital Library Program"(http://dlib.indiana.edu/collections/) includes a variety of physical collections such as text, images and music. Some of the collections also provide instructional tools to support the use of those collections.

The repositories of archives of theses and dissertations from universities consist of catalogues of publications, such as online journals, proceedings, or theses and dissertations from departments and universities. For example, the CES EPrints Repository is the publications database for the department of Electronics and Computer Science at the University of Southampton (http://eprints.ecs.soton.ac.uk/). Altogether, there were 42 such repositories harvested.

One harvested repository was inaccessible due to broken links to the site.

The latter two types of repositories collected contain digital publications and other multimedia materials. The intended users for the latter two categories of repositories are students and faculties at universities to support their research activities. However, they are also open to other users. In a broader sense, those archived documents including books, journals, thesis, tapes, films and so on, are abundant learning resources that can also be regarded as learning objects because they can be used for learners with specific learning objectives. For example, a PHD candidate in Biology department may want to search dissertations related to the topic of molecular biology and develop his own research based on those previous findings. Therefore, he may want to search dissertations and other publications in those repositories of relevant topics and acquire sufficient knowledge from those materials before he starts his own research.

The quantity of metadata was found to vary widely across repositories. For meaningful metadata analysis those repositories with little metadata were removed from the overall data set. After such data refinement, there remained 74 repositories, numbered from R1 to R74 for this analysis.

3.1.2 Method for Retrieving Metadata

The program to harvest metadata in OAI repositories was written in the programming language Java by TyMey Eap for the project of the Learning Object Repositories Network (LORNET) at Simon Fraser University. As the metadata were returned in batches of one hundred metadata of the Dublin Core format, to collect all the metadata from a repository, a subroutine was written to iterate through the harvesting request until all the metadata were retrieved and stored locally. Then another subroutine was written to navigate through each metadata of each repository and compute the frequency of the pedagogical words which appeared in the metadata title and description fields. Records of the computation were created for each repository for further analysis.

The pedagogy vocabularies utilized in the analysis were obtained from the Pedagogy and Policy vocabularies on the website of the Higher Education Academy (HEA), which were developed by RDN/LTSN community (Resource Discovery Network). The RDN is the UK's free national subject-based gateway aiming at UK's higher education to Internet resources for the learning, teaching and research community.

The currently available version of the Pedagogy and Policy vocabularies, and the one used in this study, is version 2.0 (RDN/LTSN Pedagogy Vocabularies, 2006). It is presented in Appendix 3.

3.1.3 Method for Determining Proportion of Terms Used as Pedagogical Metadata

In total, there were 102 pedagogy terms in the flat list of the Pedagogy and Policy vocabularies used in this experiment. 20 terms were randomly selected out of 102 terms using the online random number generator "random.com" (www.random.org). Using the same generator, 10 repositories were also randomly selected. For each randomly selected repository and term, the usage of the term in the first hit was manually examined to determine whether it was used for a pedagogical purpose in the metadata fields of subject, description and title.

Pedagogy is "the science, principles or work of teaching." (Chambers Reference online). Examining how a pedagogical term is used and the implicit assumptions about teaching and education that underlie its use is a valuable way to understand how the education process is perceived (Murphy, 2003). In this study, the criteria to determine whether a pedagogy term is used for pedagogical purpose in the learning object metadata records is to judge if the term has been applied to certain learning contexts to promote instruction and achieve specific learning objectives. For example, the term "critical thinking" in the metadata field "description" in the R52 repository (*NSDL Metadata Repository: MERLOT*), was applied as a pedagogical term as shown as below:

Supporting Materials

- On-line Glossary

- Study Hints
- Critical Thinking Questions

In the example above, the usage of "critical thinking" indicates that in this learning object, critical thinking questions will be used in this class module as supporting materials.

However, the terms which appear on the list in Appendix 3, are sometimes used in a non-pedagogical sense. For example, the term "simulations" appeared in the description field in the *IUBio Archive of biology software* to describe a software object K-Estimator as "a program to estimate the number of synonymous (Ks) and nonsynonymous substitutions (Ka) per site and the confidence intervals by Monte Carlo ***simulations.***" In this case, the term simulation is used to describe a certain type of simulation, not the way in which it might be used to support learning.

3.2 Results

Appendix 1 shows the frequency of 102 pedagogical terms in all 74 repositories. For example, the term "lab" appeared in the Experimental Thesis Catalogue repository 92051 times. It also had the highest overall frequency: 303554. Some terms such as "large group teaching', "one-to-one teaching" and "reflective learning" had very low frequencies in the repositories. There were seven terms which had 0 hits in all 74 repositories: enquiry-led learning, drills practice, surface learning, records of achievement, numeric skills, credit frameworks and subject-specific skills. Appendix 2 shows the repository name used in the analysis table for each repository.

Table 3.1 below shows the frequencies with which each of the manually examined pedagogical terms appeared in each of the selected repositories. The Term column identifies the 20 pedagogy terms chosen randomly from the total terms. The other columns represent the 10 repositories randomly chosen from the set of 74 repositories.

Each cell of table 3.1 represents a single sample from the harvested results that was manually examined to determine whether the term in the first hit was used as pedagogical metadata. Each sample is binary – the term in the first hit either was or was not judged to be pedagogical metadata. The cases in which the term was used as pedagogical metadata are indicated by shaded cells.

As shown in Table 3.1, the repository R52 and repository R53 belong to the category of conventional learning object repositories. In those two repositories, out of 40 terms sampled, there were 8 used in a pedagogical sense.

Among the 10 randomly selected repositories, there are 3 repositories that come from the category of digital libraries. In those repositories, out of 60 terms sampled, 2 were used in a pedagogical sense. Among the 10 randomly selected repositories, 5 were bibliographic archives of journals, theses and dissertations. No terms were found that were used as pedagogical metadata.

Table 3.1 Pedagogical metadata in 10 Repositories

Repository / Term	Learning Object Repositories		Digital Library			Archives of Journals, Theses and Dissertations				
	R52	R53	R19	R44	R66	R5	R33	R57	R67	R73
Workshops	7	**29**	99	21	0	1	196	2	17	20
Presentations	**644**	56	71132	13	44	30	18557	102	78	245
Lab	3281	4611	8990	1128	558	3689	106525	0	11077	5735
Mentoring	3	12	1	0	0	0	46	0	50	0
Theses	143	67*	104	19	118	37	2054	12	6355	170
Reliability	422	77	13	1	31	57	2861	53	267	142
Exercises	27	19	47	34	66	16	178	4	20	44
Transcripts	24	12	85	190	13	27	1610	0	26	24
Critical Thinking	**9**	4	1	0	0	0	2	0	4	0
Seminars	9	**19**	72	32	1	2	68	1	2	5
Simulations	**448**	25	4	0	76	61	38974	111	279	312
Reports	288	230	2866	1776	27	62	3359	64	110	192
Distance learning	14	**12**	0	0	0	0	24	1	21	24
E-learning	3	21	0	0	4	6	235	17	16	48
Collaborative learning	**1**	1	0	0	2	0	28	0	1	0
Lectures	24	**21**	233	808	3	1	2705	5	6	10
Dissertations	5	6	35	10	2	0	36	0	2	10
Lifelong Learning	2	10	1	0	0	0	6	0	2	0
Essays	2	9	47	104	9	0	80	1	15	45
Exams	1	6	22	13	0	0	80	0	1	45
Total Percentage(x/20):	.20	.20	0	.10	0	0	0	0	.0	0

The last row of Table 3.1 shows the proportion of sample cases in each repository which used the respective term as pedagogical metadata. The mean proportion of sample cases in the conventional learning object repositories is .20. It is .033 in digital libraries and is 0 in the archive repositories. This is an estimate of the proportion of instances of the pedagogical terms listed in Appendix 1 that are used as pedagogical metadata.

Given the mean proportion of the appearance of pedagogical metadata, the method of a confidence interval on a proportion is used to estimate the validity of the observed range of the proportion of pedagogical metadata appearance in the sample repositories. A calculator of the confidence Interval for a proportion (http://www.causascientia.org/math_stat/ProportionCI.html) was used to calculate the proportional range for the pedagogical metadata. In calculating a confidence interval on a proportion, a sample of *N* items is examined to look for some specific feature of interest. *K* items are observed to have such a feature. We calculate an estimate $P = K/N$, for the proportion of such a feature of interest. *P* is the maximum-likelihood estimate of the true proportion. A confidence interval is the interval for which the probability of error is divided equally into a range of proportions below the interval and another range above the interval.

Given the .95 confidence interval, for the observed cases in the conventional object repositories, the lower limit is .11 and the higher limit is .35. This result means that proportion of uses of the Appendix 1 terms which are pedagogical metadata is likely between .11 and .35.

Given the .95 confidence interval, for the observed cases in the digital library repositories, the lower limit is .01 and the higher limit is .11. This result means that proportion of uses of the Appendix 1 terms which are pedagogical metadata is likely between .01 and .11.

3.3 Inferences about the Frequency and Usage of Pedagogical Metadata

The result shows that the proportion of pedagogical use of pedagogy terms in the 3 types of repositories among those ten sample OAI repositories is relatively low, even though the frequency of the terms is often quite high. Although the data collected is far from exhaustive compared with the data stored in all repositories distributed worldwide, the result can provide some indication about the current situation of the actual use of pedagogy terms in the metadata records in existing repositories.

It is expected that the proportion of the pedagogical terms is small compared to more general terms in the metadata fields of those repositories. Then, the percentage of the pedagogical metadata in all the terms that appear in the metadata fields is estimated to be even smaller. This means that the pedagogical metadata in each type of those sample repositories are rather sporadic and isolated.

By examining associations between the frequencies of pedagogical metadata and the properties of repositories, it is possible to infer reasons why some there is so little pedagogical metadata in some repositories. Among the repositories, there are few repositories that have explicit pedagogical information in the metadata fields for their learning object records. Those pedagogical terms that I found are used as pedagogical metadata all come from those few repositories. Those repositories are R52 *NSDL Metadata Repository (MERLOT)*, R53 *American Memory* and R44 *AIM25 - Archives in London*. The common features of the learning objects harvested in those few repositories are that they share a similar metadata structure including educational objectives, teaching points, supporting materials, assessments and so on. Three examples of learning objects that used pedagogical terms as pedagogical metadata will be presented below to show their similarity. The first example comes from the description field of the metadata of the repository of *NSDL Metadata Repository (MERLOT)*, for the term presentations:

Suggested Student Assessment:

Have students make posters or computer **presentations** showing what the Earth looked like during different parts of the Cretaceous period. They should also indicate how continental plate movements contributed to the evolution of dinosaurs and other species during this period. They can use information from the Web sites they have already visited, plus any additional Internet and/or print resources.

Another example is the learning object that introduces the mathematical concept of chaos. The term simulations appears in the field of objectives as below:

Objectives

Upon completion of this lesson, students will:

- have experimented with several chaotic ***simulations***
- have built a working definition of chaos
- have reinforced their knowledge of basic probability and percents

The third example is for the term critical thinking. In the description metadata field, it was applied as a pedagogical term as shown as below:

Objectives: Students will work in pairs using given materials to design and build a car from given materials. Students will learn cooperatively. Develop problem solving and ***critical thinking*** skills. Work with a limited amount of materials. Discuss the difficulty of completing the activity with given materials. Cite changes that could be made to help the project if done again.

In this example, the usage of the term critical thinking indicates that this learning object aims at promoting certain cognitive skills including critical thinking when applied to a handwork curriculum.

From those examples, we can see that the structure of the metadata found in the learning objects from those few repositories exactly matches the requirements of locating learning resources surrounded by pedagogical information, such as objectives, assessments and supporting materials, which are created previously by teachers or instructors who have similar instructional design experiences when they plan and design their own courses, whereas most of the repositories under review lack such information in their metadata fields. This also explains why most of the repositories have difficulty in supporting search for pedagogically suitable learning resources because they are not structured to contain such information in their metadata.

The similar pattern of the pedagogical metadata from those few repositories implies that certain pedagogical information as educational objectives can support those teachers who intentionally search for resources that match their class plans in the online course design procedure.

3.4 Conclusion

Learning object metadata is created to store, retrieve and facilitate the instructional use of learning objects in various learning contexts. However, due to the low degree of pedagogical information in the metadata fields and incompleteness of metadata itself, the resources in repositories may be invisible to learners and instructors (Barton, Currier & Hey, 2003) and the opportunities to customize and re-purpose learning objects in suitable educational settings are decreased.

One possible reason is that metadata annotation for learning objects is effortful and time-consuming, so users are not encouraged to provide sufficient information when they register or create learning objects in the repositories, not to mention pedagogical metadata. In the meantime, the availability of domain experts to annotate learning objects in different categories is not assured, which also contributes to the problem of insufficient pedagogical metadata. Also, the high level of flexibility in metadata standards leads to loosely structured metadata. Thus the metadata records stored in the repositories is incomplete and poorly structured (Sicilia et al., 2005). Another possible reason is that the current widely deployed learning object metadata, such as LOM, lacks the precision of rendering structured knowledge in its metadata categories such as the Educational Category (Foroughi, 2004). This, in turn, hinders the involvement of pedagogical information for learning objects.

For most of the repositories, the lack of pedagogical information in metadata lies in the demand of domain expertise and exhaustive effort to fill in the metadata fields. At the same time, even for the repositories with pedagogical metadata, the current structure lacks the flexibility in extending the existing metadata contents to support reuse and relocating learning objects in diverse contexts.

