**UNIVERSITY OF PIRAEUS**

**Department of Digital Systems**

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"TECHNOLOGY EDUCATION AND DIGITAL SYSTEMS"

Track: E-Learning

# SOCIAL TAGGING EVALUATION METHODOLOGIES IN TECHNOLOGY-ENHANCED LEARNING

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# Abstract

The key objective of this Thesis is the implementation of a proposed Social Tagging Evaluation Methodology in an existing Open Educational Resources (OER) Repository, the *OpenScienceResources Repository.*

In the context of Technology Enhanced Learning, Digital Educational Resources in the form of learning objects, are used to support a wide range of educational activities. In general, Digital Educational Resources are organized according to formal descriptions from centrally designed and agreed classification systems using metadata, such as IEEE Learning Object Metadata (IEEE LOM) (IEEE LTSC, 2002). However, IEEE LOM imposes a strict classification of the content (Bateman et al., 2007; Vuorikari, 2007).

Social tagging has emerged in contrast and alongside the formal classification of content of Digital Educational Resources. Social tagging is supported by a number of web applications that encourage groups of individuals to openly share their private descriptions (or tags) of digital resources with other users, either by using a collection of tags created by the individual for his/her personal use (refereed to as folksonomy) or by using a collective vocabulary (refereed to as collabulary) (Anderson, 2007).

Increasingly, recent investigations focus on the potential benefits of digital educational resources characterization by user-based tagging rather than author-based formal description based on centrally agreed classification systems, for example metadata such as IEEE LOM (Bi et al., 2009). To this end, a number of studies have been reported in field of Technology Enhanced Learning (TeL) mainly aiming to evaluate the potential benefits of social tagging in improving the search effectiveness of digital educational resources (Trant, 2009a; Vuorikari & Ayre, 2009)

However, there are limited studies to investigate how users' tagging behaviour can influence (a) the enhancement of metadata descriptions of digital educational resources and (b) the resulted folksonomy compared to formal vocabularies used for characterizing the digital educational resources

The proposed Social Tagging Evaluation Methodology which is applied by means of this Thesis to the OSR Repository aims to investigate the aforementioned querries and examine whether different users' tagging motivations could enhance the metadata descriptions of digital educational resources.

# Περίληψη

Ο στόχος της παρούσας Μεταπτυχιακής Διπλωματικής Εργασίας είναι η εφαρμογή μιας προτεινόμενης Μεθοδολογίας Ανάλυσης Συλλογικού Χαρακτηρισμού, σε μια υπάρχουσα Αποθήκη Μεταδεδομένων Μαθησιακών Αντικειμένων, την «*OpenScienceResources Repository*».

Στα πλαίσια της Τεχνολογικά Υποστηριζόμενης Μάθησης γίνεται χρήση ψηφιακού εκπαιδευτικού περιεχομένου σε μορφή Μαθησιακών Αντικειμένων προκειμένου να υποστηριχθεί ένα μεγάλο φάσμα εκπαιδευτικών δραστηριοτήτων. Γενικά, το ψηφιακό εκπαιδευτικό περιεχόμενο είναι οργανωμένο με βάση μοντέλα μεταδεδομένων τα οποία αποτελούν κοινά αποδεκτούς τρόπους περιγραφής εκπαιδευτικού περιεχομένου, χρησιμοποιώντας μεταδεδομένα όπως αυτά που προσφέρει το διεθνές πρότυπο μοντέλο «IEEE Μεταδεδομένα Μαθησιακού Αντικειμένου» (IEEE LTSC, 2002). Ωστόσο, το μοντέλο αυτό επιβάλλει μια αυστηρή ταξινόμηση του περιεχομένου (Bateman et al., 2007; Vuorikari, 2007).

Ο Συλλογικός Χαρακτηρισμός έχει προκύψει σε αντίθεση και παράλληλα με την τυποποιημένη ταξινόμηση του εκπαιδευτικού περιεχομένου. Ο Συλλογικός Χαρακτηρισμός υποστηρίζεται από μια σειρά εφαρμογών του Παγκοσμίου Ιστού οι οποίες ενθαρρύνουν ομάδες ατόμων να μοιραστούν ανοιχτά με άλλους χρήστες τις ιδιωτικές περιγραφές τους (ή ετικέτες) του ψηφιακού περιεχομένου, είτε με τη χρήση μιας συλλογής από ετικέτες που δημιουργούνται από τα ίδια τα άτομο για προσωπική χρήση (λαϊκονομία) είτε με τη χρήση ενός συλλογικού λεξιλογίου (collabulary) (Anderson, 2007).

Ολοένα και περισσότερες έρευνες επικεντρώνονται στα πιθανά οφέλη του χαρακτηρισμού των ψηφιακού εκπαιδευτικού περιεχομένου με ετικέτες οι οποίες προέρχονται από τελικούς χρήστες, σε σύγκριση με το χαρακτηρισμό με ετικέτες προερχόμενες από τυποποιημένες περιγραφές κοινά αποδεκτών συστημάτων ταξινόμησης του περιεχομένου όπως είναι το IEEE LOM (Bi et al., 2009). Για το σκοπό αυτό, έχει εκπονηθεί στα πλαίσια του κλάδου της Τεχνολογικά Υποστηριζόμενης Μάθησης, ένας αριθμός μελετών οι οποίες έχουν ως βασικό στόχο να αξιολογήσουν τα πιθανά οφέλη του Συλλογικού Χαρακτηρισμού όσον αφορά στη βελτίωση της ποιότητας της αναζήτησης του ψηφιακού εκπαιδευτικού περιεχομένου (Trant, 2009a; Vuorikari & Ayre, 2009).

Παρ’όλα αυτά υπάρχουν περιορισμένες μελέτες οι οποίες ερευνούν το πώς η τακτική των χρηστών στη Διαδικασία Χαρακτηρισμού των Μαθησιακών Αντικειμένων μπορεί να επηρεάσει α) την ενίσχυση των μεταδεδομένων που χαρακτηρίζουν το ψηφιακό εκπαιδευτικό

περιεχόμενο και β) την προκύπτουσα λαϊκονομία σε σύγκριση με το επίσημο λεξιλόγιο που χρησιμοποιείται για την περιγραφή του ψηφιακού εκπαιδευτικού περιεχομένου.

Η προτεινόμενη Μεθοδολογία Αξιολόγησης Συλλογικού Χαρακτηρισμού, η οποία εφαρμόζεται μέσω της παρούσας Μεταπτυχιακής Διπλωματικής Εργασίας στην Αποθήκη Μεταδεδομένων Μαθησιακών Αντικειμένων «OpenScienceResources», έχει ως στόχο της να ερευνήσει τα πιο πάνω ερωτήματα και να εξετάσει κατά πόσο τα διαφορετικά κίνητρα των χρηστών στη Διαδικασία Χαρακτηρισμού, μπορούν να ενισχύσουν τα μεταδεδομένα που χαρακτηρίζουν το ψηφιακό εκπαιδευτικό περιεχόμενο.

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# Chapter 1: Introduction

## 1.1. Problem Definition

In the context of Technology Enhanced Learning digital educational resources have emerged in the form of learning objects (LOs), due to the provision of open access to digital educational resources and in order to be used to support a wide range of educational activities (McGreal, 2007). Organizing, offering and accessing these resources over the web have been key issues for both the research and the educational community.

Typically, digital educational resources are organized according to formal descriptions from centrally designed and agreed classification system using metadata, such as IEEE Learning Object Metadata (IEEE LOM), which has been noted to impose a strict classification of the content (Bateman et al., 2007; Vuorikari, 2007).

Social Tagging, one of the newest technologies of Web 2.0 presents an alternative way of annotating resources, thus contributing next to structured metadata for the management of digital content. Social tagging has gained momentum through a number of web applications that encourage groups of individuals to openly share their private descriptions (or tags) of digital resources with other users, either by using a collection of tags created by the individual for his/her personal use, refereed to as folksonomy, or by using a collective vocabulary, refereed to as collabulary (Anderson, 2007).

The value and contribution of social tagging and folksonomy has not yet been fully established (Markey, 2007) and that is why the evaluations of Social Tagging are considered very important, since Social Tagging constitutes a new area of research a number of theoretical issues and evaluation methods under probation. Investigations for the potential benefits of digital educational resources characterization by user-based tagging rather than author-based formal description based on centrally agreed classification systems, for example metadata (such as IEEE LOM) are central to understanding the underlying theoretical and methodological issues at hand.

To this end, a number of studies have been reported in field of TeL mainly aiming to evaluate the potential benefits of social tagging in improving the search effectiveness of digital educational resources (Trant, 2009; Vuorikari & Ayre, 2009). Additionally, recent studies in the field of social tagging systems suggests that users' tagging motivation has a direct influence on the properties of resulting tags and folksonomies. Nevertheless, there are no existing efforts for addressing this issue in the field of TeL.

More specifically, there is a limited number of studies that investigate how users' tagging behaviour can influence (a) the enhancement of metadata descriptions of digital educational resources and (b) the resulted folksonomy compared to formal vocabularies used for characterizing the digital educational resources.

Zervas and Sampson (2011) have proposed a Social Tagging Evaluation Methodology that aims to evaluate whether users' tagging behaviour can influence:

- the **different tags** added by the users for describing the context of use of digital educational resources
- the **resulted folksonomy** compared to formal vocabularies used for characterizing the digital educational resources

This thesis applies the proposed Social Tagging Evaluation Methodology in examining the entire population of a Learning Objects Repository. This thesis thus engages in issues concerning the Social Tagging in Technology-Enhanced Learning field, mainly whether different users' tagging motivations could enhance the metadata descriptions of digital educational resources.

## 1.2. Thesis Structure

In **Chapter 2** there is a review of Social Tagging literature and the contribution of social tagging to the Technology-Enhanced Learning filed.

This chapter first outlines significant elements concerning Social Tagging as a process and the involvement of social tagging to searching, categorizing and analyzing Social Tags themselves. In addition, there is a reference to the advantages and disadvantages of Social Tags as detected by means of Social Tagging evaluations.

Subsequently, the chapter focuses on the contribution of Social Tags along with structured metadata to the Technology-Enhanced Learning and specifically the Social Tagging of Learning Objects within the Learning Objects Repositories. Thus, Social Tags facilitate the reuse of Learning Objects, enhancing the browsing and retrieval of the content and describing the context of use according to the end-users knowledge and attitude. The chapter concludes with emphasizing/discussing/illustrating the necessity of Social Tagging evaluations.

**Chapter 3** offers a general review of Social Tagging Evaluation Methodologies. Towards the review there is a brief description of the research questions set in each of the reviewed Social Tagging evaluation methodologies, their datasets, research methods and results.

The aim of the chapter is to examine the evaluation methods and their contribution to the results of evaluation methodologies when applied in Technology-Enhanced Learning Portals as Learning Objects Repositories. Thus, the analysis of existing methods leads to the improvement of extant methodologies or the creation of enriched evaluation methodologies.

In **Chapter 4** there is a detailed description of the proposed Social Tagging evaluation methodology based on the work of Zervas and Sampson (2011). Inside the chapter, the dataset and the structure of the evaluation methodology is unfolded, illustrating the OSR Repository's tagging features, the dataset, the hypotheses set and the methods used to carry out the experimental setups including the variables used in each experimental setup. During the navigation to the evaluation methodologies' attributes there is a step by step description of the research process.

In **Chapter 5** there is a presentation of the Social Tagging Evaluation results generated from the proposed evaluation methodology. The chapter is separated according to the experimental setups and the hypotheses.

In **Chapter 6** there is a set of conclusions suggested by the entire study and further discussion on the perspective of Social Tagging in the field of Technology-Enhanced Learning.

## 1.3. Thesis Contribution

This thesis aims to apply the proposed Social Tagging Evaluation Methodology of Zervas and Sampson (2011) in an existing Open Educational Resources (OER) Repository, namely the OpenScienceResources Repository[1]. OSR (OpenScienceResources) Repository seeks to bring closer hybrid approaches of standardized metadata and folksonomies providing egregious flexibility to the use and reuse of the digital learning objects.

Particularly, this thesis studies whether the OSR users' tagging behaviour can influence

1. the enhancement of metadata descriptions of digital educational resources
2. the resulted folksonomy compared to the OSR formal vocabulariy used for characterizing the digital educational resources.

Most of the studies conducted in Social Tagging and folksonomy reflected only one of the three broad perspectives of the field (folksonomy, tagging, social tagging systems) and are focused on folksonomic vocabularies and information retrieval, on user behaviour in tagging systems, or on the socio-technical nature of those systems themselves and their description using network theory (Trant, 2009a)

Towards the proposed evaluation methodology the above variables are combined in order to produce useful conclusions about the Social Tagging behavior within different frameworks.

[1] http://www.osrportal.eu/

The proposed Social Tagging Evaluation Methodology which is applied on this thesis, uses mostly quantitative Research Methods as Measures and Metrics as also Similarity Calculations.

Specifically, it borrows proven metrics from the Social Tagging Evaluation Methodology's Literature in order to determine the type of OSR user's tagging behaviour and afterwards uses similarity calculations between the formal and informal tags to state whether users' tagging behaviour can influence the resulted folksonomy in every case.

The application of the Social Tagging Evaluation Methodology is implemented through an uncontrolled experiment, including the dataset of the OpenScienceResources repository that was available at the time of our study (March 2012).

# Chapter 2:
# Social Tagging and Technology-Enhanced Learning

## 2.1 Introduction

The present form of the World Wide Web enables the participation and the contribution of all the users in shaping the digital content which leads to the rapid growth of digital content in all sectors including digital learning object (LO). Therefore, in the course of the Web 2.0 phenomenon, the Social Tagging mechanism provides a new way to categorize and organize the content (Dahl &Vossen, 2008). This mechanism benefits also the field of Technology-Enhanced Learning, supporting the social annotation of educational content.

## 2.2 What is Social Tagging?

Social Tagging is defined as the process of adding simple words to any digital content by the end-users, where the words are called “tags” and they do not belong to any particular vocabulary dictated by a specific scientific classification (Smith, 2008; Bonino, 2009).

Social Tagging is the mean by which individuals apply free text keywords to digital objects and potentially offers expansion in terms of personal knowledge management, unexpected access to objects through tags and enhanced opportunities to share content with emerging social networks (Vuorikari et al., 2007). Social Tagging systems, growing in popularity, allow users to create, edit and share collections of online resources and associate tags in a collaborative way. The resulting assemblage of tags forms a “folksonomy”.

In order to achieve the effectively search, retrieve, and reuse of a digital content, the standardization of its description and the acceptance of a common metadata model which is structured in a way of describing the features of the digital content is required (Greenberg, 2001). However, because of the exorbitant digital information of the Web 2.0 and the need to be accompanied by metadata, a proposed solution was Social Tagging, by which the creators of metadata need no longer to be metadata experts or even the authors of the digital content.

Therefore, the metadata formation is now done by the end-users of the system (Mathes, 2004). The user reflects his self as he sums a chain of words standing on his own experience and attitude. Additionally, the collaborative tagging of the objects provides personal metadata that drain interesting information for the entire community (Dahl &Vossen, 2008).

### *2.2.1 Social Tagging and Search Effectiveness*

All along, search engines had only access to three major types of data describing pages: page content, link structure, and query or click through log data. Nowadays, a fourth type of data, tags, which is an end-user generated content that describes the pages directly, became available (Heymann et al., 2008; Khalifa & Davis, 2006). For example, if a video or an image is described with the tag “Second Life”, then when a user type in a search engine the word Second Life, the digital content tagged with the corresponding word will appear in the results list.

