Utilizing students' inputs to create and manage learning object metadata in educational system

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Abstract

Nowadays, Learning Objects have played an outsized role in the educational process. They are reusable pieces of the educational material which provides self-contained, usable and reusable unites for learning. One key issue of the learning object is the metadata. Learning objects must be tagged with metadata because it is helpful for searching and reusing. We are facing several challenges related to the creation and management of the learning object metadata. Folksonomy is a popular method used for generating metadata using user generated tags.

This thesis explores the values of the student defined tags and lecturer provided keywords and find that student defined tags can be used to create some metadata for describing the learning resource. The thesis also illustrates that lecturer can regard students' inputs as one kind of feedback which is useful for the lecturer to understand students' feeling about the material. And lecturer also uses tags as the resource which is helpful for the lecturers to improve their productions. Moreover, this thesis discusses the similarity and the difference between student defined tags and lecturer provided keywords. For the students, tags also indicate their understanding and opinions about the learning object. And other students can understand the learning object from the tags which are one kind of the descriptions.

Acknowledgements

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1 Introduction

One of the main concerns in learning technology research is how to improve the reusability and the searchable properties for the learning objects. The most important point is metadata which contains the descriptive information for the related learning object. Many projects focus on the automatic method for generating learning object metadata[8]. Other projects focus on using unstructured metadata to create structured semantic metadata folksonomy[9] [10]. Folksonomies have emerged as a successful kind of applications for categorizing web resources in a collaborative manner [11]. This project considers metadata as the major aspect in order to find that whether folksonomy can be used as effective metadata for the learning objects in the educational system. Student defined tags are the one main resource for describing the educational materials, the purpose of this thesis is to analyze student defined tags and discuss the potential of utilizing tags as learning object metadata by students and authors.

This chapter introduces what topics were covered in this master thesis, and the problem description, the justification, the motivation and the benefits, the research questions, and the summary contributions are also discussed in this part.

1.1 Topic covered by the project

Traditional content comes in a several hours chunk, however, learning objects are much smaller units for learning and they are self-contained and reusable. However, different definitions and components about the learning objects would be introduced by different researcher. From IEEE, Learning Technology Standards Committee, "Any entity, digital or non-digital, that may be used for learning, education or training" [12]. David A. Wiley, professor of Instructional Technology has a broader definition-"The main idea of 'learning objects' is to break educational content down into small chunks that can be reused in various learning environments, in the spirit of object-oriented programming" [13]. These definitions may be a little abstractive or unclear. The Learning Objects would have some properties, such as the first one is self-contained. The second would be independently and reusable. Thus, learning objects would be integrated into a larger collection of content and they should be annotated by metadata.

Metadata is structured data about an object. It contains a set of elements for describing, understanding, and searching the main information of the learning object whatever digital or non-digital resource. Every metadata generated method has its own benefits and problems.

In practice, metadata have existed as the form of tag for marking total types of resource. Tags are a kind of glossary and represent a simple mean to easily and better classify content from a personal point of view. [14] Tag is the word(s)-term which is used to describe the information of the object, such as one document or an image. Tagging is one method to label object material with free-style descriptions and it is an important approach for generating folksonomy terms which also be regarded as meta-tag. And folksonomy is a free source of unstructured metadata which can unfold many about an object, like subject, its type, and possible knowledge point. It derived from the practice and the method of collaboratively creating and managing tags for the purpose of annotation and categorization.

Additionally, "the collaborative activity of marking shared online content with keywords or tags, and as a way to organize content for future navigation, filtering or search [15]" is one definition about social tagging. Social tagging or social bookmarking services are considered as good sources of folksonomies. A lot of research has been done on analyzing the quality of folksonomy [9]. Thus, the social tagging resource would be focused in this project. And the main issue is on analyzing what enable users to trust the quality of folksonomy, and whether student defined tags replace the lecturer provided keywords or they are the complement for the keywords. Student defined tags are the resource to support the research in the thesis. In brief, the real benefits from the use of social tagging for digital educational resources would be analyzed and explained in the thesis.

1.2 Terms and Abbreviations

LOs-Learning Objects is "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning [12]".

LOM-Learning Object Metadata is a data model which is used to describe learning object or the similar digital resource in order to support learning.

LOR-Learning Object Repository is essentially storage and retrieval system for learning objects.

Folksonomy-a free source of unstructured metadata.

Tag-Student's view about the learning object.

Keywords-Lecturer's descriptions about the learning object.

1.3 Keywords

Learning object, learning object metadata, folksonomy, tagging, learning object repository, content metadata

1.4 Problem description

Learning Objects have been used in the educational practices for many years. However, the issues of the creation and the reusing of learning objects are still discussed in the current stage. Several questions are related to the learning object metadata. And the generation of learning object metadata is really crucial for the reusing of learning objects. Manual and automatic metadata generation methods are two major approaches in this area. And lecturer provided metadata are one useful way to describe his/her material. But lecturer provided metadata is a time-consuming approach and lecturers should update the related metadata if they changed the resources. And they do not know whether their metadata is good enough to support other users' learning or reusing. Thus, it is more and more popular to use social software application to classify learning objects, such as two popular social tagging services del.icio.us [1] and Flickr [2].

Folksonomies, as one of web 2.0 signatures, are considered a free source of unstructured metadata[9]. It is one popular kind of method for categorizing web resources in collaborative manner. User-defined tags are good original sources for folksonomies. The-

[1] http://delicious.com/
[2] http://www.flickr.com/

refore, does student defined tags indicate the information of the online resources? And if they can, how to utilize these tags to generate effective metadata for describing the corresponding learning object is concerned in the project. If the system can generate learning object metadata according to the creation of learning objects and students' inputs, is it more effectively than manual method? And whether the lecturer would find the useful aspects from student defined tags? The experiment and the discussion in this thesis help us to find the answers for these problems.

1.5 Justification, motivation and benefits

The main purpose for using student defined tags to generate the learning object metadata is to find whether student defined tags are valuable for the users. Personal free tags represent a simple mean to easily and better categorize learning objects from an individual view. Hence, in [14] Julien Broisin and Philippe Vidal propose that it is possible for a user to quickly access resources linked to the selected tag. In the context of supporting learning activities, good quality metadata can be used to improve the retrieval of the learning object. Thus, this thesis focuses on analyzing students' tags for discussing the information value of these tags.

For students, lecturer provided keywords are useful for them to understand the main information of the learning resources. If the student defined tags contain the similar information as the lecturer provided keywords, these tags are also helpful for students at studying. Tags generated by the users, and users understand themselves. Thus tags are better for them to search and retrieve the learning object if utilizing tags as metadata.

Additionally, if student defined tags and lecturer provided keywords describe the similar information, the lecturer could not spend more time for creating metadata and they can also review tags as one kind of students' feedback about what students think important in each lecture. Moreover, lecturers can improve their keywords, lecture notes, or the lecture if they find some mismatches or some misunderstanding from per student defined tags.

Furthermore, the school can evaluate the learning object based on students' inputs if students give a grade when they add tags for each learning object. This is one way for school to know the quality of the learning resource and also to know the students' opinion about the lecture.

For the learning object management system, using student defined tags is one choice to create learning object metadata and also an optional approach for improving a search function because this search engine uses user's words term to search in a set which contains user defined tags/keywords.

1.6 Research questions

The research questions are divided into two groups, the main research question and three sub-questions which must be used to answer the main question.

1.6.1 The main research question

To what extent can student defined tags be utilized as learning object metadata in the educational system?

1.6.2 The sub-questions

1. Could student defined tags replace lecturer provided keywords? The aim to answer this question is to find that student defined tags could be a substitute of lecturer provided keywords, or as a complement?
2. Do student defined tags add value which is beyond being metadata for learning object retrieval? This question aims at analyzing the value of tags for both students and lecturers.
3. What challenges need to be dealt with when using student defined tags as the learning object metadata? This sub-question discusses the challenges in three aspects: the challenges for the technical design, the challenges for the professor adoption, and the challenges for the student adoption.

1.7 Summary of Contributions

This thesis focuses on how to use students' inputs to generate learning object metadata in an effective way, which would improve the resource retrieval and reusable. We propose ideas to discuss the value of student defined tags and analyze how to use them in the practical system. In addition, tags cannot replace lecturer provided keywords but as a kind of complement. Moreover, tags are the feedback and the resource for the lecturer who lecturer can find what students feel important in each lecture, and students' misunderstandings, or improve his/her keywords and lecture note. For the students, tags indicate students' understanding and opinions about the learning object. Other students can get the descriptions about the learning object from the tags and lecturer provided keywords. Moreover, tags can be also used to create metadata which is helpful for describing learning resources.

2 Related Work

2.1 Learning object

2.1.1 What are Learning Objects?

Learning objects are reusable resources which support learning activities in educational process. The innovation of Learning objects (LOs) has affected people's activities with the development of Internet in the past decade not only in the working field but for studying and communications. Therefore, the new conceptualization of the learning object in the learning process has highly grounded in the object-oriented paradigm of computer science. The fundamental idea behind learning objects is that this entity would be sharable with others and retrieved by any number of people.

Learning object is a new concept of learning process, rather than the old material for learning it provides a relatively new method to present learning content and support learning. LOs enable and facilitate the use of educational content online.[16] Materials used by educators, learning resources and instructional aides are all examples which would be created as learning object by educators in every teaching day. Several years ago, we had studied a chart of the alphabet above the chalkboard in the classroom, and at that time shareable educational resources are a fixture in classrooms for different teachers when they have the same content. Thus, "learning objects are sometimes defined as being educational resources that can be employed in technology-supported learning." [16]

The different definitions for learning object are similar as the condition that is supporting learning and reusable by others. In different literatures, they try to nail down a precise definition for learning object. According to the most common definition, "learning object" is a term which focuses on one specific learning goal, such as used in teaching, support to learn, sharable with others or reusable, etc. Learning object would help and motivate students and used by teachers, which might be considered feasible support. Nugent et al. (2005) declares a learning object simply as "a structured, standalone media resource that encapsulates high quality information to facilitate learning and pedagogy" [17].

The concept of reusable is therefore a key point for the definition of the learning object, and learning object is commonly a small digital or non-digital file or module and might be used to combine with other learning object to enhance the content for the courses.

The figure 1 (adopted from [1]) is an example about creating, storing, and reusing learning objects. The learning object is produced using variety produced tools (as using Dreamweaver to develop a webpage or using Flash to create a flash for studying) and stored in a database which is called Learning Object Repository (LOR), and retrieved or presented in an appropriate situation, such as used in the classroom or widespread in internet. Adapting a definition from the Wisconsin Online Resource Center, Robert J. Beck suggests in [18] that learning objects have the following core characteristics:

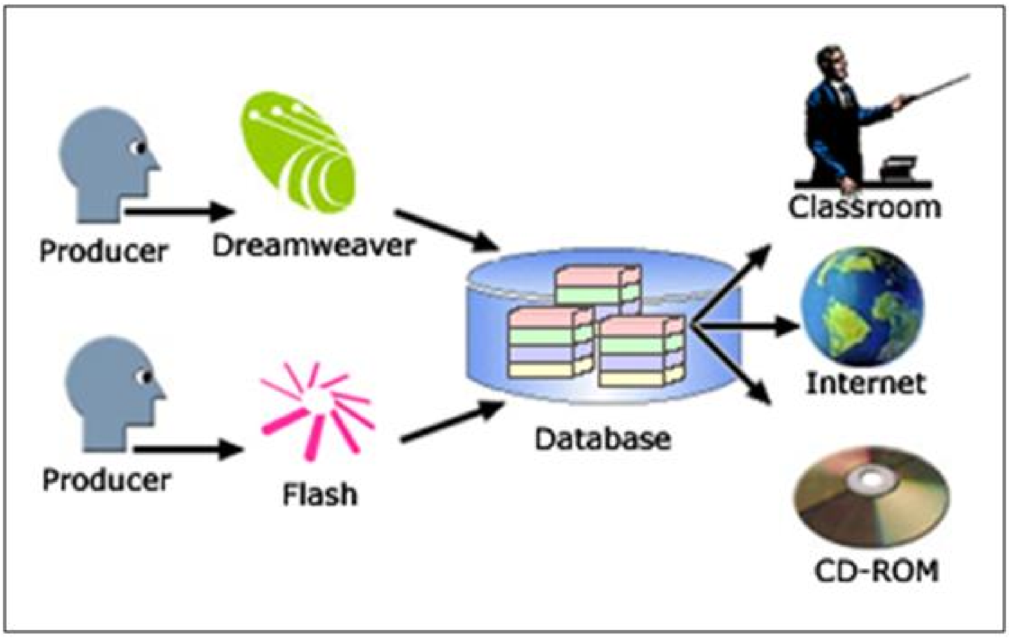

Figure 1: The processes for creating, storing, and reusing learning objects [1]

- The first is that learning objects are a new way to think about learning content. In traditional way, content would be shown in a several hour chunk, such as sharable text book, sharable video. But now, learning objects are much smaller units for learning. For example, the learning object used in the experiment of this thesis is the lecture note for the each lecturing. Thus the content of each learning object is much less than the whole book.
- The second is that learning objects are self-contained which means each learning object can be taken independently. In this project, each learning object was created by the lecturer.
- The third is that learning objects are reusable that means a single learning object may be used in multiple contexts for multiple purposes.
- The last but not least, learning object are tagged with metadata, which would make them easily found by search. And the metadata about learning object is descriptive information. In the project, some metadata are provided, which help users to understand the information of the LO.

All in all, the general consensus about the definition of the learning object should have four features as reusable, accessible, interoperable/portable, and durable.

2.1.2 Why Learning Object

If we want to know more about learning object, we should know why we need to use learning object.

- The first reason is that no need to reinvent the wheel. Some decades ago, teacher should write the course content in the blackboard with chalk every time even the two courses have the same content but different students. However, nowadays, teachers just need to modify their teaching materials when the courses have the same content but different students.

- Then, do more things to extend your material and your understanding. This aspect focuses on the modification, and creator would extend their reach based on other learning objects.
- The third reason for this question is that the some obtained learning objects have a top quality and easy to acquire with less effort.

Moreover, creating learning object would increase the versatility and the functionality. At another aspect, the benefits, such as widespread content is available, are straightforward to find not only for institutional system but also for community. One learning object is designed by one person and is made available to other instructors who might use them for variety instructional objective.

2.1.3 Learning Object Repository

As learning objects become more commonly in the development of the internet, there will be increased requirement for learning object repositories-the collections of learning objects-in order to store the learning object and improve the discovery, preview, reusing. "Learning object repositories that are being created house the LOs providing seamless access to a vast store of learning resources such as animations, videos, simulations, educational games, and multimedia texts in the same way that Napster and IPod users have access to music files. [16]"

Learning object repository is the storage and retrieval system for learning objects. Due to the tagged metadata for every learning object, it makes the retrieval process easier than before. Those searching for an appropriate learning object could search a metadata in repository to find the proper resource is present or not. As a consequence, the repository which hold learning object has good searchable interfaces and architectures that make them easy to use and permits various levels of interactivity including an object store, a metadata creation and maintenance database, also connect with internet.

In 2003, Boyle [19] describes the potential benefits of learning object repositories and hence respective repositories are developed and used for teaching especially. Two main types of learning object repositories are those containing the learning objects and their metadata, and those containing metadata only. The former collection would be used to locate and deliver learning objects and the latter collection might only used as a tool to locate learning object because learning objects are stored in a remote location in this case.

A few of the larger learning object repositories that encourage downloading and sharing of resources include the following lists, which is from the conclusion of [20]:

- **Campus Alberta Repository of Educational Objects (CAREO)**[1]. Comprised of 5,000 multidisciplinary teaching materials, the database is searchable, and the collection is web based. This Canadian project has been recognized as a leader in the LOR initiative. And this repository agreed that the following five fields should be required regardless of the learning object software used: 1) title; 2) URL; 3) material type; 4) subject/discipline; and 5) object description [21].

[1] http://www.careo.org

- **Federal Government Resources for Educational Excellence (FREE)**[2]. This contains numerous educational resources, which include teaching ideas, instructional activities, photographs, maps, audio files, digitized paintings, lesson plans.
- **FreeFoto.com**[3]This is one of several repositories that contain high-quality photographs for educational as well as commercial use.
- **Maricopa Learning Exchange**[4]. This is a digital repository that contains more than 700 learning "packages" which include plans, ideas, samples, and resources.

2.2 Metadata For LO

2.2.1 What is Metadata?

Metadata is structured data about an object. In accordance with the literal explanation, metadata is routinely defined as "data about data" or "information about data", because it originates from the development of data and has the same ability as data itself simultaneously. The etymology of "metadata" is "meta" which is a Greek prefix with the meaning of "among", "along with", "about", which depend upon the use case or the associated word. There are some sophisticated definitions which might describe it explicitly.

"Metadata is a structured, encoded data that describe characteristics of information-bearing entities to aid in the identification, discovery, assessment, and management of the described entities." [13]

Metadata is important for searching and understanding resources. When we use Microsoft Word to write some article, there has preparing work for adding attributes that could be metadata for this article. The metadata in Microsoft Word is a normal metadata set in our daily study life. It is easy to see that title and author are both metadata and data, but position in library is just metadata for the literature. From the example, it is easy to find that metadata is a set of elements with particular properties, which is necessary for querying the information or resource. So that, metadata could be chosen to describe the data conceptually in order to be understood by not only human being but also computer, such as the search engine in digital library as figure 2 (adopted from [2]). It is a typical search engine which use metadata as "Title, Keywords, Contributor name" in its advanced search.