However, there are some limits about this research. Firstly, those examined repositories are all open resources and non-profit. If we can harvest more data from commercial repositories whose metadata are not open to public, the result will be more representative with regards to the completeness and the variety of repositories that have been studied.

Secondly, although 74 repositories have been analyzed in this study, the number of repositories (especially the number of conventional learning object repositories) is still small relative to the large number of repositories available online.

Thirdly, some of the repositories collected for this study are not conventional learning object repositories. For example, those repositories that archive theses and dissertations, which may result in some question of the validity of the result. Yet, the purpose of this design is to develop a feasible methodology to track and identify pedagogical metadata in different repositories. Therefore, the variety of repositories included in the analysis empowered the methodology I used here instead of impairing the validity of the result.

We know there are users with learning content, but only through a program of iterative evaluation and simplification of the tool set can we lower the learning curve to the point where everyone can participate (Richards et al., 2003). In the next chapter, a web-based tool based on Bloom's revised taxonomy of educational objectives is designed as a possible solution to generate and incorporate pedagogical information in metadata records which promote instructional qualities in metadata creation.

CHAPTER 4: GENERATION OF EDUCATIONAL OBJECTIVES AS PEDAGOGICAL METADATA

4.1 Introduction

In previous chapters, an ontological approach was advocated and justified as a feasible solution to generate educational objectives as pedagogical metadata to support the deployment of learning resources in a pedagogically-grounded way in course design. In this chapter, I introduce a web-based computer application which can be integrated with the proposed ontology as an educational objectives creation tool. The intended audience for this tool is instructors who design and teach online courses. The purpose of creating such a tool is to facilitate the process of eliciting pedagogical metadata from users. The data collected by the tool will be imported and stored into the ontology as pedagogical metadata which can be utilized by a search engine or recommender systems. The design of the educational objectives tool and the procedure to process the collected data are discussed in the following sections.

4.2 A Revision of Bloom's Taxonomy of Educational Objectives as Pedagogical Metadata

Educational objectives are learning goals that instructors want students to achieve during the learning process. They are "explicit formulations of the ways in which students are expected to be changed by the educative process" (Bloom, Englehart, Furst, Hill & Krathwohl, 1956, p. 26). Simply speaking, when instructors teach, they expect students to learn. The expected changes resulting from teaching are the educational objectives. Therefore, objectives play an indispensable role in teaching because "teaching is an intentional and reasoned act" (Anderson & Krathwohl, 2001, p. 3).

The revised Bloom's taxonomy of educational objectives is the framework of objective statements which can assist teachers to categorize their learning goals in two dimensions: cognitive process and knowledge. The cognitive process dimension describes how the objective can be used and assessed. The knowledge dimension includes the type of knowledge represented by the objective. Consider the following example: The students will be able to distinguish (the cognitive process dimension) the differences between mammals and the amphibians (the knowledge dimension). Table 4.1 presents the interrelationship of the cognitive dimension and knowledge dimension (Anderson & Krathwohl, 2001, p. 28).

Table 4.1 The Taxonomy of Educational Objectives

The Knowledge Dimension	The Cognitive Dimension					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual knowledge						
Conceptual knowledge						
Procedural knowledge						
Meta-cognitive knowledge						

With regard to the substantial role that objectives play in teaching, the educational objectives are adopted as pedagogical metadata proposed in this research. In the next few chapters, educational objectives are generated for digital learning resources using a web-based tool, imported and stored as pedagogical metadata in the pedagogical metadata ontology and will be referenced later in searching and locating pedagogically suitable learning resources for intended users.

In the following two sections, the categories of the knowledge dimension and the cognitive process dimension are defined and explained in details.

4.2.1 The Knowledge Dimension

After carefully examining the diverse classifications of knowledge types, the authors of the revised taxonomy defined four general types of knowledge: factual, conceptual, procedural and metacognitive. Table 4.2 shows the four levels of the knowledge dimensions with their subcategories (Anderson & Krathwohl, 2001, p. 29).

Factual knowledge is defined as knowledge of content elements of a specific discipline. It includes the basic knowledge about a discipline that students need to understand and to solve any problems in this domain. Conceptual knowledge is the knowledge of categories and classifications and their relationships that make them joint and function together. Procedural knowledge is the knowledge of sequences of steps or the procedure to follow. Meta-cognitive knowledge is the knowledge of cognition and perceived consciousness of one's own cognition (Anderson & Krathwohl, 2001). The detailed categories and their definition are presented in the table 4.2 below.

Table 4.2 The Knowledge Dimension

Major Types and Subtypes
Factual Knowledge-The basic elements students must know how to be acquainted with a discipline or solve problems in it
Knowledge of terminology
Knowledge of specific details and elements
Conceptual Knowledge-The interrelationship among the basic elements within a larger structure that enable them to function together
Knowledge of classification and categories
Knowledge of principles and generalizations
Knowledge of theories, models and structures
Procedural Knowledge-How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods
Knowledge of subject-specific skills and algorithms
Knowledge of subject-specific techniques and methods
Knowledge of criteria for determining when to use appropriate procedures
Metacognitive Knowledge-Knowledge of cognition in general as well as awareness and knowledge of one's own cognition
Strategic knowledge
Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge
Self-knowledge

4.2.2 The Cognitive Process Dimension

The cognitive process dimension determines the cognitive process involved in the educational objective. It is divided into six levels: remember, understand, apply, analyze evaluate and create. Table 4.3 shows the categories and sub-categories of those six levels (Anderson & Krathwohl, 2001, p. 31).

Remember is defined as recalling knowledge from long-term memory. Understand means comprehend meaning from instructional messages by means of all types of communication. Apply is executing or following a procedure in a given situation.

Analyze means decomposing materials into smaller units and understanding the interrelationship of those parts related to each other and their overall structure. Evaluate is defined as using criteria and rules to make judgments. Create means assembling elements together to integrate as a working group (Anderson & Krathwohl, 2001). The elaborated categories and definitions are presented in the table 4.3 below.

Table 4.3 The Cognitive Process Dimension

Categories & Cognitive Processes	**Alternative Names**
1. Remember-Retrieve relevant knowledge from long-term memory	
1.1 Recognizing	Identifying
1.2 Recalling	Retrieving
2. Understand-Construct meaning from instructional messages, including oral, written, and graphic communication.	
2.1 Interpreting	Clarifying, paraphrasing, representing, translating
2.2 Exemplifying	Illustrating, instantiating
2.3 Classifying	Categorizing, subsuming
2.4 Summarizing	Abstracting, generalizing
2.5 Inferring	Concluding, extrapolating, interpolating, predicting
2.6 Comparing	Contrasting, mapping, matching
2.7 Explaining	Constructing models
3. Apply-Carry out or use a procedure in a given situation	
3.1 Executing	Carrying out
3.2 Implementing	Using

Categories & Cognitive Processes	**Alternative Names**
4. Analyze-Break material into constituent parts and determine how parts relate to one another and to an overall structure or purpose.	
4.1 Differentiating	Discriminating, distinguishing, focusing, selecting
4.2 Organizing	Finding coherences, integrating, outlining, parsing, structuring
4.3 Attributing	Deconstructing
5. Evaluate-Make judgments based on criteria and standards.	
5.1 Checking	Coordinating, detecting, monitoring, testing
5.2 Critiquing	Judging
6. Create-Put elements together to from a coherent or functional whole; reorganize elements into a new pattern or structure.	
6.1 Generating	Hypothesizing
6.2 Planning	Designing
6.3 Producing	Constructing

4.3 A Web-Based Educational Objectives Tool

In the research design described in chapter 5, a web-based educational objective tool was presented to the participants as a pedagogical metadata creation tool. The purpose of the study is to examine how this tool would be able to support the generation of educational objectives as pedagogical metadata for learning resources.

A web-based educational objective tool was designed and implemented as a proof of the concept that pedagogical metadata can be generated by an instructional design tool and coded in an ontological form. The tool was created to serve two mutually interdependent needs. For instructional designers it provides an aid to the development and storage of instructional objectives to be associated with a learning object. For instructors and teachers it provides pedagogical metadata to aid in discovering and coherently assembling learning objects for presentation to learners.

This tool is implemented based on Bloom's revised taxonomy of educational objectives. The knowledge dimension and the cognitive procedure dimension are reified in the interface as shown in Figure 4.1 and Figure 4.2.

Figure 4.1 Cognitive Dimension

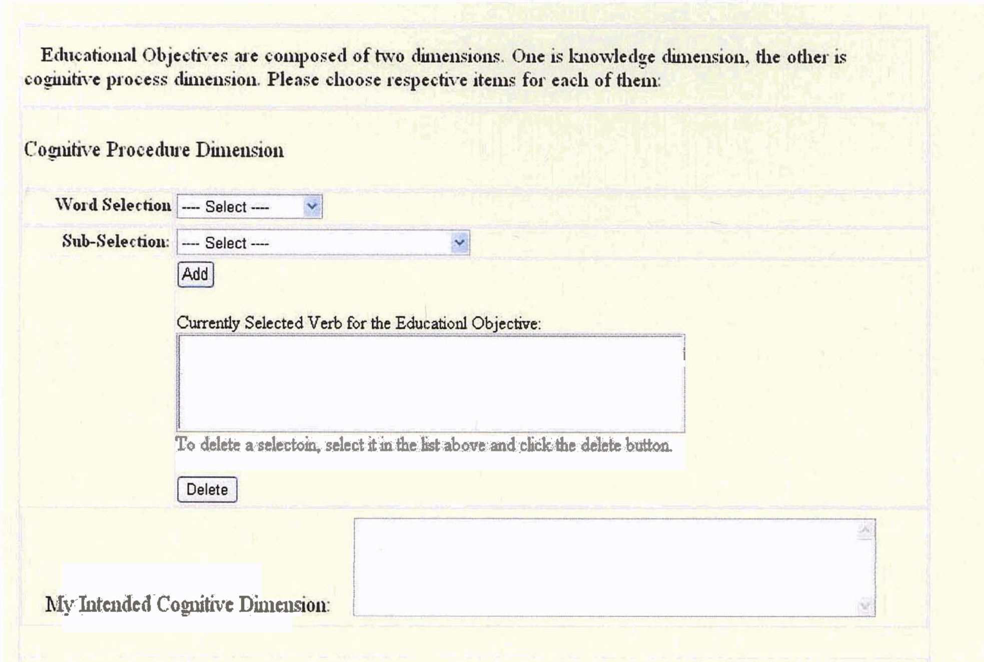
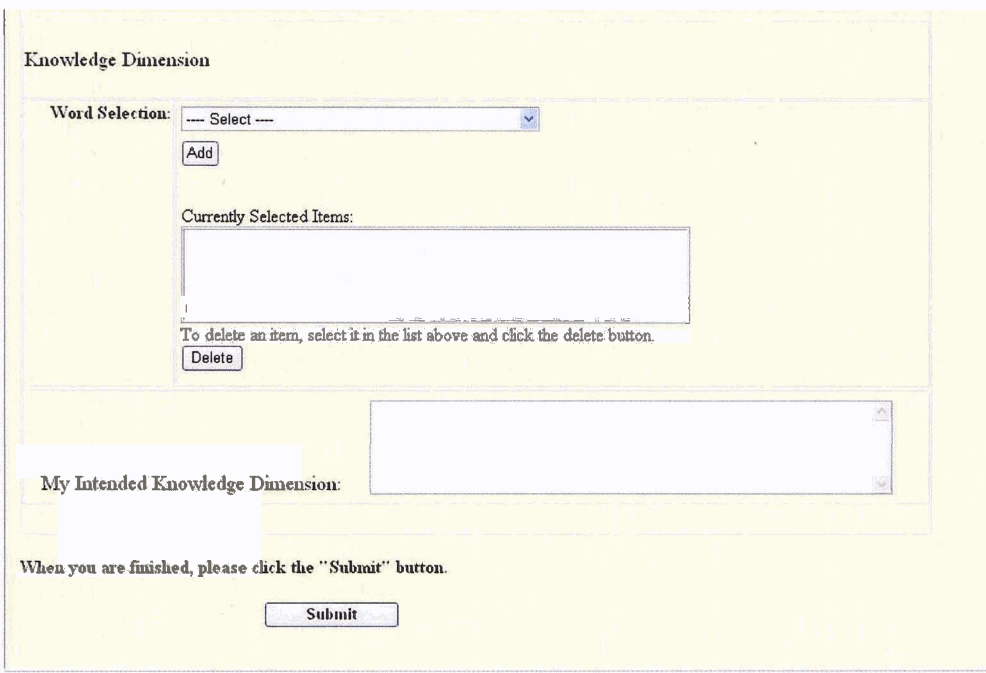


Figure 4.2 Knowledge Dimension

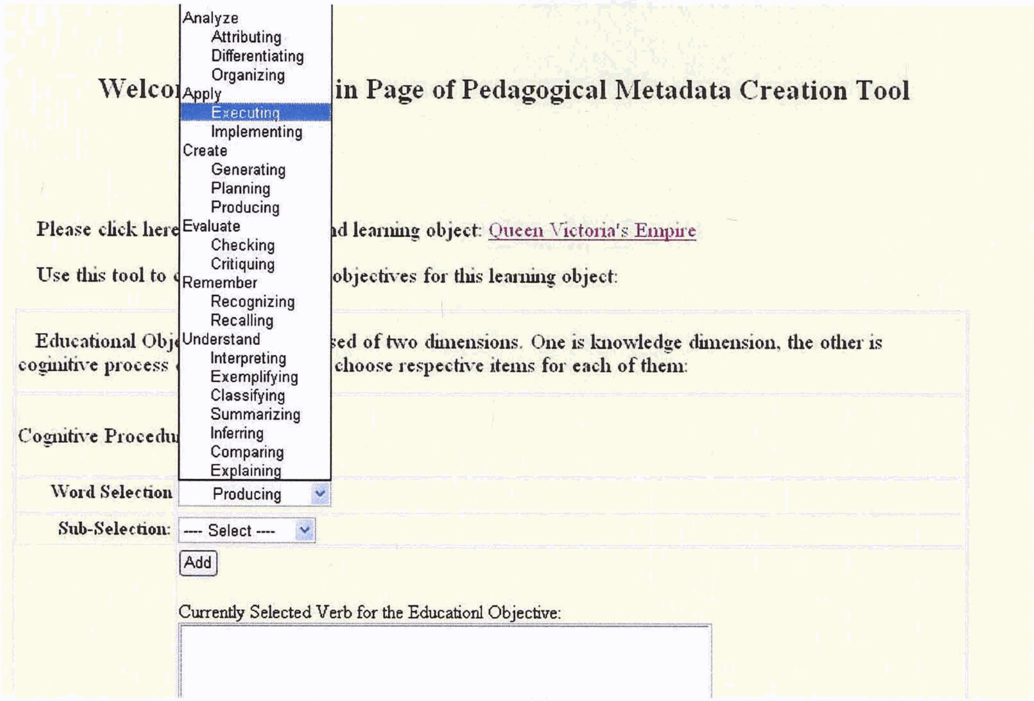


The cognitive process dimension is comprised of six categories: remember, understand, apply, analyze, evaluate and create. Each of the processes is then categorized into sub-processes. For example, remember is divided as recognizing and recalling. As we can see, those categories and subcategories are all listed in the word selection menu and sub-selection menu respectively. When users select one category in the word selection menu, the sub-selection menu will expand the subcategories automatically for the selected category in the sub-word selection and allow a more refined word selection for the cognitive process dimension. In addition, multiple choices of cognitive process are enabled for users to apply more than one objective for the same learning resource by clicking the "add" button below the selection menu. Figure 4.3 shows the cognitive procedure dimension implemented in the tool.