Consequently, tags can be a powerful tool for social navigation which can help people to share and discover new information generated by other community members (Sen et al., 2006). There is also a perspective that tags offer manifold descriptions of a given resource, which potentially augments the probability that searcher and tagger find a common verbal communication and thus retrieval effectiveness may be improved (Heckner et al., 2009). In addition, it has been shown that the use of tags helped users to retrieve quickly and easily the digital objects they visited, compared to the users that simply store the contents (Heymann et al., 2008; Budiu et al., 2007).

Folksonomy enables anyone to access to any web resource that was previously tagged, on the basis of two main models for information access: Information Filtering and Information Retrieval (Hassan-Montero & Herrero-Solana, 2007). In Information Filtering, the system is pushing or sending along information via RSS/Atom syndication and thus the user is alerted for a new resource of his interest. In Information Retrieval the user looks for information actively introducing tag or tags in the search field to obtain an ordered list of resources related to these tags.

Tag clouds are argued to provide navigational clues by displaying in a visually attractive style links to the most popular tags in the folksonomy with the font size that depends on their popularity, enabling in that way a tag-based navigation (Mesnage & Carman, 2009). They seem to be specifically useful to enhance navigation in Social Tagging systems by giving the opportunity to the users for exploring and navigating the resource space.


***Figure 1:*** *Tag Cloud (Wikipedia, 2012)*

However, research results indicate that the fashionable approaches to using tag clouds for navigational purposes is not necessarily useful when someone is looking for specific information (Sinclair & Cardew-Hall, 2008), nor enable one to infer semantic relations among tags, and generally may suffer from significant problems (Helic et al., 2010).

Hassan Montero & Herrero Solana (2007), proposed an alternative interface model which affords visualization of both the overview and the details of semantic relationships inherent in a folksonomy and is represented as a network of tags connected by the most significant links.

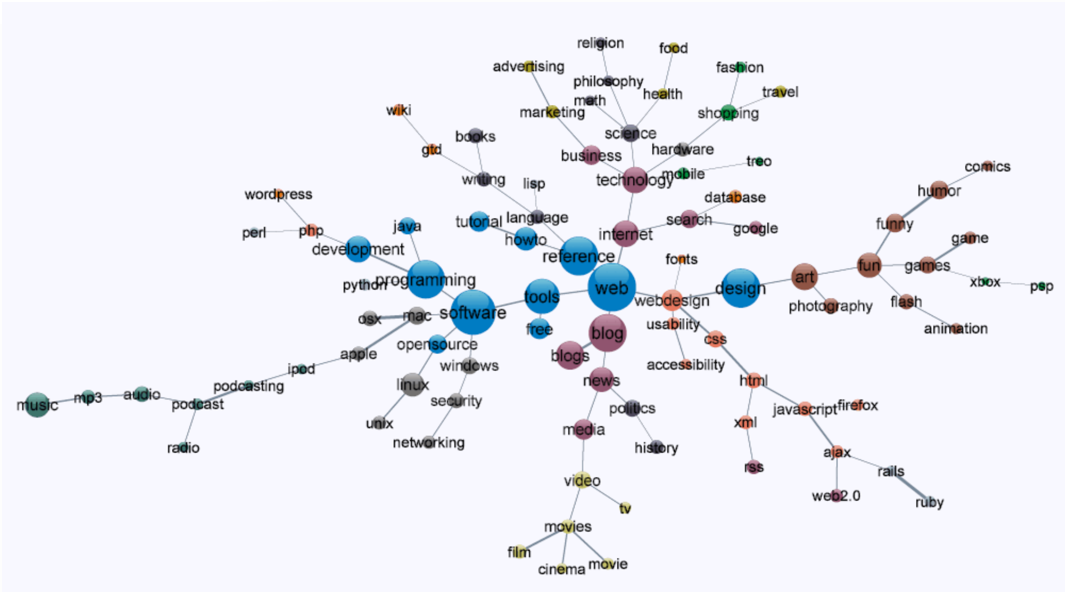



***Figure 2:*** *Alternative Interface Model (Hassan Montero & Herrero Solana, 2007)*

The tree in figure 2 shows a core of large tags around technology (web, tools, software, programming, design, etc.), where each branch of the tree contains mainly tags of the same cluster. The model is interactive and is able not only to show the related tags but also to state clearly their linking structure.

The rapidly rising quantity of shared data in folksonomies, presents new technical challenges caught up with discovering resources which are likely awareness of the user. Social Tags which mirror the meaning of resources from the user's points of view offer the opportunity to increase the quality of retrieval (Bi et al., 2009).

### *2.2.2 Social Tagging, Folksonomy and Collabulary*

A folksonomy, a term invented by Thomas Vander Wal (2004), is a user generated classification, emerging through bottom up consensus (Gupta et al., 2010). The etymology of the word "folksonomy" derives from the words "folk" (people), "taxis" (classification) and "nomos" (management) and the term was created to mean the wide-spreading practice of collaborative categorization using freely chosen keywords by a group of people cooperating spontaneously. A folksonomy can be defined as a collection of a set of users, set of tags, set of resources or objects, and a ternary relation between users, tags and resources with a time dimension (Dellschaft & Staab,2008).

In addition, given that folksonomy is rooted in collective agreement, these tags have a more precise, honest and democratic meaning than the ones assigned by a single person (author, professional indexer or librarian)(Hassan- Montero, Herrero- Solana, 2007). Therefore, there is a personal tendency while interacting with the tagging system as user's vocabulary reflects his knowledge. The user's vocabulary (the set of tags and tagged objects) developed over time is called personomy (Wetzker et al., 2009) and the collection and sharing of all users personomies constitutes the folksonomy (Hotho et al., 2006; Borth et al., 2010).

As expressed by Wu, Zhang and Yu (2006), users negotiate the meaning of tags, in an implicit asymmetric communication. Along the folksonomy and the standardized vocabulary there is also a third type that consists a compromised solution. This solution is called collabulary and is formed by the collaboration between end-users and metadata experts, constituting a shared vocabulary with help of classification professionals (O'Reilly, 2005).

According to Vandel Wal (2004), there are two alternative collaborative tagging structures, the broad system and the narrow system. A broad system has the property that any number of people may apply their own personal set of tags to an item and the tagging application is owned by the community. In contrast a narrow system represents a single shared set of tags for each item. Figure 3, demonstrates the difference between the two tagging structures. The arrow pointing from users to tags indicates that the specific group of users used this tag to describe the object. In the opposite case denotes that the group of users retrieved the object through the present tag. It is obvious that in broad folksonomies Social Tagging is more frequent and is happening from all the users of the community.

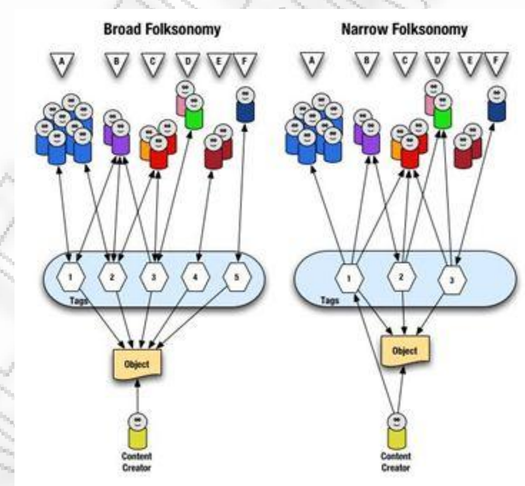



***Figure 3:*** *Broad and Narrow Folksonomy (Vandel Wal,2005)*

A broad folksonomy can be found in del.icio.us: Multiple users tag instances of the same object (a bookmark) with the same tags (Dahl &Vossen, 2008). For example, many users may tag a link to a Repository of Learning Objects "OpenScienceResources" with the tags "Science", "Resources" and a variety of different tags for the same content, storing the bookmark and the associated tags. The application of del.icio.us informs us how many people saved the link and shows the top tags.

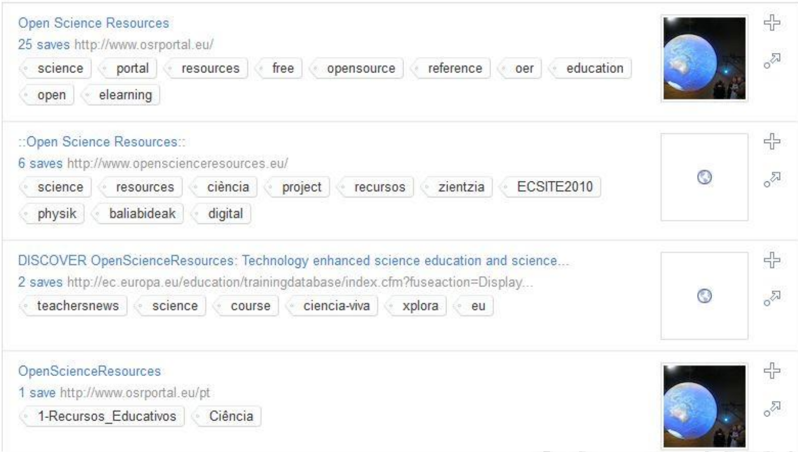



***Figure 4:*** *Del.icio.us: a broad folksonomy paradigm*

Accordingly, an example of a narrow folksonomy is Flickr, were the photos (digital objects) are singular and directly linked to tags, so the tag cannot be linked to a single object many times. As a result, a smaller number of tags for one object can be identified in that kind of folksonomy. In figure 5, there is a photo of school in Flickr followed by the tags assigned, added by the content provider.

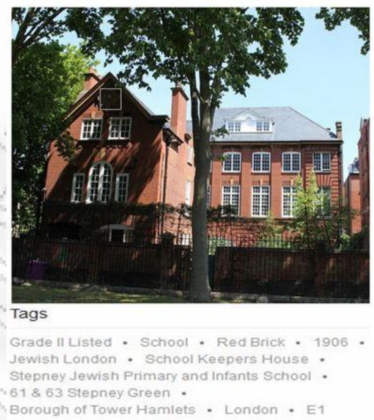



***Figure 5:*** *Flickr: a narrow folksonomy paradigm*

Thus, broad and narrow folksonomies affects another section of tagging system, the item ownership. In narrow tagging systems, people apply tags to items they created and posted. In contrast, within broad tagging systems, like del.icio.us people apply tags to work created by others as the objects most of the time are not created by the individual members of the community. The distinction which occurred by the Item ownership affects tagging behavior shaping in turn the collaborative tagging system (Sen et al., 2006).

Another considerable aspect of folksonomy formation is the social environment in which the Social Tagging takes place. The tag sharing dimension describes whether a user’s tags are shown to the other users of the system, dividing in that way the tagging systems into private, fully shared and system that lies in the middle of the aforementioned (Sen et al., 2006). In a private system, the tag application is visible only to the owner of it, while a fully shared system makes tags able to be seen from all the users. The third type is applications that provide a balance between the privacy and the openness offered by the other two types by allowing people to manage who is able to view their tags.

Folksonomy occurred through Social Tagging, contributes to the strengthening of the social networking element between the users as it is creating user communities through interaction. Specifically, both the tags that are used to characterize a specific digital object and the links between the digital objects assigned with same tag, allow users to connect to other users who used the same tag, exchanging in that way contents of common interest (Marlow et al., 2006).

In the same way, a quite opposite process may take place providing the opening to the community to influence user's tags. Thereby, users act as in a way other people is acting because they believe that this is the right way. The fact that others' tags influence behavior can also be supported by theory of social proof (Sen et al., 2006). In this regard, Golder and Huberman (2006) found that the relative proportions of tags applied to a given item in del.icio.us appear to stabilize over time.

In summary, it can be said that folksonomies are a compromise among the traditional structured classification and no classification/metadata at all. Further, the familiarization of the classification scheme from end-users could be an either difficult or impossible procedure. Maintaining a controlled vocabulary could be expensive in term of development time thus making folksonomies is better than nothing when the structured classification is not viable (Gupta et al., 2010). Eventually, folksonomies are equivalent to end-users' actual requests and language.

### *2.2.3 Social Tagging Process*

Tagging Applications were made especially for carrying out the Social Tagging. For the process we can represent the folksonomy by a tuble F:= (U, T, R, Y) where T is the set of tags that comprise the vocabulary expressed by the folksonomy, R represents the set of objects that are annotated with tags T and U corresponds to the set of the users-taggers that annotate the objects R. Finally, Y is the set of assignments of each tag to an item by a user (Bi et al., 2009; Cantador et al., 2010). Figure 6 demonstrates the Social Tagging process on museum websites.

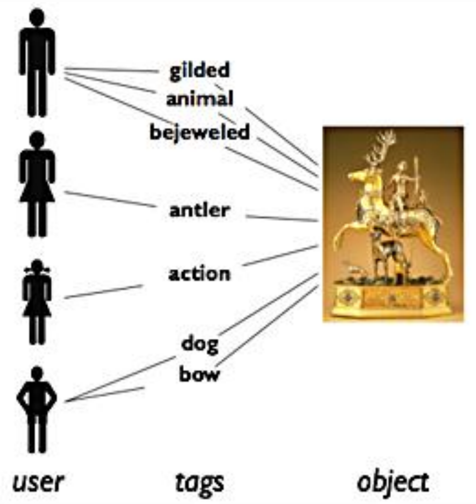



***Figure 6:*** *Social Tagging process on a museum website(Trant, 2009b)*

**User:**

User in Social Tagging is able to describe a digital resource adding a tag or a set of tags on it accordingly to his personal tendency, knowledge and attitude. Through the tags reflects his personal meaning towards the assigned digital object and enhance the ability of search and retrieving of the current objects benefitting his own self and the other users.

**Object:**

Object in Social Tagging may be many types of digital resource like text, video, image available in the World Wide Web. In order to be retrievable, the object is described by standardized metadata. In Social Tagging the object is assigned to a set of tags derived from users showed a specific interest in it.

**Tags:**

Tag is a word or a set of words, used in order to describe an object. Tag is considered as a type of metadata with a lack of a standardized vocabulary. As a result, tags can be added from all the users.

Furnas et al. (2006) proposed a conceptual model for Social Tagging systems (figure 7) where users assign tags to a specific resource and tags are represented as typed edges connecting both users and resources. Furthermore, resources may also be connected to each other (as links between web pages) and users may be associated by a social network or sets of affiliations (users in the same workplace).

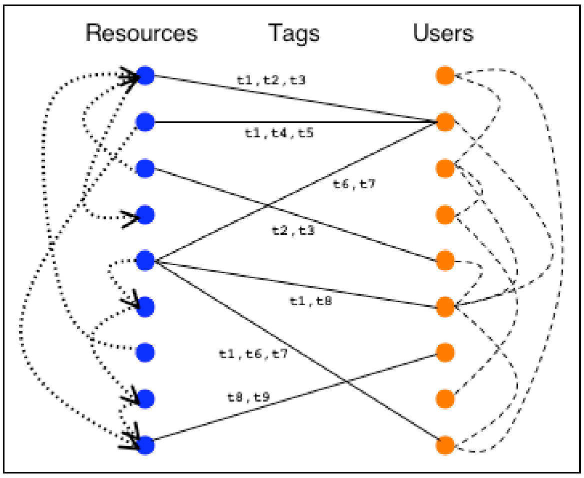



***Figure 7:*** *Conceptual model for Social Tagging systems(Furnas et al., 2006)*

However, there is also the claim (Walker, 2005) that Social Tagging is a structure out of control, where the same tag is assigned to different resources with different semantic senses, and thus connects unrelated resources.

### *2.2.4 Tags in Social Tagging*

Tags used in Social Tagging are divided and categorized in relation to many aspects of them. Xu et al. (2006) cited a taxonomy of tags constituted by 5 categories:

**Content-based tags**

The Content-based Tags express the content of an object or the categories in which the object belongs to. These tags are usually specific terms and are frequent in My Web 2.0.

**Context-based tags**

Tags provide the context of an object in which the object was created or saved, e.g., tags describing locations or time (Athens, 05/05/2012)

**Attribute tags**

Attribute tags are inherent attributes of an object but may not be able to be derived from the content directly (Jeremy's Blog).