2.2.2 Main Types of Metadata

Metadata can describe attributes about resource, such as the name of file, or the content of resource, or the main content. It also describes immutable elements or mutable elements. Immutable metadata elements mean that metadata of one resource may not be changed unless the resource itself also changed. For example, the title and the author(s) of one resource are immutable metadata because the author(s) cannot change except the resource changed. Mutable metadata elements mean that metadata of one resource may be changed even if the content of the resource has not been changed. Such as, the location of one resource, it may be changed when put it in two library

Three main types of metadata have represented in the [22], which contains Descriptive Metadata, Structural Metadata, and Administrative Metadata. Thus, just as the name implies, descriptive metadata is used to describe the information, the literature

[2]http://www.ed.gov/free
[3]http://www.freefoto.com
[4]http://www.mcli.dist.maricopa.edu/mlx

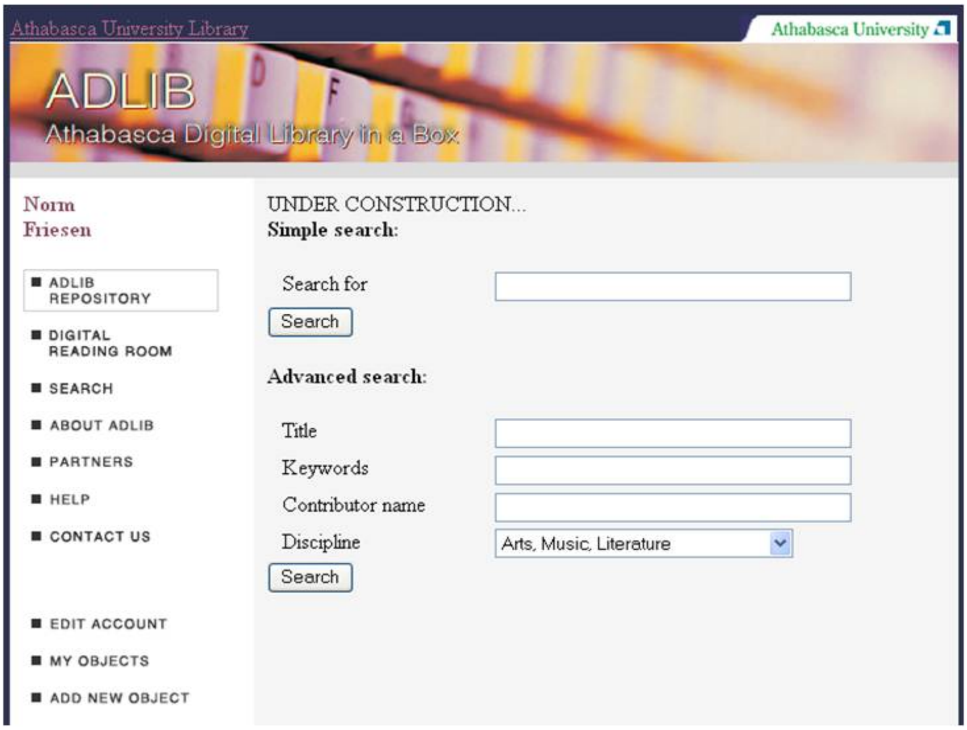

Figure 2: A search engine example use metadata in one digital library [2]

in the library is an example for this type. In the book Understanding Metadata [22], it describes the structural metadata with the concept as that it indicates how compound objects are put together. And the last type is the metadata which is helpful for resource management. Other type for metadata-technical metadata, which was also classified by the content, mutability and logical function. Most essential issues would be considered when categorize metadata, which are risks, lifecycle, and storage.

Every type of metadata is appropriate for different information requirement. They might be used to distinguish, discover, and access information so that to satisfy user's requirement. Furthermore, it also evaluates resource in the appropriate way. Whatever the purpose for utilizing metadata is, whole types of metadata manage the information for past, present, and future, in order to reuse the resource easier than before.

Descriptive metadata is what kind of metadata used in the thesis. Student defined tags are one source for describing object. And if tags contain the similar information as lecture provided keywords, they can be used as description for the learning material.

2.2.3 The Reasons for Using Metadata

One important aspect of the metadata is designed for improving the retrieval of the information resource. Information must be clearly identified for the audience when they search it and they could judge that the information is useful for them or not by using metadata. There is an essential link between information user and creator when metadata is available because the purpose for providing metadata is to improve the access for information resource. Some reasons were demonstrated by Chris Taylor, the manager of University of Queensland Library, for why using metadata in [23]: improving resource discovery, administrative control, security, personal information, management information, content rating, rights management, and preservation.

If you have the experience that you try to find one book in the library, you may find that it is very hard for you to find book when you see books one by one in the bookshelf. However, if you search this book in library system, such as BIBSYS [5] of GUC, it is easier for you to find this book. There have a lot of examples like it. Nowadays, our world is filled with the application of metadata.

"Metadata enriches the resource it describes by extending user's understanding of its content and the factors surrounding its creation." [24]

Metadata is an important notion for information retrieval not just for human but also for computers. Without it, the processes of searching, exchanging, and reusing would be difficult to obtain. Thus, it becomes more and more essential to find the correct metadata about information especially with the increasing for the number of documents at present and in the future.

2.2.4 Metadata Schemas

Metadata is a set of attributes or elements which are indispensable or selectable and make human to add tags for the resource with a standardized method though it is not greatly uniform. Each metadata schema usually contains the following features: the number of elements is limited, element name and meaning. "Standardization in the way that metadata is created means that information about resources can be presented in a meaningful and consistent way, and is crucial for effective resource discovery." [24]

So what is schema for metadata? It is a standardized approach for metadata organization and presentation to obtain searching, retrieval, reusing, and so forth. In the library environment, metadata is commonly used for any formal scheme of resource description, applying to any type of object, digital or non-digital resource.

Some of the most frequently used metadata schemas contain: Dublin Core, MODS (Metadata Object Description Schema), AACR2 (Anglo-American Cataloging Rules), IEEE LOM (IMS Global Learning Consortium), and so on. Furthermore, some important encoding schemes, such as HTML, XML, RDF (Resource Description Framework), are also commonly used at the present time. The metadata could be processed by a computer program if using programming code because it understands the semantics of metadata schemas.

Dublin Core

The study from the Dublin Core Metadata Initiative in [3], the Dublin Core Metadata Element Set is a standard for describing information resource which crossed more than one domain and make things easy to search or find. Dublin Core is widely used to describe digital materials which include text, image, video, sound and web pages. It is defined by ISO in ISO standard and NISO standard. The summary of the qualifiers is provided as table 3 (adopted from [3]) shown.

The Dublin Core Metadata Element Set is a vocabulary of fifteen properties for use in resource description. Whole Dublin Core Elements contain 15 elements which are Title, Creator, Subject, Description, Publisher, Contributor, Date, Type, Format, Identifier, Source, Language, Relation, Coverage, Rights. Each Dublin Core element might be repeated during the using process and optionally as well. If we use LaTeX to create article, there have a file for storing the literature information which include some Dublin Core

[5] http://ask.bibsys.no/ask/action/stdsearch?cmd=nullstill&kilde=biblio:HIG&lang=nb

DCMES Element	Element Refinement(s)	Element Encoding Scheme(s)
Title	Alternative	-
Creator	-	-
Subject	-	LCSH MeSH DDC LCC UDC
Description	Table Of Contents Abstract	-
Publisher	-	-
Contributor	-	-
Date	Created Valid Available Issued Modified	DCMI Period W3C-DTF
Type	-	DCMI Type Vocabulary
Format	Extent	-
	Medium	IMT
Identifier	-	URI
Source	-	URI
Language	-	ISO 639-2 RFC 1766
Relation	Is Version Of Has Version Is Replaced By Replaces Is Required By Requires Is Part Of Has Part Is Referenced By References Is Format Of Has Format	URI
Coverage	Spatial	DCMI Point ISO 3166 DCMI Box TGN
	Temporal	DCMI Period W3C-DTF
Rights	-	-

Figure 3: The Summary of Qualifiers [3]

elements.

Dublin Core metadata schema has some advantages: usability and generic for using it, its elements are easily identifiable by having the work in hand, optional and repeatable as the upper explanation, syntax independent to support its use in the widest range of applications, and so on.

2.2.5 How to decide which standard would be used

With different purposes, varying standards would be selected for describing. Because of the advantages of Dublin Core, it is widely used by so many projects all over the world. And IEEE LOM is also a commonly used to describe the learning object and it will be introduced in the next section.

Two aspects need to be considered when choose the standard for the learning object. The first thing to choose the standard is to identify what the content would be described and to know what the aspects contained in the learning object. Follow the first step the suitable standard would be selected with features of the describing object, such as the type, the target. And for this thesis, some metadata elements are used for describing the learning resource and the reasons are shown in the next chapter.

2.2.6 Learning Object Metadata

Learning Object Metadata is a data model which is used to describe learning object or the similar digital resource in order to support learning, for instance the reusability of learning object, to support discoverability and facilitate the interoperability. In [25], the definition about learning object metadata data element is that "a data element for which the name, explanation, size, ordering, value space, and data type are defined in this standard.

Usually, the learning object metadata is encoded in XML and in the context of online learning management system. The most relevant standards for describing learning objects are Learning Object Metadata, Dublin Core and MPEG-7. The IEEE Learning Object Metadata is a hierarchical metadata standard and usually encoded in XML. In the following sections, the basic and the details of LOM would be presented.

LOM Standards

The IEEE Learning Technology Standards Committee (LTSC) has been providing for the development and maintenance of the Learning Object Metadata standard since 1997. The first multi-part standard for LOM, which LTSC LOM is responsible for maintaining, is developing and evolving. The IEEE LOM standard has been well received, recognized, and adopted internationally.

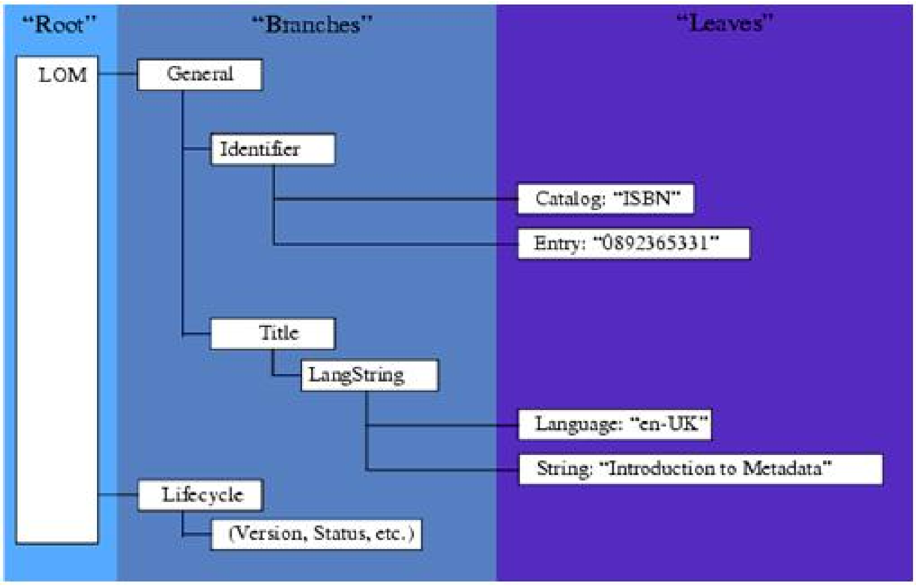

Figure 4: The hierarchy schema of LOM [4]

Learning Object Metadata defines a basic schema which comprises a hierarchy of data elements for learning object metadata. As the figure 4 (adopted from [4]) shown that at the first level (after the root level), there are nine categories, each of which contains sub-elements which may be simple or aggregate elements with different contents. The figure 5 (adopted from [4]) shows the detail of these nine categories which contain 77 data elements are as following introduced:

1. General category: is used to describe the general information of learning object as a whole;
2. Life cycle category: is used to describe the related history and current state of the learning object and those who have affected the learning object during its evolution;
3. Meta-metadata category: is used to group the information about the metadata itself rather than the learning object;
4. Technical category: is used to describe the technical requirements and technical characteristics of the learning object;

5. Educational category: is used to describe the educational and pedagogic characteristics of the learning object;
6. Rights category: is used to describe the intellectual property rights and conditions of use for the learning objects;
7. Relation category: is used to describe the features which define the relationship between the learning object and other related learning objects;
8. Annotation category: describe the comments on the educational use of the learning object and the information on when and by whom the comments were created;
9. Classification category: describe the association between the learning object and the particular classification system.

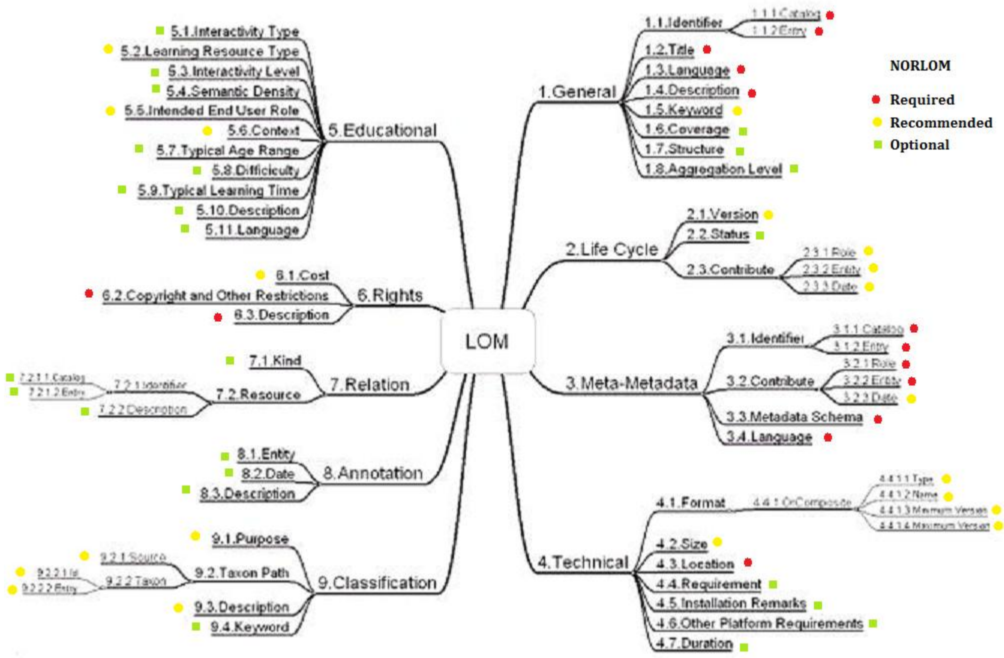

Figure 5: The elements and structure of the LOM conceptual data schema [4]

LOM indicates a data type, name, size, explanation, example value and other important details for every data element. For instance:

- General.Title: Name given to this learning object.
- General.Identifier.Catalog: a kind of identifier which is in the General category.
- Annotation.Classification: where this learning object falls within a particular classification system.

LOM in XML

Learning object metadata XML binding should be used for IEEE LOM data model and this activity is ongoing. Each LOM data element is similar as Dublin Core metadata element but there are some overlaps between these two parts. Figure 6 (adopted from [5]) is an example which contains a learning object-an image-and its related learning object metadata.

Figure 6: An example of a Learning Object and its associated LOM [5]

Application Profile of LOM

Application profile is a set of metadata elements, policies, and guidelines defined for a particular application. A set of metadata elements may comes from one or more element sets, thus allowing a given application to meet its functional requirements by using metadata from several element sets including locally defined sets. The advantage of defined application profile is that this permits to develop the loosely-coupled systems which also offer powerful capabilities.

The localization of LOM for different areas would improve the performance of the LOM and this method would not need local extensions or modifications. Dublin Core is used commonly by general and LOM is almost used for education. Interoperability is another important part for application profile. Thus, the local standard would improve the performance for utilizing the local requirements. The main purpose of application profile is to increase the interoperability between the various users. The following lists are different applications of LOM in various areas:

1. UK
   - LOM Core-for UK Further and Higher Education [26]
   - CETIS-Center for Educational Technology Interoperability Standards [6]
2. Canada
   - Athabasca University [7]
   - CanCore-in the LOM standard, it provides detailed guidance for the interpretation and implementation of each data element [8]
3. Norway
   - NORLOM-Norwegian application profile, created to suit Norwegian educational

[6] http://jisc.cetis.ac.uk/
[7] http://www.mba.athabascau.ca/
[8] http://cancore.athabascau.ca/en/

needs [27]

4. China
   - CELTSC-Chinese E-Learning Technology Standardization Committee [9]

NORLOM uses the same elements as the IEEE LOM standard, but it focuses on involved them into three subsets: required, recommended and optional. The whole LOM elements set are too big to use them for most situations. Required subset contains the most important metadata elements and always has to be filled for learning objects. Recommended subset contains the metadata elements which are recommended used. The optional subset contains the rest of the elements which regard as less important part when compares with the elements in other two subsets. The three subsets were presented in figure 5.

2.2.7 Comparison between LOM and Dublin Core

The previous mentioned IEEE LOM and Dublin Core both contain different elements for describing the learning object or the digital resource. The relation between LOM and DC would be presented in this part. Sutton presents the relation between them in [28] as the following descriptions in 15 aspects which are also discussed in the DC elements.

1. **Contributor**: the Dublin Core element contributor presents similar information as Lifecycle.Contributor.Entity[IEEE 2.3.2] of IEEE LOM which describes that "Persons or organizations contributing to the resource (includes creation, edits and publication). If [Lifecycle.Contribute.]Role (2.3.1) is not equal to Author or Publisher, then this element corresponds with the Dublin Core element DC.Contributor. If the entity is an organization, then it is typically a university department, company, agency, institute, etc. under whose responsibility the contribution was made."
2. **Coverage**: DC.Coverage represents the same as General.Converage[IEEE 1.7] which describes that "the spatial or temporal characteristics of the intellectual content of the resource."
3. **Creator**: DC.Creator introduces information as General.Coverage[IEEE 1.7] which introduces "persons or organizations contributing to the resource."
4. **Date**: it presents information as Lifecycle.Contribute.Date[IEEE 2.3.3] which means the date of the contribution."
5. **Description**: DC.Description presents information as General.Description[IEEE 1.5] which is the textual description of the content for the resource.
6. **Format**: DC.Format displays information as Technical.Format[IEEE 4.1] which means technical date type of the resource.
7. **Identifier**: DC.Identifier present information as the elements General.Identifier*[IEEE 1.1] (a unique label for the resource) and/or Technical.Locaition[IEEE 4.3] (a location or a method that resolves to a location of the resource)
8. **Language**: DC.Language introduces the similar as General.Language[IEEE 1.4] which displays the human language of the resource.