The visual representations of the categories of the cognitive dimension allow users to select the relevant terms associated with their individual objectives. In this way, the popup menu functions as a reminder for users to create educational objectives.

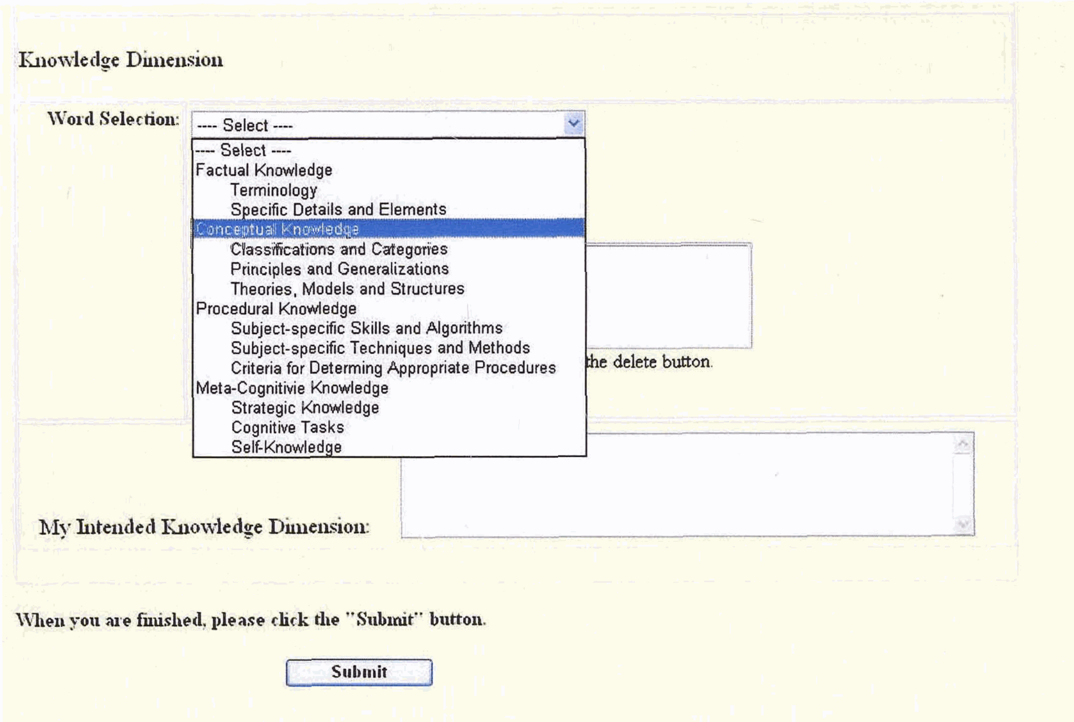
Moreover, users are also allowed to fill in their preferred terms in the text box "My intended Cognitive Dimension." They can enter terms which are not listed in the menu selection as shown in Figure 4.1. In this case, the categories in the word selection menu work as a framework for the intended user word selection in this dimension.

Figure 4.3 Category of Cognitive Procedure Dimension



The knowledge dimension consists of four types of knowledge: factual knowledge, conceptual knowledge, procedural knowledge and meta-cognitive knowledge. Each of those four categories is then subcategorized into more concrete knowledge classifications. For instance, knowledge of principles and generalizations are classified as a subcategory of conceptual knowledge. Similarly, users are enabled to select items in the word selection menu and sub-word selection menu in the knowledge dimension. Figure 4.4 shows the knowledge dimension implemented in the tool. They are also allowed to choose multiple types of the knowledge in the menu for the same learning resource. More specific information of knowledge dimension can be added in the text box of "My Intended Knowledge Dimension" shown as below.

Figure 4.4 Category of Knowledge Dimension



After users complete the creation process, the generated educational objectives are stored in a relational database. Later on, the data will be exported from the database as an xml file and imported into the educational objective ontology as pedagogical metadata. The ontology is a knowledge base for pedagogical metadata that can be utilized in search engines and expert systems such as recommender systems. This content will be elaborated in the next section.

4.4 Data Importing and Representation in Pedagogical Metadata Ontology

In the proposed research approach, educational objectives collected by the tool are regarded as pedagogical metadata and will be imported into the pedagogical metadata ontology. In the following two sections, I described how the data is imported from the collected data into the pedagogical metadata ontology and how they are represented in the ontology.

4.4.1 Data Importing in the Pedagogical Metadata Ontology

Those created educational objectives are stored in the database of the system. Then they will be imported as Resource Description Framework (RDF) files into the pedagogical metadata ontology built based on Bloom's revised taxonomy of educational objectives.

Figure 4.5 and Figure 4.6 show the structure of cognitive process dimension in the format of RDF files exported from the educational objective tool as below.

Figure 4.5 RDF Structure of Cognitive Process Dimension


```xml
<class>
    <name>The_Cognitive_Process_Dimension</name>
    <type>owl:Class</type>
    <own_slot_value>
        <slot_reference>rdf:type</slot_reference>
        <value value_type="class">owl:Class</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>owl:disjointWith</slot_reference>
        <value value_type="class">The_Knowledge_Dimension</value>
    </own_slot_value>
    <superclass>owl:Thing</superclass>
    <template_slot>Descriptions</template_slot>
</class>

<class>
    <name>Analyze</name>
    <type>owl:Class</type>
    <own_slot_value>
        <slot_reference>rdfs:subClassOf</slot_reference>
        <value value_type="class">The_Cognitive_Process_Dimension</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>rdf:type</slot_reference>
        <value value_type="class">owl:Class</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>owl:disjointWith</slot_reference>
```

Figure 4.6 RDF Structure for the Category in Cognitive Process Dimension

```
<class>
    <name>Create</name>
    <type>owl:Class</type>
    <own_slot_value>
        <slot_reference>rdfs:subClassOf</slot_reference>
        <value value_type="class">The_Cognitive_Process_Dimension</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>rdf:type</slot_reference>
        <value value_type="class">owl:Class</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>owl:disjointWith</slot_reference>
        <value value_type="class">Understand</value>
        <value value_type="class">Apply</value>
        <value value_type="class">Analyze</value>
        <value value_type="class">Remember</value>
        <value value_type="class">Evaluate</value>
    </own_slot_value>
    <superclass>The_Cognitive_Process_Dimension</superclass>
</class>

<class>
    <name>Generating</name>
    <type>owl:Class</type>
    <own_slot_value>
        <slot_reference>rdfs:subClassOf</slot_reference>
        <value value_type="class">Create</value>
```

Figure 4.7 and Figure 4.8 show the structure of the knowledge dimension in the format of RDF files exported from the educational objective tool as below.

Figure 4.7 RDF Structure of Knowledge Dimension

```
<class>
    <name>The_Knowledge_Dimension</name>
    <type>owl:Class</type>
    <own_slot_value>
        <slot_reference>rdf:type</slot_reference>
        <value value_type="class">owl:Class</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>owl:disjointWith</slot_reference>
        <value value_type="class">The_Cognitive_Process_Dimension</value>
    </own_slot_value>
    <superclass>owl:Thing</superclass>
    <template_slot>Contents</template_slot>
    <template_slot>Comments</template_slot>
</class>

<class>
    <name>Conceptual_Knowledge</name>
    <type>owl:Class</type>
    <own_slot_value>
        <slot_reference>rdfs:subClassOf</slot_reference>
        <value value_type="class">The_Knowledge_Dimension</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>rdf:type</slot_reference>
        <value value_type="class">owl:Class</value>
    </own_slot_value>
    <own_slot_value>
```

Figure 4.8 RDF Structure of the Category in Knowledge Dimension

```
<class>
    <name>Knowledge_of_Principles_and_Generalizations</name>
    <type>owl:Class</type>
    <own_slot_value>
        <slot_reference>rdfs:subClassOf</slot_reference>
        <value value_type="class">Conceptual_Knowledge</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>rdf:type</slot_reference>
        <value value_type="class">owl:Class</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>owl:disjointWith</slot_reference>
        <value value_type="class">Knowledge_of_Classifications_and_Categories</value>
        <value value_type="class">Knowledge_of_Theories_Models_Structures</value>
    </own_slot_value>
    <superclass>Conceptual_Knowledge</superclass>
</class>

<class>
    <name>Knowledge_of_Theories_Models_Structures</name>
    <type>owl:Class</type>
    <own_slot_value>
        <slot_reference>rdfs:subClassOf</slot_reference>
        <value value_type="class">Conceptual_Knowledge</value>
    </own_slot_value>
    <own_slot_value>
        <slot_reference>rdf:type</slot_reference>
```

4.4.2 Data Representation in the Pedagogical Metadata Ontology

Figure 4.9 and 4.10 show the screenshots illustrating a portion of the proposed pedagogical ontology. Users can view and navigate among educational objectives created for the learning resources. This use of pedagogical metadata would shape users' understanding and application of pedagogical concepts. Those metadata stored in the ontology will then referenced by large learning object repositories and other system to support the retrieval and recommendation of learning resources.

There are different types of languages that can be used to create an ontology and describe shared vocabularies and their relationships in an ontology. The language OWL (Web Ontology Language) is used here to build the ontology of the pedagogical metadata.

Figure 4.9 Cognitive Process Dimension in Pedagogical Metadata Ontology

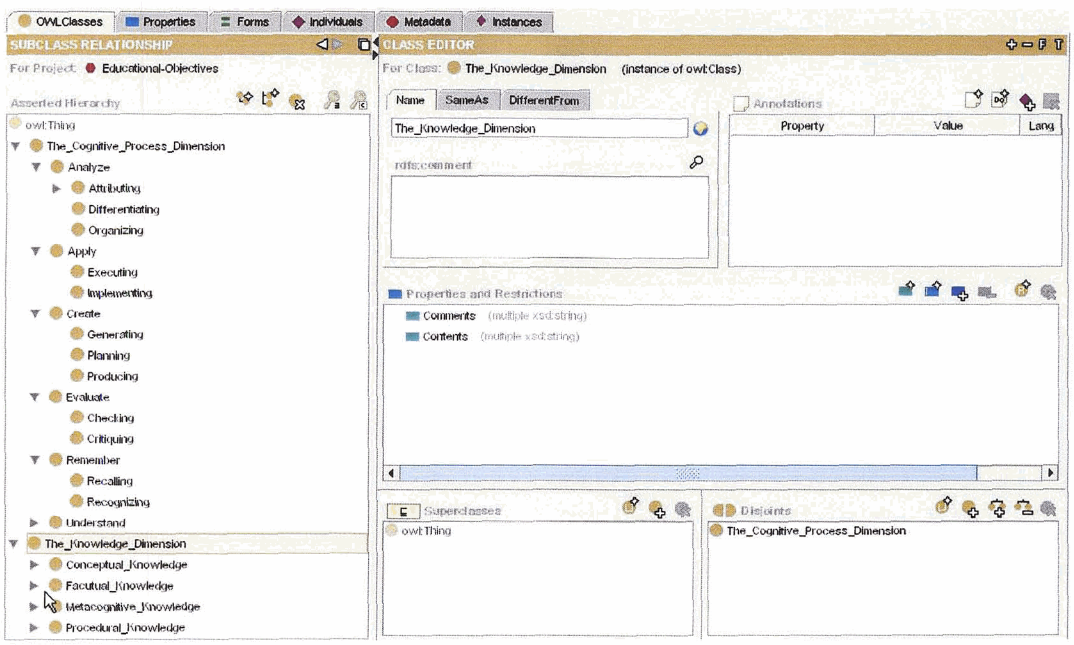
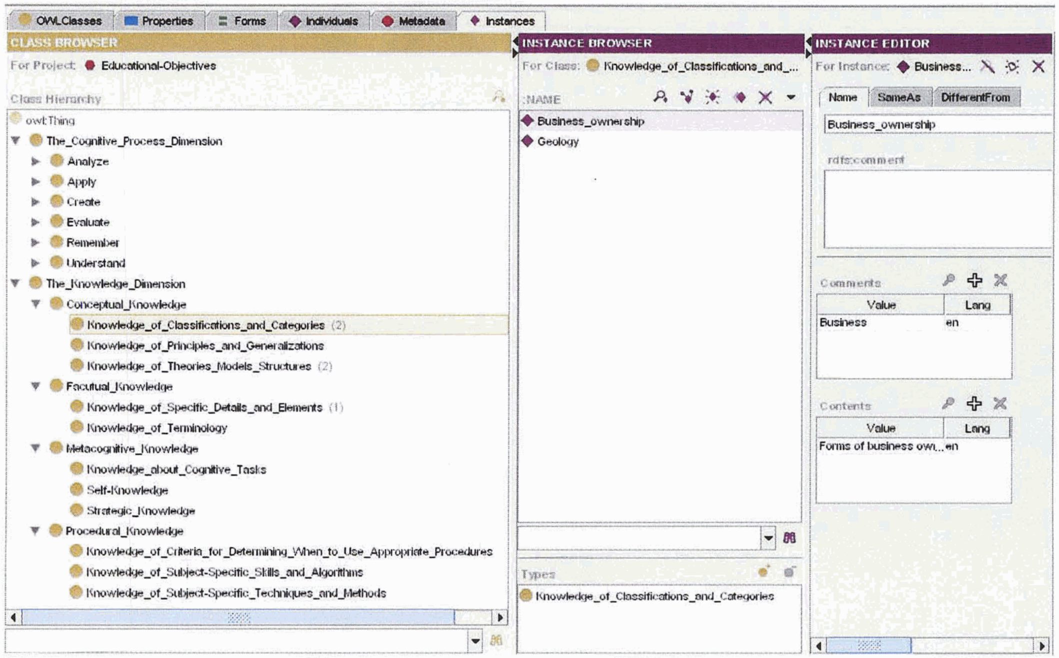