**Subjective tags**

Subjective tags state user's opinion and emotion (funny, cool).

**Organizational tags**

Organizational tags identify personal stuff, e.g., my paper or my work, and tags that serve as a reminder of certain tasks such as "to-read" or "to-review". This type of tags is usually not useful for global tag aggregation with other user's tags.

Golder and Huberman (2006) identified seven function of the tags by which they categorize the tags into seven categories:

**Identifying What (or Who) it is About**

Tags identify the topics of the object. These items include common nouns of many levels of specificity, as well as many appropriate nouns, in the case of content discussing people or organizations

**Identifying What it Is**

Tags can identify what *kind* of thing an object is (text, image, video) in addition to what it is about.

**Identifying Who Owns It**

Objects are tagged according to who owns or created the content. Given the apparent popularity and quantity of digital contents in web, identifying content ownership can be particularly important.

**Refining Categories**

Some tags do not seem to stand alone and, rather than establish categories themselves, refine or qualify existing categories. Numbers can be Tags of this category.

**Identifying Qualities or Characteristics**

Adjectives such as scary, funny, stupid according to the tagger's opinion of the content

**Self Reference**

Tags beginning with "my," like "mystuff" and "mycomments" identify content in terms of its relation to the tagger.

**Task Organizing**

When collecting information related to performing a task, that information might be tagged according to that task, in order to group that information together. Examples can be "toread", "jobsearch". Grouping task-related information can be an important part of organizing while performing a task (Jones et al. 2005).

Sen et al. (2006) through their research taking place in MovieLens platform introduced a compacted version of Golder and B. Huberman's taxonomy. In Table 1there is the association between Golder and B. Huberman's taxonomy and Sen et al.'s type of tags used in their research.

***Table 1:*** *Corresponding types and categories of tags*

| Type of tags by Sen et al. (2006) | Categories of tags by Golder & Huberman (2006) |
|---|---|
| **Factual Tags** | Identifying What (or Who) it is About |
| | Identifying What it Is |
| | Refining Categories |
| **Subjective Tags** | Identifying Qualities or Characteristics |
| **Personal Tags** | Identifying Who Owns It |
| | Self Reference |
| | Task Organizing |

**Factual Tags**

The factual tags identify "facts" about a movie such as people, places and concepts. Factual tags are agreed to be the most people would apply to a specific movie. This type of tags, help to describe movies and also help to find related movies. The current category corresponds to the Golder's classes: item topics, kinds of item, category refinements.

**Subjective tags**

Subjective express user opinions related to a movie. They can be used to help evaluate a movie recommendation. This category corresponds to "item qualities" class.

**Personal tags**

Personal tags have an intended audience of the tag applier themselves. They are most often used to organize a user's movies. This category corresponds to "item ownership", "self-reference" and "task organization" class.

Table 2 shows the ten tags of that class applied most often, across groups. The tagging system, was a broad system where people could apply their own set of tags at each movie.

*Table 2: Ten most popular tags in every class and their frequency (Golder & Huberman, 2006)*

| Factual | Subjective | Personal |
|---|---|---|
| **action (134)** | classic (235) | bibliothek (253) |
| **drama (104)** | chick flick (61) | in netflix queue (177) |
| **disney (86)** | funny (60) | settled (148) |
| **comedy (86)** | overrated (54) | dvd (122) |
| **teen (64)** | girlie movie (51) | my dvds (110) |
| **james bond (62)** | quirky (39) | netflixq (87) |
| **super-hero (57)** | special (29) | get (58) |
| **japan (56)** | funny as hell (25) | ohsoso (48) |
| **true story (55)** | funniest movies (23) | buy (35) |
| **crime (54)** | must see! (22) | (s)vcd (32) |

## 2.3 Advantages and Disadvantages of Social Tagging

The use of Social Tagging in describing digital resources causes some advantages and disadvantages. The review is upon the comparison of Social Tags and formal metadata and the overall usability of Social Tagging in the digital world of resources as revealed from literature (Bi et al., 2009; Yin et al., 2009; Trant, 2009a; Hayman, 2007; Vuorikari et al., 2007; Xu et al., 2006).

### *2.3.1 Advantages of Social Tagging*

Proponents of tagging systems cite a number of theoretical advantages derived from Social Tagging, from the resulting folksonomy and from network effects. In this section the characteristics of tagging and folksonomies that can be seen as beneficial features are analyzed:

1. Social Tagging is a very speedy, easy and straightforward process where users can apply their tags without proper training in classification or indexing. So, folksonomies are benefit from that fact and an increasing number of users have been

taking part in Social Tagging systems and have contributed a great amount of resources.

2. Social Tags are multidimensional: users can express a concept by combining a large number of tags representing web objects in a meaningful feature space. Therefore Social Tagging may bridges some gap between browsing and search. Browsing list all objects and finds the desirable one by exerting the recognition feature of human brain, whereas search uses association and jumps straight to the interested objects, and thus is mentally less repugnant.
3. Users can use their own language: the tags are words having meaning for them. These words are possible to be modern and mirror local usage.
4. By Social Tagging users analyze items to highlight what is important and with meaning to them
5. Social Tagging creates knowledge through the aggregation of shared tags. In this way crucial information helping to pull together new ideas can be gathered (Rainie, 2007). At the same time this information is provided to professional providers and managers about areas of interest and how they are being described. Generally is a way to provide insight into users' desires and habits.
6. An object tagged with many different terms it can be readily assembled by searching for single tags or pairs. Thus, instead of having to store an item in a single folder, it can be tagged and categorized in various groups. As a result it is offered serendipitous access to objects through tags.
7. By Social Tagging, the development of communities around common interests and viewpoints is fostered. Therefore, Social Tagging also gives enhanced possibilities to share resources with emerging social networks and develop social cohesion in a group.
8. The new concepts that are emerged in personal tags and shared in social systems, leads new users to content. This is where Social Tagging seems to offer a number of affordances, primarily related to the use of the resulting folksonomy by others for information retrieval, browsing, searching or current awareness.
9. Social Tagging, potentially offers advantages in terms of personal knowledge management and it can also considered as a re-discovery tool.
10. Social Tagging provides the mean to interconnect web objects in order to indicate implicit relationship and bridge heterogeneous objects so that category information can be propagated from one domain to another.
11. Social Tagging promotes a sense of ownership of content

### 2.3.2 *Disadvantages of Social Tagging*

However, despite the advantages of Social Tagging features in Web 2.0, is impossible not to be accompanied by some disadvantages which hinder its effective utilization. Some of Social Tagging drawbacks are denominated below.

1. The simplicity and ease of use of tagging can result in poorly chosen and applied tags. This also may lead Social Tagging systems vulnerable to spam and malicious practice. Additionally, tags are not connected to each other by a reference structure and as a result they are not narrower or broader terms. Since tags are created by end-users in a free form, they can be messy when compared with an expert structured metadata system and this lack of order can result in a failure, leaving the users muddled in a "hodgepodge"
2. Tags can be applied at different levels of specificity by different or the same user. For example both the tags "dog" and "animal" can be used.
3. Different terms may be used for the same concept by different or the same user. So "mammals" may be used for some items and "dogs" for others. Also, tags in Social Tagging are likely to be changed towards new trends evolution. For example a tag describing blogs is virtually sure to be seen as "blog" or "weblog" or "blogging" where all of them will be used for the same concept.
4. A person searching for pictures will have to use many different terms to be sure of finding all items. For example "dog", "animal" and "mammal".
5. The Social Tags with personal meaning are of practically no use to anyone else. For example in Flickr the tag "myhomeinGreece".
6. In Social Tagging the same term can be used for different concepts. For example the word play could occur in an educational resource collection in the drama context or the games context and no information about the meaning of the tag is provided. There is concern over the relativistic nature of socially created vocabularies such as problems with synonymy and polysemy and the congenital unconformity of a user-generated vocabulary may restrict the importance of a folksonomy as an indexing language and retrieval tool. Even if folksonomies are built for specific communities where the meanings chosen are appropriate for that context there is a chance that within communities there can be ambiguities of meaning.
7. Uncontrolled Social Tagging can cause a mixture of types of things, names of things, genres and formats. Some of these problems arise even with specialist indexers, for example using "video" as a tag when the item is a video or if it's an item of other type talking about videos.

8. Many systems allow only single word tags. It may be difficult to assign terms to complex concepts using only a single word and running two or more words together is difficult in many ways – the resulting words will be highly idiosyncratic and difficult to read and to search with precision
9. Tagging other people's items as opposed to their own items could cause a consciously or unconsciously different behavior as the objectivity of a professional indexer is absent in Social Tagging.
10. Social Tagging interaction in a community is likely to result in discouraging the usage of the less popular tags that are excessively oppressed by the mass and over time tags may come to correspond to a dominant view. This will lead to less precise tags available for the concept of objects as the creation of the users' own tags will be depressed. As Zeldman (2005) writes: "Network effects being exponential, what is immediately mildly popular quickly becomes artificially very popular, while what has yet to become popular never will be."

It is assumed that as folksonomies grow, the larger scale can bring some organization into the tagging process (Hayman, 2007). Thoughtful users will evaluate tags and are inclined to use existing tags to assist with forming useful connections. Thus, tagging conventions can be developed in order to serve several communities through group agreement rather than an externally compulsory and probably dated formal system. A sort of this convention may form the "collabulary" mentioned in previous chapter.

Undoubtedly, beyond the disadvantages of Social Tagging, there are definitely clearly immense profits in Social Tagging and folksonomies, particularly in the wealth, currency, significance and variety of the terms used, and the collections of resources created. It is certainly vital to seek to hold on to those qualities in any effort to direct folksonomies.

## 2.4 Contribution of Social Tagging in Technology-Enhanced Learning

Technology Enhanced Learning (also known as e-Learning) is a learner-focused approach to the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services, as well as remote exchanges and collaboration (European Commission, 2008).

Rosenberg (2001), discusses the opportunities Internet and World Wide Web offers to all fields of practice underlining the infrastructure and technology considerations for succeeding in technology-enhanced learning. She argues that any e-learning strategy is doomed to failure without adequate access to the Internet as access to information is as essential for learning as instruction.

Adding an *e* to learning has introduced other factors to the equation for maximizing the efficiency of education (such as the significance of technology and infrastructure) but it has also confirmed or even increased the importance of Content as a founding pillar of Education (eLearning Industry Group report, 2005). As technology broadening itself into our daily lives and more specifically into schools, the need for rich media content of high quality is growing rapidly. Furthermore, the desirable content must be effectively interoperable as to fit to different platforms and digital devices.

More specifically, the key components of Technology-Enhanced Learning are (Sampson, 2011):

**Learning Digital Content**

Learning digital content consists by objects and ontologies with independent learning value called Learning Objects which are properly annotated with Educational Metadata.

**Learning Digital Activities**

Learning digital activities contain both the description of the learning activity (the participants with their needs and attributes, the necessary tools for implementation etc.) and the Learning Digital Content.

Bateman et al. (2007) endorse that Social Tagging has a strong possibility of being a leading technique by which learner-centric metadata are collected and in general Social Tagging systems have potential to be a good fit with e-learning systems, because of the following:

1. Learning content in LMS (Learning managements systems) currently lack sufficient support for self organization.

2. Learning content has a potential to be enriched with further peer interactions and peer awareness through Social Tagging practice.

3. Students are most likely to take advantage of Social Tagging as by its very nature is a reflective practice, which can offer students the opportunity to sum up new ideas. In the meanwhile, they are receiving peer support through viewing other learners' tags and tag suggestions.

4. The tags provided by the Social Tagging practice, nourish the insight on learner's comprehension and activity. Undoubtedly, its impacts seem to be useful for both educators and administrators.

While the Social Tagging practice in technology-enhanced learning is quite straightforward, currently is largely unemployed, even in popular web-based LMS as Blackboard and Moodle. On the other hand Social Tagging and folksonomies seem to be participant in a daily e-learning practice in other systems like Elgg and have even impacted the development of new pedagogical theories such as connectivism (Torniai et al., 2008; Siemens, 2005).

Online learning communities and the use of eLearning tools have been verified to enhance social consistency and social capital links between European citizens by shaping virtual, learner-centric learning communities(eLearning Industry Group report, 2005). In view of the fact that social integration lies on the contribution of all citizens in education and training, Social Tagging can be a social e-Learning tool which favors Technology-Enhanced Learning.

### *2.4.1 Social Tagging and Learning Objects*

The Learning Object paradigm suggests that online learning digital content can be collected, gathered, and packaged up for delivery to learners, educators or other people interested in Technology-Enhanced Learning.

Specifically, based on the unified definition "A learning object is a potentially reusable digital or non-digital resource or a collection of interconnected resources and is annotated with metadata, is designed for a specific purpose, aims to achieve one or more Educational Objectives, and is used to support one or more educational activities for which there are clear metrics to achieve the educational goals set." (Sampson & Papanikou, 2009)

According to Schoonenboom (2012) Learning Objects are the smallest objects and are described from these three elements:

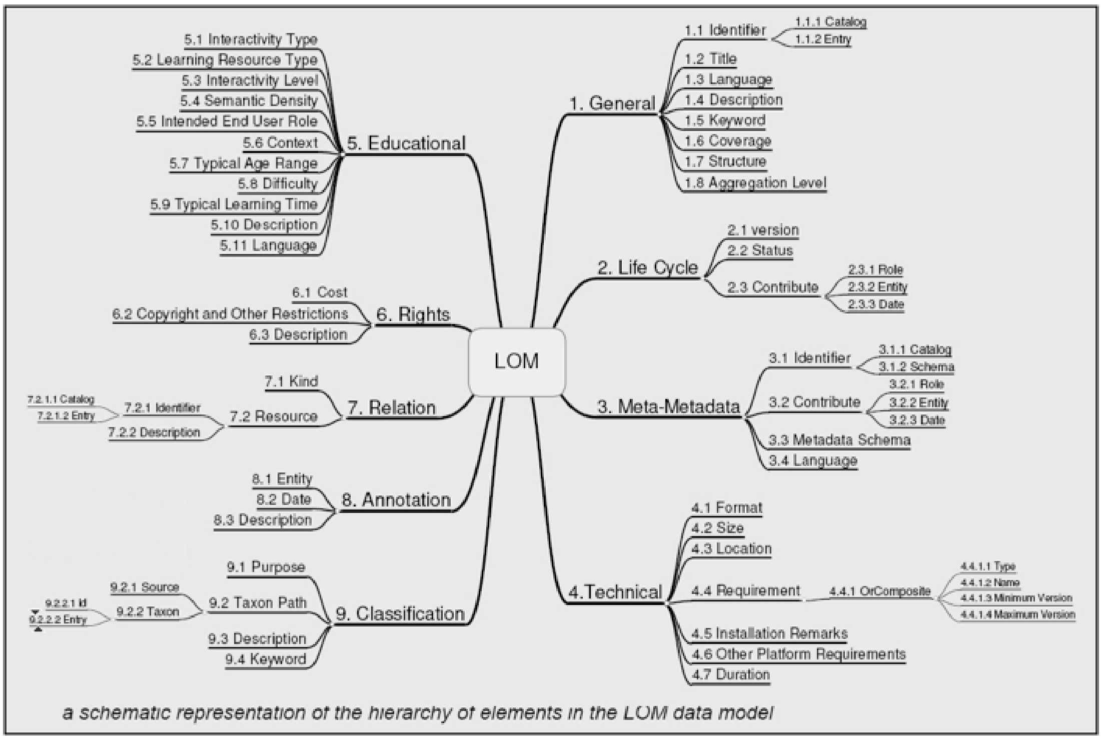
1. Sharing: are being used separately by the intended audience;
2. Flexibility: can be used within a set in different sequences;
3. Cohesion: address one learning objective

However, it is not enough to design the content according to the mentioned fixed standards, it is also important to make sure that the various content repositories are made available for search and retrieval in a standard fashion (eLearning Industry Group report, 2005). It is claimed that educational metadata can significantly enhance the effective description, search and retrieval of learning objects resulting in efficient organization of educational resources for technology supported instruction (Sampson & Zervas, 2008).