[9] http://pi.cs.tsinghua.edu.cn/projects/e-learning/celtsc.html

9. **Publisher**: DC.Publisher represents information as Lifecycle.Contribute.Entity[IEEE 2.3.2] which describes persons or organizations contributing to the resource.
10. **Relation**: it represents as Relation*[IEEE 7][IEEE 7.1 & IEEE 7.2.2] which introduce features of resource in relationship to other resources.
11. **Rights**: it also contains the information as Rights[IEEE 6] which means the conditions of using resource.
12. **Source**: DC.Source also represents as Relations[IEEE 7].
13. **Subject**: DC.Subject contains the information as three elements in IEEE LOM Schema-General.Keywords[IEEE 1.6], Classification.Keywords[IEEE 9.4], and/or Classification [IEEE 9].
14. **Title**: DC.Title means General.Title[IEEE 1.2] which presents name given to the resource.
15. **Type**: DC.Type contains the information as Educational.LearningResourceType[IEEE 5.2] which means the specific kind of the resource, such as exercise, questionnaire, figure, table, and so on.

2.3 Defining Metadata Quality

Metadata is commonly used for describing the characteristics of resources or objects. Thus the main purpose of using metadata is for supporting retrieval or reusing relevant content of the resource. Manual generation of metadata is resource demanding and is often viewed by users. Social tagging is one method for generating metadata by public and it is also the good resource for folksonomy. Although user-defined tags are ambiguous, there have some researches to analyze how to employ some algorithms or processes to disambiguate tags [9] [10] [29].

The experimented results studied in this thesis were evaluated using the framework [6] to measure "metadata quality". In [6], it introduces a framework, as figure 7 shown, which contains three concepts to distinguishing "quality" with the goal and mean.

In the context of the above framework, the "metadata quality" based on:

1. **Syntactic quality:** Analysis how well the metadata corresponds to the language or document format standard.
2. **Semantic quality:** Analysis how well the metadata corresponds to the resource's relevant domain and the metadata schema.
3. **Pragmatic quality:** Analysis how well the metadata corresponds to its users interpretation.

In 2002, Quality Assurance Framework (QAF) for statistical data was developed by Statistic Canada (STC), it provides a basis for metadata quality indicators and subsequently applied to metadata assessment by Paul Johanis in [30] in 2002. STC version of QAF contains six categories: relevance, accuracy, timeliness, accessibility, interpretability, and coherence. In 2004, Bruce and Hillmann examine seven of the most commonly recognized characteristics of quality metadata based on QAF in [31]. These seven characteristics are completeness, accuracy, provenance, conformance to expectations, logical consistency and coherence, timeliness, and accessibility.

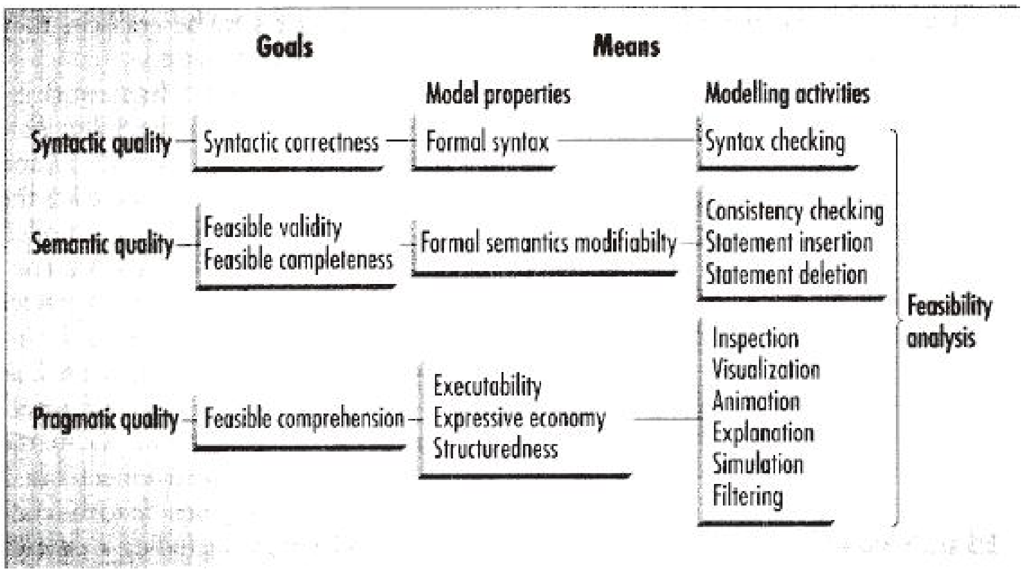

Figure 7: Proposed framework for distinguishing quality-improvement goals and the means of achieve them [6]

1. **Completeness:** Metadata should be complete in two aspects: first, the use of metadata elements would describe target object in more details and as completely as possible; second, the use of metadata elements would reflect particular content or information which are desired by users.
2. **Accuracy:** Metadata should be accurate and correct in the way it describes resources.
3. **Provenance:** The provenance of metadata means the information of who created metadata and the experience of the creator.
4. **Conformance to expectation:** Users' expected metadata elements are available.
5. **Logical consistency and coherence:** Logical consistency indicates the relatedness of the real metadata criteria and users' expected. Coherence indicates whether the metadata elements are available.
6. **Timeliness:** Two different aspects refer to metadata timeliness: first, Currency-occurs when the target resource changes but the metadata does not; second, Lag-occurs when the target resource is distributed before some or all metadata is knowable or available.
7. **Accessibility:** The metadata are available and understandable by users.

Any kind of metadata quality definition should address three properties of the metadata as the syntax, the semantics and the values of data. In this thesis, the metadata quality evaluation was measured using the first framework with the last seven aspects.

2.4 Folksonomy and Social Tagging

As the development of Web 2.0 technologies, new creator-oriented, collaborative and social bookmarked are popular and to become commonly option for predefining metadata. Folksonomies are the most popular one among them and user-defined tags or -reused tags are commonly used for searching and cataloguing.

2.4.1 Folksonomy

Folksonomy, which is a portmanteau word about folk and taxonomy, derived from the practice and method of collaboratively creating and managing tags for the purpose of annotation and categorization. It was first coined by the information architect Thomas Vander Wal in August of 2004 and the definition about folksonomy is as "the result of personal free tagging of information and objects for one's own retrieval. The tagging is done in a social environment (shared and open to others). The act of tagging is done by the person consuming the information" in [32].

It is an approach which generates metadata by public. Folksonomy becomes popular because more and more social software applications use this user defined classification, such as previous examples del.icio.us and Flickr. The main sources of folksonomies are considered as user defined tags from social tagging system. Personal free tags represent a simple mean to easily categorize learning object from an individual view. Folksonomies are not exempt of problems, such as lack of structure in keyword-based tags, as well as sensitivity to linguistic phenomena such as plurals, polysemy, synonymy and homonymy. [33] When a set of tags from different users are described learning objects, this set of tags would be processed as what have been proved in the [9] and used to classify learning objects.

Folksonomy is a benefit classification for personal free tagging information and retrieving resources by their own way. Furthermore, folksonomy has its own value which stem from user when they label with their own vocabulary with explicit meaning. The following features might be used to summarize folksonomy:

1. This classification is defined by personal motivated;
2. Classification with tag is free shared, and it would be used by public;
3. The frequencies from the common definition decide this classification.

Just as before mentioned content, some researchers would enjoy describing web resources with folksonomies which would present keywords as a free source. These keywords might be considered as annotations which would be converted into semantic metadata. The key point is how to convert folksonomy annotations into valid semantic metadata effectively. It is better to evaluate semantic metadata from folksonomy with which come from other methods. Folksonomy is a manual approach for generating metadata for ontology, thus it contains some unique opinions about ontology which would not be generated by automatic method.

2.4.2 Social Tagging

Social tagging is an informal way which encourages public engagement in order to assign user-defined labels to content items. These labels are tags. In [34] discusses that "tagging lets users assert their own connections and associations between objects in ways that reflect personal perspectives and interests" and "tagging as a potential means to bridge the semantic gap between art historians and art museums' visitors".

Social tagging system is a typical and promising Web 2.0 application [35], where users label digital materials by using freely selected tags. Table 1 (adopted from [7]) concludes definitions of social tagging in this domain abound. From the understanding of definitions of social tagging, tags are supplied by the social public and shared in a common online environment which would be collaborative tagging system or folksonomy.

Study	Object of definition	Definition
[34]	Social Tagging	"The collective assignment of keywords to resources"
[36]	Tagging	"Labeling objects with free-style escriptors"
[15]	Tag	"One-word descriptor[s] or term[s] to describe the image or bookmark"
[37]	Social tagging	"The collaborative activity of marking shared online content with keywords, or tags, as a way to organize content for future navigation, filtering or search"
[38]	Collaborative tagging	"A practice whereby users assign uncontrolled keywords to information resources"
[39]	Tags	"Short free form labels used to describe items in a domain"

Table 1: Definitions of Social Tagging [7]

Tagging is one important method for generation folksonomy metadata which also would be recognized as meta-tag. For the learning object, we try to use keywords as meta-tags in order to find the similarities and the differences between experts' keywords and users' tags. The use of learning object can be used as evaluation tools for assessing the learning object and the outcomes. In order for student to effectively learning the content they have understand the potential object(s) of the learning object and its relationship to other learning objects. When they tag a keyword they should reflect on its meaning and content, and redescribe it based on their understanding.

2.5 Summary

The introduction about a lot of previous work tries to figure out the definitions of the learning object and the learning object metadata, and represents the LOM standard and DC for describing resource. One important aspect illustrated the best use of students' tags and some approaches about how to use user defined tags to generate learning object metadata to support learning and retrieving, but it is still hard to conclude about what the value of students' tags contain. To investigate the problem in a structure way, from the next chapter how to setup an experiment and how to find out the conclusion about the research question are presented in detail.

3 Experiment Setup

This thesis focuses on finding the efficient approach to solve how to use student defined tags to generate effective learning object metadata. Social tagging is a recent innovation and very popular used in a lot of websites currently. Thus, who participate in the experiment and how to collect students' inputs are the primary task for the experiment.

This chapter presents the mainly participants in two groups, details of one system which was used for collecting data, and the main limitations of the experimental website.

3.1 Participants

The participants were Master of Science in Media Technology (MMT) students from the GUC enrolled in two master courses. One is first year master course-Coding and Compression of Media Data (IMT4451), another is second year master course-Semantic Web (IMT4931). All participants were divided into two groups. Group one is the first year MMT students who add tags for IMT4451, and group two is the second year MMT students who add tags for IMT4931. Group one students were studying IMT4451 when they participate in this experiment, and they added tags after the lecture immediately. Group two students had finished the studying about IMT4931 when they participate in this experiment. Students in the same group have the similar backgrounds and learning contexts and they use their favorite words to tag each learning object. The amount of the participants is not same for each learning object. Thus, the number of how many students added tags are the tagger in the results' table in the next chapter.

To ensure the amount of collected tags, we used two different groups in the experiment. Moreover, the studying status is another consideration when we divided participants into two groups. If the added tags would be influenced by the studying status, there would have differences between two groups when participants "are studying" and "had studied" the courses.

The learning objects used in the experiment were the lecture notes and the lecture recording for both two groups. The learning objects in the group one were the ".PDF" lecture notes and the ".WMA" lecture recordings. The lecture notes contain more than 30 slides and the duration time of the lecture recording is more than 30 minutes. In the group two, the amount of the slides in the lecture note is around 9.

3.1.1 How to Motivate Participation?

In order to enhance the participation, the processing of collecting data is divided into two stages: the first two months is the first stage, last two months is the second stage. Student defined tags would be collected as the questionnaire in the classroom after the each lecturing time during this stage. In the second stage, student defined tags would be collected by one system which will be introduced in next part.

In addition, in order to increase students' interesting to add tags for learning resources, some useful information would be displayed in the one system which has tentatively been called as "DRES" (Digital Resource Evaluation System), such as lecturer-generated keywords for each learning object, the searching function in different metadata range, and other students' evaluation for some learning objects, etc.

3.2 Description for Collecting Student defined Tags

For the purpose of this study, the critical step is how to collect tags for each learning object in educational system. There have a lot of social bookmarking services but no one is completely fit to be used for this research. Thus, one website called DRES should be developed for collecting data, which also allows the user to tag, evaluate, and retrieve the learning resources. The link page of this system is:

http://www.stud.hig.no/ 080455/home.php

3.2.1 Purpose

The main purpose of the created system is to enable tagged, searchable, and shared learning objects on web. It provides access to a limited collection of the lecture notes and the lecturing recording that are supplied with metadata such as title, keywords, author, and target by the lecturers. These lecture notes, lecture recording and metadata keywords were provided by Rune Hjelsvold and Faouzi Alaya Cheikh, who were the lecturers of IMT 4931 and IMT 4451 respectively. Additionally, this system allows a collaborative tagging activity where users can share their ideas about the resource with each other, both authors and learners. Keywords provided by different lecturers needs to be analyzed as well, and they was analyzed by the categories of keywords.

3.2.2 Digital Resource Evaluation System

Homepage and Browsing

Browsing interface of DRES is shown as the figure 8. Users start the browsing for their favorite learning objects on the right side or favorite lecture on left side. They also can search by entering a search term in input text after the "New Search" and choosing the item in drop down list. They can also click "Advanced" to search term in keywords or tags subset. Additionally, they can sort the lecture notes, view the "Users' Comments" and the list of tags, or see the details of each learning object (as figure 9).

Tagging

Tags are the main experiment data in the project. Thus, tagging part is the key function for the experiment. When the user clicks Comments, evaluation and tags on the right side of details interface as figure 9, the tagging interface would be shown as the figure 10. Users can add their tags for the learning object, and also evaluate learning object in two aspects, or write some comments for it as well.

History Tags

One interface offers the information of the tagged month and previous tags list from other users. This page is the history tags and which presents each tag and its tagged amount, and the tagged month. Figure 11 is an example of the overview of this interface. And user can click the link "Hot tag" in the homepage to review this one.

3.2.3 Metadata Elements Used

In the experiment, the focus is on the learning object metadata. Hence, LOM elements which describe specific information of the learning object would be used in the DRES. In order to provide as much detail as possible when displaying learning objects in the system, there is a need to use some metadata elements. The following elements have