Figure 4.10 Knowledge Dimension in Pedagogical Metadata Ontology



CHAPTER 5: USER EVALUATION OF THE EDUCATIONAL OBJECTIVES TOOL

To evaluate the effectiveness of the educational objectives tool in helping to generate pedagogical metadata, it is essential to understand users' perceptions. This chapter reports on an evaluation of the tool that used data collected through a questionnaire completed by participants who used it. Quantitative and qualitative analyses of the questionnaire results are described. In addition to this data analysis, the ontological representation of the collected data and the procedure of importing it into the pedagogical metadata ontology are addressed.

5.1 Method

5.1.1 Participants

Participants for the study were 10 students, 7 females and 3 males, who were studying educational psychology or educational technology in the faculty of education at two universities in western Canada. One of them was an undergraduate student, two of them were PhD students, and the rest were masters' students.

It was intended to select the participants from the faculty of education to increase the likelihood that they have teaching experiences and knowledge relevant to this study. Most of participants had previous experience taking one or more online courses. There was one student who had a very rich experience in designing online courses. Also, the majority of the participants in the study had teaching experience, either as teaching assistants or instructors in schools, but those experiences were not necessarily online teaching experiences.

5.1.2 Materials

In this study, a web-based educational objective tool was provided to the participants as a pedagogical metadata creation tool, as introduced in the previous chapter. The purpose of the study is to examine the effectiveness of this tool to generate educational objectives and pedagogical metadata for learning resources. In the design, participants were required to use the educational objective tool to create educational objectives for three learning objects using free text and the scaffolded approach.

After participants completed the objective creation process, they submitted the objectives and the data which was then stored in a database. Later on, the data was exported from database in the RDF format and imported into the educational objective ontology as pedagogical metadata. The ontology constituted a knowledge base for pedagogical metadata that can be utilized in search engines and experts systems.

Three learning objects to be used in the evaluation were selected from the learning object repository MERLOT. To ensure the effective comparison between free text and the proposed tool to generate learning goals, the objects were selected to be similar in topics, the amount of content and difficulty. All the three learning objects were in the category of history. The first learning object depicted the history of the Song Dynasty of China. The second one introduced the empire of Queen Victoria. The third one described archeological findings in Egypt. All three objects cover five to six aspects of the aforementioned topics in some detail. The information provided by the learning objects formed was introductory in nature, and their intended audience seemed to be senior high school students or university freshmen. Table 4.1 provides primary information about each learning object.

Table 5.1 Primary information about assigned three learning objects

LO Name	Primary Subject Category	Type	Author	Primary Audience
The Song Dynasty of China	Humanities/History Humanities/History/ Topical/Social Humanities/History/ Area Studies/Asia/China	Lecture/Presentation	East Asian Institute Columbia University	High School, College
Queen Victoria's Empire	Humanities/History/ Topical/ BiographyHumanities/ History/AreaStudies/ World Systems Humanities/History/ AreaStudies/Europe/ Western	Simulation	Public Broadcasting System	High School, College
Mysteries of Egypt	Humanities/History/ Topical/Archaeology	Reference Material	Canadian Museum of Civilization	High school

The participant questionnaire was constructed to solicit information concerning participants' gender, previous experiences with online courses, and their evaluations of using this tool. The questionnaire consisted of 29 items divided into two sections. The first section, which included 6 items, gathered demographic data on the participants' experience in online education. The second section consisted of 23 items that evaluated the tool. Most of the items in these two parts were in a likert format. Each likert item provided a response scale ranging from strongly agree to strongly disagree. There were 4 items in the second part that were in free text format. To make the questionnaire truly reflect the attitude and opinions of the participants, multiple items were constructed for each attitudinal construct. The order of items was randomized. None of the items asked the participant to supply information that could be used to identify them. There were four attitudinal constructs assessed in the questionnaire:

- The effectiveness of this tool in metadata generation
- The usefulness of generated pedagogical metadata
- The necessity for such a tool to generate pedagogical metadata
- The tool's overall design, interface and layout.

The entire questionnaire is provided in Appendix 4.

5.1.3 Procedure

Prior to beginning their participation, all participants were provided with a short tutorial on how to use the tool to generate pedagogical metadata. During the tutorial, participants were given sufficient time to become familiar with the tool. They were encouraged to ask any questions relating to the usage of the tool to avoid any unnecessary failure in using the tool throughout the study.

After the tutorial, three selected learning objects were presented. For the first learning object, participants were asked to create one or more educational objectives that the object would assist in fulfilling in a specific instructional scenario. In this case they submitted their objectives in free text format. For the second learning object, participants were asked to use the tool to create educational objectives. For the third learning object, participants were asked to choose whether or not to use the tool to create the learning objectives. After the participants completed the metadata creation for the three learning objects, they were asked to respond to a questionnaire collecting data on their opinion of the tool. Participants were given as much time as they wanted to complete the procedure and were allowed to ask questions. After they had completed the questionnaire, the participants were asked to comment on any significant aspects of the tool or procedure which they had not mentioned in their questionnaire response.

5.2 Results

The purpose of the study was to determine usefulness and effectiveness of the tool to generate educational objectives and recognize the important role of objectives for learning resources. The results of from the questionnaire are summarized as follows.

- Effectiveness of this tool in metadata generation

Results from all the participants' response to the tool showed that 8 out of 10 participants recognized the effectiveness of the tool to create educational objectives.

- Usefulness of generated pedagogical metadata

Results showed that 9 out of 10 participants agreed that generated pedagogical metadata is useful.

- Possible improvements of the tool in design and layout and suggestions on improving the overall approach.

9 out of 10 participants indicated that the overall user interface can be improved in terms of providing more relevant information of creating metadata.

- Necessity for such a tool to generate pedagogical metadata

7 out of 10 participants agreed that there is a necessity to use a specialized tool to generate pedagogical metadata.

Also, some participants were not familiar with Bloom's taxonomy of educational objectives. As I did not provide such background information in the tool, I explained it to them briefly in person.

In the following sections, I will discuss each of the attitudinal constructs in detail.

5.2.1 Participants' Experience in Online Education

As the focus of this study is on online learning sources, it is assumed that the previous experiences in teaching or studying in online courses may have some influence on their attitudes and preferences on using such a tool. A participant with no teaching experience, may be unable to appreciate the purpose and value of educational objectives and unable to generate appropriate objectives with the support of the tool. Such a participant may be limited in their ability to evaluate the educational objectives tool.

Table 5.2 Participants' Experience with Online Courses

Type of experience	Always	A Few Times	Once or Twice	Never	Experienced participants
Studying	0	2	6	2	.80
Teaching	1	1	0	8	.20
Designing	1	1	0	8	.20

Table 5.2 shows the responses of the participants about their previous experience relevant to online education. All the participants except one indicated that they had some

experience in online courses. Of the 10 participants, 8 had taken an online course as a student, 2 had taught an online course, and 2 had designed an online course. The participants' limited experience in teaching and designing online courses must be considered when interpreting the results of this study.

5.2.2 Perceived Effectiveness of the Tool for Constructing Learning Objectives

Five multiple-choice items were used to assess this attitudinal construct. All the items focus on the effectiveness of using such a scaffolded tool to create educational objectives. To have a clear understanding of the attitudes toward using the designed tool from the participants, all 5 items are listed as below:

Table 5.3 Perceived Effectiveness of the Educational Objective Tool for Metadata Generation

Questions	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	Proportion Approving Tool
17. For creating educational objectives, a free text format is easier than a scaffolded format.	0	0	3	6	1	.70
18. There is no advantage in using a specialized tool for creating educational objectives.	0	0	0	8	2	1.00*
19. Overall, a scaffolded entry format is helpful for defining a resource's learning objectives.	3	7	0	0	0	1.00*
20. Without using a specialized tool, it is easy to forget the different categories of learning objectives.	3	6	1	0	0	.90*
21. If I had to tag learning resources with pedagogical information, I would like to use a tool like this.	2	7	1	0	0	.90*

$^{*}p < .06$

Table 5.3 indicates that all the participants have a positive attitude toward the effectiveness of this tool to support the generation of objectives for learning resources. The observed level of approval was particularly strong for items 18, 19, and 20. The chi-square test of proportion can be used to determine whether proportions in a sample can be used to infer a difference in the population from an expected proportion (the null hypothesis). Specifically, the chi-square test can be applied to a sample of participants responding in two categories to determine if the population proportion differs from uniformity ("50:50") across the two categories. When applied to a small sample of 10 participants, a proportion of .80 (8 out of 10) produces a chi-square value of 3.6, p = .058. A population proportion of .90 (9 out of 10) produces a chi-square value of 6.4, p = .011. For the purposes of inferential analysis, the data reported here can be reduced to the two categories of approval (responding in a manner favoring the tool) and disapproval or uncertainty (responding neutrally or in a manner disapproving of the tool). Thus, for the data reported here, a proportion of .80 or greater in the approval category will be interpreted as statistically detectable evidence of approval at the $p < .06$ level.

This result from this measurement section provides the useful insight that people would like to rely on a scaffolded tool to create metadata for digital learning resources, as indicated by question 20. The result is consistent with the comments from the participants on the tool's interface discussed in the latter section, a scaffolded tool with a friendly user interface is able to "refresh their memory" and "activate their knowledge" for designing a course.

Compared to other items, responses to item 17 indicated the lowest level of approval for the tool such that no preference for the tool could be statistically detected. Although the research hypothesis claims that using a scaffold tool saves participants' effort in creating objectives for learning resources in comparison with freely generated text, 3 of the 10 participants were uncertain (neutral) that the scaffolded format provided by the tool is easier than free text. Despite this uncertainty, these participants recognized the value of the tool as indicated in the other 4 items. In addition to the user interface concern, the complexity and difficulty of the learning materials themselves may have an influence on participants' opinions of whether to choose free text or a scaffolded tool, for instance, if the content of a learning material is very simple, so the objective for the learning material is very evident, then it would be easier to just use free text to annotate it than using the objective creation tool.

5.2.3 Perceived Usefulness of Learning Objectives Constructed Using the Tool

All the items designed to assess this attitudinal construct focus on the usefulness of the objectives created with the educational objectives tool. The purpose of the items was to reveal whether participants would recognize the usefulness of the generated pedagogical metadata after they interacted with the tool, which can be reflected explicitly from their judgment on the tool, for example, their willingness to recommend this tool to others.

Table 5.4 shows that the results of their answers are consistent with the previous one. Most participants revealed a positive attitude toward the usefulness of generated pedagogical metadata except the item 26. Three or fewer participants responded neutral on some items, but none denied the usefulness of the tool or responded negatively toward it.

Table 5.4 Perceived Usefulness of the Educational Objective Tool for Metadata Generation

Questions	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	Proportion Approving Tool
22. I would have more confidence in learning objects which have been tagged with educational objectives by using such a tool.	1	8	1	0	0	.90*
23. I would like to recommend this tool to my colleagues to tag pedagogical information for shared online recourses.	0	8	2	0	0	.80*
24. Instructors can easily locate online resources without knowing their applicable learning contexts .	1	0	1	8	0	.80*
25. I find learning resources annotated with pedagogical metadata such as educational objectives can be easily use and reuse in different educational settings because such metadata explicitly reflects the quality and oriented audience of the learning resources.	4	6	0	0	0	1.00*
26. I find that the contents of educational resources can influence more on my course design than those learning objects annotated with pedagogical information such as educational objectives.	0	3	3	3	1	.40

* $p < .06$

Among the 5 items, the item 25 has the highest percent of congruity (100%). This result confirms the claim in this study that, from the user perspective, less effort is required in searching learning resources when they are tagged with pedagogical information. Moreover, it also suggests that when resources are labeled with such information they are more readily accessible to the end users in their customized learning experiences.