For the annotation of the Digital Learning Objects with educational metadata there are two paths. The first path is Social Tagging, a relative new practice which is being examined in this report and the second one is the pre-existent path of formal metadata offered by metadata standards. Nevertheless, It is believed that the combination of these two approaches can improve some typical activities in learning as revisiting learning material, personal note taking and connecting with peers (Bateman et al., 2007). For the better understanding of

Social Tagging practice, formal metadata practice is also being examined in order to distinguish the differences between the two practices and to allocate the whole procedure of learning objects' description.

The commonly accepted approach to annotate educational resources is the IEEE Learning Object Metadata (LOM) Standard. Nonetheless, some educational metadata management systems are still using other specifications (Ariadne, Dublin Core, etc.). The IEEE LOM is the standard that specifies a conceptual data schema defining the structure of metadata instance for a learning object (IEEE, 2002). The metadata instance of the learning object describes the features of the object which they may be grouped in several categories. Also, it specifies the data elements which compose the metadata instance for a learning object. The IEEE LOM standard is useful to the management, location, evaluation or exchange of the objects. The complete LOM element hierarchy is presented in figure 8




*a schematic representation of the hierarchy of elements in the LOM data model*

***Figure 8:*** *Categories and elements of IEEE LOM Standard*

IEEE LOM defines a hierarchy of elements that are grouped into nine categories: General, Lifecycle, Meta-metadata, Technical, Educational, Rights, Relation, Annotation, and Classification. Each category is comprised of sub-elements that have some basic characteristics in common and appear either as a single element or as an aggregation of other elements.

However, the use of a specific metadata standard sets limits as it is difficult to cover all the requirements of applications. This issue led to the creation of Application Profiles. An application profile is an assemblage of metadata elements selected from one or more metadata schemas. The European Committee for Standardization (CEN/ISSS) defines an Application Profile (AP) as a package of adapted or combined existing schemas and be customized as to fulfill the functional necessities of a particular application whilst hold on to interoperability with the authentic base schemas.

As a result, the applications that make use of application profiles can benefit by developing the features of an existing schema and by elevating them with desired characteristics. At this point, an even more specialized Application Profile has been deployed, the "Science Education LOM Application Profile" (Sampson et al., 2011). Some popular application profiles are CanCore, GEM, UK Learning Object Metadata Core, DC-Ed and SCORM. Figure 9 shows the ASK-LOMAP, an open source web-based application for creating application profiles and manipulating application profile registry.

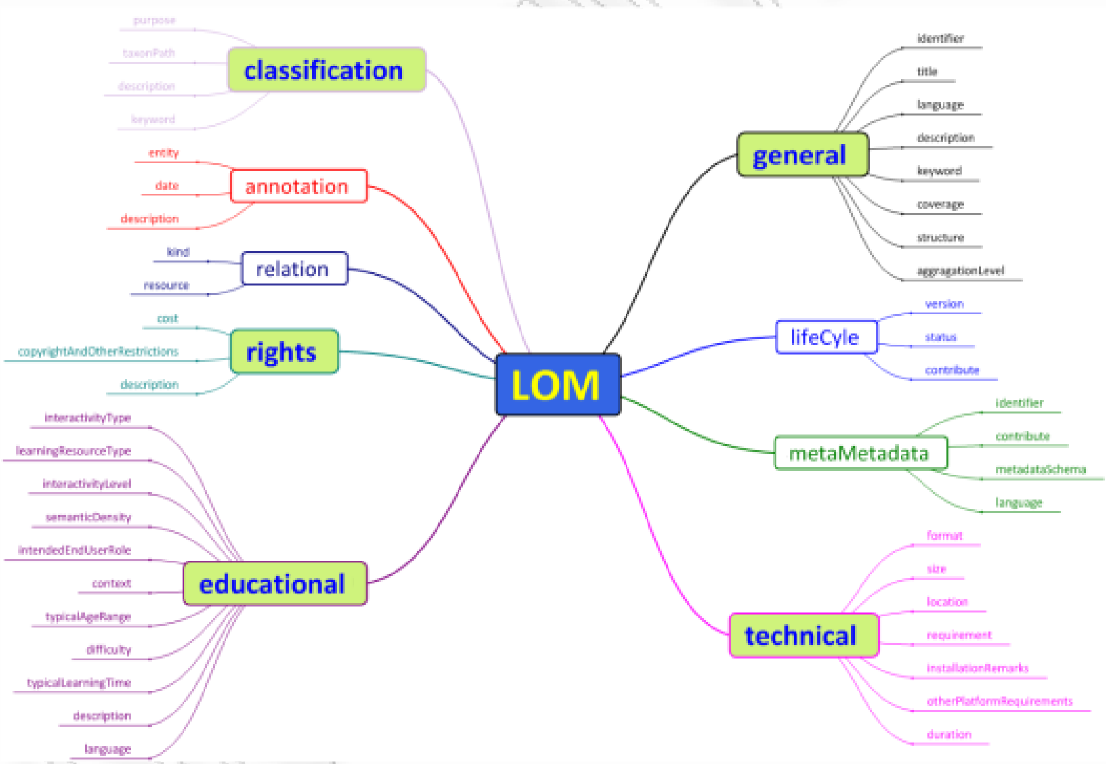



***Figure 9:*** *ASK-LOM-AP: application for creating application profiles*

In the field of Technology-Enhanced Learning, the annotation of the Learning Objects is carried out by (Currier & Barton, 2003):

**Metadata Experts**

Metadata experts are responsible for the annotation (basic information or descriptive notes) of a Learning Object which a user or a machine has recorded. The information must be rewritten as conformant metadata. The trained metadata expert carries out this task as well as ensuring that the remainders of the necessary fields are filled in correctly. However, sometimes metadata experts are not adequately informed for the cognitive subject or the specific learning activity resulting in inefficient filling of Object's Learning Metadata.

**Authors**

The author of a resource creates all the learning metadata when uploading their resource to the repository. Users of this category are not metadata experts and they may only have access to the upload tool provided by the repository. For the annotation of the Learning Objects with metadata there are likely direction comments, online tutorial or wizards as drop-down menus. In general, the support in classifying may be automated and probably there are suggesting classifications based on keywords already entered. The annotation of Learning Objects by non metadata experts may cause negative consequences on the quality of metadata. Therefore, a validation of the author's metadata from a metadata expert is required.

**Collaborative**

The third category consists of both the learning object's author and the metadata expert. In this situation, the author enters information in certain fields, such as their own name, the resource title, the institution, the digital rights information and the educational fields. A metadata expert in his turn checks the abovementioned for their accuracy and inserts information of technical nature to the other selected fields such as the subject classification, the keywords and the accessibility information. The collaboration may be truly constructive, with the parties communicating directly, or less collaborative with the expert just checking occasionally the records.

In the last years the web has witnessed an explosion of information created and shared, by individuals and through social interaction (Sen et al., 2006). Given that each user has different expectations, needs, goals, knowledge, and desires to be satisfied, this quantity of information has generated a huge require for successful access to resources. Therefore, since 2004 *Tagging* sites and services have blossomed on the Internet (Sen et al., 2006; Hammond, 2005), where enable users to save and tag pages enhancing the browsing and search for the content without being metadata experts or event content authors. Some well known tagging services on the web is Flickr, Delicious, My Web 2.0, etc.

Consequently Social Tagging in the Web 2.0 environment is a relatively new aspect of personal organization of online information (Moulaison, 2008). Additionally, it is observed that Social Tagging on online portals has become a trend now (Gupta et al., 2010) consisting one of the best ways of associating metadata with web objects.

Along with the increase of digital content and tagging services in Web 2.0, a comparable increase of the Learning Objects available online was observed resulting to the creation of the aforementioned Learning Objects Repositories (LOr).

The metadata of the Educational Objects are stored in databases called Learning Objects Repositories (LOr). As the quantity and quality of the learning objects increases, LORs are becoming more and more significant resources for both learners and instructors. In a LOr is available the exploring tracking, access and retrieval of Learning Objects through their metadata. In order to take full advantage of LOs, instructors, developers and learners need to know about LORs and have some training in how to make optimal use of them.

There are three types of Learning Objects Repositories (McGreal, 2007):

1. Type 1: LOr that host content mainly on site;
2. Type 2: LOr that mainly provide metadata with links to LOs housed at other sites;
3. Type 3: Hybrid LOr sites that provide both housed content and links to external content. These repositories include both general repositories that host learning resources from a broad diversity of subject areas and those that are focused on specific themes or issues.

Some examples of Learning Objects repositories are the famous “MERLOT”, “EduSource Canada”, “LORN”, “ARIADNE”, “OpenScienceResources”, etc.

As the annotation of the Learning Objects in the Lors through the IEEE LOM standard, imposes a strict classification of the content and complicates the search and retrieve of the appropriate Learning Objects (Bateman et al., 2007; Vuorikari, 2007), folksonomies based on Social Tagging of content have emerged as a promising new way for discovery, categorization, classification and reuse of them.

The reuse of a Learning Object is an important component and it is defined as “the extent to which a Learning Object can be used in different digital or non digital learning activities, where a learning activity is defined as the interaction of learner(s) with other(s) and with a learning environment, which emerges as a result of performing a task within a particular learning context in order to achieve one or more learning objectives” (Sampson & Papanikou, 2009).

In literature, two types of reuse are distinguished (Bennett et al., 2006; Lockyer et al., 2009). The first one is related to the reuse of content like a piece of learning materials that are called as we stated above "learning objects" and the second one occurs when a "learning design", a documentation of learning practice is reused.

As it is known the development of e-learning materials is expensive (Gobee, 2005) and because of that, it is aimed to make e-learning materials better reusable in the form of Reusable Learning Objects (RLO's). Once the ratio of production "cost" to "number of uses" nears zero, access to learning objects can be made available for free (Wiley, 2011). Therefore, a very important factor of having free access to Digital Learning Objects is the repeated reuse which nowadays is facilitated by the growing ubiquity of the ICT . In this sense, as metadata is an 'interface' to data (Klemke et al., 2010; Schaffner, 2009) and context is important in determining meaning (Wiley, 2011), the annotation of the Learning Objects with formal (standardized vocabulary) or informal (Social Tagging) metadata, will make available the reuse of Learning Objects, constituting the answer key for the learning content management practice.

### *2.4.2 Social Tagging and Context of use of Learning Objects*

This kind of new way of collaborative tagging offers an attractive alternative to recent efforts at semantic web ontologies (Golder & Huberman, 2006; Shirky, 2005b). Although social annotations, compared to the formal annotations, are informal and indeterminate, they reflect better the digital resources meaning from the users' point of view (Wu et al., 2006) and they are also more accessible to more people.

Social Tagging systems provide users the opportunity to freely choose, the so-called, tags to annotate the Learning Objects without the enforcing of use rigid taxonomies with controlled and standardized vocabulary. Therefore, the creators of metadata need no longer be metadata experts like in library information systems or authors, as it is mentioned above. Instead, the creation of metadata is now done by the end-users of the system (Dahl & Vossen, 2008; Mathes, 2004), who are personally interested in Learning Objects.

In this context, Social Tagging has emerged as an alternative to traditional forms of organizing information (Helic et al., 2011) by which tags constitute personal metadata provided by many users and form a "folksonomy" when brought together, providing to an entire community of users interesting information and the opportunity to reuse an entire community of Learning Objects

Pegler (2012) focused on identifying what appears to *motivate* sharing and/or use (reuse) of online educational resources (table 3)

***Table 3:*** *Three Classes of Factors*

| Factors | Description |
|---|---|
| **TECHNICAL** | This factor includes technical concerns about metadata and rights, e.g. how resource descriptions were recorded and shared, what form of license was chosen, etc. |
| **QUALITY** | This factor is usually related to the resource used or shared, although they could also refer to the quality of the service, e.g. the user-friendliness of the repository interface. |
| **MOTIVATION** | This factor is related to the *purposes* informing the decision to engage in reuse (sharing or use), or leading to decisions or preferences about the *conditions* under which reuse occurs. Those could impact on Quality or Technical decisions. . |

Pegler due to his research research, distinguished factors for having a positive effect on motivation to reuse of existing learning objects in contrast to creating new ones. The most important factors are:

1. The learning quality is improved;
2. This practice will save me time;
3. The resource is rare or unusual;
4. This practice is more efficient and saves money;
5. This practice increases use of resources

Therefore, every user is tagging for personal reasons and the annotations are stored in a database of a Learning Object by either formal metadata or Social Tagging enhancing the context of use of the content. Without the annotations it can be difficult to decide exactly what a learning object is supposed to mean and where it might or might not fit (Wiley, 2011).

It is agreed that Learning Objects should be reusable in different contexts (Duncan, 2003; Polsani, 2004; Silveira et al., 2007; Wiley, 2001) and for that reason they need to be sophisticated, sequenced and context-oriented to support various learning styles and knowledge levels (Kim & Moon, 2012; Muyinda et al, 2011).

By metadata, the content and its source is completed, since metadata define the structural associations between the Learning Objects or within them and clarify the context. User-generated metadata as Social Tagging may be as useful as professional metadata for retrieval in some contexts although users providing metadata might not even know what metadata and of which category is (Melenhorst et al., 2008). In view of education content, metadata includes the general meaning of Learning Objects, physical content information, and standard components for interoperability (Sanchez-Alonso et al., 2011, Kim & Moon, 2012).

Allen & Mugisa (2010) proposed three main dimensions or spaces of Learning Object use and therefore context:

**Intra-learning object context**

The intra-learning object context is specifically related to the established pedagogic significance of a given learning object. This space is the maximum amount of context which lies within the learning object and it is mostly a description in terms of educational value and pedagogical context. Also, it's in charge for the limitation of the scope of learning object's usage, adjusting it into pedagogically suitable scenarios, allowing the user to judge whether the learning object is suitable for a particular educational situation and enhancing the search in the LOr. Moreover, it's remarkable that this context space doesn't change in any situation.

**Inter-learning object context.**

The inter-learning object context describes the context within a learning object assembly or composition. For instance, the description of a context, allocates the learning object as a part of a sequence, stating which part is preceded or comes next to it. The values of this space of context vary from one usage scenario to another. Thus, in one context the learning object can be a part of a course and in another context the same learning object can be a part of a course.

**Extra-learning object context.**

The extra-learning object context has to do with the details of the learning component that is to be created and the environment within which it could be used. Extra-learning as inter-learning object context can vary from one usage scenario to another as the same object may create a word or a pdf file. Despite the type of the component, the intra-learning object context remains exactly the same as the extra learning object context change from a usage to another.

Furthermore, a learning object's component that matters a lot in reusability is size. The size of the learning object is defined as "granularity" (Wiley et al., 2000). It is argued that as the grain size of learning objects decrease reusability increases and the learning object can be more easily used in a variety of contexts and vice versa (Allen & Mugisa, 2010). That's happening because in general the smaller objects are less contextual and meaningful, so they can be used in many contexts. So it could be said that context has somewhat of a negative effect on reusability and there is an ongoing challenge to find the balance among the decreasing context for higher levels of reusability while including sufficient context to make the learning object meaningful (Robson, 2004; Allen & Mugisa, 2010).