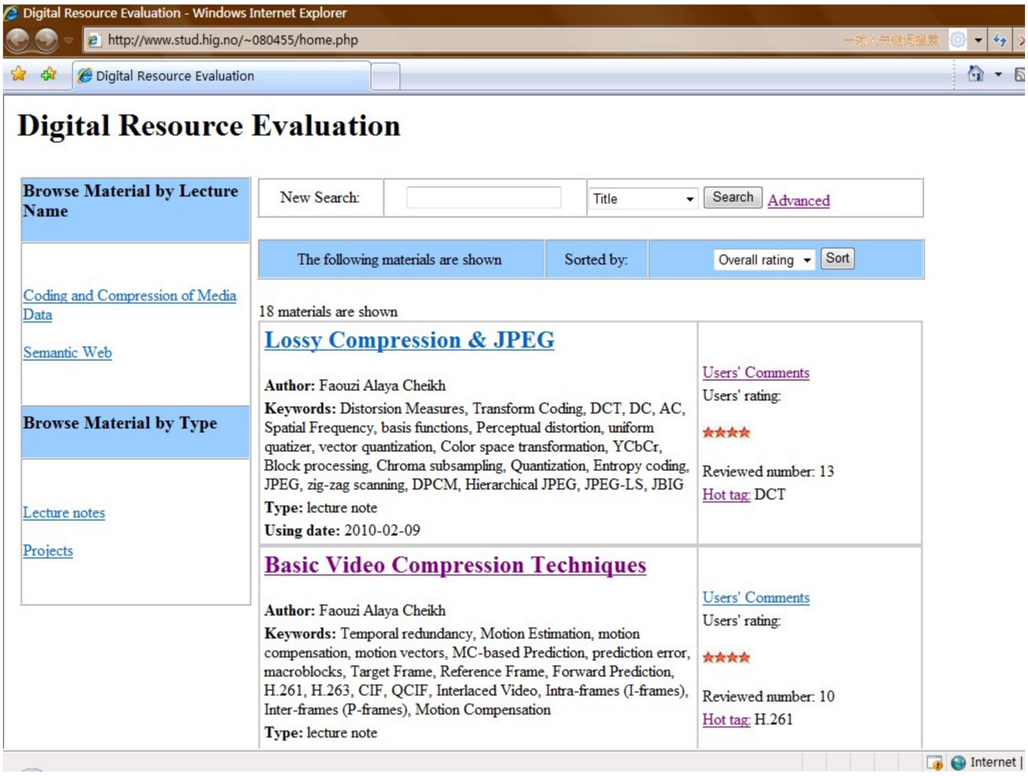

Figure 8: The homepage interface of Digital Resource Evaluation System

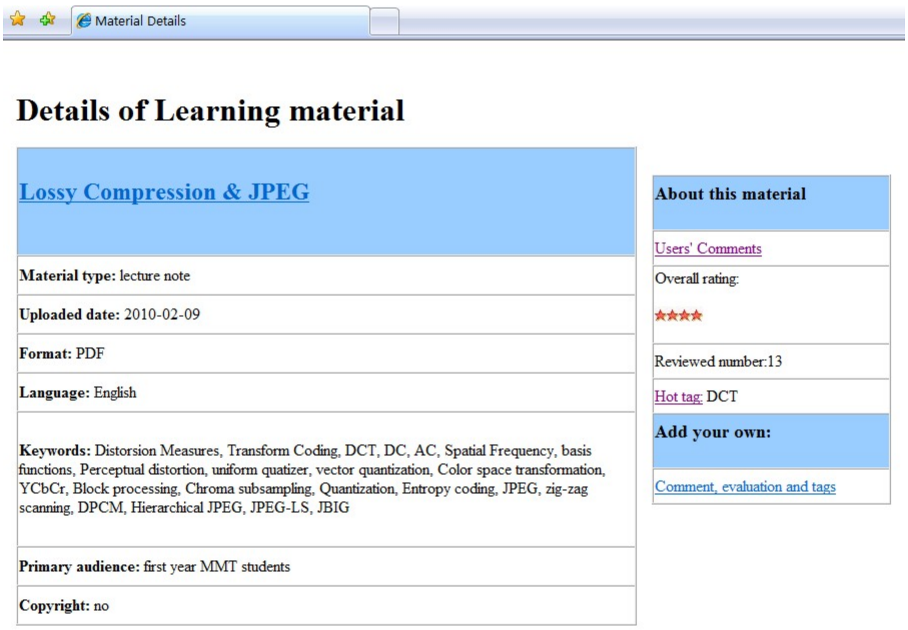

Figure 9: The overview of the learning object detail interface in the DRES

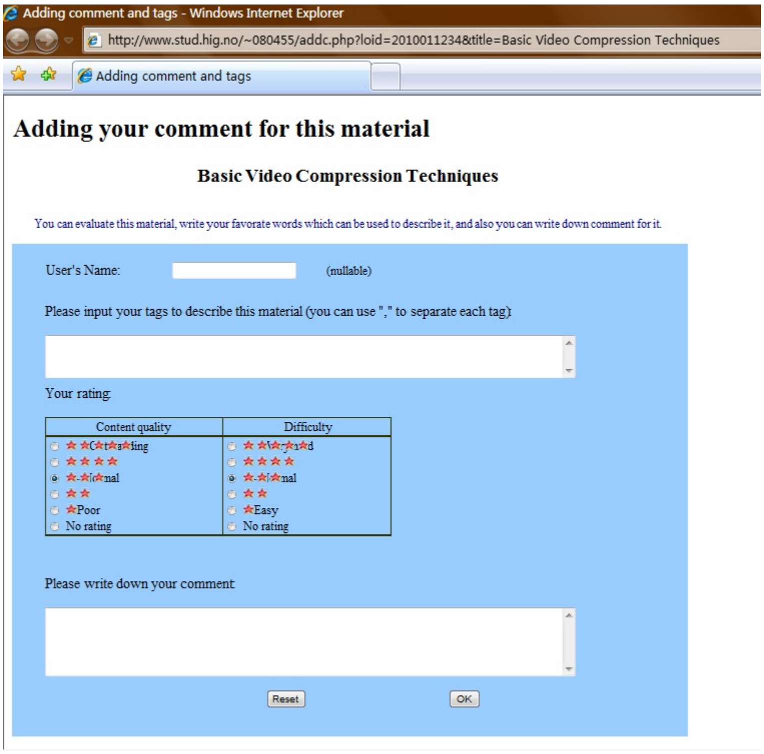

Figure 10: The overview of tagging interface in the DRES

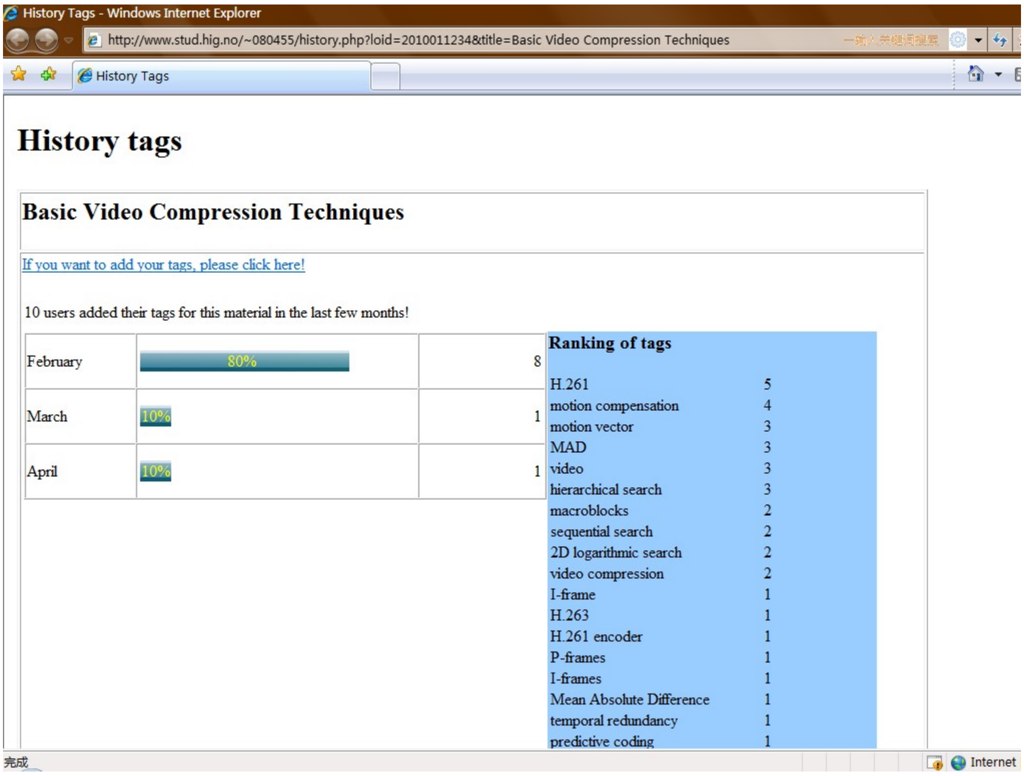

Figure 11: The overview of history tags interface in the DRES

been used to describe learning objects in table 2, the Title, Creator, Language, Keywords, and Audience are semantic elements. To specify a Creator, the IEEE LOM uses two elements: one for the role of contributor, and one element for the creator name. For this experiment, the Creator is the name. Format is a syntactic element used to determine how to understand the file content. Another element Audience, the IEEE LOM uses one element category "Educational" to specify as the Learning Context or the End User. And the details of them have introduced in chapter two (2.2.5), the comparison between IEEE LOM and Dublin Core.

Used elements name	IEEE LOM	Dublin Core
Title	General.Title	Title
Creator	Lifecycle.Contributor.Entity	Creator
Type	Educational.LearningResourceType	Type
Date	Lifecycle.Contribute.Date	Date
Format	Technical.Format	Format
Language	General.Language	Language
Keywords	General.Keywords	Subject
Audience	Educational.LearningContext Educational.IntendedEndUserRole	
Copyrights	Rights	Rights

Table 2: Used Metadata Elements

3.3 DRES Implementation

This system was made to be as a simple system which was able to present and introduce the learning objects and provide a platform for students to add tags and evaluate or comment the learning object. It is a system that runs purely in the users web-browser. And user can view other's tags and evaluations for the learning objects, and also can display their own ideas about the resource.

3.3.1 System Platform

DRES was built using PHP 5 for the server side code because this is the version of PHP that runs on GHC's web-server. Some php scripts are represented in appendix A. And the database MySQL is used. The webpage has been introduced in the previous section. And the database model is as figure 12 and there have six tables.

Table LO contains the basic information about each learning object. And the "lid" is the foreign key and related to the table "Lecture". From the "url" to the "target" are the metadata which are used to describe the learning object. The table "comment" contains the each comment from the students, and also the number of students who agree with the comment and who do not agree. The table "rating" illustrates the students' evaluation about the learning object in two aspects, content and difficulty. Additionally, the table "tag" documents the tag name, tagged month, and the tagged user which can be null. And table "amount" is the summary of the tags and this table aims at summing up the amount of the students who use this tag to describe this learning object. Thus, "LOid" related to the table "LO".

The first purpose of the DRES system is presenting the information of the learning object which may increase students' interesting to view the webpage and to add tags for the learning objects. Secondly, the aim is at providing a platform for collecting tags for

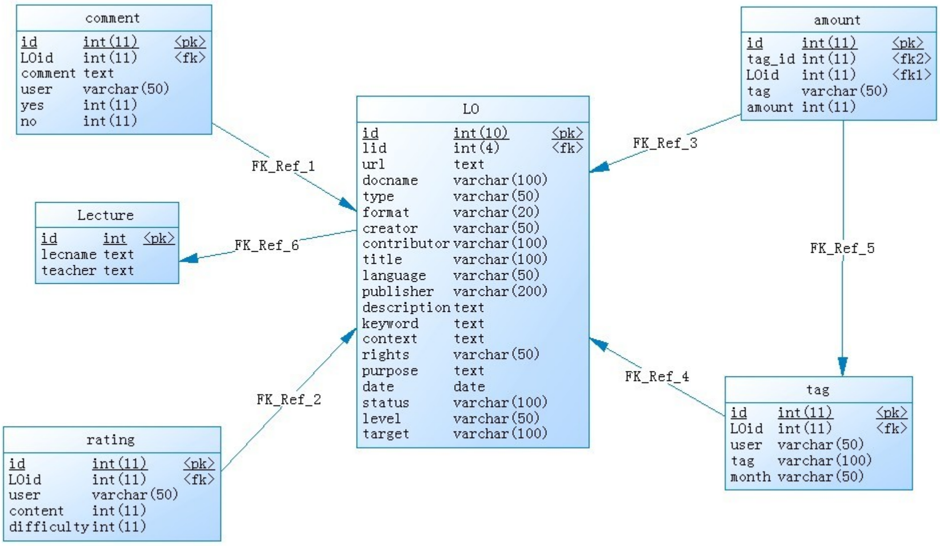

Figure 12: Model of the simple MySQL database

the experiments.

Because of the time limited we did not spend too much time on developing this system. And the main purpose of the project is to analyze tags, thus there are some limitations about this system. One limitation is that no login functions in this system. This means users can add tags and review the learning object whatever who you are. It is not a wise way to show information like that. But this system is just used for the experiment. Thus, this limitation is not essential, but if for the real system, login should be contained. The next drawback is that no function for the lecturer to upload the learning objects. This means that only database administrator can upload or change the information for the learning object. Thus, the two limitations need to be modified in the future real system development. Moreover, the layouts are not beautiful, and the searching function is a simple one which just searches the metadata.

The pre-mentioned limitations are the main problems for this system. And some other problems may need more improvements. For instance, the database design can be improved and some tables can be modified. The metadata elements can be redesigned in order to indicate more descriptions about the learning object for the users.

4 Experimental Results

This chapter describes the experimental data from the two groups. The experimental methods and the results are introduced in this part.

4.1 Experimental Methods

In order to find the overlap, relatedness, and the difference of student defined tags and lecturer provided keywords, the following introduced approaches would be used to support the experiment.

1. Counting up the amount of the lecturer provided keywords for per learning object, which represents how many keywords provided: this method is used to analyzing the keywords in the two groups
2. Counting up the number of tags for per learning object and per student, which can be used to compare the amount of tags by per student with the amount of keywords in order to find the difference between tags and keywords;
3. Listing the number of the common terms between keywords and tags, which is an effective method to find the overlap between the tags and the keywords;
4. Listing the amount of the average common terms of per tagger for each learning object, which is one approach to analyze the relatedness between individual student defined tags and lecturer's keywords;
5. Counting up the number of folksonomy terms in the aspects of the amount of tags and the amount of common terms, which is helpful for analyzing the changes from original data to the folksonomy data;
6. Counting up the top three tags, this method aims at analyzing the overlap of student defined tags.

4.2 Basic Experimental Results

This section presents results from the experiment. The experiment was done in two groups, which was introduced in the last chapter. The details of tags and Keywords for each learning object are represented in appendix C.

4.2.1 Experimental Results for Group One

First group is the experiment for Coding and Compression of Media Data course and some students add their favorite words as tags. The basic data from the experiments are as the table 3 shown. The columns in the table 3 and table 4 are as the above explanation.

- Tagger amount: it is the number of students who added tags for the learning object;
- Tags amount–total: it means the total amount of the different tags for each learning object;
- Tags amount–aver. per tagger: it is the average amount of tags which generated by

each student for the learning object, and the number is calculated as the example: three students generated 4, 2, 3 tags respectively, and the average amount of tags for per student for this learning object is (4+2+3)/3 =3;

- Keywords amount: it is the number of lecturer provided keywords for each learning object;
- Common terms: it is the same terms number between tags and keywords;
- Average common terms per tagger: it is the average number of the common terms in the set of keywords and individual student defined tags' set, and the number is calculated as the example: three students generated three sets of tags respectively, and the common terms between each set and the keywords are 2, 0, 1 respectively. So the average common terms per tagger is (2+0+1)/3=1;

LO title	Tagger amount	Tags amount		Keywords amount	Common terms	Average common terms per tagger
		Total	Aver. per tagger			
Coding1	14	9	2.6	8	6	1.6
Coding2	14	17	2.9	11	3	0.5
Coding3	11	7	1.9	13	2	0.6
Coding4	14	21	3.9	22	5	1.9
Coding5	8	22	4.5	15	8	2
Coding6	9	25	4.78	18	6	1
Coding7	8	27	4.6	18	7	1.5
Coding8	7	17	3.14	12	5	0.9
Average	10.6	18	3.5	14.6	5	1.3

NOTE:
Coding 1: Digital Image Fundamentals
Coding 2: Lossless Compression Algorithms
Coding 3: Digital Image Data Representation
Coding 4: Lossy Compression & JPEG
Coding 5: Basic Video Compression Techniques
Coding 6: Video Coding I MPEG-1 and MPEG-2
Coding 7: Digital Audio Coding and Compression
Coding8: Video Coding II MPEG-4

Table 3: Basic data from group one

In the table 3, it can be clearly seen that the gap between student defined tags and lecturer provided keywords is astonishing. According to the statistics presented in the table, it is apparent that the number of taggers overall decreased from the Coding1 to the Coding8. And the average amount of tags for per tagger was only one fourth of the amount of the lecturer-provided keywords. What also impresses us is that the average number of the common terms was the one third of the keywords amount (5 common terms and 14.6 keywords). Moreover, the average common terms for per tagger was only 1.3, which reflected that each tagger only agreed one keyword in the whole keywords term in average.

4.2.2 Experiment Results for Group Two

Second group is the experiment for Semantic Web course and some students add their favorite words term as tags. The basic data from the experiments are as the table 4 shown. According to the statistical information of the number of tags and keywords, it helpful for us to find the difference of the average amount of lecturer-provided keywords for per learning object, and the average amount of tags generated by per student for each learning object, and also helpful for us to analyze the difference between two groups.

LO title	Tagger amount	Tags amount		Keywords amount	Common terms	Average common terms per tagger
		Total	Aver. per tagger			
SW1	9	17	3.7	10	7	1.7
SW2	9	18	3.9	5	3	1.9
SW3	9	10	1.9	4	2	0.3
SW4	10	29	4.5	12	9	2.2
SW5	8	20	3.38	5	2	0.6
SW6	9	18	3.56	7	2	0.4
SW7	10	7	3	8	5	2.8
SW8	9	16	2.44	4	2	0.9
Average	9.1	17	3.3	6.9	4	1.35

NOTE:
SW 1: week0940OWLFeaturesPart1
SW 2: week0940PracticalUseOfRDFSandOWL
SW 3: week0943OWLFeaturesPart2
SW 4: week0943OWLFeaturesPart3
SW 5: week0944GoodAndBadModelingPractices
SW 6: week0944OntologyDevelopment
SW 7: week0945SemanticWebServiceApproaches
SW 8: week0945SemanticWebServices

Table 4: Basic data from group two

The table 4 reveals the difference between student defined tags and lecturer provided keywords for the experiment in the group two. The average amount of the common terms was 4 which approximated to the amount of keywords if we do not consider general words (course name and code) in keywords set.

4.3 Folksonomy Combination

Each learning object has a set of tags which defined by the students and a set of keywords which provided by the lecturer. The original combination for each learning object is the group containing both tags and keywords. However, the same term may be presented as different forms, such as the singular and plural or the full name and the abbreviation, etc. The folksonomy combination is the processed terms from original combination. The processed approaches for Folksonomy combination are as the [10] introduced. For example, tags were converted to the same form of the abbreviation and the plural and singular; the compound words were processed as the same form; the similar tags are grouped, and we talked with the lecturers to discuss what similar tags are. And the reasons why used them for processing would be discussed in next chapter. The results of the folksonomy combination data for each group were presented in the table 5. And, the columns in the table respective means as

- Tags amount: it means the amount of processed student defined tags in the folksonomy combination. The amounts for some learning object decreased because student defined tags have some problems as previous examples;
- Keywords amount: it means the amount of processed lecturer provided tags in the folksonomy combination. The values of this item were not changed greatly because lecturer provided keywords have no problems as previous examples;
- Common terms: it shows the amount of the common terms in the folksonomy combination;

LO title	Tags amount	Keywords amount	Common terms	LO title	Tags amount	Keywords amount	Common terms
Coding1	9	8	7	SW1	16	10	8
Coding2	14	11	7	SW2	15	5	3
Coding3	7	13	2	SW3	6	4	2
Coding4	18	22	8	SW4	25	12	9
Coding5	17	15	7	SW5	15	5	2
Coding6	24	18	8	SW6	14	7	2
Coding7	23	18	11	SW7	6	8	5
Coding8	15	12	5	SW8	14	4	2
Average	16	14.6	6.9	–	14	6.9	4.1

Table 5: Folksonomy combination data about two groups

The table 5 indicates the data for the folksonomy combination. From comparing the table 5 with the table 4 and the table 3, it is easy to find that no large changes between original combination and the folksonomy combination. It means that the data processing does not make a large impact on the amounts of the results. Thus, the original combination is used in the comparing and the discussion.

4.4 Top Three Tags

Table 6 and the table7 are the experiment data tables which list top three tags for each learning object in the two groups. It contains the name of the tag and the average number of the corresponding term. From this table, it is easy to find the name and the average amount of the top three tags which were used by the students.

Each column in the table has its own mean. The first column indicates the learning object name which is the same as the first two groups. The second column illustrates the top one tag which is most-used tag in the whole tag set. And in this column, two subcolumns are the name and the average amount. Name is the tag's name, and the average amount is calculated as the "tagged amount/tagger number". The tagged amount means how many students used this tag to describe the learning object. The tagger number is the total amount of how many students participated in adding tags. The next column indicates the top two tag which is the second most-used tag in the whole tag set, and the last column indicates the top three tag which is the third most-used tag. And the sub-columns are the same as the second column.