There is an interesting finding in the participants' responses as well. For the item 24, there appeared one participant who has an opposite opinion from the rest of participants. This result may be an indication of the lack of real life experience dealing with online resources. By checking the participant's demographic information, I confirmed that he or she has no experience working with online resources in studying, teaching or designing.

Among all 5 items, the item 26 has the lowest evaluation compared to other positive responses. Three people agreed that the content of the resources influenced more their decision on the selection of resources in the course design than those resources assigned with pedagogical information while 4 people disagreed with this idea and 3 people responded neutrally. The 4 participants who disagreed with the statement in item 26 think that objectives are more essential than the contents of the resources. For those participants who chose "neutral", it appeared that they weighted equally the contents of the resources and the pedagogical information around the resources. The 3 participants who agreed with the statement have explicitly recognized the significance of objectives around learning resources but their responses to this question show that they put different weights on objectives compared to resource content.

5.2.4 The Necessity of the Educational Objective Tool to Generate Pedagogical Metadata

In this section, there are also six multiple-choice items ranging from "Strongly agree" to "Strongly disagree". All the items focus on the necessity of using such a scaffolded tool to create educational objectives. To have a clear understanding of the responses from the participants, all 6 items are listed in the table 5.5 as below:

Table 5.5 The Necessity of the Educational Objective Tool for Metadata Generation

Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Proportion Approving Tool
7. It is easier for instructors to identify suitable learning resources if their learning objectives are displayed.	3	7	0	0	0	1.0*
8. Being able to search for learning resources according to their learning objectives is not a useful feature. I can easily find pedagogically suitable learning resources even if they are not annotated with pedagogical information such as educational objectives.	0	0	3	6	1	.70
9. The learning objects selected for use in a course should align with the educational objectives for the course.	7	3	0	0	0	1.0*
10. I care more about the content of a learning object than the educational objectives provided by its author.	1	0	4	5	0	.50
11. Online learning resources should have definite pedagogical purpose.	5	3	2	0	0	.80*
12. It is impossible to identify learning objectives for a learning object that are meaningful in most of the situations in which the learning object can be used.	0	0	3	7	0	.70

* $p < .06$

The purpose of the items in this section was to reveal whether participants think it is necessary to have such a tool around when they are trying to annotate pedagogical metadata for digital learning resources. Those items were phrased to identify the cruciality of education objectives in searching learning resources to reflect the essentiality of having such a tool to create them. Table 5.5 shows that most participants expressed their inclination to have such a tool available in terms of their recognized necessity of educational objectives, some of whom showed strong preferences to it, for example, in the item 7 and 9.

For the item 10, it seemed that responses from participants are not quite consistent from the item 26, both of which have a similar meaning but different in wording. In this section, participants tended to have more neutral options compared to the previous one. There is only one participant who insisted on his opinion in both of the sections. Actually the answers in this section appeared closer to the expected responses from participants. I talked to one of the participants about their understanding of such an item after I found the inconsistency of the answers for those two items. She told me that she was not quite sure about if there was a right answer, but she felt that both the contents and the instructional information about the resources were equally important to her. Maybe the other participants also had difficulty in determining the priority of those two factors in course design.

5.2.5 The Suggestions and Overall Improvements to the Approach and the User Interface

This part of questionnaire focused on collecting opinions from participants about the interface of the tool and the approach to creating metadata. There are 3 multiple-choice items and 4 free-text items.

The analysis of the responses from participants revealed that 9 out of 10 participants agreed that if the overall interface improves, it would be more useful in helping generate pedagogical metadata. Those participants also made the following suggestions.

Participant 1: In addition, you may create another page to explain what educational objectives are according to the Bloom's taxonomy. Some users/instructors might want to refresh their memory or learn about the Bloom's taxonomy. (not every user/instructor is familiar with educational objectives) Thus, they will use the tool with better understanding of the underlined principle.

Participant 2: It would be helpful if there is a brief introduction of the specific meaning of the terms of the Bloom's revised educational objectives.

Participant 3: An example to illustrate how to generate educational objectives process will be helpful as well.

There is one participant who said the interface hindered the creation of objectives. However, that participant still admitted there is an advantage in using a specialized tool for creating educational objectives.

With regard to the comments on this study itself, 7 participants left it blank. The remaining 3 participants have different opinions about the educational objectives. One thought that educational objectives should be rather "high-level as a guideline but not detailed for specific purpose" while the other believed that objectives were specific according to the audience and lesson plan.

5.3 Conclusion

The educational objectives tool was evaluated by 10 users, who were given a questionnaire assessing four attitudinal constructs. The results showed that participants recognized the effectiveness, usefulness and necessity of such a tool in supporting the creation of learning objectives. With regard to those responses from participants, it indicates that the proposed approach of generating pedagogical metadata would be welcomed by users who have previous experience with online education. Therefore, it has the potential to be improved to overcome the dilemma to generate pedagogical metadata for learning resources and make the design process easier and more enjoyable.

5.3.1 Methodological Limitation of the Evaluation

There are some limitations in the methodology of this study which could be improved to achieve more valid measurements. First, due to the constraints of time and resources, the number of the sample participants is too small. If more participants could join the test, more data would be available for a more detailed analysis, which, in turn, would result in better understanding the effectiveness and usefulness of the tool. The attitudes of the users when they interact with the tool could also be more thoroughly observed, monitored and recorded. Therefore, the overall quality of the measurement could be greatly improved.

Secondly, although all the participants in the test have previous teaching experience, most of them are not professional instructional designers and teachers and do not have rich experience in online education. There are one participant who has never taken part in any online courses before. In this case, the insufficient experiences of online courses from the participants may influence their attitudes to the tool and their judgements on the items in the questionnaire.

Thirdly, most of the participants are not familiar with Bloom's revised taxonomy of educational objectives, so they may not be so willing to use tool due to a lack of prior knowledge.

Last but not least, some participants knew the examiner well, so it is possible there might be some bias in their responses to the questionnaire among those participants because of their inclination to generate preferred answers.

CHAPTER 6: CONCLUSION AND FUTURE WORK

6.1 Conclusion

In this study, the deficiencies of current learning object metadata were claimed with respect to the process of assembling learning resources into larger structures such as courses. A review of 74 repositories harvested from Open Archive Initiatives (OAI) gateway supported the claim and further identified the fact that there is a lack of pedagogical information in the learning resources in the repositories which hinder the use and reuse of those resources.

Ontologies are capable of explicitly representing conceptualizations such as instructional design theories, learning goals, learning activities, assessments and other pedagogical elements. In this research, an ontological representation of pedagogical metadata based on Bloom's revised taxonomy of educational objectives was proposed as a solution to overcome those problems. In the process of building this ontology, the educational objectives are categorized into two major dimensions: the cognitive process dimension and the knowledge dimension. Each of the dimensions is then broken down into subcategories with a comprehensive set of classifications which cover that dimension.

To bridge the gap between general users and the proposed pedagogical metadata ontology approach, an online tool was created to assist the generation of learning objective procedure. Ten university students from 2 western Canadian universities used the tool to create educational objectives for three different learning objects. The value of this tool was assessed by a questionnaire that measures four aspects of the tool in metadata creation. Overall, the results showed optimistic attitudes toward the effectiveness, usefulness necessity and the interface of such a tool to generate pedagogical metadata. The results also revealed the fact that participants recognized the usefulness of the created educational objectives and showed an increased confidence in the resources with such pedagogical information.

Supporting the sharing and unifying the domain terminologies, the key contribution of this research is the ontological representation of educational objectives as pedagogical metadata for digital learning resources. In addition to providing a knowledge base for metadata storage, this pedagogical metadata ontology enables a common understanding and sharing of educational objectives, thus providing a greater accessibility and interoperability for learning resources in repositories.

Moreover, a pedagogical metadata ontology could provide enriched support for interacting with learning resources. In the experience of instructional course design, given the educational objectives tagged by the previous users and the authors for the resources, instructors would be able to identify those learning resources that match best with their own instructional goals. In addition, after teaching such courses, instructors can contribute their experiences by providing other possible educational objectives or expanding the current objectives associated with the chosen resources. This forms a constant cycle in annotating, discovering and refining pedagogical metadata for learning resources.

Similarly, in customized personal learning, learners with specific learning goals are more encouraged to identify the resources that can fulfill their objectives. By referring to previous learner interactions with the resources, a collaborative learning experience is enabled.

6.2 Limitation and Future Research Work

Despite the promising future of this approach, there remain some challenges to the ontological representation of pedagogical metadata. There are significant challenges in establishing an adequate ontology for pedagogical metadata. As evidenced by the many unused elements in the existing metadata standard, the mere definition and provision of metadata fields does not ensure that users will expend effort to populate them with useful information. Thus, devising a feasible way to motivate users to pedagogically describe the resources they design and use becomes a key element in pedagogical metadata creation.

Designing socio-technical systems in which learning object designers and users are inherently motivated to annotate objects with pedagogically oriented information seems to be a promising approach to this problem. The emergence of Web 2.0 changes the way people interact with digital information. According to Downes (2005), Web 2.0 applications allow web content to be "created, shared, remixed, repurposed, and passed along."

Also called the "read/write web," Web 2.0 "is about enabling and encouraging participation through open applications and services." Through this technology, people are self-motivated to communicate and work collaboratively with users of similar interests on a particular topic. Through social networking, users may be attracted to contribute pedagogical metadata. In such an approach, users from any location may read and write pedagogical metadata in relation to particular learning resources. Drawing from their experiences with those resources, users may evaluate them on dimensions such as usability and accessibility (Nesbit, Belfer, & Vargo, 2002), and enter information such as suggested learning activities in which the resources may be used. Perhaps wiki-like models will be adopted that allow open editing of all pedagogical metadata. Such data may be used by recommender systems to support the retrieval and aggregation of resources.

Another possible challenge to such a pedagogical metadata ontology is the technical solution for communication among educational systems, learning object repositories and the ontology. To utilize the pedagogical metadata stored in this ontology, fitting the structure of the pedagogical metadata in various educational systems as an extension of the current learning object standards becomes an inevitable problem.

The generation of pedagogical metadata is a never-ending task. Besides the technical issues, it involves a variety of issues relating to social interaction and user collaboration. However, fostering a customized learning experience is an unavoidable future trend in the development of online education. It is the ultimate goal of researchers to create an environment allowing ubiquitous accessibility to learning resources and customized learning experiences for all learners.

REFERENCE LIST

Advanced Distributed Learning (ADL). (2001). *ADL website* http://www.adlnet.org/

Allert, H., Dhraief, H., & Nejdl, W. (2002). How are learning objects used in learning processes? Instructional roles of learning objects in LOM. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2002*, Chesapeake, VA: AACE., 40-41.

Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE). *ARIADNE website* http://ariadne.unil.ch/

Anderson, L.W., & Krathwohl, D. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.

Australian Flexible Learning Framework (AFLF). (2005). *Learning object repositories: Issues for VET sector organisations*. Retrieved April 14, 2006, from http://pre2005.flexiblelearning.net.au/projects/resources/ VLOR_learning_object_repositories_issues.pdf

Barton, J., Currier, S., & Hey, J. (2003). Building quality assurance into metadata creation: An analysis based on the learning objects and e-Prints communities of practice. *Proceedings DC-2003 (2003 Dublin Core Conference) Supporting Communities of Discourse and Practice - Metadata Research and Applications, USA,* 39-48. Retrieved July 12, 2006, from http://www.siderean.com/dc2003/201_paper60.pdf

Bloom, B., Englehart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain.* New York: Longmans Green.

Brsetti, E., Dettori, G., Forcheri, P., & Ierardi, M.G. (2005). A pedagogical approach to the design of learning objects. *Proceedings of the third international conference on Multimedia and Information & Communication Technologies on Education (CTE 2005), 290-294*. Retrieved June 28, 2006, from http://www.formatex.org/micte2005/173.pdf.

Campus Alberta Repository of Educational Objects(CAREO). *CAREO website* http://www.careo.org/

CANARIE. (2001). *Advanced network applications, services and technologies funding program.* White paper for a learning object repository. Retrieved April 14, 2006, from http://oknl.edu.gov.on.ca/eng/pdf/1_3_13_1.pdf

Chambers Reference online. (2006). *"Pedagogy" definition.* Retrieved April 14, 2006, from http://www.chambersharrap.co.uk/chambers/chref/chref.py/ main?query=Pedagogy&title=21st

Cohen, D., and & Ball, D. (1990). Policy and practice: An overview. *Educational Evaluation and Policy Analysis, 12*(3), 347-353.

Cooperative Learning Object Exchange (CLOE). *CLOE website* http://pilot.uwaterloo.ca: 8080/CLOE/index_html

Darrin, H. (2001). *Learning objects: Developments and implications for instructional design for distance education.* An Industry Research Report, November 30, 2001

Del Corso, D., Ovcin, E.,& Morrone,G.(2005). A teacher friendly environment to foster learner-centered customization in the development of interactive educational packages. *IEEE Transaction on Education, 48*(4), 574-579.

Devedžić, V. (2003). Web intelligence and artificial intelligence in education. *Proceedings of the AIED 2003 Workshop Towards Intelligent Learning Management Systems,* 23-33.