In this case, there is the challenge of creating learning objects that meet the golden mean of both reuse value and reusability. Though, the granularity case is not clear yet as there are different approaches to measuring learning object granularity even if nearly always it is determined by the needs of the given organization and its needs.(Thompson & Yonekura, 2005; Allen & Mugisa, 2010)

IEEE LOM metadata standard, through its aggregation model suggests four learning object aggregation levels. The granularity levels are named as levels 1 to 4 where Level 1 represents the smallest level of granularity, level 2 represents a collection of level 1 objects, level 3 is made up of level 2 objects and level 4 the largest level of aggregation is made up of level 3 objects or can recursively contain other level 4 objects. However the model is noted to be vague because it doesn't specify clearly the meaning of each level (Allen & Mugisa, 2010; Balatsoukas et al., 2008).

Table 4 shows briefly some assertions for Learning Objects and its context which (Wiley, 2011) proposed:

***Table 4:*** *Assertions of Learning Objects' Context*

| Assertion | Description |
|---|---|
| ***1. A learning object has no meaningful external context independent of its instructional use*** | External context is defined as the juxtaposition of a learning object against other elements, including other learning objects. The most meaningful external contexts for interpreting the meaning of a learning object are those spatial and temporal juxtapositions made in purpose to support the learning process. |
| ***2. The number of external contexts in which a learning object will fit instructionally is a function of the internal context of the learning object.*** | For example, a set of museum artwork object is easily usable in an art history curriculum because the component learning objects have been selected and instructionally used specifically to facilitate learning the particular lesson. |
| ***3. A large learning object has a greater internal context than a small learning object*** | Two or more small objects are contained in a large object and thereby, a large learning object has a greater internal context. |

| | |
|---|---|
| ***4. Large learning objects fit into fewer external contexts than small learning objects*** | One of the content management implications of this assertion is that if learning objects are stored in smallest pieces it is likely to maximize their potential for reuse. |
| ***5. Metadata facilitates the discovery, and therefore the instructional use of learning objects*** | Many learning objects are non contextual and because of that they cannot be discovered via full-text searching. Metadata provide a way for these learning objects to be located. |
| ***6. Metadata about the internal context of large learning objects is more valuable to users of a learning object than metadata about the large learning object's previous external contexts*** | A large object has an internal context sufficient to restrict its use to a closed set of learning or external contexts . |
| ***7. Metadata about the previous external contexts of small learning objects is more valuable to users of a learning object than metadata about the small learning object's internal context*** | Small learning objects are by definition single elements. |
| ***8. The potential for instructional use of different types of learning objects will be maximized by different types of metadata.*** | One of the content management implications of this assertion is that is difficult<br>to combine assertions 4 and 5 and thus capture different kinds of metadata about different kinds of learning objects. |
| ***9. The value of objective metadata in facilitating learning object discovery is stable across learning object types be they small or large, and should be captured for all learning objects*** | Assertion 8 states that different types of metadata must be used to maximize the potential for discovery and use of different types of learning objects. |
| ***10. Automation of the instructional use of large learning objects may be possible in simple cases*** | The internal context of a large learning object significantly limits the external contexts into which it will fit instructionally. |

| | |
|---|---|
| ***11. The instructional use of small learning objects cannot be safely automated.*** | The internal context of a small learning object constrains the number of external contexts into which it could fit much less than the internal context of a large learning object does. |
| ***12. Different types of learning objects are best suited to instructional use by different types of learning object users*** | An important decision must be made before implementing a learning objects strategy. For instance if you search for an assembly of learning objects you should search in a learning object architecture comprised of larger learning objects and the surrounding metadata early on. |

Consequently, some factors related to context and being responsible for the arduous practice of reusing Learning Objects are (Allen & Mugisa, 2010; Sampson & Papanikou, 2009):

1) A constituent smaller part of a learning object may be reusable in terms of its actual content but it could be difficulty in ease of reuse because of inherent interdependencies between itself and its original context. This is difficult to solve because learning material characteristically includes references to other parts within it.
2) A constituent learning object may be very difficult to reuse because it covers multiple concepts or learning activities that a user may not necessarily wish to reuse together.
3) The requirements of the learning activity do not match to the learning object. For instance, they may differ in any of the learning context characteristics in relation to the initial learning activity such as Subject Matter, Difficulty, Pedagogical Approach, Learning Objective, Characteristics of the Participants, Environment Type, Duration and/or the task characteristics such as the Type and Technique, Role, Interaction Type, Tools, Services, Resources and LOs, Assessment.

Gobee (2005) despite the fact that size is significant for reuse, argued to spoil the reuse of Learning Objects disagree with the size reduction, highlighting that the smaller objects may be better reusable but this comes at the price of simultaneously transferring less meaning so the context freedom doesn't offer a real solution.

Moreover, Wiley (2004) discusses a problem called "the reusability paradox" where humans make meaning by connecting new information to that which they already know so meaningfulness of educational content must be a function of its context. Based on that state further states that the more context a learning object has, the more (and the more easily) a learner can learn from it (Wiley, 2011).

### 2.4.3 Social Tagging and Description Vocabulary of Learning Objects

As pointed out in a previous section, the use of a learning metadata standard like IEEE LOM and Social Tagging aim at a main target. The scope of the Learning Objects' annotation with users' knowledge is the reuse of the specific Learning Objects through an effective search and retrieval (Dahl &Vossen, 2008).

The IEEE LOM standard provides a widely accepted approach of describing the basic dimensions of a learning activity and its associated learning objects. Figure 10 outlines the educational metadata of a learning objects based on IEEE LOM standard.

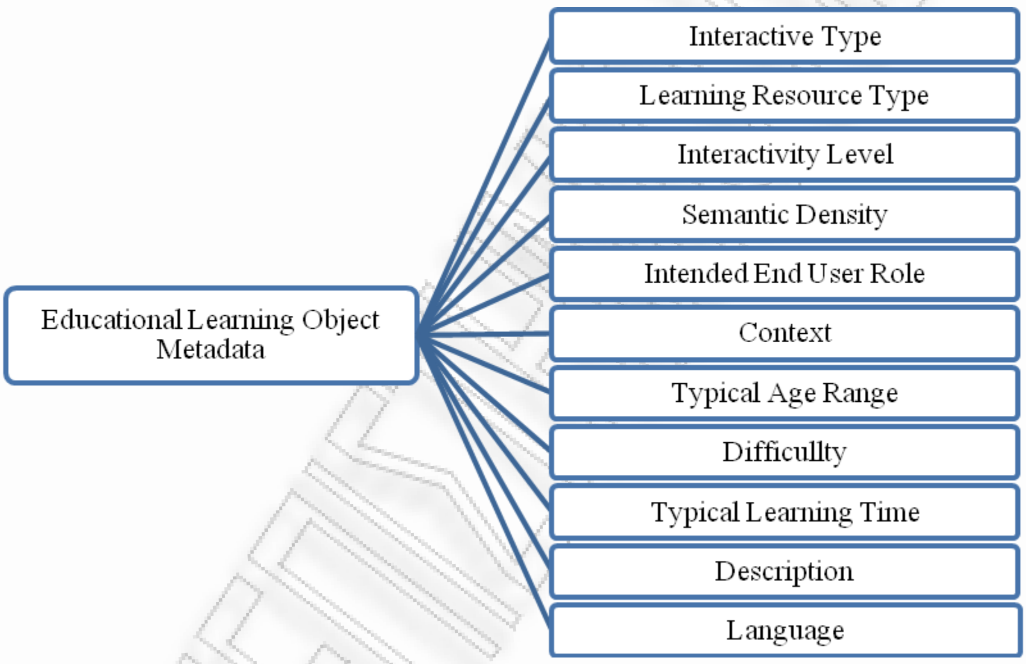



***Figure 10:*** *IEEE LOM Standard - Educational Metadata*

In contrary to the standard vocabulary that provides the metadata of IEEE LOM, in Social Tagging the annotation of the learning objects takes place through free tags. Despite the positive elements of Social Tagging, the description of Learning Objects with free tags is argued that it's not an appropriate practice for the required way of the LO's description and result to lead to an inefficient search, retrieve and reuse of the Learning Objects (Furnas et al, 2006).

However, the proponents of Social Tagging believe that the folksonomy type of vocabulary has been a "forced move" and emerged because of the non practical and economically extensive controlled vocabularies (Shirky, 2005a; Quintarelli, 2005; Trant, 2009a).

An interesting study of tagging in a museum has revealed that a huge proportion of 90% of the terms tagged by users were not listed in the vocabulary of the museum Trant (2009b).This fact reflects that sometimes the conceptual definitions adopted by the experts are often different from the common users.

Concurrently with the criticizers and the proponents of Social Tagging, there are also the supporters of a hybrid approach of the two practices.

Heymann & Garcia-Molina (2009), outlined the follow 3 observations while studying the differences between controlled vocabulary keywords and Social Tags.

1. Users and experts' keywords had many similarities, but eventually vary heavily as to how to apply them.
2. Experts are impossible to annotate works with all of the appropriate keywords.
3. Experts only label highly representative works with a term, rather than all works that might be considered to have the term, leading to low recall.

After the observations it was mentioned that even that the possibilities are ultimately bad for retrieval using expert assigned controlled vocabularies, a shared keywords-vocabulary is considered appropriate as the intersection among the formal vocabulary and the tags rarely intersect significantly

Rolla (2009) after comparing the users' tags and the library's suggests in a digital library, concluded that the tags can enhance the access to the objects but they cannot replace the controlled vocabulary. Alongside this finding, they conjectured that in a public library the tags may be more useful since the collections there are composed by popular materials.

Several major problems were identified with the current tagging systems: polysemy, synonymy and level variation (Golder & Huberman, 2006a; Golder & Huberman, 2006b; Szomszor et al., 2008; Noruzi, 2006; Sood et al., 2007; Vuorikari et al., 2007)

**Polysemy**

In polysemy phenomenon a single tag can have multiple meanings and refers to instances where a single tag can have multiple meanings. For instance, the tag "apple" may refers to the fruit or the company.

**Synonymy**

In synonymy, multiple tags seems to have the same or a very closely related meaning. It's a common fact as people tags in relation with their own experience and knowledge. An example may be the word "photograph", which someone may tag as "photo", "foto" or "photography". Synonymy is particularly problematic as authors must rely on their own instinct to select the suitable tag to represent the content of their post. Running folksonomies against automatic indexing software would be a solution for controlled synonymy by studying in the repository workflow where the action could take place (Rolla, 2009)

**Level variation**

Level variation refers to the phenomenon of users tagging content at differing levels of abstraction. For example a content can be tagged as “cat” or “feline”.

**Plurals**

Plurals, parts of speech and spelling can undermine a tagging system. A tagging system when the tag “Maltese dog” is applied, it will not retrieve results for the content tagged “dog” except if it has the capability to apply replacements. In addition, if a user wants to search multiple queries, a tag will retrieve only the content containing the tag, unlike to the advanced search provided by a library formal metadata catalogue.

**Multilingualism**

Multilingual tags have started emerging on popular Social Tagging systems because of their international level. Though, multilingualism occurs despite the fact that an existing aspect among current studies relating to tagging assumed that tags are represented in a common language understandable by all the members of the user community. Currently two ways for dealing with multilingualism exist: a) the crowdsourcing (problems are broadcast to an unknown group of solvers in the form of an open call for solutions) and b) systems supports multiple languages to certain extent

In general, issues related to the improvement of Social Tagging practice often conclude to move tags closer to a controlled vocabulary. Therefore, proposals for clear recommendations for tag choice and formation in repositories in order to avoid mismatch problems in vocabularies (Jorgensen, 2007; Goh et al., 2009), lead to the establishment of controlled vocabularies lead to “thesaurus”.

A controlled vocabulary named thesaurus is able to control the use of synonyms homonyms, homographs, heteronyms, and other grammatical variations (Noruzi, 2006) by establishing a single form of the term like for example the word “photograph” for each kind of relative word, reducing in that way the probability that relevant resources will be missed during a search. Noruzi (2007), insists that there is no other way to sustain consistency over time or across folksonomy users without a thesaurus.

The idea of a controlled vocabulary is intensively discussed and many opinions occur. Unlike Shirky (2005b), who argues that there is no value in controlled vocabulary for the web, Weibel (2006) indicates that there is value both in the formal hierarchies of controlled vocabularies and the value in the electronic warrant provided by folksonomies. Consequently, Weibel proposes a hybridization of both approaches by which the combining of folksonomies with the controlled vocabulary it is likely to create richer metadata.

According to Lemieux (2009), there are four hybrid approaches to taxonomy and folksonomy as:

1 Co-existence: Taxonomy and folksonomy are used side by side. There is no relationship between the matadata of taxonomy and the tags of folksonomy. Therefore, each approach is preserved, keeping their philosophy saved.

2 Folksonomy-directed taxonomy: Both of the taxonomy and folksonomy are co-exist. Though, tags are used in order to enrich the taxonomy keeping it in that way up to date and informing it for trends and new terminology. For the achievement of this approach the users' tags are evaluated based on their frequency and salience within context. After the evaluation, the resultant tags are used in combination with taxonomy.

3 Taxonomy-directed folksonomy: While Folksonomy-directed taxonomy gives opportunity for taxonomy enhancement, this type of approach provide the tagger suggestions from a controlled set of terms/tags in form of drop-down menus, check boxes, type ahead or tree view. In that way tags are leveraged by adding meaning to them and search and retrieval is supported in a better way.

4 Folksonomy hierarchies/ontologies: There are two kinds of folksonomy hierarchies in this approach. A) user-powered and B)automatic derivation. In the user powered approach a typically small population makes the contribution and is considered as a social approach. On the other hand, the folksonomy hierarchies or else "folksontology" is done through statistical or clustering Algorithms

A hybrid approach to taxonomy and folksonomy was created by Tsui et al. (2010), who developed an algorithm to automatically convert folksonomy into a hierarchical taxonomy to enhance knowledge navigation in a corporate environment (Kiu & Tsui, 2011).

Lim (2007) recommended that for a successful balance between the contextualization for reusability and maintaining educational value of learning objects, various educational context wrappers can be built around existing learning objects. These wrappers provide the necessary context and "glue" that would hold the objects together making it possible for them to be used meaningfully in a variety of contexts (Allen & Mugisa, 2010).

A method like the one described by Lim, may be the "collabulary learning". Collabulary, corresponds to a convergence of the words "collaborative" and "vocabulary". Marinho et al. proposed collabulary learning method which takes a folksonomy and domain-expert ontology as input and applies semantic mapping to produce an enriched folksonomy. So, the collaboration derives from the compromise between the flexibility and dynamics of folksonomies and the more systematic structure of controlled vocabularies. Consequently, collabulary represents the knowledge of both users and experts in an integrated fashion (Marinho et al., 2008). Collabulary result in richer, more current controlled vocabularies (Thomas et al., 2009; Rosenfeld; 2005) and arises like a folksonomy do. Collabulary seems to be very privileged as they combine the rich but law entry cost folksonomy and the consinsancy of a supervised controlled vocabulary-taxonomy. Hence, collabulary can be linked to the abovementioned hybrid approach of folksonomy-directed taxonomy.

## 2.5 Necessity of Social Tagging Evaluation Methods

In recent years, associating and labeling digital resources in the web meet systems as Social Tagging which have emerged as an attractive alternative approach. This innovation has shaped a fascinating opportunity for the Hypertext research community in order to expand new perspectives and understanding about the potential of tagging and linking in large scale (Korner & Strohmaier, 2010).

However, as it is discussed and analyzed in a previous section, folksonomies suffer from several problems. Some of the problems mentioned are the lack of tag meanings, semantics, and a coherent categorization scheme. Additionally, a noticeable drawback is the time and the size of the community required for the emergence and consolidation of a folksonomy. A folksonomy, unlike ontology, does not represent knowledge understandable to machine, indicating in this way the need for bridging ontological and folksonomic representation (Torniai et al., 2008).

Currently, several Social Tagging evaluations took place, where each of them aims to examine different aspects of Social Tagging practice. The evaluations as a whole, seek to a sustainable function of Social Tagging, discovering new prospective of it and eliminating the flaws mentioned. Throughout the evaluations, both qualitative and quantitative methods are developed in order to provide a scientific verified way leading to the sufficiently data process and the occurrence of reliable results regarding the Social Tagging technology.