Table 6 and the table7 explain the overlap of the tags for each learning object. The average value represents the percentage of how many students use the same tag. In the

LO title	Top1 tag		Top2 tag		Top3 tag	
	Name	Aver.	Name	Aver.	Name	Aver.
Coding1	sampling	0.57	quantization	0.57	linear/nonlinear operations	0.43
Coding2	Lossless	0.36	Shannon code	0.29	coding	0.29
Coding3	color space	0.36	dithering	0.27	grey scale	0.18
Coding4	DCT	0.86	quantization	0.43	JEPG	0.36
Coding5	H.261	0.625	motion compensation	0.375	motion vector	0.375
Coding6	MPEG	0.67	scalability coding	0.44	H.261	0.44
Coding7	masking	0.5	ADPCM	0.375	Audio	0.375
Coding8	MPEG-4	0.57	object based encoding	0.29	video-object	0.29

Table 6: Top three tags from group one

LO title	Top1 tag		Top2 tag		Top3 tag	
	Name	Aver.	Name	Aver.	Name	Aver.
SW1	inverse of	0.44	symmetric properties	0.33	equivalence	0.33
SW2	SKOS	0.89	FOAF	0.78	RDFS constructs	0.22
SW3	OWL restrictions	0.67	restrictions	0.22	OWL features	0.22
SW4	cardinality	0.4	sets	0.4	disjoint	0.4
SW5	antipatterns	0.375	modeling errors	0.25	exclusivity	0.25
SW6	ontology design	0.33	properties	0.33	reuse	0.22
SW7	WSDL-S	0.7	OWL-S	0.7	SAWSDL	0.7
SW8	web services	0.56	semantic web services	0.33	goals	0.11

Table 7: Top three tags from group two

group one, more than half of the students added the top one tag for the learning object in six cases except "Coding2" and "Coding3". For half of the learning objects in the group two, more than half of the students used top one tag to label the learning objects. More discussion about the overlap will be represented in the next chapter.

5 Discussion of the Experimental results

It is clearly to see the difference between the student defined tags and the lecturer provided keywords from the experimental results. And in this chapter, the aims are to discuss the reasons why there have some differences between tags and keywords, to find out the tags' value which can be seen by users when they use student defined tags, and to discuss the challenges when using student defined tags as the learning object metadata.

In our work, we represent two parts for analyzing data: the first part is analyzing the problems of tags when processing them and discussing the methods which were used to process tags. The second part is to discuss the value and the challenges of tags when comparing the tags with keywords.

Thus, this chapter illustrates the findings from analyzing experimental results in the first part, and introduces the approaches of how to process data when we analyze them. The reasons why use them to analyze and process data also were introduced in this chapter, and the advantages and challenges of using them would be presented also. Then, the value and the challenges of the student defined tags are represented as well.

5.1 Data Analysis

In this study, we have collected 16 lecture notes in two courses, "Coding and Compression of Media Data" and "Semantic Web". These lecture notes and the lecture recordings are related to two subjects, various content like OWL features and Semantic Web Services in Semantic Web, JEPG and MPEG in Coding and Compression of Media Data. These resources were then annotated by respective lecturers and students.

Tags are the descriptions for the resources and provided by the social people, rather than being defined by a single user. Thus, tags are as the role of jointing users' subjective understanding and object information. Thus, tags and folksonomy can help us understand more information for the resources.

5.1.1 Data Problems

Each learning object is represented by a set of tags which reflect students' understanding for this resource. Each student has own opinion to understand each learning object, and has own habit to add tags as different form. Because tags reflect users' subjective description on objective resources, there have some problems for each set of tags when we analyze them:

1. Tags which have the same meaning with different forms are chosen by different students: such as some typical examples in the research, abbreviation (e.g. "SKOS" and "Simple Knowledge Organization System"), singular and plural (e.g. "enumeration" and "enumerations"), spelling habits (e.g. "antipattern" and "anti-pattern"), case sensitive (e.g. "Model" and "modeling").

2. Tags describe similar/same topics, but they have a few differences: two examples occur frequently, "inverse of" and "inverse", or "operations with classes" and "operations to classes".

3. One tag expresses the same meaning as the combination of two or three tags: one example is that "web services" and "semantic" describe the same as "semantic web services".
4. Some spelling errors happened when students added tags: for example, "equivalence" and "eqvivalence" are the same term in meaning but the second one has some spelling error.

5.1.2 How to minimize problems?

In order to minimize the intrinsic problems of the social tags, some classic methods were used for cleaning the tags. In [9], it presents a series of filters which called normalization process in order to clean tags. In our analyzing process, four approaches are used to solve the pre-mentioned 4 problems.

1. To solve the first problem, four steps are used for generating folksonomy tags: the first one is to insure the same form of the abbreviation and the full title tags which have the same meaning; secondly, keeping tags have the same form of plural and singular when they just look different on singular and plural; thirdly, making compound words as the same form, for example, keeping or removing the dash "-" from the "anti-pattern"; the last but not least, converting tags to lower case except abbreviation.
2. To group the similar tags, ignoring "preposition" is a useful method for folksonomy. For pre-mentioned examples, "inverse of" and "inverse" or "operations with classes" and "operations to classes", ignoring "of" "with" and "to" can group them as the same term.
3. Looking two or more terms together, when they express the same meaning as another term, is the third approach for processing original tags as the folksonomy tags.
4. Spelling errors need the correction for folksonomy tags.

5.1.3 Challenges of the methods for processing data

All introduced approaches are used to generate folksonomy tags. But there exist some challenges if processing tags as them. Firstly, manual processing ensures the quality of folksonomy tags but it is very time-consuming because person who processes data needs to understand the learning object more than others and also needs to spend a large amount of time to do it. Secondly, if utilizing folksonomy data in the searching process, the searching results may be decreased because the amount of tags is reduced.

5.1.4 How to avoid or improve these challenges?

The first method tries to research an automatic method in order to reduce the spending time, which has been professional tool, such as FolksAnnotation tool in [9]. The next method improves the searching method in order to ignore "singular and plural", "abbreviation" and "preposition" in the searching process. These two methods would improve the problems but need more researches to prove them. And these can be regarded as the future work.

5.1.5 Data Quality

As mentioned in the chapter two, metadata is usual used to describe the information of the resources or the objects. Thus one of the main features of metadata is that it supports the process of indexing. Metadata quality is one important factor for discovering the resource quickly and easily. If utilizing student defined tags as the metadata-keyword, they can be the descriptions for the corresponding learning object in the next discussion.

Figure 7 introduced three aspects for distinguishing "metadata quality", syntactic, semantic, and pragmatic quality.

1. **Syntactic quality:** If using student defined tags as metadata, firstly, this kind of metadata has the same language as the learning object. And secondly, this metadata would be processed, thus the format would be the same as the resource as well.
2. **Semantic quality:** Students generate tags for the material. From the study about the student defined tags, most of the tags describe the subject area of the learning object except a few spelling errors. But this error would be improved by the data processing. And the tags are semantic descriptions.
3. **Pragmatic quality:** Tags are generated by the students who are the main users of the corresponding learning objects. Thus, using tags to generate metadata would correspond to the users' interpretation.

In the chapter two, the seven characteristics of quality metadata from Bruce and Hillmann [31] were introduced. The metadata quality in these seven aspects are also discussed as

1. *Completeness* Tags are created by students and they are similar as keywords when comparing them as a group. And tags generated by students, thus, they are desired by students as well.
2. *Accuracy* Although a few imprecise tags in this set, but these few tags do not influence the descriptions of the resources seriously.
3. *Provenance* Student defined tags are mainly used by the students and the lecturer. Although students are not the expert in the subject area of the learning objects, they are the learners about the learning objects.
4. *Conformance to expertation* This factor means the expected metadata elements are available. And keywords are great expected because we have asked most students who added tags in the experiment.
5. *Logical consistency and coherence* Keywords are students' expected and this element is also available.
6. *Timeliness* Tags would be changed if the corresponding learning object changed.
7. *Accessibility* The keywords are from students' inputs, they are also available and understandable by students after the processing.

Even the quality is not very high and tags may miss a few information if utilizing tags as metadata-keywords, but this kind keywords are also good for students to understand the main information of the resources, and they can use them to discover materials.

5.2 Experimental Results Comparison and Discussion

The figure 13 reflects the average data in both tables 3 and 4. We can see most similar values in the figure 13 except the keywords amount. The keywords amounts in two groups are great different, and the reason why there has big difference in group one will be discussed in the above parts. However other data in both two tables more or less represented the similar information for the experiment. And the discussion was divided into five parts.

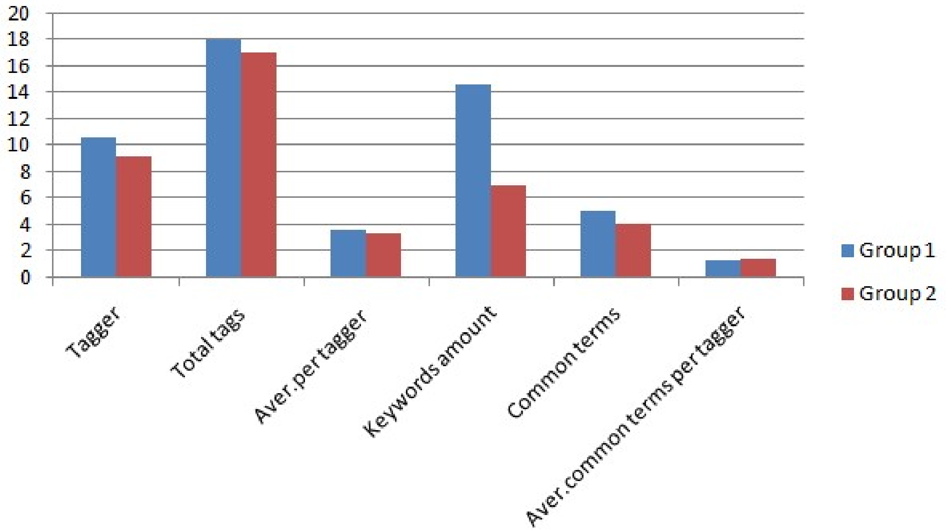

Figure 13: The data comparison about two groups

5.2.1 Comparing the keywords between two lecturers

Similarities and Difference

The similar point of the keywords in both two groups is that the key aspects are described by the keywords. And the differences of the keywords between two lecturers are as following listed.

1. No general words as the keywords in the group one, but one or two general words in the group two. General words can be the lecture name or lecture code. From the appendix C, it is easy to find the lecture name or code in the keywords set in the group two. But no this kind of keywords in the group one;
2. The numbers of keywords in two groups are different. It can be clearly seen from the figure 13 that a big gap of the keywords amount between two groups. The value in group one is 14.6, but 6.9 in group two;
3. One or two keywords are the same as or from the title of the corresponding learning object in the group two, but that is rare in the group one. For example, "OWL" is the keyword for the SW1, SW2, and SW3, "modeling practice" is the keyword for SW5-week0944GoodAndBadModelingPractices. But it is hard to find these kind keywords in the group one.

Discussion

The above mentioned differences are discussed in two aspects.

Firstly, different lecturer has his/her own habit to create keywords and they have different backgrounds and experiences for the responding researching areas. Lecturer provided keywords are also lecturer's understanding and the object information. Thus, it is normally if they create different number of keywords or use different types of the words as the keywords. The role of the keywords indicates the description for the learning object no matter what types they are or how many numbers they have.

Additionally, the content of the learning object and the lecturing hours are two reasons which can explain the difference between two groups. The learning objects in the group one have more keywords comparing with that in the group two, and respective content are also different seriously. The learning objects in the group two have no more than 12 slides, but the slides for the learning objects in the group one are no less than 30 and the slides in some resources are more than 70. This is one important reason why the gap of the number of the keywords in two groups is serious.

More discussions about the keywords are represented in the "comparing tags with keywords"

5.2.2 Comparing the tags among students

Similarities and Difference

It is easy to find some similar aspects of student defined tags in two groups from the figure 13. The similarities are listed as above discussion. The items 1 and 2 are the similar aspects from the figure 13, and others are analyzed from the data in the appendix C.

1. The average amount of tags is 18 and 17 in two groups respectively. It reflects that the amount of student defined tags is around a range and the one or two outlier value is acceptable;
2. The average amount of tags for each tagger is 3.5 and 3.3 for two groups respectively. It also indicates that the number of student defined tags is about 3 or 4 in most cases, and the outlier value is also the normal case;
3. A few students tags in each learning object indicate imprecise or generic information, for example seeing appendix C, "RDFS features" and "RDF features" are not important in the learning object SW1, or the tags "video" or "coding" were also added a few times in the group one but they are the generic words for describing the lecture Coding and Compression of Media Data, and from these words, it is hard for users to understand the content of the learning resource;
4. In most cases, a few tags are the same as the title of the learning object or a part of the title. For example, "lossless" is the tag for Coding2, "JEPG" is the tag for Coding4, "OWL features" is the tag for SW1, "semantic web service approaches" is the tag which is the same as the title of SW8;
5. The tags are similar if the key knowledge in the learning object is clearly to be seen, such as the tags in the Coding1, the tags in the Coding4, and the tags in the SW7, the hottest tags were tagged a lot of times. This similarity can also be seen from the table 6 and the table7. The top three tags have high tagged times in the "Coding1", "Coding4", and "SW7".

However, there also have the differences of student defined tags and the tagger amounts are also different.

1. Some students only chose one term as their tags, but some students used more than 4 terms as their favorite tags to describe the learning object. Students have own habits to decide the type and the amount of the tags;
2. Looking individual student defined tags, each set describes different key aspects when

the learning object contains rich content. For instance, 29 tags were added for SW4 but 7 tags for SW7, because they are different at the content;

3. The tagger amount in the group one overall decrease from 14 to 7, but that is around 9 in the group two;

Discussion

Tags describe students' understanding for the learning object. Because students have different backgrounds and different experiences, it is normally that they select different words as tags. And especially, the individual understandings are different when the resource contains rich content. Thus, it is acceptable if the differences exist in the tags.

Additionally, title is the first impression for most of learners, which maybe the reason why there have some tags which is the words term from the title of the learning object. And it is not serious if no this kind of words in the corresponding learning objects, because title is also one kind of metadata for introducing the information of the learning object.

Moreover, some students may not recall all the issues when they add tags. Thus, there have some differences between each student's tags group, especially when the lecture note contains rich content. And also, this is the reason why some tags are similar and some tags are not.

Overlap between Tags

The overlaps between each student defined tags are indicated from the table 6 and the table7. Although the overlap has no clearly relation with the content of the learning object, we found that most top three tags are the same as lecturer provided keywords when comparing top three tags with keywords in both two groups. This comparing indicates the tags which added more frequently are similar as the keywords in most cases.

In the group one, the top three tags in the "Coding4" and "Coding5" are all the same as the keywords. Two of the top three tags in the "Coding3" and "Coding7" are the same as the keywords for the corresponding learning object as well. And each of the "Coding2", "Coding6", and "Coding8" has one top tag which is the same as the keywords in the corresponding learning object.

In the group two, however, three top tags are the same as the keywords in four cases, "SW1", "SW2", "SW4", and "SW7". For others two learning objects, they have two top tags which are the same as the keywords. And each of the "SW3" and the "SW6" has one top tag which is the same as corresponding keywords.

The comparing between three top tags and the keywords for each learning object in both groups indicates the three top tags in the group two describe better information about the learning object than that in the group one. And this summary also illustrates that the tags in the group one may miss some issues about the learning object. Moreover, tags which have high frequency are better to be used for describing the learning resources comparing the tags with low frequency. Additionally, because a few imprecise tags describe unimportant information for the learning object and this set of tags usually has low frequency. For instance, in appendix C the tags "string", "dictionary", and "tree" are used only one time respectively for the "Coding2", and the lecturer found that these tags are all imprecise tags for describing "Coding2".

5.2.3 Comparing tags with keywords

Similarities and Difference

One similarity between student defined tags and lecturer provided keywords is that for each learning object the tags are similar as lecturer provided keywords if looking tags as a group. Comparing with the keywords, the group of tags also describes most important issues for the learning object;

The differences of student defined tags and lecturer provided keywords are as the list.

1. Student defined tags are more specific, and lecturer provided keywords are more broader. Some students focus on the details of the learning objects and lecturer describes the whole learning object with some keywords;
2. A few student defined tags are imprecise or describe unimportant issues for the learning object, but each keyword indicates the main aspect for the learning object. For instance, "RDFS features" and "RDF features" are not the important issues in the "SW1", but these two tags are tagged two times respectively. And "decoder" "blocks" are also imprecise for describing "Coding4", but tagged 2 times respectively.
3. Some tags are generic, such as "video" and "coding" in the group one, and the whole lectures in the group one is talking about coding and compression for the media data. Thus, video is one part of media data, and coding is too generic;
4. Lecturer provided keywords are more professional and more perfect than student defined tags. Lecturer would use the same form for the keywords and no spelling errors, but students would not.
5. No general words in the tags, for example the course name or course code, but one or two general words were used keywords as in the group two, such as the course name "Semantic Web" is used as keywords for each learning object in the group two;
6. The number of tags generated by per student is less than the number of keywords for each learning object, especially in the group one;

Discussion

Comparing tags with keywords has two cases, one is comparing tags as a group with keywords and another is comparing each student's tags with keywords. Obviously, two cases have different comparison results because of the previous comparison between tags among students. Students have different understanding and spent different time to add and choose words as tags. And also, the background and pre-experience influence their opinions to learn the learning object.

In addition, lecturers are the subject expert and the creator of the learning objects, as well as they understand their productions much deeply. Thus their keywords are much more precise if comparing them with students' tags. But this does not mean that the keywords' set is perfect metadata to describe the corresponding learning object. And the value of the tags for the lecturers would be illustrated in the next part, which was based on the interview results with the lecturers.