Dublin Core Metadata Initiative (DCMI). *DCMI website* http://dublincore.org/

Foroughi, R. (2004). Extending LOM with pedagogical descriptions. *COMPUTER GRAPHIK- Reports on Computer Graphic, 16*, 12-19.

Frosch-Wilke, D. (2004). An extended and adaptable information model for learning objects. *Proceedings of at the fourth4th IEEE international conference on Advanced Learning Technologies (ICALT'04),* 166-170.

Gruber, T. (1993). Toward principles for the design of ontologies used for knowledge sharing. *International Journal Human-Computer Studies, 43*, 907-928.

Guzmán, C. L., & Peñalvo, F. (2005). Ontologies applied to learning objects repositories for educational environments in the semantic web. *Proceedings of the Third International Conference on Multimedia and Information and Communication Technology in Education*, 1038-1042.

Hatala, M., & Nesbit, J. (2001). An evolutionary approach to building a learning object repository. *Proceedings of 4th IASTED International Conference on Computers and Advanced Technology in Education (CATE 2001),* 54-59.

Hatala, M., Richards, G., Eap, T., & Willms, J. (2004, May). The interoperability of learning object repositories and services: Standards, implementations and lessons learned. In S. I. Feldman, M. Uretsky, M. Najork, & C. E. Wills (Eds.), *Proceedings of the 13th International Conference on World Wide Web - Alternate Track Papers & Posters, New York, USA*, 19-27.

Herridge Group, (2006a) *Comparing learning object models in corporations and higher education (online).* Retrieved April 14, 2006, from: http://www.herridgegroup.com/pdfs/RLOs%20in%20Corporations%20&%20Higher%20Education.pdf

Herridge Group, (2006b) *Learning objects and instructional design.* Retrieved April 14, 2006, from: http://www.herridgegroup.com/pdfs/Learning %20Objects%20&%20Instructional%20Design.pdf

Higher Education Academy(HEA). *HEA website* http://www.heacademy.ac.uk/default.htm

Hodgins, H. W. (2000). The future of learning objects. In D. A. Wiley (Ed.), *The instructional use of learning objects* (Chap. 5, pp. 1-24): Online Version. Retrieved April 14, 2006, from: http://reusability.org/read/chapters/hodgins.doc

Holden, C. (2003). *From local challenges to a global community: Learning repositories and the global learning repositories summit V1.0, ADL Academic Co-lab.* Retrieved April 14, 2006, from http://www.academiccolab.org/resources/FinalSummitReport.pdf

IMS. (2000). *Instructional management systems project website* [On-line]. Retrieved April 14, 2006, from: http://imsproject.org/ .

IMS. (2006) *Learning Resource Meta-data Information Model Version 1.2.4 - Final Specification,* Retrieved April 14, 2006, from http://www.imsproject.org/metadata/mdinfov1p1.html

Institute of Electrical and Electronics Engineers, Inc (IEEE) Learning Technology Standards Committee (LTSC). (2002). *Draft standard for learning object metadata* (IEEE 1484.12.1-2002). Retrieved April 14, 2006, from http://ltsc.ieee.org/wg12/

Kleinberger, T., Schrepfer, L., Holzinger, A., & Müller, P. (2001). A multimedia repository for online educational content. *Educational Multimedia, Hypermedia and Telecommunication, 2001, Association for the Advancement of Computing in Education, Charlottesville,* 975 – 980.

Konstantopoulos, M., Darzentas, J. S., Koutsabasis, P., Spyrou, T., & Darzentas, J. (2001). Towards integration of learning object metadata and learner profiles design: Lessons learnt from GESTALT. *Interactive Learning Environments, 9*(3), 231-254.

Learning Technology Standards Committee (LTSC). (2000). *Standards for the learning technology glossary, Working draft, IEEE P1484.3.* Retrieved April 11th, 2006 from: http://ltsc.ieee.org/doc/.

Li, J., Nesbit, J. C., & Richards, G.. (2006). Evaluating learning objects across boundaries: The semantics of localization. *International Journal of Distance Education Technologies, 4*(1), 17-30.

Ma, W. 2005. Learning object recommender systems. *Proceedings of IASTED International Conference on Education and Technology, Calgary, Alberta, Canada*, 113-118.

Madche, A., & Staab, S. (2001). Ontology learning for the semantic web. *IEEE Intelligent Systems, 16*(2), 72-79.

Martinez, M. (2001). Designing learning objects to mass customize and personalize learning. In D. Wiley (Ed.), *The instructional use of learning objects agency for instructional technology and the association for educational communications and technology*. Retrieved April 11th, 2006 from: http://www.reusability.org/read/chapters/martinez.doc

McDonnell, L. M., & Elmore, R. F. (1987). Getting the job done: Alternative policy instruments. *Educational Evaluation and Policy Analysis, 9*(2), 133-152.

Middleton, S. E., Shadbolt, N. R., & Roure, D. D. (2003, October). Capturing interest through inference and visualization: Ontological user profiling in recommender systems. In J. H. Gennari, B. W. Porter, & Y. Gil (Eds.), *Proceedings of the 2nd International Conference on Knowledge Capture (K-CAP 2003), New York, USA*, 62-69.

Mills, S. (2002). *Learning about learning objects with learning objects.* Retrieved April 11th, 2006 from AliveTek, Inc Website: http://www.alivetek.com/learningobjects.php/site_paper.htm

Mizoguchi, R., & Bourdeau, J. (2000). Using ontological engineering to overcome common AI-ED problems. *International Journal on Artificial Intelligence in Education*, *11*, 1-12.

Multimedia Educational Resource for Learning and Online Teaching (MERLOT). MERLOT website. http://www.merlot.org/

Murphy, P. F. (2003). Defining pedagogy. In P. F. Murphy & C. V. Gipps (Eds.), *Equity in the classroom: Towards effective pedagogy for girls and boys* (pp. 9-22). London: Routledge Falmer.

Mwanza, D., & Engestrom,Y. (2005). Managing content in e-learning environments. *British Journal of Educational Technology 36*, 453-463.

National Learning Network (NLN). *NLN website*. http://www.nln.ac.uk/index.asp

Nesbit, J. C., Belfer, K., & Vargo, J. (2002). A convergent participation model for evaluation of learning objects. *Canadian Journal of Learning and Technology 28*(3), 105-120.

Niederhauser, D. S., & Stoddart, T. (2001). Teachers' instructional perspectives and use of educational software. *Teaching and Teacher Education, 17*(1), 15-31.

Open Archive Initiative OAI. *OAI website*.http://www.openarchives.org/

OWL. (2004). *Web ontology language.* Retrieved April 14, 2006, from http://www.w3.org/TR/2004/REC-owl-features-20040210/

Paquette, G. (2004). Instructional engineering for learning objects repositories networks. *Proceedings of International Conference on Computer Aided Learning in Engineering Education (CALIE 04), Grenoble, France.* Retrieved April 14, 2006, from http://www-clips.imag.fr/calie04/actes/Paquette.pdf

Parrish, P. (2004). The trouble with learning objects. *ETR&D, 52*(1), 49-67.

Porter, D., Curry, J., Muirhead, J., Muirhead,W., & Galan, N. (2002). *A report on learning object repositories: Review and recommendations for a pan-Canadian approach to repository implementation in Canada.* Retrieved April 14, 2006, from http://www.canarie.ca/funding/elearning/lor.pdfhttp://www.canarie.ca/

Preacher, K. J. (2001, April). *Calculation for the chi-square test: An interactive calculation tool for chi-square tests of goodness of fit and independence* [Computer software]. Retrieved July 2006, from http://www.quantpsy.org

Random.org website. www.random.org

RDN/LTSN Pedagogy Vocabularies. Version 2.0. Retrieved April 14, 2006, from http://www.heacademy.ac.uk/2875.htm

Recker, M. M., Walker, A., & Wiley, D. A. (2000). Collaboratively filtering learning objects. In D. Wiley (Ed.), *The instructional use of learning objects - online version.* Retrieved April 11th, 2006 from: http://reusability.org/read/chapters/recker.doc.

Reigeluth C.M., & Nelson L. M. (1997). New paradigm of ISD. In R. M. Branch & B. B. Minor (Eds.), *Educational media and technology yearbook* (pp. 24 - 35) Englewood, CO: Libraries Unlimited.

Resource Discovery Network RDN (2006).RDN website.http://www.rdn.ac.uk/

Richards, G., & Hatala, M. (2003). Interoperability frameworks for learning object repositories. In Vilas, A.M., Gonzalez, J.A.M., & Gonzales, J.M. (Eds.) *Advances in technology-based education: Toward a knowledge- based society, badajoz: Junta de extremadura, Consejera de education. Cienca y tecnolgia* (pp. 366-372).

Richards, G., McGreal, R., Hatala, M., & Friesen, N. (2003). The evolution of learning object repository technologies: Portals for on-line objects for learning. *Journal of Distance Education, 17*(3), 67-79. Retrieved April 14, 2006, from: http://cade.athabascau.ca/vol17.3/richards.pdf

Sampson, D., & Karagiannidis, C. (2002). From content objects to learning objects: Adding instructional information to educational metadata. *Proceedings of the IEEE International Conference on Advanced Learning Technologies*, 513-518.

Sicilia, M. A., Garcia, E., Pages, C., Martinez, J. J., & Gutierrez, J. M. (2005). Complete metadata records in learning object repositories: some evidence and requirements. *International Journal of Learning Technology, 1*, 411-424.

SMETE. (2006). *Universal access to academic excellence in science mathematics, engineering and technology education*. Retrieved April 14, 2006, from http://www.smete.org

Spector, J. M. (2001). An overview of progress and problems in educational technology. *Interactive Educational Multimedia 3*, 27-37.

Spector, J. M., & Anderson, T. M. (Eds.). (2000). *Integrated and holistic perspectives on learning, instruction and technology: Understanding complexity*. Dordrecht: Kluwer Academic Press.

The Inclusive Learning Exchange (TILE). *TILE website* http://barrierfree.ca/tile/about/lorepository.htm

The Learning Object Repository Research Network LORNET. *LORNET website* http://www.lornet.org/eng/index.htm

Vargo, J., Nesbit, C. J., Belfer, K. & Archambault, A. (2003). Learning object evaluation: Computer mediated collaboration and inter-rater reliability. *International Journal of Computers and Applications, 25*(3),198-205.

Wallace, R.M., Kupperman, J., Krajcik, J.S. & Soloway, E. (2000). Science on the web: Students online in a sixth-grade classroom. *The Journal of the Learning Sciences, 9*(1), 75-104.

Wiley, D. A. (2000). Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy. *The instructional use of learning objects-Online version.* Retrieved March 20 2006, from http://reusability.org/read/chapters/wiley.doc.

Wilson, P. (1991). *Computer supported cooperative work: An introduction*. Oxford, UK: Intellect Books.

APPENDICES

Appendix 1

This appendix consists of the attached CD-Rom contains the MSExcel file

Repositoryinfo-R74.xls

Appendix 2

Repository Number	Repository Name
R1	Repository name: PhilSci Archive (University of Pittsburgh) Repository URL: http://philsci-archive.pitt.edu/perl/oai2
R2	Repository name: Les thèses en ligne de l'INP Repository URL: http://ethesis.inp-toulouse.fr/perl/oai2
R3	Repository name: Indiana University Digital Library Program Repository URL: http://oai.dlib.indiana.edu/phpoai/oai2.php
R4	Repository name: VTT Publications Register Repository URL: http://cgi.vtt.fi/progs/inf/OAI
R5	Repository name: lu-research Repository URL: http://lu-research.lub.lu.se/php/oai.php
R6	Repository name: BioMed Central Repository URL: http://www.biomedcentral.com/oai/2.0/
R7	Repository name: Baltic Marine Environment Bibliography 1970- Repository URL: http://cgi.vtt.fi/progs/inf/balticOAI
R8	Repository name: DLIST, Digital Library of Information Science and Technology Repository URL: http://dlist.sir.arizona.edu/perl/oai2
R9	Repository name: CCSD théses-EN-ligne Repository URL: http://tel.ccsd.cnrs.fr/perl/oai20
R10	Repository name: UNITN-eprints Repository URL: http://eprints.biblio.unitn.it/perl/oai2
R11	Repository name: IJN : articles de l'Institut Jean Nicod - Paris Repository URL: http://jeannicod.ccsd.cnrs.fr/perl/oai20
R12	Repository name: ENS-LSH Repository URL: http://eprints.ens-lsh.fr/perl/oai2
R13	Repository name: CCSU Digital Archive Repository URL: http://fred.ccsu.edu:8000/perl/oai2
R14	Repository name: PhysNet, Oldenburg, Germany, Document Server Repository URL: http://physnet.physik.uni-oldenburg.de/oai/oai2.php
R15	Repository name: Auburn University - Transforming America Repository URL: http://diglib.auburn.edu/cgi-bin/OAI-XMLFile/XMLFile /auburn/oai.pl
R16	Repository name: ibiblio Linux Software Archive Repository URL: http://ibiblio.org/oaibiblio/data/software/app/oai2.php
R17	Repository name: Acervo General de la biblioteca – Dr Jorge Villalobos Padilla, S.J.- del ITESO Repository URL: http://148.201.94.8/oai/ite/default.aspx
R18	Repository name: University of Michigan Library, Digital Production Service Repository URL: http://www.hti.umich.edu/cgi/b/broker20/broker20