In general, social tagging can be examined within several frameworks, with evaluations related to the tagging process, the folksonomy and the social tagging systems. Thus, it can be considered as a personal information management tool and a retrieval tool or be examined as a part of the social network theory or finally to be analyzed for its technical context of use (Trant, 2009a). However, each of the evaluation methodologies gain information about the impact of user-generated information within a context.

Concluding, it is obvious that with the establishment of Social Tagging evaluation methods, the consequences are successful studies offering crucial findings for the use, influence and development of Social Tagging, enhancing in further the effort of making digital objects, and particularly Learning Objects, meaningful, findable, retrievable and the most important, reusable.

## 2.6 Summary

Social Tagging has emerged as an attractive alternative approach to describe and label Learning Objects reinforcing the search, retrieval and reuse of Digital Learning Content and hence the Technology-Enhanced Learning. Throughout the literature review made in this chapter, apart from the benefits of Social Tagging practice several drawbacks were detected too. Nevertheless, Social Tagging is a relative new technology in Web 2.0 and can accommodate many improvements to deliver its full potential. At this point, Social Tagging Evaluation Methodologies gain the role of the intermediary for a sustainable and successful function of Social Tagging.

# Chapter 3:

# Overview of Social Tagging Evaluation Methodologies in Technology-Enhanced Learning

## 3.1 Introduction

In this chapter, a general review of Social Tagging evaluation methodologies takes place. Towards the review there is a brief description of the research questions, the dataset, the research methods and the results.

The projects included in the review are related to research studies examining the influence of Social Tagging in formal or informal Technology-Enhanced Learning, in lower and higher levels of education.

The disclosure of this research studies is very significant because of their contribution to the formation of evaluation methodologies due to the analysis of Social Tagging potential in Technology – Enhanced Learning and other fields.

Hence, the wade in the methods provided by several evaluation methodologies is facilitating in enriching and improving a newly created evaluation methodology by paving the way informing for the pros and cons of each method.

## 3.2 Social Tagging Evaluation Methodology in "MELT" project

MELT project[2] (Zens et al., 2009) conducted by European Schoolnet Organisation and co-funded by the European Commission. MELT has been designed to allow users an easy access to the resources by providing more useful types of metadata. Thus, users are able to find resources which fit their language, cultures and preferred ways of teaching and learning.

In order to find the appropriate resources, there are several search options available on the welcome page of the portal (figure 11)

1. Find Resources: This option is an advance search that uses the formal metadata created by experts. Users can enter a keyword and determine the language or/and the subject of the resource from a drop down list.
2. Find by subject: This option contains a list of subjects that each contains a list of the available material. There are also the choices of refining resource type, language and age group.
3. Find by tags: This option provides a tag cloud containing all the tags created by users. There is also the alternative way of entering a tag in a “Jump to tag” field and search for a specific tag.

[2] http://info.melt-project.eu/ww/en/pub/melt_project/welcome.htm

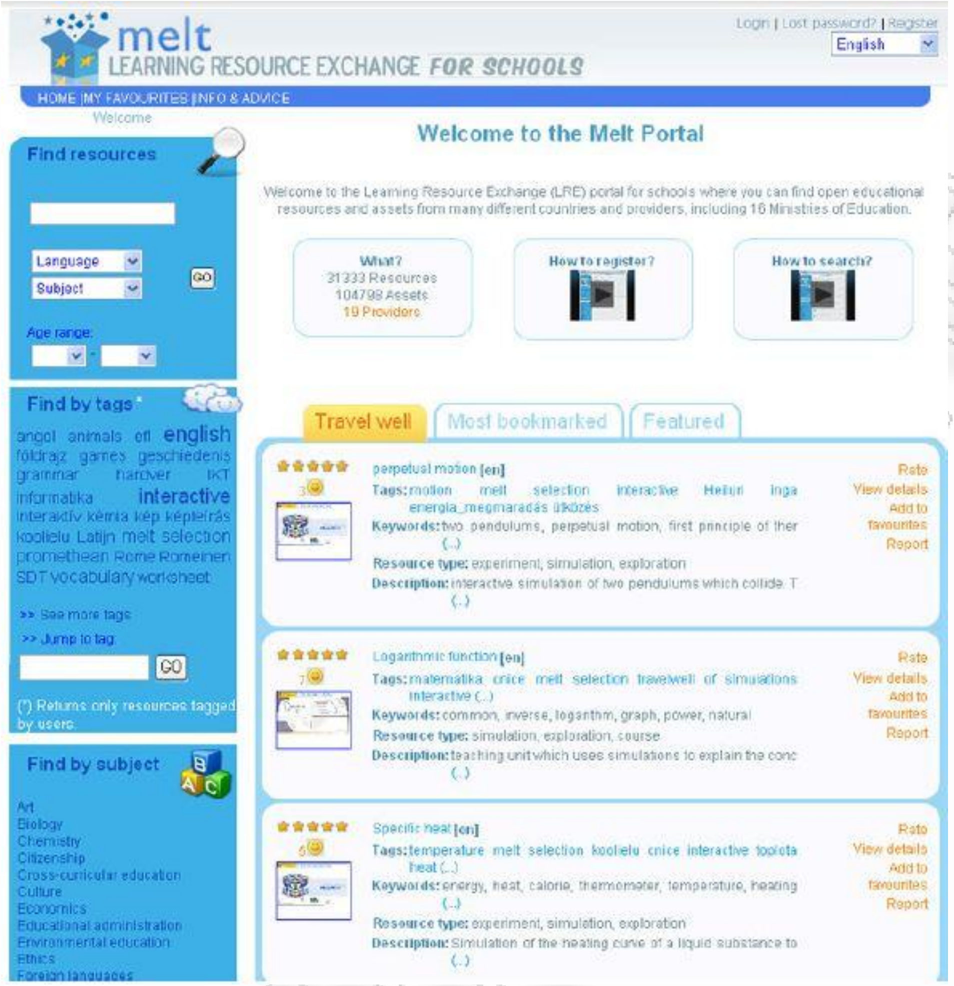



***Figure 11:** Search options in welcome page of MELT Portal*

Each of the results isdisplayed in the search result's list. The most important information are presented: title, tags, resource type, brief description and average rating. When clicking "view details", a more detailed metadata record can be viewed.

Tagging in MELT portal is carried out only if combined with the "save" in favourite function. Thus, prior to learning object tagging, the user must first "Add to favourites" the resource and then choose to add tags. The tagger create a list of available tags which is displayed for all MELT users.

### *3.2.1 Research question*

The research question of the MELT evaluation is the determination of MELT portal effectiveness. The evaluation of the effectiveness is related to some success indicators on which the hypothesis based on. The goal of the evaluation is to assess the effectiveness of MELT in terms of previously set indicators. The indicators are listed below:

1) Quantity and quality of structured metadata

2) Quantity and usefulness of Social Tags
3) Effectiveness and efficiency of metadata search process
4) Availability and quality of the content based on users' satisfaction with the portal
5) Use of the MELT portal
6) Use of content & pedagogical benefit
7) Cross-linguistic and cross-border use of content

### *3.2.2 Evaluation Instruments*

The evaluation consisted tools of both qualitative and quantitative methods like questionnaires, interviews, log data, metadata snapshots ans statistical user-related data from the database.

**1)** Questionnaires: were made available online through the LimeSurvey tool

**"Searching and Finding Content"**

It was responsible for the analysis of the search goals, the outcomes, the search strategies and the Social Tagging activities. In general it was examining the search and retrieval process efficiency.

**"Usage of Content"**

It was responsible for the analysis of resources context of use, advantages, quality, educational intention, technical problems, modification and sharing. In general it was examining the use of MELT resources in teaching activities.

**2)** Interviews with Teachers

The interviews were semi-structured and contained questions related to the personal data of the participants (language, subject taught), school context (primary/secondary, location), search behaviour (frequency of search, frequency of useful materials found), and feedback to MELT portal (problems, satisfaction, pedagogical benefits, availability and quality of the content).

**3)** Log Data & User-Related Data

The data were taken from the database of the portal. The user-related data contained the nationality, language and role of the users and the log data provide statistical figures regarding the users' actions on the portal as tagging, saving resources in the favourites, searching for resources, etc.

**4) Snapshots of Tags**

The snapshots of tags contain the resources ID and the related number of tags for each resource. The snaposhot were taken for the final analysis.

**5) Structured Metadata & Quality Metrics**

The analysis of metadata focused except from the quantity of metadata records, on the quality of the metadata too. Towards the quality measure, several metrics were provided and calculated by KUL (Katholieke Universiteit Leuven), using complex procedures.

### *3.2.3 Dataset: Description*

Learning Resources

The MELT projects consisted of a total of 153585 learning resources, containing both assets (defined as the smaller unit of information transfer, e.g.: picture) and learning objects (defined as a combination of assets with useful structure, e.g.: demonstration).

Users

The participants of the MELT projects were mostly teachers interested in MELT. The teachers were organized by WP6 and came from a wide range of countries and school types and in addition there was a diversity in the subjects taught by the whole team. The users registered at the portal (except the project staff) were 356. The countries with the greatest number of participants were Belgium, Hungary, Austria, Finland, and Estonia but in general individuals from 23 different countries were participating. For each instrument and evaluation, a different number of participants involved:

1) "Searching and Finding Content" questionnaire**:** the questionnaire was completed 111 times from 13 registered participants of the MELT portal.
2) "Usage of Content" questionnaire: the questionnaire was completed 87 times by 30 users. The number of participants was low because of the volunteer character of participating.
3) Interviews: In the interviews were participated 18 teachers, 9 male and 9 female from the four basic countries.

### *3.2.4 Evaluation Process and Methods*

For the evaluation process, the aforementioned evaluation instruments were used in order to provide the method of the evaluation in each case. The evaluation indicators were examined by combining 2 or more of the evaluation methods (table 5).

*Table 5: Evaluation method for each indicator*

| Indicators | Method |
|---|---|
| **Quantity and quality of structured metadata** | Structured Metadata<br>Quality Metrics |
| **Quantity of Social Tags and how useful they are for locating content** | Snapshots of tags<br>Log Data |
| **Effectiveness and efficiency of metadata search process** | Search & Find Questionnaire<br>Interviews<br>Results of the Log Data |
| **Availability and quality of the content based on users' satisfaction with the portal** | Usage Questionnaire<br>Interviews<br>Results of the Log Data |
| **Use of the MELT portal** | Log Data<br>Number of Registered Users |
| **Use of content & pedagogical benefit** | Usage Questionnaire<br>Interviews<br>Log Data |
| **Cross-linguistic and cross-border use of content** | Usage Questionnaire<br>Interviews<br>Log Data |

1) Search & Find Questionnaire

The data of the online questionnaires were saved in a database and then exported to Excel and imported into the statistical program SPSS for Windows and prepared for the analysis like restructured and coded.

The data were enriched and combined with user-specific data as nationality or language. The qualitative data of the questionnaires as the open comments, were analyzed by classification into a categorization scheme.

2) Usage Questionnaire

The questionnaire at some stage was additionally integrated into the MELT portal so the questionnaire was connected directly to the MELT resources ID that have been saved in the favourite list of users. The data were exported to Excel files and imported into SPSS. In the end, questionnaires from LimeSurvey and MELT portal compound into a single dataset.

3) Interviews

The interviews were recorded on audio tape and transcribed by using the transcription program “f4”. The transcripts were analyzed by means of classification into a categorization scheme.

4) Log Data

The log data of portal activities were made available as “xls” or “csv” files. Thereafter, the files were restructured and coded in order to be analyzed. Subsequently, the data were imported into SPSS and analyzed in combination with the user-specific data. Along the user-specific data, ranking from most popular resources were collected.

In order to make possible the analysis of sequences of action like the effects of different search strategies, the log data were entirely restructured. For this purpose, different activities of one session as view, search and obtain a resource for the favourites were transformed from sole cases to a series of actions in one only case.

5) Snapshots of Tags

Snapshots of resources containing Social Tags were made available as an Excel file which was imported into SPSS and analyzed descriptively. Moreover, a ranking of resources was gathtered enclosing the largest number of tags.

6) Snapshots of Structured Metadata & Quality Metrics

Snapshots of structured metadata records and several quality metrics for each metadata instance were provided by KUL. The quantity of metadata records is determined by juxtaposing goal figures and actual figures. The goal figures are 35624 for learning objects and 97747 for assets. The metrics had been calculated automatically by using complex logarithmic functions (Xavier, 2008):

**Completeness**

Measures the completeness of the metadata instance to describe a resource, providing all the appropriate information as the degree to which the metadata instance contains all the information for a comprehensive representation. Completeness is measured by calculating the number of filled in metadata fields.  The range of the results is from 0 to 10, where when the result is 0, none of the number of fields contains a value (it's an empty instance) and when the result is 10 all the fields contain information

**Weighted Completeness**

The weighted completeness metric, gives a particular degree of meaning to each metadata field depending on how important a field is. Thereby, it measures in deep the completeness of an instance multiplying the presence or absence of a metadata field with a weighting factor representing the importance of the field. The results of this metric may range from 0 (all fields with importance different from 0 are filled) to 10 (all fields with importance different from 0 are empty).

**Information Content of Categorical Fields**

The information content of categorical fields (those that can only take a value from a defined and limited vocabulary) is calculated using the entropy method. Entropy is the negative logarithm of the probability of the message. The resources with dissimilar metadata instances are easier to be found as it helps to distinguish one resource from another. Thereby, instances with rare words in their metadata fields are preferred in order to carry more information. To obtain the Categorical Information Content for a given instance, the entropy values of the categorical fields are averaged. The range of the metric is between 0 (bad quality information) and 1 (good quality information)

**Information Content of Textual Fields**

The information content of textual fields is calculated by the frequency of each word appeared in the document, multiplied by the negative log of the word frequency in the whole repository. It can be considered as weighted entropy because of the significance of each word. For instance a word that appears frequently in a resource may be considered as important. As well, a word that appears frequently in the whole repository may be considered as minor.

That's happening because of the freedom appeared in text fields (title and description). The results of the measure begin from 0 and have no upper limit. As the result increases, the text indicates a better amount of information.

### *3.2.5 Results*

1) Quantity and quality of structured metadata:

**Quantity of Structured Metadata**

The metadata instances in MELT portal reached the number of 153585. The assets were 109970 and the learning objects 43615. The initial goal for the number of learning objects was 97747 and 35642 respectively so that it was exceeded considerably in both types.

The most of the instances were by providers from Austria, Spain, Italy, Hungary and UK. Also, 71.5% licensed under “Creative Commons” licence and the rest of them another open licence. In addition 100% had “attribution” licence and 75% “non commercial” licence type.

**Quality of Structured Metadata**

The quality metrics were applied on 146086 metadata records covering about the 90% of the total dataset. In general, the quality of the analyzed metadata records was very good to excellent as most of the important fields were completed.

The results of each metric were:

1) **Completeness of metadata records**

The results across all providers shown that the completeness is medium (M=4,724)

2) **Weighted completeness of metadata records**

The analysis show that weighted completeness is quite high (M=8,042)

3) **Information content of categorical fields**

The results across all providers revealed an excellent value for the information content of nominal information (M=1,691)

4) **Information content of textual fields**

The information content of free-text fields (textual information) was very good (M=5,853)

The results of the first two metrics had shown that though not all fields contain an entry, the most of the important fields are completed.

To summarize, the conclusion was that the quality differed significantly between the providers but the information of all metadata records was very good to excellent for almost all providers.

2) Quantity of Social Tags:

The quantity of Social Tags was analyzed by taking snapshots of tagged resources and log data pertaining to the action "tag a resource"

**Snapshots**

Until 12.2.2009, 2008 resources of the MELT portal were tagged by users with a total number of 10.131 tags.