However, as a set of tags for each learning object, the gap between tags and keywords is not serious. Two reasons can be used to explain. Firstly, as a group of students, their understandings are the similar as lecturer's issues. Then, the information in the learning object is clearly for students to learn.

5.2.4 Comparing data in two groups

Before discussing the relatedness of data in two groups, one figure is helpful for the observers to analyze data. In figure 14, blue color is the data for the group one, red color is the data for the group two. The first two bars are the values from the results as "(the total tags amount)/(the common terms)", the middle two bars are the values from the results as "(the keywords amount)/(the common terms)", and the last two bars are the values the same as the average common terms per tagger in the table 3 and table 4.

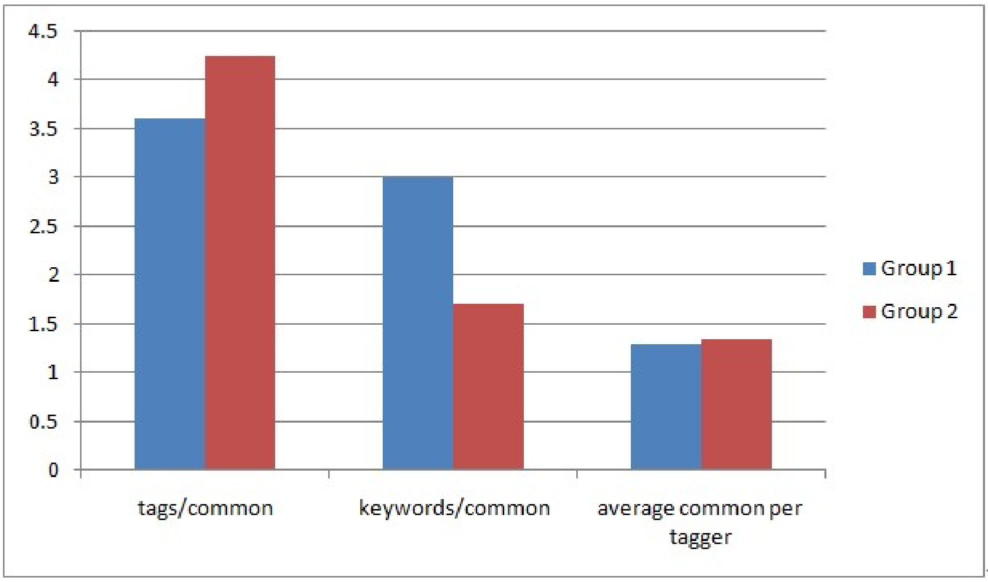

Figure 14: The data comparison for two groups

It is clearly from the figure 14 to seen the similarity and the difference between the data in two groups.

1. The values of the average common terms per tagger are similar. The similarity indicates that in average at least one tag in the set of tags which generated by per tagger is the same as one term in the corresponding keywords set in each group.
2. The values of (the total tags/common terms) are not serious different. In both two groups, the value of the tags' amount and the common terms are similar. In the group one, the average value of the total tags amount is more than three times of the common terms, and that is more than four times in the group two, which means 13 tags are not the same as the keywords in average for both groups. This indicates one case, some tags are overlap terms which is different at the forms, as the previous introduced singular and plural or the abbreviation, etc. The second aspect is that some tags are too specific to illustrate the learning resource or not imprecise to describe the materials. This aspect had examples in the previous discussion.
3. A clear gap between the values of (the keywords amount/common terms) in two groups. This big difference is mainly because of the different keywords amount. This difference is mainly because of the different amount of keywords. In average, considering the data in the group one, only two or three keywords were not used as tags by the students, and if consider the general words-course name and code-only one or

two keywords were not used in the tags set. But in the group one, nine to ten keywords were not contained in the corresponding tags' set in average. The difference in this aspect illustrates that the students may miss more content in group one than that in the group two when compared keywords with tags.

5.2.5 Comparing Original Combination with Folksonomy Combination

After the data processing, the data amounts in folksonomy combination changed, and the changes from the original terms and the folksonomy terms were reflected in two aspects, one is the average amount of the total tags, the other is the average number of the common terms. After the processing, the average number of the total tags decreased from 18 to 16 in the group one, and that decreased from 17 to 14 in the group two. The average value of the common terms increased from 5 to 6.9 in the group one, and that did not changed clearly in the group two. This difference illustrates the data processing can be used to clean the tags. In order to group the tags and generate folksonomy combination, data processing is the necessary procedures.

6 Tag Added Value

6.1 Results of the Interview with Lecturers

The interview with lecturers where done in two parts. One part was done with the associate professor Faouzi Alaya Cheikh, who is the lecturer and the expert for Coding and Compression of Media Data at GUC. The other part was done with the professor Rune Hjelsvold, who is the subject expert and the lecturer for Semantic Web at GUC. And also, they are the contributors of the keywords for their respective lecture. In addition, a list of questions was made up beforehand, and all questions were asked to both lecturers. A rough list of the base for questions can be found in appendix B.

6.1.1 First Part

The tags' set the first lecturer was going to review was student defined tags for the "Coding and Compression in Media Data". The lecturer answered the interview questions after comparing his keywords and student defined tags. Also, the student defined tags and interview questions were sent before the interview. Because the lecturer answered questions and wrote down his ideas, no conversation recoding in this part.

Interview summary

Faouzi Alaya Cheikh thought that there have somewhat differences between his keywords and student defined tags, but not too far away from his ideas. And he said that student defined tags are imprecise and generic, such as the words "coding" and "video" were used by the students frequently, but they are imprecise if using them to describe the learning objects.

But he still thought that seeing tags is useful for him because it can be looked as a feedback about what students see and feel important in each lecture. In addition, he would like to use fewer student defined tags in one or two cases when he finds a mismatch between his keywords and student defined tags, and also he would include a tag from the tags.

Moreover, he thought maybe that he would stress more on a few of the notion in the lecturing and would not change lecture notes too much if student defined tags seem to miss something or there are significant differences between tags and keywords. And from the student defined tags, he said that students might missed some key aspects of the lecture, but the reason may that they do not recall all the important issues immediately after the lecture.

Others he commented are to provide a list of keywords and some terms which are not in the lecturer provided keywords and let students to select their favorite terms, which are helpful for students to recall the issues in the lecture.

6.1.2 Second Part

The second lecturer reviewed the tags for the "Semantic Web" and also answered the interview questions after comparing his keywords and student defined tags. Also, the student defined tags and the interview questions were sent before the interview. And the conversation was recorded by a voice recorder of SAMSUNG mobile phone.

Interview summary

Rune Hjelsvold thought that student defined tags and his keywords are quite close if comparing them when looked at whole tags as a group for each learning object. However, if looking at student defined tags individually, he said, students' inputs are quite different. And he supposed some reasons as that students added tags quickly and they did not dedicate in the adding tags, or they did not understand some issues in the learning object.

In addition, he characterized the differences between his keywords and student defined tags with the following aspects. One is that students generated small number of tags for each learning object comparing with him. Then, student defined tags are more specific and they were trying to explain the same concepts and the details of the learning object, but his keywords are more broader than students' tags.

Although there have some differences between student defined tags and lecturer provided keywords, he still believed that seeing students' tags is useful for him because that it is a feedback for him to know what students get out from his lecture and what students understand from the studying, and it is also a way to include some words in the keywords set, and the words are proposed by the students as the tags.

Furthermore, he said that he would not make serious change to his list of keywords if he found mismatch from the comparison but he found some useful tags in some cases and he would like to include them in his keywords list. And he would not remove or delete his keywords. Additionally, some tags represent some unimportant aspects and some misunderstandings in a part of the cases and he will focus on the important issues in the lecturing and the lecture notes in order to help students to cover important concepts for understanding what is important and what is unimportant.

Moreover, he said students missed some important issues if tags for individual student were indeed what he/she would think. And in some cases, there has difference between individual students because they are individual person and have different experiences and background. Thus they have different understanding for the same learning object.

6.1.3 Values of the Tags Discussion

Interview results indicate some aspects which are helpful for the lecturer.

1. Both two interviewees agreed that student defined tags are not far away from their keywords, but it is quite different if comparing individual student defined tags with keywords.

2. Although some tags are generic or far away from lecturers' keywords, they are still useful for the lecturers after they reviewed tags because tags are one kind of feedback to reflect the students' understanding of the learning object;

3. From the review of tags, lecturers would make some improvements in their keywords or lecturing or lecture notes in order to stress key aspects for the learning object if they find some misunderstanding in the tags. But they would not change or remove the original keywords;

4. Reviewing tags would help lecturers to improve their keywords set, such as including a few tags as their keywords.

6.2 Results of the Interview with Students

Six students participated in the interview, and they are first year MMT students who attended the Coding and Compression of Media Data in the GUC. These interviews were not recorded because this interview was like one kind of chatting during the break times. But we made a note for each interview. And the main questions were about: what kind of information do students want to see from the teacher and other students? And what is the good information for you when you review the learning materials in the educational system? Students' answers which are useful for analyzing the thesis were summarized as the above list.

1. All interviewed students thought that lecturer provided keywords are useful for them to understand the learning resource and also helpful for them to find the key aspects of the materials.
2. Four students said that they want to see some suggestion or tips from the second year MMT students who attended the lecture, and they also though that tags may helpful for them to understand, but they were not sure this aspect.
3. Four students illustrated some suggestions for the lecture notes. Three of them said that it is better if more relevance resources exampled in the lecture notes. And another suggestion is that it is good if the recording can be added in the lecture note.

7 Conclusion and Future Work

This thesis discusses the potentials of using students' inputs to create learning object metadata. Student defined tags were not only used for describing learning resources, but also a good feedback about the students' understanding of the materials. Although tags cannot be used to generate all of the learning object metadata elements, several of the important elements can be created based on students' tags. The conclusions are represented as answers to the three research sub-questions.

7.1 Could student defined tags replace lecturer provided keywords?

This question aims at finding student defined tags could be a substitute of lecturer provided keywords, or as a complement?

Not substitute

Student defined tags cannot replace lecturer provided keywords. They are not the substitute of the keywords. Student defined tags contain the similar information value as teacher-provided keywords when consider tags as a set for each learning object. However, the tags are far away from teacher's ideas if comparing tags from individual student with teacher's keywords. Moreover, a few words are imprecise for describing learning object in most cases. If using tags to replace the keywords, the imprecise words may introduce unimportant information about the learning object. Then, one or two words are very generic, which cannot explain the information of the resource. Furthermore, most tags describe details of the resource, they are more specific. Thus, tags cannot replace the keywords.

Complement

Student defined tags are one kind of complement for the keywords group. This is because lecturer believed that they would choose a few tags to improve their keywords set from the interview. Thus, it is one kind of complement for the lecturer.

7.2 Do student defined tags add value which is beyond being metadata for learning object retrieval?

The purpose of this question is to analyze the value of tags for both students and lecturers. The value of student defined tags is beyond being learning object metadata.

Practical purpose

The practical purposes of the tags used as metadata for the learning object are as the above list. In the educational system, student defined tags can be used to describe the following exampled metadata elements:

1. In Dublin Core, tags can be used to describe description, subject;
2. In IEEE LOM, tags can be used as 1.4 Description, 1.5 Keywords, 9 Classification;

Additional value

Student defined tags are as two roles and provide two additional values for the lecturer.

As the feedback: from the interviews it can be concluded that student defined tags are a students' feedback about their understandings for the learning resource. One important feature is that reviewing tags is a way for the lecturers to know what students understand about the course and what they feel important in each lecture. Thus it is undoubtedly one way to know students' studying.

As the resource: student defined tags are also one kind of resource for the lecturer. Some tags can be included in the set of lecturer provided keywords. And also, tags are helpful for the lecturer to improve the lecturing or the lecture notes when they find a mismatch between the tags and the keywords or when they find that students might had some misunderstandings for the lecture.

7.3 What challenges need to be dealt with when using student defined tags as the learning object metadata?

This question discusses the challenges in three aspects: the challenges for the technical design, the challenges for the professor adoption, and the challenges for the student adoption.

Challenges in technical design

If utilizing student defined tags as the learning object metadata, the main challenges for the technical design are:

- How to perform a function for adding tags by students in the educational system? Adding tags is not a hard function, but if put this function in the educational system, it is difficult at how to design this part for the learning object.
- Data processing function: the data processing is a necessary step, which aims at getting a normalized list of folksonomy tags. Because of different spelling forms of the same words, which have been mentioned in the previous chapter, processing data is an important procedure for cleaning tags. This normalization process was developed many time by different researchers, thus, how to add this process in the educational system is the first thing.
- How to store, classify and display tags in the system? Storing, classifying and displaying are three aspects for the data. It is a good design if it is easy for the user to find the tag.
- Individual student's tags should better not be used as metadata or descriptions for the learning object, because individual opinion cannot describe the whole learning object.

Challenges for the professor adoption

Lecturers said that student defined tags are useful for them to improve the keywords, lecture note, and the lecturing. But it also exist some challenges if utilizing students' tags.

1. Tags are one feedback from the students, but it does not reflect the overall students' understands about the learning resource. Many reasons could influence their tags, such as they could not recall all important things, or they focus on one or two know-

ledge. Thus, the overall observation for the tags is essential for the lecturers if they want to use them to understand students.

2. Individual student's tags should better not be used as the resource for improving lecturer's productions, but from individual opinion lecturer would find some misunderstanding about the learning object from the students.

Challenges for the student adoption

Some students may think others' tags are helpful for them to understand the information about the learning resource. But some challenges need to be mentioned to the students whatever when they use tags or when they add tags.

1. Do not try to add tags after lecture immediately because some students do not recall all the important issues in the lecturing.
2. Not all tags are exact for introducing the learning object, comparing with the low frequency tag, high frequency tags are more appropriate for description than the low frequency tags. High frequency means the tag was added by too many students.
3. Comparing tags and keywords if there have lecturer provided keywords for illustrating learning object.

7.4 Future Work

7.4.1 Effect on students

No studies have so far been able to come to analyze the value of tags for the students. Some aspects would be used to analyze this value. Firstly, is seeing other students' tags useful for the understanding of the learning resource? Then, will students change their tags when they see others tags? As no conclusive results were reached in these two parts, they are still the interesting issues in this area. Interviewing with students is a good method to know students' ideas, and also a good way to understand how students add tags for each object and how many time for the students to add tags or to study the learning objects.

7.4.2 More Experiments for Analyzing

Some factors may influence the students' understanding of the learning resource, such as the students' level. Working on more experiments like lecturers producing learning object and keywords together or choose the similar level's participants to add tags for the course might be helpful for finding more useful features of tags. Additionally, interviewing lecturers together may be helpful for finding some other values of tags.

7.4.3 Utilizing Tags for Retrieval

Another purpose of using students' tags is using tags to retrieve the corresponding resources. How to make computer understandable metadata of the learning material and how to make tags as clear descriptions still need more experiments and researches. And whether student defined tags can improve the retrieval results is the main questions for this future work.

7.4.4 Realizing Adding Tags in the Future System

The function of adding tags is one important part in the future educational system if we want to collect students' inputs for the learning resource. Some works what we have not done in this project will be noticed in the future work.

- "Login" is a necessary requirement for adding tags because students would want to use their favorite tags to classify the learning object and they also want to have a own classification for the learning objects.
- The metadata elements would be used carefully because metadata describe learning objects and metadata would provide the information which is better that the students want to see.
- Tags are one feedback about the students' understanding of the learning resource and also one resource for the lecturers to improve their production. How to present tags to the lecturer is also one challenge, individual student defined tags just reflect individual student's understanding; a group of tags cannot reflect what are missed by the students.
- Lecture recording is also one kind learning object. It can be regarded as individual learning object or the corresponding resource for the lecture note. How to present lecture recording is the challenge which also need to be surveyed.
- Database design is an important part in the future system. The database model in this project is not perfect. If we want to develop a good educational system, database is essential.