R19	Repository name: University of Illinois Library at Urbana-Champaign Repository URL: http://bolder.grainger.uiuc.edu/uiLibOAIProvider/2.0/oai.asp
R20	Repository name: Miami: Dissertationen der ULB Münster Repository URL: http://miami.uni-muenster.de/servlets/OAIDataProvider
R21	Repository name: Edinburgh Research Archive (ERA) Repository URL: http://www.era.lib.ed.ac.uk/dspace-oai
R22	Repository name: Verlag Krause und Pachernegg – Medizinische Fachzeitschriften Repository URL: http://www.kup.at/cgi-bin/OAI/XMLFile/kup/oai.pl
R23	Repository name: Digital Library of the Commons Repository URL: http://dlc.dlib.indiana.edu/perl/oai2
R24	Repository name: ArchiveSIC : articles en Sciences de l'Information et de la Communication Repository URL: http://archivesic.ccsd.cnrs.fr/perl/oai20
R25	Repository name: digbib - digital library at the Univeristy Of Oslo Repository URL: http://wo.uio.no/as/WebObjects/theses.woa/wa/oai
R26	Repository name: University of Pittsburgh Electronic Thesis and Dissertation Archive Repository URL: http://etd.library.pitt.edu/ETD-db/NDLTD-OAI2/oai.pl
R27	Repository name: OLAC Aggregator Repository URL: http://www.language-archives.org/cgi-bin/olaca3.pl
R28	Repository name: Marshall Technical Report Server (NASA TRS) Repository URL: http://trs.nis.nasa.gov/perl/oai2
R29	Repository name: Bibliotheksservice-Zentrum Baden-Württemberg, Germany, Virtueller Medienserver Repository URL: http://www.bsz-bw.de/cgi-bin/oai20_send.pl
R30	Repository name: Dspace at UFPR - 2004 Repository URL: http://dspace.c3sl.ufpr.br/dspace-oai/request
R31	Repository name: Theses KHKempen (DoKS) Repository URL: http://doks.khk.be/eindwerk/oai
R32	Repository name: The LearningOnline Network with CAPA Repository URL: http://nsdl.lon-capa.org/cgi-bin/OAI-XMLFile /XMLFile/nsdlexport/oai.pl
R33	Repository name: Citebase Search Repository URL: http://citebase.eprints.org/cgi-bin/oai2
R34	Repository name: IUBio Archive of biology software Repository URL: http://iubio.bio.indiana.edu:7780/perl/oai2
R35	Repository name: SUUB Repository URL: http://elib.suub.uni-bremen.de/cgi-bin/oai2
R36	Repository name: University of Saskatchewan Library ETD Archive Repository URL: http://library.usask.ca/etd/OAI/oai.pl
R37	Repository name: Sammelpunkt. Elektronisch archivierte Theorie Repository URL: http://sammelpunkt.philo.at:8080/perl/oai2
R38	Repository name: Documenting the American South Repository URL: http://www.lib.unc.edu/cgi-bin/oai/das/das/das/oai.pl

R39	Repository name: University of Tennessee Sunsite Open Archives Initiative Repository URL: http://oai.sunsite.utk.edu/cgi-bin/oai2.cgi
R40	Repository name: Archive of European Integration (University of Pittsburgh) Repository URL: http://aei.pitt.edu/perl/oai2
R41	Repository name: Universidad de La Sabana Bogota Colombia Repository URL: http://biblioteca.unisabana.edu.co/tesis/oai.php
R42	Repository name: Humboldt University Berlin, Document Server Repository URL: http://edoc.hu-berlin.de/OAI-2.0
R43	Repository name: MUNDUS - UK Missionary collections Repository URL: http://www.mundus.ac.uk/cgi-bin/oai/OAI2.0
R44	Repository name: AIM25 - Archives in London Repository URL: http://www.aim25.ac.uk/cgi-bin/oai/OAI2.0
R45	Repository name: Caltech Computer Science Technical Reports Repository URL: http://caltechcstr.library.caltech.edu/perl/oai2
R46	Repository name: Cornell University Library Technical Reports and Papers Repository URL: http://techreports.library.cornell.edu:8081/Dienst
R47	Repository name: Policy Documentation Center Repository URL: http://pdc.ceu.hu/perl/oai2
R48	Repository name: Universidad de las Américas, Puebla: Digital Theses Repository URL: http://ict.udlap.mx:9090/Tales/Oai_tesis
R49	Repository name: University of Tennessee Libraries Repository URL: http://diglib.lib.utk.edu/cgi/b/broker20/broker20
R50	Repository name: Organic e-prints Repository URL: http://orgprints.org/perl/oai2
R51	Repository name: HGF-MARCOPOLI(AWI) Repository URL: http://www.awi-bremerhaven.de/cgi-bin/ OAI-XMLFile-2.1/XMLFile/MARCOPOLI-AWI/oai.pl
R52	Repository name: NSDL Metadata Repository (Merlot) Repository URL: http://services.nsdl.org:8080/nsdloai/OAI
R53	Repository name: American Memory [LoC] Repository URL: http://memory.loc.gov/cgi-bin/oai2_0
R54	Repository name: African Journals Online Repository URL: http://www.ajol.info/oai
R55	Repository name: mémSIC : mémoires en Sciences de l'Information et de la Communication Repository URL: http://memsic.ccsd.cnrs.fr/perl/oai2
R56	Repository name: Hong Kong University Theses Online Repository URL: http://sunzi.lib.hku.hk/cgi-bin/OAI/hkuto.pl
R57	Repository name: Department of Electronics and Computer Science Database/Archive, University of Southatmpon Repository URL: http://eprints.ecs.soton.ac.uk/perl/oai2
R58	Repository name: UGent Institutional Archive Repository URL: http://archive.ugent.be/oai/

R59	Repository name: Archeologia e Calcolatori Journal -Index Repository URL: http://purl.oclc.org/NET/ugent/lib/srepod/ www.progettocaere.rm.cnr.it/databasegestione/A_C_oai_Archive.xml
R60	Repository name: The Open University ePrints Archive Repository URL: http://libeprints.open.ac.uk/perl/oai2
R61	Repository name: Experimental Thesis Catalog Repository URL: http://alcme.oclc.org/xtcat/servlet/OAIHandler
R62	Repository name: BU Theology Library Test Site Repository URL: http://comm745-server.bu.edu/bibliotheca/
R63	Repository name: NDAD - UK National Archive of Datasets Repository URL: http://ndad.ulcc.ac.uk/cgi-bin/oai/OAI2.0
R64	Repository name: Hussein's Picture Album Repository URL: http://www.husseinsspace.com/cgi-bin /VTOAI/hspics/hspics/oai.pl
R65	Repository name: University of North Carolina at Chapel Hill Manuscripts Department Repository URL: http://www.lib.unc.edu/cgi-bin/oai /mss/OAI-XMLFile/XMLFile/mss/oai.pl
R66	Repository name: Universitätsbibliothek Tübingen / Tuebingen University Library, GERMANY Repository URL: http://w210.ub.uni-tuebingen.de/dbt/oai/oai2.php
R67	Repository name: Virginia Tech ETD Collection Repository URL: http://scholar.lib.vt.edu/theses/OAI2/
R68	Repository name: ViFaPhys Repository URL: http://vifaphys.tib.uni-hannover.de/oai/oai2.php
R69	Repository name: E-LIS: E-prints in Library and Information Science Repository URL: http://eprints.rclis.org/perl/oai2
R70	Repository name: http://genesis2.jpl.nasa.gov/perl/oai2 Repository URL: http://genesis2.jpl.nasa.gov/perl/oai2
R71	Repository name: Georgia Tech Electronic Theses and Dissertations Repository URL: http://etd.gatech.edu/ETD-db/OAI2/oai.pl
R72	Repository name: Digitale Hochschulschriften der Ludwig Maximilians Universitat Munchen Repository URL: http://edoc.ub.uni-muenchen.de/perl/oai2/
R73	Repository name: IBICT - Brazilian Aggregator Repository URL: http://oai.ibict.br/oai/mypoai/oai2.php
R74	Repository name: GAP - German Academic Publishers Repository URL: http://opus.ubka.uni-karlsruhe.de/oai2/gap- c/oai2.php

Appendix 3

value	scope note
Active Learning	Methods that attempt to develop the cognitive and effective dimensions of the learning process in such a way that learners' active involvement in the learning process is improved
Alignment	Tendencies to achieve greater coherence and make education at all levels work as one system; or the degree to which assessment, curriculum content, educational materials, level, lecturer preparation and professional development all reflect and reinforce the educational programme's objectives and standards
Analytical Skills	Ability to identify a concept or problem, to dissect or isolate its components, to organize information for decision making, to establish criteria for evaluation, and to draw appropriate decisions. These are core transferable skills highly valued by employers
Assessment	Judging students' performance or behavior according to established criteria: measuring, comparing and judging the quality of student work. For institutional or government policies, standards, strategies or regulations relating to assessment, USE Assessment policies (Policy themes vocabulary); for resources relating to evaluation of programmes, USE Evaluation (Policy themes vocabulary); for resources relating to evaluation of teachers, USE Staff performance or one of its subordinate terms (Policy themes vocabulary)
Assignments	Assessed learning tasks allocated to individuals or groups of learners
Autonomous Learning	Learning in which the learner has much of the responsibility for planning and organizing learning, that may be directed or assisted by instructional staff through periodic consultations; also, the ability to take charge of one's learning and fulfill one's obligations within the confines of a specified learning task. For autonomous learning in a group, USE Self-directed learning
Blended Learning	The use of traditional face-to-face teaching in conjunction with computer-based methods
Cognitive Skills	Use for general works on the scope of activities that encompasses thinking (eg recall, inferring, generalizing, planning, deciding, analyzing, etc); prefer a more specific (narrower) term where possible
Collaborative Learning	Process of learning based on the cooperation of a small number of learners towards the fulfillment of a given task. For learning processes where the learners themselves define the task, USE Self-directed learning
Communication Skills	Proficiency in the exchange of information. This term should only be used to describe resources which are about both oral and written communication skills; USE the narrower terms where possible

Competence	Possession of a satisfactory level of relevant knowledge and acquisition of a range of relevant skills that are necessary to perform tasks that reflect the scope of professional practices. Competence may differ from performance, which denotes actions taken in a real life situation. For specific skills and knowledge, USE Employability and its subordinate terms
Computer Based Teaching	The use of computers in teaching. Use for resources which are about the teacher's experience of using computers; for resources about computer-based education from the learner's perspective or resources about both teaching and learning, USE E-learning; for resources specifically about the use of the Internet in teaching, USE Online teaching.
Computer Aided Assessment	Any use of computers for the purpose of delivering, marking and reporting of assessments
Consistency	Extent to which something is consistent, stable and/or complies with shared educational standards over repeated trials; also, trust in the accuracy or provision of one's results. For consistency of research results or test scores, USE Validity
Continuous Assessment	Regular evaluation of work throughout a course where the marks achieved count towards the final result; may include assessments of coursework and/or examinations. For evaluations which do not count towards the final result, USE Formative assessment
Creativity	Constructive originality; the ability to think and/or approach a problem in an original or flexible way. Often manifested in the student's ability to discover new solutions to problems or find new modes of artistic expression; may be applied to any subject area
Credit Frameworks	Frameworks based on credit values, agreed for the purpose of quantifying the work completed by a student to enable the accumulation of credit towards a qualification; for qualitative frameworks of assessment, USE Marking or Grades.
Critical Thinking	The disciplined ability and willingness to assess evidence and claims, to seek a breadth of contradicting as well as confirming information, to make objective judgments on the basis of well supported reasons as a guide to belief and action, and to monitor one's thinking whilst doing so (metacognition). For the process of applying critical thinking to a specific problem or concept, USE Analytical skills
Deep Learning	Approach to learning that is concerned with extracting principles and underlying meanings, in order to make sense of facts and feelings and to integrate them with previously acquired knowledge
Demonstrations	Teaching method in which explanations are given by example or experiment
Discussions	Exchange of opinions, usually to analyze, clarify or reach conclusions about issues, questions or problems
Dissertations	Written report submitted for assessment purposes at the end of a programme; also, a treatise advancing a new point of view resulting from research. For written reports submitted to satisfy the requirements of a PhD, USE Theses

Distance Learning	Instruction provided at a distance to students who do not necessarily come to the institution; USE Distance teaching for resources about the teacher's experience of this learning situation
Distance Teaching	Providing instruction with little or no face-to-face contact with learners, using correspondence, computers, telephone, video conferencing etc. Use for resources which are specifically about the teacher's experience of this situation; otherwise USE Distance learning
Drills Practice	Intensive repetition of tasks or procedures with the sole aim of improving skills; for learning tasks which do not necessarily involve repetition, USE Exercises
Educational Strategies	Overall (teaching) plans for implementing instructional goals, methods or techniques. For learning plans made by students, USE Strategic learning
E-learning	Education via the Internet, network or standalone computer; for resources specifically about the use of the Internet or an institutional Intranet, USE Online learning; for resources specifically about the teacher's experience of computer-based education, USE Computer based teaching
Employability	Employability primarily relates to a student's ability to make good career/specialism choices and to work effectively in the professional environment. For resources about government policies on employability and institutional strategies for enhancing it, USE Employability (Policy themes vocabulary)
Enquiry Led Learning	Learning through the process of addressing a question by seeking knowledge and information to develop understanding
Essays	An assessment method, distinguished from short-answer questions by the scope, the length of required answers and the relative lack of specific clues for recall. Essay questions typically deal with larger issues and are based on information that is spread out over a number of learning resources. Students' answers should reflect both how much is known about a topic and how well organized their knowledge of the subject is
Exams	Written exercises, oral questions or practical tasks, set to test a student's knowledge and skills in controlled conditions and usually taking place at or near the end of a course/module; results are usually, though not always, marked and/or checked by external examiners. For more informal assessments of a student's knowledge and skills under exam conditions, USE Tests
Exercises	Actions performed or repeated in order to develop, improve or display a specific skill or knowledge.
Experiential Learning	Learning by doing, by using, or by experiencing a concept or testing a skill; learning through hands-on experience, accomplished by field trips, internships, or activity-oriented projects, as opposed to traditional classroom learning