Some significant observations based on tags snapshots are:

• The range of tags per resource was from one single to a maximum of 79 tags with a median of 4. The percentages of resources tagged with one to three tags and four to ten tags were 47% and 43% respectively, while resources with ten and more or twenty and more were fluctuated to percentages of 11% and 3% respectively.

• The tagged resources were widely images with a proportion of 26% and "data" type with 16%. Other tagged resources were simulations, lesson plans, web pages, and presentations. Also, resources for exploration and entire courses were tagged frequently.

**Log Data**

During the period from 22.1.2008 to 3.2.2009, 106 users placed 9979 tags to 1979 different resources .

Some significant notes derived from the log data are:

- The users that tagged were from Hungary (32%), Belgium (20%), Austria (17%), Estonia (18%) and other countries.
- The most frequent role of the users in most cases, was "teacher", achieving the proportion of 85%
- Most of the tags (79%) were placed by Hungarian users. The fact that motivated them so much was that they were being paid for their participation..
- A small number of nine users were responsible for half of the tagging actions with the most active user placing 712 tags, three users between 100 and 416 tags and seven users 50 to 100 tags.
- A percentage of 21% of the tags were placed to resources that related to the subject "languages". Moreover other frequent subjects were "foreign language" (16%), "geography" (6%) and "earth sciences" (5%)

3) Effectiveness and efficiency of metadata search process:

Regarding the results of the Search & Find Questionnaire, the interviews with the teachers, and the log data will be discussed in the following sections.

**Search & Find Questionnaire**

From the Search & Find Questionnaire the following observations were distinguished.

- In more 88 sessions (84%) the users preferred to use the advanced search options as choosing language, age range of students, or subject to refine their search. In total, 43 reported search sessions used advanced search options exclusively and for just 8 search sessions only tags were used for searching for materials. Both, advanced search and tags were used in 43 sessions.

- In 66% of the 88 search sessions in which advanced search options were used, the participants perceived the advanced search options as helpful or very helpful for finding content while for the 18% of the search sessions, the participants pointed out that advanced search options were of little or no help.
- For 61% of the search sessions in which tags were used, the users perceived the tags as helpful or very helpful for finding materials while for five search sessions (9%) participants indicated that tags were of only little help or of no help at all for finding content.
- For the 40% of the participants one of the most valuable search features was the function "search by subject". Equally many users found the tagging feature to be most useful.
- 7 participants indicated that searching within the tag cloud was useful and the tags provided additional description of the content. Some drawbacks mentioned were the existence of multiple tags, tags in multiple languages and several topics without tags. In addition, 20 participants added the problem of invalid links or password secured websites in the result list.
- The teachers' satisfaction to the outcomes of the searches was overall average.

**Interviews**

All of the interviewees had experiences with searching within digital learning resources on the Web. Regarding the MELT portal search function, the majority of the respondents initially explored all available search features and afterwards combined two of these features for the following searches.

Some notes from the interviews were:

- Multilingual tagging was an issue. For some teachers, tags in foreign languages they did not understand were annoying.
- Equivalent tags in the list, which made the search confusing
- The tags were perceived to be too general for a specific search

The conclusion was that beyond the drawbacks, tagging was seeming to be a feature with a great potential, given that many teachers used it and the mentioned deficiencies had been repaired.

**Results of the Log Data**

The log data tenders to the analysis of the users' actions "search for resources", "play (view) a resource", and "bookmark a resource in the favourites" in order to determine the effectiveness of different search strategies in terms of viewed and saved resources.

In total 16561 searches were performed and some notes upon the number are:

- Advanced search was used 7668 times (46%), "browse subjects" was used 5050 times (31%), and "search by tags" (browse tags) was used 3842 times (23%).
- Concerning advanced search, the most frequent use consisted of a conjoint selection of subject and language (34%).
- Free-text keywords as a single search strategy were used in 24% of the cases.
- Users searched for a broad range of subjects. Highly represented were the subjects Informatics/ICT (10% of all searches), Biology (9%), Mathematics (9%), Foreign languages (8%), and Language and literature (6%). Geography, history, and physics were frequently researched as well.
- In total, 2468 bookmarks were saved in Favourites and 9449 resources were viewed

From the results, derives the conclusion that subject, language, and search term were salient options for finding and obtaining content while the first two are considered the most useful from the teachers. Tags are seemed not to be very useful when a specific search must be made.

4) Availability and quality of the content based on users' satisfaction to the portal:

The analysis regarding the availability and quality of content involved interviews with teachers, an analysis of log data (rating of resources), and one question of the Usage Questionnaire.

**Usage Questionnaire**

The results of the questionnaire pointed to a high quality of provided resources. In total, 80% of the participants rated the quality of the used resources as high or very high.

**Interviews**

The interviews pointed to a high satisfaction with the amount and quality of content. Also, the interviews' results noted that the quantity of retrieved materials diverged among the subjects. For example, resources for English language teaching, natural sciences and IT-related topics appear to be covered very well while teachers looking for other subjects did not find sufficient content, or no content at all.

**Results of the Log Data**

The log data as the questionnaire's result, recorded a very high rating concerning the quality of the resources. In total, 75% of the ratings contained the values "useful" and "very useful"

5) Use of the MELT portal

The indicators for the use of the portal are the number of registered users on the portal and the log data of the users' activities.

The visitors of the MELT portal in the evaluation period were 6306 but the teachers within the project were only 100. The portal usage ranged from 2-3 times in general up to 2-3 time a week or even daily. All interviewed teachers had found useful teaching resources.

6) Use of content & pedagogical benefit

The usage of MELT content was explored by means of individual interviews with teachers, by the "usage questionnaire" and by log data concerning the action "bookmark in the favourites".

**Usage Questionnaire**

- A total of 87 evaluated resources, a large part of the repository, were designed for secondary schools and related to the subjects "language and literature" and "foreign languages". The resources were mainly in Estonian, German, and English language.
- Most of the evaluated resources were learning objects related to the resource types "presentation", "web resource", and "drill and practice".
- Resources were primarily destined for teaching in class, but also for preparation purposes. The pedagogical intention of the usage of MELT resources was to impart information to the students, to encourage learning by practice and by exploration.
- The pedagogical benefit of using MELT content was rated as very high: 80 percent of the participants of the usage questionnaire rated the pedagogical benefit as high or very high but the ratings differed among the users' country of origin

**Interviews**

- The most important pedagogical intention of the usage of MELT resources was to encourage learning by independent exploration, "learning by doing", and to motivate students to study in a self-reliant fashion.
- In connection with self-reliant learning, supporting the students' information management skills was indicated.

- Another pedagogical intention was to enhance students' comprehension of difficult or invisible processes, such as molecular biology.

**Log Data**

- Learning objects such as web pages were bookmarked most frequently.
- About one third of the teachers used the materials for foreign language teaching and one third of the applied materials was used in interdisciplinary settings.

7) Cross-linguistic and cross-border use of content

The cross-linguistic and cross-border use of MELT content was investigated by means of individual interviews, the Usage Questionnaire and log data regarding the function "bookmark a resource in the favourites".

**Usage Questionnaire**

The resources used across languages were in average 25% of all resources where the percentage of learning objects was 20% and the assets' 60%.

**Interviews**

The teachers highly valued the opportunity of an international portal which provides the learning resources for pedagogical intentions within a European context. Furthermore, it was considered as an important opportunity for cultural exchange while getting new ideas for teaching from other countries.

**Log Data**

The log data revealed a higher proportion of cross-linguistic bookmarking: about 60% of all bookmarks were saved across languages. The log data also recorded a high frequency of the subjects "art", "natural sciences", and "technology".

## 3.3 Social Tagging Evaluation Methodology in "MELT Phase II"

The search options provided in the welcome page of MELT portal remain the same as in Phase I:

1. Find Resources: This option is an advance search that uses the formal metadata created by experts. Users can enter a keyword and determine the language or/and the subject of the resource from a drop down list.
2. Find by subject: This option contains a list of subjects that each contains a list of the available material. There are also the choices of refining resource type, language and age group.
3. Find by tags: This option provides a tag cloud containing all the tags created by users.

Furthermore the tagging tool is the same, allowing users to save the resources in "Favourites" and afterward they are able to assign tags on them for an easy retrieval. However, there was an adjustment that improved the search speed on the portal.

Since the beggining of the Phase II, the tags assigned by the teachers have been monitored allowing the development of methods and metrics for future monitoring. The scope of Phase II was to evaluate the quality of Social Tags added to MELT resources.

### *3.3.1 Research Question Evaluation I*

The queries deriving from the scope of the Phase II MELT project are focused on the validity and the potential value of Social Tags in terms of describing a resource.

Consequently, the research question is:

"How useful are the user-created tags as metadata descriptors to describe learning resources?"

### *3.3.2 Dataset: Description Evaluation I*

<u>Learning Resources</u>

For the evaluation, 10 learning resources were chosen. The chosen resources had two attributes: a high number of teacher generated tags and offered variety in terms of discipline and type of resources. The resources were in multiple languages.

<u>Expert Indexers</u>

For the evaluation a group of experts with experience in indexing learning resources was invited to fill in the online evaluation form. The experts were part of the MELT project and represented indexers who either participated in the Metadata Working Group or were contracted by the MELT partner to carry out learning resource indexing. The number of the invited evaluators was 10.

### *3.3.3 Evaluation Instrument/Methodology Evaluation I*

The qualitative evaluation Instrument/Methodology was an evaluation web-based questionnaire which the expert indexers had to complete. The form was available online for 10 days.

In the evaluator questionnaire there were three questions:

1. "Which of these keywords do you find suitable (i.e. clear and unambiguous) as indexing keywords?"

Both thesaurus descriptors and the teacher-generated tags were contained in the list of keywords. The type of the keyword was a blind setting so the evaluator did not know whether one was a tag or descriptor. They were asked to choose as many terms as they thought were appropriate.

2. "Below you can find teachers' keywords. Compared to the current indexing words (xx, yy), estimate their additional value as descriptors".

   For the estimation of the value there was a scale from 1 to 5 where 1 is no useful information and 5 very usufeul information. The option 6 indicates "I don't understand the word".

3. "The current indexing keywords are: xx and yy. Would you want to revise the original LOM description of the resource and, if so, which of the following terms might you adopt?"

   The evaluator was able to choose from the list contained the teacher-generated tags the tags that s/he found suitable. An alternative choice is to choose "I would not change anything". The evaluators were able to choose as many terms as they wished.

In addition, the evaluators were invited to provide written comments related to any of the questions above.

The goal of the instrument was the development of suitable evaluation methodology for this sort of qualitative evaluation for a future larger scale analysis.

### *3.3.4 Research Process and Results Evaluation I*

Due to the multilingualism of portal and Social Tags the evaluators' competency in language was asked. The results indicated that all of them had competency in English, 6 in Hungarian, 4 in Russian, 3 in French and 1 for any other language.

Each resource was annotated by both thesaurus terms and tags. The evaluators had not been informed for the type of each term. Table 6 shows the distribution of thesaurus terms and tags in every resource.

***Table 6:*** *Resources, their thesaurus indexing terms and tags(Vurikari & Ayre, 2009)*

| Resource # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Thesaurus term** | **4** | **3** | **1** | **2** | **3** | **2** | **1** | **1** | **5** | **1** |
| Tags | 9 | 13 | 15 | 7 | 5 | 5 | 18 | 7 | 3 | 6 |

There were 23 thesaurus terms and 88 tags applied to all resources (79% tags, 21% thesaurus terms). On average, for each thesaurus term there were 3.8 tags.

1. **“Which of these keywords do you find suitable (i.e. clear and unambiguous) as indexing keywords?”**

In relation to the suitability of the keywords, all the 111 terms, both Thesaurus (23) and tags (88), received 414 votes from evaluators. Consequently, the mean for the votes per term was rather low (32%). In addition, there is frequently less consensus about tags than about thesaurus terms.

All thesaurus terms received 28.5% of all given votes. As thesaurus terms comprised 20% of all the terms in this exercise, we can note that, proportionally, they received more votes than tags.

In further analysis it was indicated that:

- 14 tags didn’t receive any votes. 6 of these were in other languages than English and 3 in languages that none of the experts had competencies in and 5 contained stop-words like “of”, “for”, “in”.
- 12 out of 88 tags were actually terms that also exist in the LRE (Learning Resource Exchange) multilingual thesaurus (13.6%). These tags were called “thesaurus tags”, as they are end-user generated but also exist in the Thesaurus.
- There are also some potential thesaurus tags, with almost identical spelling to terms in the Thesaurus.

In order to determine which are suitable terms for indexing 2 ways were identified. The first method was to settle on suitability per resource: 5 top terms for each resource; the second method was to compare most voted thesaurus terms against tags

The suitability per resource was examined by selecting 5 terms for each resource, as ISO recommendation for indexing proposes 3-5 keywords. Therefore, the total was 50 terms where 37 were tags and 13 thesaurus terms.

In table (7) there is a list of the most suitable terms found, according the evaluators’ vote. Suitable terms were considered those obtained a rating above average. In addition, the term is accompanied by its type (tag or thesaurus).

*__Table 7:__ Suitable Indexing Terms (Vurikari & Ayre, 2009)*

| Resource | Suitable indexing terms | |
|---|---|---|
| 1. Resource | photo (tag) 80%; picture (tag) 80% | Tags |
| 2. Resource | art (thes) 60%; Europe (tag) 60% | Both |
| 3. Resource | vocabulary (tag) 90%, English (tag) 80%, exercises (tag) 70%; games (tag) 70%; young_learners (tag) 70% | Tags |
| 4. Resource | physics (thes) 82%; thermodynamics (tag) 64% | Both |
| 5. Resource | mathematics (thes) 100%, mathematical analysis (thes) 73%; logarethmic functions (tag) 73% | Both |
| 6. Resource | Mathematik (thes) 91% | Thes |
| 7. Resource | NewYork (tag) 92%; traveling (tag) 67%, web_quest (tag) 58% | Tags |
| 8. Resource | French (tag) 87%; vocabulary (tag) 73% | Tags |
| 9. Resource | physics (thes) 93; mechanics (physics) (thes) 53%; sciences (thes) 53% | Both |
| 10. Resource | non above average | None |

For the comparison of most voted thesaurus terms against tags, all terms were ranked according to the percentages of votes they obtained. Afterwards, a cut-off at mean on 33% of the votes has been made and the terms with ranking above this threshold was kept. The remaining terms were 46 (42%) where the 74% were tags.

Subsequently, the same amount of most voted tags was compared against thesaurus terms (23 terms for both). The average vote for tags became much higher reaching the 66% while thesaurus terms were at 42%. This indicates that tags appear to be more applicable to the experts than the thesaurus terms in the same list.

2. **"Below you can find teachers' keywords. Compared to the current indexing words (xx, yy), estimate their additional value as descriptors"**

Due to this question, a table containing a list with the most voted words was created. A noteworthy observation was that some evaluators were rating a word as "useful" although they declare that its language was unknown to them. That resulted to the conclusion there are "travel well" tags which are understandable by people around the world. Some examples are:

a) names for countries, places, famous people (e.g. Londres);
b) disciplines with very similar spelling (e.g. matematika);
c) generic terms like Web2.0.

3. **"The current indexing keywords are: xx and yy. Would you want to revise the original LOM description of the resource and, if so, which of the following terms might you adopt?"**

The results of the questionnaire vote indicated that most evaluators wanted to change the original metadata description to adopt some of the tags as indexing terms. In detail, in 3 resources evaluators agree to adopt some tags as descriptors and in 7 resources opinions were diverged. On the whole, only 25% of the resources were judged to have satisfactory metadata and the expert-indexer would not make any changes in the current metadata.