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A Code Example

```

<?php
function hotTagFun($loid)
/*The function for finding the hottest tags from DB*/
{
MAX( amount ) FROM amount WHERE LOid =2010011232)
$query = "SELECT * FROM amount WHERE LOid = ".$loid."
AND amount = (SELECT MAX(amount) FROM
amount WHERE LOid= ".$loid.")";
$result = mysql_query($query)
or die("Error 1 in query: $query. ".mysql_error());
if (mysql_num_rows($result)>0)
{
$temp = mysql_fetch_row($result);

$tempt = $temp[2];
}
else
{
$tempt = "NULL";
}
return $tempt;
}
?>

<?php
function tagcount($string)
//This function focuses on clean tags
{
$tags = explode(",", $string);
for ($i = 0; $i <count($tags) ; $i++)
{
$tags[$i] = addcslashes($tags[$i], "'");
$tags[$i] = trim($tags[$i]);
}
return $tags;
}
?>

<?php
//The following code focus on add data to DB
    include "ratingValue.php";
        $tempid = $_GET[loid];
        $_GET[title];

        $host = "mysql.stud.hig.no";
        $user = "s080338";
```

```
        $pass = "PASSWORDS";
        $db = "s080338";
        $connection = mysql_connect($host, $user, $pass) or
        die ("Unable to connect!");
        mysql_select_db($db) or
        die("Unable to select database!");

        if (isset($_POST["ok"]))
        {
                if(!empty($_POST['usern']))
                {
                $usern = $_POST['usern'];
                }
                else
                {
                $usern = 'null';
                }
                if(!empty($_POST['tag']))
                {
                $tag = $_POST['tag'];
                        $tags = tagcount($tag);
                        for($i = 0; $i < count($tags); $i++)
                        {
                        $querytag1 = "SELECT * FROM
                        amount WHERE tag = '".$tags[$i]."' AND
                        LOid=".$tempid."";
                        $resulttag1 = mysql_query($querytag1) or
                        die("Error in query tag 1:
                        $query. ".mysql_error());
                        if(mysql_num_rows($resulttag1)>0)
                        {
                        $rowtag1 = mysql_fetch_row($resulttag1);
                        $amount = $rowtag1[3] + 1;
                        $queryam="UPDATE amount SET
                        amount=".$amount." WHERE id=".
                        $rowtag1[0]."";
                        $resultam = mysql_query($queryam) or
                        die("Error in query tag amount +1:
                        $query. ".mysql_error());
                        }
                        else
                        {
                        $querytag2 = "INSERT INTO amount
                        (LOid, tag, amount) VALUES
                        (".$tempid.",'".$tags[$i]."', 1)";
                        $resulttag2 = mysql_query($querytag2) or
                        die("Error in query add new tag:
                        $query. ".mysql_error());
                        }
                        }
                }

                $cvalue = $_POST[con];
```

```
                $dvalue = $_POST[dif];
                ratingValue($tempid, $cvalue, $dvalue);
    //Adding evaluation for the LO

                if(!empty($_POST['comment']))
                {
                $comment = $_POST['comment'];
                $host = "mysql.stud.hig.no";
            $user = "s080338";
            $pass = "PASSWORD";
            $db = "s080338";
            $connection = mysql_connect($host, $user,
            $pass)or die ("Unable␣to␣connect!");
                mysql_select_db($db) or
                die("Unable␣to␣select␣database!");
                $queryc = "INSERT␣INTO␣comment
␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣(LOid,␣comment,␣user,␣yes,␣no)␣VALUES
␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣($tempid,␣'$comment',␣'$usern',␣0,␣0)";
                        $resultc = mysql_query($queryc) or
                        die("Error␣in␣query␣comment:
␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣$queryc.␣".mysql_error());
                }
        }
        $host = "mysql.stud.hig.no";
        $user = "s080338";
        $pass = "PASSWORD";
        $db = "s080338";
        $connection = mysql_connect($host, $user, $pass) or
        die ("Unable␣to␣connect!");
        mysql_select_db($db) or
        die("Unable␣to␣select␣database!");
        $query = "SELECT␣*␣FROM␣LO␣WHERE␣id␣=".$tempid."";
        $result = mysql_query($query) or die
        ("Error␣in␣query␣reused␣no.␣:␣$query.␣".mysql_error());
        if (mysql_num_rows($result)>0)
        {
        $row = mysql_fetch_row($result);
        $temp = $row[25];
        $newGrade = $temp + 1;
        $queryg = "UPDATE␣LO␣SET
␣␣␣␣␣␣␣␣reusedno=".$newGrade."␣WHERE␣id=".$tempid."";
        $resultg = mysql_query($queryg) or
        die ("Error␣in␣query␣reused:␣$queryg.␣".mysql_error());
        }
        $arr = getdate();
        $month = $arr['month'];
        $querymon = "SELECT␣*␣FROM␣hist␣WHERE
␣␣␣␣␣␣␣␣LOid␣=".$tempid."AND␣month␣='".$month."'";
        $resultmon = mysql_query($querymon) or
        die ("Error␣in␣query:␣$querymon.␣".mysql_error());
        if (mysql_num_rows($resultmon)>0)
        {
        $rowm = mysql_fetch_row($resultmon);
```

```
          $newamount = $rowm[3] + 1;
          $querymn = "UPDATE␣hist␣SET
␣␣␣␣␣␣␣␣amount=".$newamount."WHERE␣id=".$rowm[0]."";
          $resultmn = mysql_query($querymn) or
          die ("Error:␣$querymn.␣".mysql_error());
          mysql_free_result($resultmon);
          }
          else
          {
          $newQ = "INSERT␣INTO␣hist␣(LOid,
␣␣␣␣␣␣␣␣month,␣amount)␣VALUES␣(".$tempid.",
␣␣␣␣␣␣␣␣'".$month."',␣1)";
          $newresult = mysql_query($newQ) or
          die ("Error:␣$newQ.␣".mysql_error());
          }
     mysql_free_result($result);
          mysql_close($connection);
          echo ("<script>alert
␣␣␣␣␣␣␣␣('Thanks␣for␣your␣evaluation!')</script>");
          echo("<script>
␣␣␣␣␣␣␣␣location.href('home.php')</script>");
?>

<?php
function ratingValue ($loid, $grade1, $grade2)
/*For calculating the evaluated value for LO*/
{
     $host = "mysql.stud.hig.no";
          $user = "s080338";
          $pass = "PASSWORD";
          $db = "s080338";
          $connection9 = mysql_connect($host, $user, $pass) or
          die ("Unable␣to␣connect!");
          mysql_select_db($db) or die("Unable␣to
␣␣␣␣␣␣␣␣select␣database!");
          $query9 = "SELECT␣*␣FROM␣LO␣WHERE␣id␣=␣".$loid."";
          $result9 = mysql_query($query9) or
          die("Error␣in␣query:␣$query.␣".mysql_error());

          if(mysql_num_rows($result9)>0)
          {
          $row = mysql_fetch_row($result9);
          $newG1 = ($row[22]/($row[22]+1))*$row[21]+
          ($grade1/($row[22]+1));
          $row[21] = $newG1;

          $newG2 = ($row[24]/($row[24]+1))*$row[23]+
          ($grade2/($row[24]+1));
          $row[23] = $newG2;

          $newrating=($row[21]+$row[23])/2;
          $newnc=$row[22] + 1;
          $newnd=$row[24] + 1;
```

```
          $query1 = "UPDATE␣LO␣SET
␣␣␣␣␣␣␣␣rating=".$newrating."␣WHERE␣id=".$loid."";
          $result1 = mysql_query($query1) or
          die("Error␣in␣query␣1:␣$query1.␣".mysql_error());
          $queryc = "UPDATE␣LO␣SET
␣␣␣␣␣␣␣␣rcno=".$newnc."␣WHERE␣id=".$loid."";
          $resultc = mysql_query($queryc) or
          die("Error␣in␣query␣c:␣$queryc.␣".mysql_error());
          $query2 = "UPDATE␣LO␣SET
␣␣␣␣␣␣␣␣rcontent=".$newG1."␣WHERE␣id=".$loid."";
          $result2 = mysql_query($query2) or
          die("Error␣in␣query␣2:␣$query2.␣".mysql_error());
          $queryd = "UPDATE␣LO␣SET
␣␣␣␣␣␣␣␣rdno=".$newnd."␣WHERE␣id=".$loid."";
          $resultd = mysql_query($queryd) or
          die("Error␣in␣query␣d:␣$queryd.␣".mysql_error());
          $query3 = "UPDATE␣LO␣SET
␣␣␣␣␣␣␣␣rd=".$newG2."␣WHERE␣id=".$loid."";
          $result3 = mysql_query($query3) or
          die("Error␣in␣query␣3:␣$query3.␣".mysql_error());
          }
          else
          {
          echo"no␣recording␣founded!";
          }
          mysql_free_result($result9);
          mysql_close($connection9);
}
          ?>
```

B Interview Questions

1. Do you think the student tags are far away from your ideas?
2. How would you characterize the differences between your keywords and student tags?
3. Do you think seeing the student tags is useful for you? Why?
4. What changes would you make to your list of keywords when you find a mismatch between the students' tags and your own keywords?
5. Do you think you will be able to improve your lecture planning when after you have reviewed the student tags?
6. Will you change your lecture notes when you find that there are significant differences between your keywords and tags?
7. Does the student tags indicate that the students might have missed some of the key aspects of the lecture?
8. Do you have other comments after comparing your keywords and the student tags?

C Experiment Data

The numbers after each tag "such as (8/14) means 8 students add this tag for the learning object in 14 students".

The table after each learning object represents the details of tags which are added by each student. The first number after each tag is the total number of how many students use this tag. "s#" means a student.

In the table, "1" means that the student uses this tag, "0" means that the student doesn't use this tag.

C.1 Group One data for the lecture Coding and Compression of Media Data

Coding1. Digital Image Fundamentals

Keywords: Analog to Digital Conversion, Visual Perception, Electromagnetic Spectrum, Image Sensing, Image Acquisition, Sampling, Quantization, Image File Formats

Tags: sampling (8/14), quantization (8/14), image file formats (4/14), linear/nonlinear operations (6/14), visual perception elements (3/14), light (2/14), electromagnetic spectrum (1/14), image sensing (1/14), image acquisition (1/14)

		s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	s13	s14
sampling	8	1	1	0	0	1	1	1	1	1	0	1	0	0	0
quantization	8	1	1	0	0	1	1	0	1	1	0	1	0	0	1
linear/nonlinear operations	6	1	1	0	0	0	1	0	0	0	1	1	0	0	0
image file formats	4	0	1	1	0	0	1	1	0	0	0	0	1	1	0
visual perception elements	3	1	0	0	1	1	0	1	0	0	0	0	0	0	0
image sensing	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
image acquisition	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
electromagnetic spectrum	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
light	2	0	0	0	0	0	0	1	0	1	0	0	0	0	0

Figure 15: Tags details for LO Coding1

Coding2. Lossless Compression Algorithms

Keywords: information, Compression ratio, Run-Length Coding, Variable-Length Coding, Shannon-Fano Algorithm, Huffman coding, codeword, sibling property, Lempel-Ziv-Welch (LZW), Dictionary-based Coding, Arithmetic Coding

Tags: lossless (5/14), shannon code (4/14), entropy (4/14), LZW (3/14), arithmetic coding (3/14), adaptive coding (3/14), shannon-Fano algorithm (3/14), Huffman coding (1/14), Huffman code (/14), VLC (/14), algorithm (/14), string (/14), dictionary (/14), tree (/14), RLC (/14)

Coding3. Digital Image Data Representation

Keywords: Analog to Digital Conversion, quantization, sampling, aliasing, Nyquist, uniform quantizer, midtread, midrize, Image Types, Dithering, halftoning, Color Spaces, look-up tabe

		s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	s13	s14
Lossless	5	1	0	1	0	0	1	0	0	1	0	1	0	0	0
Shannon code	4	0	1	1	0	0	0	1	0	0	0	0	1	0	0
coding	4	0	0	0	0	1	0	0	0	0	1	1	1	0	0
entropy	4	0	0	0	0	1	1	1	1	0	0	0	0	0	0
Arithmetic coding	3	0	0	1	0	0	0	0	0	0	1	0	0	0	1
adaptive coding	3	0	0	0	0	0	0	0	1	0	0	0	0	1	1
LZW	3	0	0	0	1	0	0	0	0	0	1	0	0	1	0
Shannon-Fano Algorithm	3	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Huffman coding	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
huffman code	2	0	1	1	0	0	0	1	0	0	0	0	0	0	0
huffman	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0
VLC	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0
algorithm	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
string	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
dictionary	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
tree	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
RLC	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Figure 16: Tags details for LO Coding2

Tags: color space (4/11), dithering (3/11), grey scale (2/11), YCbCr (1/11), pixels (1/11), binary image (1/11), digital image (1/11)

		s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11
color space	4	1	0	0	0	0	0	0	1	0	1	1
dithering	3	1	0	0	0	0	1	1	0	0	0	0
grey scale	2	0	0	1	0	0	0	0	0	1	0	0
YCbCr	1	1	0	0	0	0	0	0	0	0	0	0
pixels	1	0	1	0	0	0	0	0	0	0	0	0
binary image	1	0	0	0	1	0	0	0	0	0	0	0
digital image	1	0	0	0	0	1	0	0	0	0	0	0

Figure 17: Tags details for LO Coding3

Coding4. Lossy Compression & JPEG

Keywords: Distorsion Measures, Transform Coding, DCT, DC, AC, Spatial Frequency, basis functions, Perceptual distortion, uniform quatizer, vector quantization, Color space transformation, YCbCr, Block processing, Chroma subsampling, Quantization, Entropy coding, JPEG, zig-zag scanning, DPCM, Hierarchical JPEG, JPEG-LS, JBIG

Tags: DCT (12/14), quantization (6/14), JEPG (5/14), zig zag (4/14), RLC (3/14), compression (3/14), decoder (2/14), blocks (2/14), ratio (2/14), entropy (2/14), DPCM (2/14), encoder (2/14), lossy compression (2/14), IDCT (1/14), YCbCr (1/14), run-length (1/14), rate-distortion (1/14), JEPG encoder (1/14), spatial (1/14), JEPG block (1/14), arithmetic coding(1/14)

Coding5. Basic Video Compression Techniques

Keywords: motion estimation, motion vectors, MC-based Prediction, prediction error, macroblocks, Target Frame, Reference Frame, Forward Prediction, H.261, H.263, CIF, QCIF, Interlaced Video, Intra-frames (I-frames), Inter-frames (P-frames), Motion Com-

		s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	s13	s14
DCT	12	1	1	1	1	1	1	1	1	1	1	1	1	0	0
JEPG	5	0	0	1	0	0	0	0	0	1	1	1	0	0	1
quantization	6	1	0	0	1	0	1	0	1	1	0	1	0	0	0
zig zag	4	0	0	0	0	0	0	1	0	0	0	0	1	1	1
RLC	3	0	0	0	0	0	0	0	0	1	0	0	0	1	1
compression	3	1	0	1	0	0	0	0	0	0	0	1	0	0	0
decoder	2	0	0	0	0	0	1	0	0	0	1	0	0	0	0
blocks	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0
ratio	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0
entropy	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0
DPCM	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1
lossy compression	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1
encoder	2	0	0	0	0	0	0	0	1	0	1	0	0	0	0
IDCT	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
arithmetic coding	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
YCbCr	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
runlength	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
rate-distortion	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
JEPG encoder	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
spatial	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
JEPG block	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Figure 18: Tags details for LO Coding4

pensation

Tags: H.261 (5/8), motion compensation (4/8), motion vector (3/8), MAD (2/8), video (3/8), hierarchical search (2/8), macroblocks (2/8), sequential search (2/8), 2D logarithmic search (2/8), video compression (2/8), I-frame (1/8), H.263 (1/8), H.261 encoder (1/8), P-frames (1/8), Mean Absolute Difference (1/8), I-frames (1/8), temporal redundancy (1/8), predictive coding (1/8), motion estimation (1/8), compensation (/18), search (1/8), P-frame (1/8)

Coding6. Video Coding I MPEG-1 and MPEG-2

Keywords: interlacing, bidirectional prediction, B-frame, frame prediction, field prediction, slice, group of pictures, Profiles, alternate scan, field DCT, scalable coding, SNR scalability, Spatial Scalability, Temporal Scalability, Hybrid scalability, bit base, bit enhance, non-linear quantization

Tags: MPEG (5/9), scalability coding (3/9), H.261 (3/9), H.263 (2/9), MPEG-2 (3/9), MPEG-1 (3/9), I-Frame (1/9), P-Frame (1/9),frame sequence (1/9), coding (2/9), SNR 19), frame prediction (1/9), frame (1/9), forward prediction (1/9), video (1/9), motion prediction (1/9), macroblock (1/9), temporal and special scalability (1/9), SNR scalability (1/9), enhancement (1/9), scaling (1/9), interlacing (1/9), GOS (1/9), GOD (1/9)

Coding7. Digital Audio Coding and Compression

Keywords: Audio, webers law, A-law, Mu-Law, Sampling, quantization, Nyquist theorem, aliasing, sample rate, decibel, ADPCM, Psychoacustics -masking, MP3, Adaptive quantizer, Equal loudness curve, Frequency masking, Temporal Masking, MPEG-2 AAC

		s1	s2	s3	s4	s5	s6	s7	s8
H.261	5	0	1	0	1	1	1	0	0
motion compensation	3	1	1	0	0	0	0	0	1
motion vector	3	1	0	0	0	1	1	0	0
MAD	2	0	0	1	0	0	1	0	0
video	3	0	1	0	0	1	1	0	0
hierarchical search	2	0	0	1	0	0	0	0	1
macroblocks	2	0	1	1	0	0	0	0	0
sequential search	2	0	0	1	0	0	0	0	0
2D logarithmic search	2	0	0	1	0	0	0	0	0
video compression	2	0	0	1	0	0	0	0	0
I-frame	1	0	0	0	1	0	0	0	0
H.263	1	0	0	0	0	0	0	1	0
H.261 encoder	1	1	0	0	0	0	0	0	0
P-frames	1	1	0	0	0	0	0	0	0
I-frames	1	1	0	0	0	0	0	0	0
Mean Absolute Difference	1	0	1	0	0	0	0	0	0
temporal redundancy	1	0	1	0	0	0	0	0	0
predictive coding	1	0	1	0	0	0	0	0	0
motion estimation	1	0	0	0	0	0	0	1	0
compensation	1	0	0	0	0	0	0	1	0
search	1	0	0	0	0	0	0	1	0
P-frame	1	0	0	0	1	0	0	0	0

Figure 19: Tags details for LO Coding5

		s1	s2	s3	s4	s5	s6	s7	s8	s9
MPEG	6	1	1	1	0	1	1	1	0	0
scalability coding	4	1	1	1	0	0	0	0	0	1
H.261	4	1	1	0	0	0	1	1	0	0
H.263	2	0	0	0	1	0	0	1	0	0
MPEG-2	3	0	0	1	0	0	1	1	0	0
MPEG-1	3	0	0	0	1	0	0	0	1	1
coding	3	1	0	1	1	0	0	0	0	0
I-Frame	1	0	0	0	1	0	0	0	0	0
P-Frame	1	0	0	0	1	0	0	0	0	0
frame prediction	1	0	0	0	1	0	0	0	0	0
SNR	1	0	0	0	0	1	0	0	0	0
frame sequence	2	1	0	0	0	0	0	0	1	0
frame	1	0	1	0	0	0	0	0	0	0
forward prediction	1	0	1	0	0	0	0	0	0	0
video	1	0	0	0	0	0	1	0	0	0
motion prediction	1	0	0	0	0	1	0	0	0	0
macroblock	1	0	0	0	1	0	0	0	0	0
special scalability	1	0	0	0	1	0	0	0	0	0
temporal scalability	1	0	0	0	1	0	0	0	0	0
SNR scalability	1	0	0	0	0	0	0	0	0	1
enhancement	1	0	0	0	1	0	0	0	0	0
scaling	1	0	1	0	0	0	0	0	0	0
interlacing	1	0	0	0	0	0	0	0	1	0
GOS	1	0	0	0	0	0	0	0	1	0
GOD	1	0	0	0	0	0	0	0	1	0