Fairness	The ability to make judgments free from discrimination or dishonesty. Used for fairness in assessment, ie assessing students performance and abilities without bias, and fairness in admissions procedures
Field Work	Technique for data collection where the researcher leaves his place of work to directly access elements related to his study; for laboratory-based investigations, USE Lab/studio work/practical
Flexible Learning	The institution provides the students with flexible access to learning experiences in terms of at least one of the following: time, place, pace, learning style, content or assessment. Flexible learning is usually student-centred, rather than teacher-centred
Formative Assessment	Use for ongoing diagnostic assessment methods providing information to guide instruction and improve student performance. For more formal methods which count towards the final assessment, USE Summative assessment or Continuous assessment
Grades	Marks given for coursework or examinations. For the process of awarding marks, USE Marking.
Group Assessment	Method where the group as a whole rather than each individual member is given a common mark; also includes distribution of marks within a group. For assessment methods where members of a group assess each other, USE Peer assessment.
Group Work	Type of practical exercise where several students work together
Independent Learning	An approach that seeks to empower students to take responsibility for their own learning and through this to further develop their academic and personal potential; also used for programmes of study developed for learners who wish to study alone
IT Skills	Computer literacy, including using computers to communicate with others
Large Group Teaching	Teaching a large number of students, usually in a formal situation
Learning	Process of acquiring knowledge and understanding or skills from study, instruction or experience; also, any relatively permanent change in the behaviour, thoughts or feelings of an individual that results from experience. Use for comprehensive, broad-based resources on learning in general; prefer a narrower term where possible
Learning Environments	Any environment in which learning takes place; includes all staff, students, equipment and space used for design of such environment. For information/computer environments in which learning is managed or takes place, USE the narrower terms: MLEs for computer environments in general, VLEs for online interactions between learners and tutors
Learning Outcomes	What the learner should have achieved at the end of a given learning period (includes formal statements of expected outcomes). For formal records of actual outcomes, USE Records of achievement
Learning Resources	Materials used for learning or supporting teaching
Learning Styles	Preferences that students have in their approach to learning; also, different approaches or ways of learning (visual, auditory, kinesthetic)

Lectures	Teaching method, usually used to teach large groups of students in formal situations. The information is communicated by giving an oral presentation to students who take notes and can ask questions
Lifelong Learning	The idea that individuals need to learn continuously throughout their lives; also used to describe programmes of lifelong learning
Literacy Skills	The ability to read, write and comprehend
Marking	The process of awarding marks based on varying levels of achievement, especially in course assignments or examinations; for the marks themselves, USE Grades
Mentoring	Supervision by people who have personal and direct interest in the development and/or education of younger and less experienced individuals, usually in professional education or professional occupations; includes apprenticeships
MLEs	A Managed Learning Environment (MLE) includes the whole range of information systems and processes of a college (including its VLE if it has one) that contribute directly, or indirectly, to learning and the management of that learning. Managed learning environments (MLEs) are a coherent set of computer applications to support the whole learning process, from potential students showing interest, to alumni. The key is the interoperation of the various components of the system so that data is fed appropriately to the various systems
Numeracy Skills	The ability to understand, analyze, critically respond to and use mathematics
One To One Teaching	Method of individual instruction
Online Learning	Type of learning organized through the Internet or an Intranet. For resources specifically about the teacher's experience of Internet-based education, USE Online teaching
Online Teaching	The use of the Internet in teaching; for resources about the learner's experience of Internet-based education or about both teaching and learning, USE Online learning
Open Learning	Learning organized to enable learning at students' own pace and at a time and place of choice. Usually associated with delivery without a tutor being present and may or may not form part of a formal programme of study. May also imply no entry barriers, e.g. no prior qualifications
Oral Assessment	Assessment of a student's ability to communicate an understanding of their subject orally (eg in a viva) and/or demonstrate fluency in a second language
Oral Communication Skills	The ability to communicate in speech and/or sign language
Peer Assessment	Assessment undertaken by a peer of the person being assessed (eg a fellow student or fellow teaching professional). USE Group assessment for assessments where marks are awarded to a group as a whole by another; USE Self-assessment for assessments carried out by the assessing him/herself

Peer Teaching	Students teaching each other in ways that are mutually beneficial and involve sharing knowledge, ideas and experience between the participants. Use for situations where students are responsible for discovering and presenting information to each other in formal or semi-formal situations (eg giving presentations). For less formally-organized peer teaching situations, USE Autonomous learning or Self-directed learning
Performance Assessment	Any assessment which attempts to judge a person's ability to perform a given task. Used for drama performances, music recitals, practical examinations (eg in medicine or teaching), exhibitions, oral/visual presentations... Use for resources which address the pedagogic issues of designing and administering such assessments; for resources on staff performance, USE Staff performance (Policy themes); for resources on students' level of attainment or proficiency in relation to a standard measure of achievement, USE Student performance (Policy themes)
Portfolios	A collection of evidence that learning has taken place, usually set within agreed objectives or a negotiated set of learning activities. Some portfolios are developed in order to demonstrate the progression of learning, while others are assessed against specific targets of achievement
Practical Skills	Set of skills gained through practical exercise (eg dissection)
Practical Work	Use for situations where the learner carries out experimental investigations in a laboratory, either in order to practice previously learned theories or in advance of other learning. For experimental investigations in other contexts, USE Fieldwork
Presentations	Methods of communicating ideas, information and data to students; also used for presentations by students
Problem Based Learning	An approach to learning where the problem comes first and the knowledge is developed as a consequence of trying to solve the problem. Traditional curricula tend to begin with transmitting the information and then proceed to solving problems by using the information. Problem based learning can be a way to develop decision making, critical thinking and problem solving skills in students
Projects	Study of a particular topic or object, sometimes involving original research, that is intended to build or produce something new or deal with an existing problem. For formal reports produced at the end of such projects, USE Dissertations or Theses
Records Of Achievement	Records of a student's achievements and learning, including targets for the future, as well as results of tests and assessments, which are built up over the length of a course or of school attendance
Reflective Learning	Learning process which involves dialogue with others for improvement or transformation whilst recognizing the emotional, social and political context of the learner; also used for a learning process in which the learner reviews and considers their own thoughts, feelings and experiences in order to learn from them
Reports	Formal account or summary of the findings of an individual or group (eg summaries of research, projects, meetings...)

Research	Systematic investigation, collection and analysis of data to reach conclusions, estimate effects or test hypotheses; includes research conducted by students
Research Skills	Ability to undertake research, including strategies and tools that can be learnt. See also Analytical skills and Critical thinking
Role Play	A learning experience based on enacting specific roles in order to develop particular skills and to achieve particular learning objectives
Self Assessment	Assessment undertaken by the learner in order to evaluate his/her own performance, strengths and weaknesses. USE Peer assessment for methods of assessment which involve members of a peer group assessing each other.
Self Directed Learning	Learning with a passive leader or without a specified leader in which all members agree on group goals and procedures. For learning processes where the task is assigned to the group by a leader/teacher/lecturer, USE Collaborative learning
Seminars	Teaching in small groups of students led by a tutor
Simulations	Technique in which real life situations and values are simulated by substitutes, mathematical models or role-play situations, allowing the learner to experience the situation in a risk free controlled environment
Situated Learning	A relational view of the person and learning. In contrast with learning as internalisation, it is learning as increasing participation in communities of practice and concerns the whole person acting in the world. Instead of acquiring structures or models to understand the world, learners participate in frameworks that have structure. Learning is seen as a process of social participation; it does not belong to individual persons, but to the various conversations of which they are a part
Small Group Teaching	Informal method of teaching, usually involving free discussion or role-playing between students
Strategic Learning	Learners adapt their learning approaches in order to fit with the assessment requirements
Subject Specific Skills	Skills required and/or gained which are specific to a particular subject area
Summative Assessment	Formal assessment, usually taking place at the end of a course and leading to the attribution of a grade or a mark to the learner, which will allow the learner to move to the next part of the course or complete it. For assessments which do not contribute towards the final result and/or are informal, USE Formative assessment; for assessments which take place throughout the course, USE Continuous assessment
Surface Learning	Learning approach where the emphasis is put on the memorisation of details without attempting to give deeper meaning to them, e.g. rote learning, or the kind of learning many students do for their exams
Teaching	Process by which knowledge, attitudes and skills are deliberately conveyed. It includes the total instructional process from planning and implementation to evaluation and feedback
Team Teaching	A method of classroom instruction in which several teachers combine their individual subjects into one course
Teamwork	Cooperative effort to achieve a common objective

Tests	Written exercises, oral questions or practical tasks, set to assess a student's ability, understanding, knowledge or skills in controlled conditions; tests may take place throughout a course, not necessarily towards the end. For tests which count towards the final assessment, USE Exams
Theses	Written report, usually including original research, submitted to satisfy the requirements of a PhD
Transcripts	The official record kept by an institution containing students' grades in the courses completed. For records which include other information, USE Records of achievement
Transferable Skills	Skills which are useful in a number of different contexts; for skills which are unique to a particular context, USE Subject-specific skills
Tutorials	Instruction provided to a learner or a small group of learners by direct interaction; traditionally one-to-one teaching, but now increasingly used for small groups
Validity	A term that reflects a solid foundation or justification for bringing the intended (test, exam or research) results; also used for resources on how to judge whether results are valid. In the case of assessment, validity means the degree to which a measurement instrument truly measures what it is intended to measure. Includes content, predictive and criterion-related validity. Content validity is the one of greatest concern to teachers as the test/question/exam must contain a representative sample of the subject matter the student is supposed to have learned. For validity in other contexts, USE Consistency
Values	Educational principles and standards that determine the merit of objects or acts
VLEs	The term Virtual Learning Environment (VLE) is used to refer to the "online" interactions of various kinds which take place between learners and tutors. For information systems that contribute directly to learning and the management of learning, USE MLEs
Work Experience	A planned programme which enables students to gain experience of the working environment. For other learning experiences in the workplace, USE Work-based learning
Work Based Learning	Learning acquired in the work place, typically under the supervision of a person from the same company and/or a professional teacher from outside the company, eg as in the apprenticeship model. For work-based learning provided as part of a course of formal education, USE Work experience
Workshops	Programmes in which individuals with common interests and problems meet to engage, often with experts, in order to exchange information and learn needed skills or techniques
Written Assessment	Learning tasks which require the student to produce a written report or composition for the purpose of assessment

Appendix 4

Questionnaire of the Educational Objective Tool

1. What is your gender?
a) Male
b) Female

2. What is your occupation?
a) Researcher
b) Teacher/Instructor from University/College Secondary school
c) Student Graduate student Undergraduate Secondary school student
d) Instructional Designer
e) Others

3. If you are a teacher/instructor, have you ever taught online courses before?
a) Always
b) A few times
c) One or two times
d) Never
e) I am not a teacher/instructor

4. If you are a student, have you ever taken an online course?
a) Always
b) A few times
c) One or two times
d) Never
e) I am not a student

5. If you are an instructional designer, have you ever designed an online course?
a) Always
b) A few times
c) One or two times
d) Never
e) I am not an instructional designer

6. If you are a researcher, have you ever design/work with an online course?
a) Always
b) A few times
c) One or two times
d) Never
e) I am not a researcher

7. It is easier for instructors to identify suitable learning resources if their learning

objectives are displayed.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

8. Being able to search for learning resources according to their learning objectives is not a useful feature. I can easily find pedagogically suitable learning resources even if they are not annotated with pedagogical information such as educational objectives.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

9. The learning objects selected for use in a course should align with the educational objectives for the course.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

10. I care more about the content of a learning object than the educational objectives provided by its author.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

11. Online learning resources should have definite pedagogical purpose.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

12. It is impossible to identify learning goals for a learning object that are meaningful in most of the situations in which the learning object can be used.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

13. If the overall interface improves, it would be more helpful in generating learning goals for the chosen learning objects.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

14. The interface will not necessarily influence my creation of learning goals as long as I am provided sufficient learning object information and associated scaffold for metadata creation.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

15. The interface hinders my creation of educational objectives in terms of its unfriendly user interface and layout
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

16. I have some suggestions regarding the improvement of the user interface for this tool:

17. For creating educational objectives, a free text format is easier than a scaffolded format.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

18. There is no advantage in using a specialized tool for creating educational objectives.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

19. Overall, a scaffolded entry format is helpful for defining a resource's learning objectives.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

20. Without using a specialized tool, it is easy to forget the different categories of learning objectives.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

21. If I had to tag learning resources with pedagogical information, I would like to use a tool like this.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

22. I would have more confidence in learning objects which have been tagged with learning goals by using such a tool.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

23. I would like to recommend this tool to my colleagues to tag pedagogical information for shared online recourses.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

24. Instructors can easily locate online resources without knowing their applicable learning contexts .
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

25. I find learning resources annotated with pedagogical metadata such as educational objectives can be easily use and reuse in different educational settings because such metadata explicitly reflects the quality and oriented audience of the learning resources.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

26. I find that the contents of educational resources can influence more on my course design than those learning objects annotated with pedagogical information such as learning goals.
a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

27. Could you recommend other methods to improve the approach to generate pedagogical metadata?

28. Do you have any other comments regarding generating educational objectives you would like to share?

29. Do you have any recommendation for the improving this tool for generating pedagogical metadata?