Figure 20: Tags details for LO Coding6

Tags: Masking (4/8), ADPCM (3/8), audio 38), quantization (2/8), audio compression (2/8), psychoacoustic (1/8), equal loudness curves (1/8), frequencies (2/8), amplitude (1/8), MPEG (1/8), audio layers (1/8), non-linears PCM (1/8), non-linear quantization (1/8), sound (1/8), conversion (1/8), temporal redundancy (1/8), lossless (1/8), frequency (1/8), quantizer (1/8), A-law (1/8), Mu-law (1/8), MP3 (1/8), psychoacoustics (1/8)

		s1	s2	s3	s4	s5	s6	s7	s8
Masking	4	0	0	1	0	1	0	1	1
ADPCM	3	0	0	1	1	0	0	0	1
Audio	3	0	1	0	0	1	0	0	1
quantization	2	0	0	0	1	0	1	0	0
audio compression	2	0	0	0	1	0	0	1	0
psychoacoustic	1	0	0	0	0	0	0	1	0
equal loudness curves	1	0	0	0	0	0	1	0	0
frequencies	2	0	1	0	0	0	1	0	0
amplitude	1	0	0	0	0	0	0	1	0
Mpeg	1	0	0	0	0	0	0	1	0
audio layer 3	1	0	0	0	0	0	1	0	0
PCM	1	0	0	0	0	0	0	0	1
MPEG layers	1	0	0	0	0	0	0	0	1
non-linears PCM	1	0	0	0	0	0	0	1	0
non-linear quantization	1	1	0	0	0	0	0	0	0
Sound	1	0	0	0	0	1	0	0	0
conversion	1	1	0	0	0	0	0	0	0
temporal redundancy	1	1	0	0	0	0	0	0	0
lossless	1	1	0	0	0	0	0	0	0
frequency	1	0	0	0	0	1	0	0	0
quantizer	1	0	0	1	0	0	0	0	0
A-law	1	0	0	1	0	0	0	0	0
μ-law	1	0	0	1	0	0	0	0	0
MP3	1	0	0	1	0	0	0	0	0
psychoacoustics model	1	0	0	1	0	0	0	0	0
Tone	1	0	0	0	0	1	0	0	0
psychoacoustics	1	0	0	0	0	0	0	0	1

Figure 21: Tags details for LO Coding7

Coding8. Video Coding II MPEG-4

Keywords: object-based coding, video object, user interactivity, Content-based interactivity, Integration of both natural and synthetic objects, Scene composition, scene description, Mesh Object Coding, Model-based Coding, Extended Padding, Shape Adaptive DCT, shape coding, 2009Context-based Arithmetic Encoding , Sprite Coding, Global Motion Compensation, face objects, body objects , Face Definition Parameters, Face Animation Parameters, Body Animation Parameters, H.264

Tags: MPEG-4 (4/7), object based encoding (2/7), video-object (2/7), video object layer (1/7), video (1/7), coding (1/7), object (1/7), arbitrary shape (1/7), motion vectors (1/7), shape coding (1/7), video-object sequence (1/7), object types (1/7), padding (1/7), motion compensation (1/7), video coding (1/7), object-based coding (1/7), sprite coding (1/7)

		s1	s2	s3	s4	s5	s6	s7
MPEG-4	4	0	0	1	1	1	0	1
object based encoding	2	1	0	0	0	0	1	0
video-object	2	0	1	0	0	0	0	1
video object layer	1	0	0	0	0	0	0	1
video	1	0	0	1	0	0	0	0
coding	1	0	0	1	0	0	0	0
object	1	0	0	0	1	0	0	0
arbitrary shape	1	0	1	0	0	0	0	0
motion vectors	1	0	0	0	0	1	0	0
shape coding	1	0	0	0	0	1	0	0
video-object sequence	1	0	0	0	0	0	1	0
object types	1	0	0	0	0	0	0	1
padding	1	0	0	0	0	0	0	1
Global Motion Compensation	1	0	0	0	0	0	1	0
video coding	1	0	0	0	0	0	0	1
object-based coding	1	0	0	0	0	1	0	0
Sprite Coding	1	1	0	0	0	0	0	0

Figure 22: Tags details for LO Coding8

C.2 Group Two data for the lecture Semantic Web

SW1: week0940OWLFeaturesPart1

Keywords: semantic web, OWL, inverse of, symmetric properties, transitive properties, equivalence, functional properties, inverse functional properties, object properties, data type properties

Tags: inverse of (4/9), OWL features (3/9), properties (3/9), symmetric properties (3/9), transitivity (3/9), equivalence (3/9), RDFS features (2/9), RDF features (2/9), functional properties (2/9), data type properties (1/9), symmetric property (1/9), object properties (1/9), inverse functional properties (1/9), Class Property and Instance equivalence (1/9), inverse of a property (1/9), Relationships (1/9), OWL/RDF(S) Subclass Relationships (1/9)

SW2: week0940PracticalUseOfRDFSandOWL

Keywords: semantic web, RDFS constructs, OWL constructs, SKOS, FOAF

Tags: SKOS (8/9), FOAF (7/9), transitive (2/9), equivalence(2/9), RDFS/OWL constructs (2/9), RDFS constructs (2/9), symmetric (1/9), symmetric properties (1/9), subclass and sub-properties (1/9), inference (1/9), Simple Knowledge Organization System (1/9), OWL (1/9), inverse of (1/9), inverse (1/9), OWL ontology (1/9), constructs (1/9), OWL Features (1/9), inverse functional properties (1/9)

SW3: week0943OWLFeaturesPart2

Keywords: semantic web, OWL, restrictions, types of restrictions

Tags: OWL restrictions (6/9), restrictions (2/9), OWL features (2/9), types of OWL restrictions (1/9), subclass (1/9), equivalent class (1/9), types of restrictions (1/9), subclass/equivalent class (1/9), value (1/9), define and type of OWL restrictions (1/9)

SW4: week0943OWLFeaturesPart3

Keywords: IMT4931, semantic web, OWL, union, intersection, complement, enumerations, differentiating individuals, disjoint, sets, cardinality, inferring class relationships

		s1	s2	s3	s4	s5	s6	s7	s8	s9
inverse of	4	0	0	0	1	1	1	0	1	0
OWL features	3	1	0	1	0	0	0	0	0	1
properties	3	1	0	0	0	0	1	0	1	0
symmetric properties	3	0	0	1	1	0	0	0	0	1
transitivity	3	0	0	0	1	1	1	0	0	0
RDFS features	2	0	1	0	0	0	0	0	1	0
RDF features	2	1	0	0	0	0	0	1	0	0
equivalence	3	0	0	0	1	1	0	1	0	0
data type properties	1	0	0	0	0	0	0	0	0	1
symmetric property	1	0	0	0	0	1	0	0	0	0
object properties	1	0	0	0	0	0	0	0	0	1
inverse functional properties	1	0	0	0	0	0	0	0	1	0
functional properties	2	0	0	1	0	1	0	0	0	0
class property and instance equivalence	1	0	0	0	0	0	0	0	0	1
inverse of a property	1	0	0	0	0	0	0	1	0	0
relationaships	1	1	0	0	0	0	0	0	0	0
OWL/RDF(S) subclass relationships	1	0	0	0	0	0	0	1	0	0

Figure 23: Tags details for LO SW1

		s1	s2	s3	s4	s5	s6	s7	s8	s9
SKOS	8	1	1	1	1	1	1	0	1	1
FOAF	7	1	1	1	1	1	1	1	0	0
transitive	2	0	0	0	0	1	0	0	1	0
equivalence	2	0	0	0	0	1	0	0	0	1
RDFS/OWL constructs	2	1	0	0	0	0	0	0	0	1
RDFS constructs	2	0	1	0	0	0	0	0	1	0
symmetric	1	0	0	0	0	0	0	0	1	0
symmetric properties	1	0	0	0	0	1	0	0	0	0
subclass and sub-properties	1	0	0	0	0	0	0	0	0	1
inference	1	0	0	0	0	1	0	0	0	0
Simple Konwledge Organization System	1	0	0	0	0	0	0	1	0	0
OWL	1	0	0	0	0	1	0	0	0	0
inverse of	1	0	0	0	0	1	0	0	0	0
inverse	1	0	0	0	0	0	0	0	1	0
OWL ontology	1	1	0	0	0	0	0	0	0	0
constructs	1	0	0	0	0	0	1	0	0	0
OWL features	1	0	0	0	0	0	0	1	0	0
inverse functional properties	1	0	0	0	0	0	0	1	0	0

Figure 24: Tags details for LO SW2

		s1	s2	s3	s4	s5	s6	s7	s8	s9
OWL restrictions	6	1	1	1	1	0	0	1	1	0
restrictions	2	0	0	0	1	0	1	0	0	0
OWL features	2	0	1	0	0	1	0	0	0	0
types of OWL features	1	0	0	0	0	0	0	1	0	0
subclass	1	0	0	0	0	1	0	0	0	0
equivalent class	1	0	0	0	0	1	0	0	0	0
types of restrictions	1	0	0	0	0	1	0	0	0	0
subclass/equivalent class	1	0	0	0	0	0	1	0	0	0
value	1	0	0	0	1	0	0	0	0	0
define and type of OWL restrictions	1	0	0	0	0	0	0	0	0	1

Figure 25: Tags details for LO SW3

Tags: cardinality (4/10), sets (4/10), disjoint (4/10), set operations (3/10), enumerations (3/10), intersection (2/10), complement (2/10), inferring class relationships (2/10), class Unions (1/10), union (1/10), relationships (1/10), subclassing (1/10), integrating existing ontologies (1/10), integrating existing ontologies (1/10), open and closed world (1/10), class complements (1/10), class intersections (1/10), class relationships (1/10), enumerations disjoint (1/10), operations with classes (1/10), class (1/10), subclass (1/10), OWL (1/10), close OWL world (1/10), operations to classes (1/10), differentiating (1/10), classes (1/10), bottom-up ontologies union (1/10), top-down (1/10), differentiating single and multiple individuals (1/10)

SW5: week0944GoodAndBadModelingPractices

Keywords: IMT4931, semantic web, modeling practice, modeling errors, antipatterns

Tags: antipatterns (3/8), exclusivity (2/8), naming conventions (2/8), class hierarchies (2/8), modeling (2/8), modeling errors (2/8), hierarchy (1/8), common modeling errors (1/8), identify model purpose (1/8), defining classes (1/8), everything is class (1/8), antipatern (1/8),objectification (1/8), class identifiers (1/8), purpose of modeling (1/8), good practice (1/8), classes (1/8), model (1/8), practice (1/8), creeping conceptualization (1/8)

SW6: week0944OntologyDevelopment

Keywords: IMT4931, semantic web, ontology development process, reuse, class design, property design, naming conventions

Tags: ontology design (3/9), properties (3/9), terms (2/9), taxonomy (2/9), instances (2/9), scope (2/9), reuse (2/9), class hierarchies (2/9), classes (2/9), naming conventions (2/9), facets (2/9), testing (2/9), defining classes (1/9), ontology (1/9), design (1/9), developing ontology (1/9), process (1/9), ontology design process(1/9)

SW7: week0945SemanticWebServiceApproaches

Keywords: IMT4931, semantic web, web services, semantic web services, WSDL-S, SAWSDL, OWL-S, WSMO

Tags: WSDL-S (7/10), OWL-S (7/10), SAWSDL (7/10), WSMO (6/10), web services (1/10), WS (1/10), semantic web service approaches (1/10)

SW8: week0945SemanticWebServices

Keywords: IMT4931, semantic web, web services, semantic web services

		s1	s2	s3	s4	s5	s6	s7	s8	s9	s10
cardinality	4	1	0	0	1	1	0	0	1	0	0
sets	4	1	0	0	0	0	0	1	0	1	1
disjoint	4	1	0	0	0	1	0	0	0	1	1
set operations	3	0	1	0	0	0	1	0	1	0	0
intersection	2	0	0	0	0	1	0	0	0	1	0
complement	2	0	0	0	0	1	0	0	0	0	1
enumerations	3	0	0	0	1	1	0	0	0	1	0
inferring class relationships	2	1	0	0	0	0	0	0	0	0	1
class unions	1	0	0	0	0	0	0	1	0	0	0
union	1	0	0	0	0	0	0	0	0	1	0
relationships	1	0	0	0	0	0	0	1	0	0	0
subclassing	1	0	0	0	0	0	0	0	0	0	1
integrating existing ontologies	1	0	0	0	0	0	0	1	0	0	0
open and closed world	1	0	0	0	0	0	0	1	0	0	0
class complements	1	0	0	0	0	0	0	1	0	0	0
class intersections	1	0	0	0	0	0	0	1	0	0	0
class relationships	1	0	0	0	0	0	1	0	0	0	0
enumerations disjoint	1	0	0	0	0	0	0	0	0	0	1
operations with classes	1	1	0	0	0	0	0	0	0	0	0
class	1	0	0	1	0	0	0	0	0	0	0
subclass	1	0	0	1	0	0	0	0	0	0	0
OWL	1	0	1	0	0	0	0	0	0	0	0
close OWL world	1	1	0	0	0	0	0	0	0	0	0
operations to classes	1	0	0	0	0	1	0	0	0	0	0
differentiating	1	0	0	0	1	0	0	0	0	0	0
classes	1	0	1	0	0	0	0	0	0	0	0
bottom-up ontologies union	1	0	0	0	0	1	0	0	0	0	0
top-down	1	0	0	0	0	1	0	0	0	0	0
differentiating single and multiple individuals	1	0	0	0	0	0	0	0	1	0	0

Figure 26: Tags details for LO SW4

		s1	s2	s3	s4	s5	s6	s7	s8
exclusivity	2	0	0	0	0	1	0	0	1
antipatterns	3	0	0	0	1	1	0	0	1
naming conventions	2	0	0	0	1	0	0	1	0
class hierarchies	2	0	1	0	0	0	0	0	1
hierachy	1	0	0	0	0	0	0	1	0
common modeling errors	1	0	0	0	0	0	1	0	0
identify model purpose	1	0	0	0	0	0	0	0	1
defining classes	1	0	0	0	0	0	0	0	1
everything is class	1	0	0	0	0	1	0	0	0
antipatern	1	0	1	0	0	0	0	0	0
objectification	1	0	0	0	0	1	0	0	0
class identifiers	1	0	0	1	0	0	0	0	0
purpose of modelling	1	0	0	0	0	0	1	0	0
good practice	1	1	0	0	0	0	0	0	0
modeling	2	0	1	1	0	0	0	0	0
classes	1	0	1	0	0	0	0	0	0
modeling errors	2	1	0	0	1	0	0	0	0
model	1	1	0	0	0	0	0	0	0
practice	1	0	0	0	0	0	0	0	1
creeping conceptualization	1	0	0	0	0	0	0	1	0

Figure 27: Tags details for LO SW5

		s1	s2	s3	s4	s5	s6	s7	s8	s9
ontology design	3	0	1	0	0	1	0	0	1	0
terms	2	0	0	0	1	0	0	0	0	1
properties	3	0	0	0	1	0	1	0	0	1
taxonomy	2	0	0	0	1	0	0	0	0	1
instances	2	0	0	0	1	0	1	0	0	0
scope	2	0	0	0	1	0	1	0	0	0
reuse	2	0	0	0	1	0	1	0	0	0
class hierarchies	2	0	1	0	0	1	0	0	0	0
classes	2	0	1	0	0	0	0	1	0	0
naming conventions	2	0	0	0	0	1	0	0	1	0
facets	2	0	0	0	1	0	1	0	0	0
defining classes	1	0	0	0	0	1	0	0	0	0
testing	2	0	0	0	1	0	1	0	0	0
developing ontology	1	0	0	1	0	0	0	0	0	0
process	1	1	0	0	0	0	0	0	0	0
design	1	1	0	0	0	0	0	0	0	0
ontology	1	1	0	0	0	0	0	0	0	0
ontology design process	1	0	0	0	0	0	0	1	0	0

Figure 28: Tags details for LO SW6

		s1	s2	s3	s4	s5	s6	s7	s8	s9	s10
WSDL-S	7	1	1	0	1	1	1	0	1	0	1
OWL-S	7	1	1	0	1	1	1	0	1	0	1
SAWSDL	7	1	1	0	1	1	1	0	0	1	1
WSMO	6	1	1	0	1	1	1	0	0	1	0
web services	1	0	0	1	0	0	0	0	0	0	0
WS	1	0	0	0	0	0	0	1	0	0	0
semantic web service approaches	1	0	0	0	0	1	0	0	0	0	0

Figure 29: Tags details for LO SW7

Tags: web services (5/9), Semantic web services (3/9), goals (1/9), problems (1/9), OWL (1/9), semantic web services motivation (/19), service consumer (1/9), WSDL (1/9), web services characteristics (1/9), automation (1/9), reusable (1/9), protocol (1/9), access (1/9), semantic (1/9), characteristic (1/9), motivation (1/9)

		s1	s2	s3	s4	s5	s6	s7	s8	s9
web services	5	1	1	1	0	1	0	0	1	0
semantic web services	3	0	1	0	0	0	0	1	0	1
goals	1	0	0	0	0	0	1	0	0	0
problems	1	0	0	0	0	0	1	0	0	0
OWL	1	0	0	0	0	1	0	0	0	0
semantic web services motivation	1	0	0	0	0	1	0	0	0	0
service consumer	1	0	0	0	0	1	0	0	0	0
WSDL	1	0	0	0	0	1	0	0	0	0
web services characteristics	1	0	0	0	0	1	0	0	0	0
automation	1	0	0	0	1	0	0	0	0	0
reusable	1	0	0	0	1	0	0	0	0	0
protocol	1	0	0	0	1	0	0	0	0	0
access	1	0	0	0	1	0	0	0	0	0
semantic	1	1	0	0	0	0	0	0	0	0
characteristic	1	1	0	0	0	0	0	0	0	0
motivation	1	0	0	0	0	0	1	0	0	0

Figure 30: Tags details for LO SW8