### *3.3.5 Research Question Evaluation II*

In addition to the first evaluation, a small case study by a repository owner in the project took place, analyzing the tags with the aim of addressing the following research questions:

1. "How useful are the user-created tags as metadata descriptors to describe learning resources?"
2. "To what extent can social bookmarks be used to indicate something regarding the quality of the bookmarked resources?"

### *3.3.6 Dataset: Description Evaluation II*

Learning Resources

The case study was covered by 63 resources by which 84 bookmarks were created. The learning resources were released in MELT portal by TRL (Tiger Leap Foundation) repository, a partner in MELT project.

Evaluator

The evaluator of the case study was settled on by the TRL.

### *3.3.7 Evaluation Method Evaluation II*

In terms of the first question: "How useful are the user-created tags as metadata descriptors to describe learning resources?" the tags were compared to the existing keywords, LRE Thesaurus terms and other classification information such as the national curriculum.

In order to address the second question: "To what extent can social bookmarks be used to indicate something regarding the quality of the bookmarked resources?" the resources were evaluated by the repository owner on a scale of 1 to 5, where 1 indicates "very poor" and 5 "very good".

### *3.3.8 Evaluation Results Evaluation II*

In the first question it was found out that in 49% the information provided by the tags was contained either in existing keywords or LRE Thesaurus terms. The cases that tags contained additional value were 25%, where sometimes they described more evidently the content of the resource. Meanwhile, the cases that tag having unnecessary information as resource type were 26%.

For the second question, the evaluator assessed 56 from the 63 resources and ranked them with an overall average of 4.1. Particularly, 16 were found to be of very good quality (5), 32 of good quality (4) and 6 of average quality, while only 2 were considered of poor quality.

A significant observation was that the content marked to be of very good quality was produced by a team of experts. The features of a very good quality resource, were the resource to be a printable ready to use worksheet, a media rich presentation or a complex set of learning materials like WebPages.

Similarly, reasons that the quality of resources was reduced were the lack of information like illustrations' authors or license or the fact that some of them were only based presentations or clipart illustrations.

## 3.4. Social Tagging Evaluation Methodology in "Steve" project

Steve Project (Trant, 2009b) conducted in Archives & Museum Informatics of University of Toronto. The general problem that stimulated the research was the challenge of locating and gaining access to resources of cultural heritage. Specifically, the scope of the research was to explore the retrieval potential of works of art retrieval, located in public or private collections, by students, theme, artists and other people interested in the area of culture.

Despite the fact that on-line museums provide far more access than traditional museums, the access offered to their works of art are still not satisfactory. Additionally, there is no possibility to search museum collections as a whole but only separately in each museum's website. Also, the works are described by a highly specialized language and are usually without a meaning and isolated from their cultural context.

Steve project engaged to Social Tagging mostly because of the success of image tagging environments. Yet, as the specialized vocabulary of museum address works of art from a different perspective than non expert public the tags may help contributing an alternative point of view and reflecting the public's approach to works of art.

### *3.4.1 Research Question*

In order to determine the research questions, both the multiple aspects of Social Tagging and their connection to museum documentations have been considered. Toward the process, various methods developed to answer the research questions and therefore the contribution of Social Tagging to on-line art museum collections.

The basic research questions were of two categories: a) tag-related questions and b) tagging environment questions.

Tag-Related Questions:

1) Tags and professional museum documentation comparison.

The user tags are examined in relation to the professional museum documentation terms to locate the correlation between them. In case that the two categories' terms have not any intersection, tags can be proposed to constitute another access point improving the retrieval of art works.

2) Staff members opinion about the tags usefulness

Museum professionals are examined the tags assigned to work of art and determine whether are helpful for searching the museums' art collections.

3)User tags and museum documentation's correlation to search terms in on-line art museum collections.

The matching percentage between museum documentation and search terms indicates the up to date situation. Therefore, if the match between users terms and search terms is increased related to the first case, searching is concidered improved.

Tagging Environment Question:

4) Tagging interface and tags

In order to make available a test on the simple differences in tagging interface, various controlled interfaces were developed by the tagging software. According to the results of the evaluation, its going to be proven or not the fact that interface can influence tags assigned for some reasons.

### *3.4.2 Data Set: Description*

**Works of Art**

Steve.museum collected 1,784 works of art. At first 1552 works were available but after a while some more works were added bringing the total number to 1784.

The works of art included in the project, represented a broad range of styles and periods, covering the full range of types of works in art museum collections: Audio-Video, Architecture, Books, Costume and Jewelry, Textiles, Installations, Prints and Mixed Media. In addition the objects included both two- and three-dimensional objects that both were representational and non-representational works.

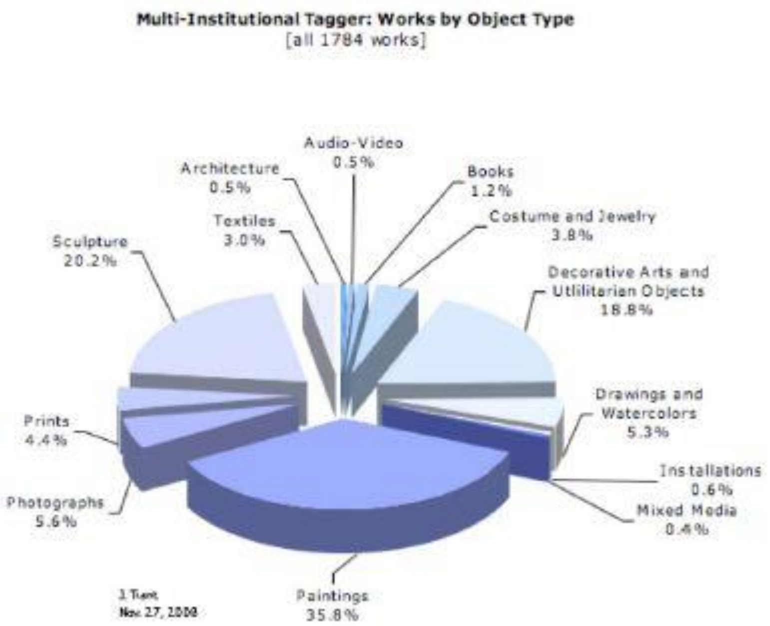



***Figure 12:*** *Distribution of works per tag (Trant, 2009b)*

Each object was represented by a digital picture of 1024 x 768 pixels size. The size made available from the museum professionals and was chosen because supports “full screen” displays. For the display in steve tagger software pictures were embedden in the tagging screen after being resized.

**Participants**

1) Museums

Steve.museum projects consists of many participating museums that each contributed a number of work of arts. The paricipating museums and their contribiutions are shown in Table 8.

***Table 8:*** *Number of works by institute (Trant, 2009b)*

| Museum | Total | Term Set 1 26-Mar-07-10-Jul-07 | Term Set 2 11-Jul-07-15-Oct-07 | Term Set 3 15 Oct-07-13-Mar-08 | note |
|---|---|---|---|---|---|
| The Metropolitan Museum of Art | 249 | 251 | 249 | 249 | *2 removed July 23, 2007* |
| Indianapolis Museum of Art | 250 | 250 | 250 | 250 | |
| Minneapolis Institute of Arts | 243 | 243 | 243 | 243 | |
| Boston Museum of Fine Arts | 237 | 237 | 237 | 237 | |
| Los Angeles County Museum of Art | 191 | 191 | 191 | 191 | |
| San Francisco Museum of Modern Art | 161 | 46 | 46 | 161 | *115 added for 11 Oct., 2007* |
| Skirball Cultural Center | 153 | 153 | 153 | 153 | |
| Cleveland Museum of Art | 117 | 0 | 0 | 117 | *117 added for 11 Oct., 2007* |
| Rubin Museum of Art | 111 | 111 | 111 | 111 | |
| Tate Modern | 50 | 50 | 50 | 50 | |
| Denver Art Museum | 20 | 20 | 20 | 20 | |
| **Total** | **1782** | **1552** | **1550** | **1782** | |

**Users**

Users had the choice to start a tagging session even if they were unregistered. Therefore, a total of 2,017 users (registered or non-registered) can be identified in the steve.museum data set. The tagging sessions derived From the whole number of the users participated are 2382.

The taggers recruited randomly and successfully from the internet community through museum electronic mailing list requests, popular press, blog postings, etc. and have been asked to tag the works of art in the project collections. Tagging was voluntary and unsupervised and users may start more than one sesssion.

**Tags**

The assigned tags in the steve.museum works of art reached the 36981 tags from both registered and unregistered users. The tags received from registered users were 21,619 and from Anonymous Users 15,362 (Table 9).

***Table 9:*** *Number of Works, Users, Terms and Sessions (Trant, 2009b)*

| | Works | | Users (incl. zero tags | | | Terms | | | | | Sessions | | | Works per Session | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Term Set* | *total* | *tagged* | *total* | *reg. users* | *anon. users* | *total* | *per work tagged* | *reg. users* | *anon. users* | *black-listed* | *total* | *reg. users* | *anon users* | *avg.* | *reg. users* | *anon users* |
| Term Set 1 | 1,552 | 1,199 | 602 | 147 | 455 | 9,611 | 8 | 4,663 | 4,948 | 4 | 675 | 220 | 455 | 5.2 | 6.4 | 4.6 |
| Term Set 2 | 1,550 | 1,499 | 744 | 271 | 473 | 15,165 | 10 | 9,815 | 5,350 | 4 | 856 | 383 | 473 | 7.7 | 11.4 | 4.7 |
| Term Set 3 | 1,782 | 1,440 | 731 | 250 | 481 | 12,205 | 8 | 7,141 | 5,064 | 12 | 851 | 370 | 481 | 5.1 | 6.9 | 3.8 |
| Totals | 1,784 | 1,772 | 2,017 | 608 | 1,409 | 36,981 | 21 | 21,619 | 15,362 | 20 | 2,382 | 973 | 1,409 | 6.1 | 8.6 | 4.4 |

### *3.4.3 Evaluation Instrument*

Steve tagger, an open source tagging tool, was developed in order to gather data. Its source code is available for download and its programming team included a number of different steve.museum partners.

Steve tagger was the mediator to study the aforementioned research questions. It gathers details about the taggers and the tags linked to art works in a number of different interface configurations. Data is recorded in a MySql database.

The stever tagger [3]is still available for tagging works of art.

### *3.4.4 Research Process and Methods*

1) Tags and professional museum documentation comparison:

[3] http://tagger.steve.museum.

Hypothesis

The hypothesis of the first research question is that Social Tagging, a perspective different from the professionals', will contribute in the museum context. In order to examine the hypothesis, a comparison between the following elements took place:

- Tags and documentation provided by museums
- Tags and extended documentation
- Tags and controlled vocabulary

The comparison performed to tags and museum documentation assigned to a particular work. Prior to the comparison, there was a statement indicating that tags which match with terms in museum documentation are redundant, else are descriptors.

Method

**Tags and documentation provided by museums:**

For the comparison, tags were collected from a range of users for a number of works were compared to museum documentation for those same works.

A simple truncated character-string compare took place, after shifting all information into lower case. Towards this method, the full tag was compared to any partial field of museum documentation.

**Tags and extended documentation:**

For the comparison each museum selected a couple of works for which they had extensive additional documentation. The type of the extended documents are: public/non-public; machine readable/human readable. The final dataset was: tags and documentation for 12 works of art, from six steve.museum member institutions.

Each tag was searched (by character strings) in all the documentation provided by the museums and it was recorded every time that appeared as full or partial match. For words of 3 letters only full matches were recorded and for longer words when the string appeared in the word was considered a likely match as it was usually the meaning that user intended.

**Tags and controlled vocabulary**

For the comparison tags were compared to two controlled vocabularies adopted by the museums: the Art and Architecture Thesaurus (AAT) (J. Paul Getty Trust, 2000a) and the Union List of Artists Names (ULAN) (J. Paul Getty Trust, 2000b).

Tags and controlled vocabulary were compared by scripts written by Ron Daniel of Taxonomy Strategies. The results were recorded along the location of term the tag was found.

2) Staff members opinion about the tags usefulness:

The hypothesis of the second research question is: "tags assigned by users are appropriate and help to understand the contribution of tagging".

Method

In order to address the above hypothesis a qualitative analysis took place, where the museum staff had to review tag by tag the folksonomy. Therefore, they reviewed each tag collected in dataset and stated whether each tag was helpful to find the art of work which it was assigned in. The method is similar to that of Von Ahn and Dabbish (2004) and the question considered for the determination of tags usefulness was: "if you found this work using this term in a query, would you be surprised?". The result was depended on the staff's reaction.

The participants of the review practice were one or more people of each museum (museum group) and each review was documented in a questionnaire and collected using an on-line tool. The review could be approached either from the works assigned or terms assigned, concluding in displaying a work of art accompanied with the terms assigned to it.

3)User tags and museum documentation's correlation to search terms in on-line art museum collections:

The hypothesis of the third research question lies on the literature of tagging that assumes that tags assigned are similar to the terms used to search.

In order to examine the hypothesis, the tags assigned to works were compared to search terms (gathered from logs of searches of museum Web sites). The relation between the two categories is depended on their intersection. If there was a high degree of overlap, tags are flagged as useful for searching collections. Important was also the frequency of the two categories' match.

Another way of assessing the contribution of tags to searching was to see how many terms assigned to a work are able to retrieve it in a museums' on-line catalogue. This method is applied by using each of the tags assigned to a work of art as a query in on-line catalogue and see the retrieval success.

**4)** Tagging interface and tags:

The hypothesis of fourth research question is that the interface variables influence tagging systems.

Method:

In order to examine the hypothesis, six different interfaces were developed by the steve tagger tool. Those experimental interfaces contained the same content-work of art to be tagged but other environmental variables were changed. The variables are the following:

- No Tags, No Metadata:

The user was shown only an image of a work and a box to add its own tags, without showing any other data in the screen.

- Metadata Only:

The user was shown only museum-supplied metadata. The basic question arised from this environment is whether the displayed museum documentation for a work of art influence the tags assigned

- Tags Only:

The user was shown tags previously assigned by other users. A question related to this environment is of the user behavior changes when sees the tags that others assigned.

- Metadata and Tags:

The user is shown both museum-supplied metadata and tags by other users. A question upon this environment is if tags vary when both museum metadata and user supplied tags are shown

- Museum-defined Works in Sets:

Similar works are grouped in sets as to provide some continuity between the works in the same group. The question linked to this environment was if users tagging sets of like-works could assign more useful tags and vice versa.

- User-defined Works in Sets:

Works are grouped in sets by user’s choice. The question was if this practice will effect tagging.

### *3.4.5 Results*

1) Tags and professional museum documentation comparison.

**Tags and documentation provided by museums**

When the full steve.museum tag set was compared to the museum documentation, 35,307 tags (86%) didn’t match either in full or partial. The tags that match to museum documentation (the remaining 14%) were most of the following categories: Object Type (44%), Materials (21%) and Primary Title (24.8%).

The number of Full Word Partial Field matches are likely to be lower than it should be, as when the there is a matched against only a part of the field's value the matching is increased, for example matches in category "Primary Title" were increased form 24,8% to 41,1%.

**Tags and extended documentation:**

Towards the comparison 4 kinds of matches were found out:

- **No match**: the string provided by the user tag didn't match a string in the extended documentation.
- **Exact matches:** there were exact match but not only the tag-string had the same meaning with the string in the extended documentation. For instance the same work might be used for other reason: "work of art", "nice work"
- **In partial matches**, the string provided by the user appears within a word of the documentation in a sense relevant to the search
- **Inapplicable matches** occur when the sense of the term matched is different from what the user could have intended. For example the user wants to describe the context of the picture and the extended documentation the type of the work shown in the picture

The comparison between tags and extended documentation had far less matches than the comparison to the more limited documentation. In addition, when "match" existed was not really applicable. The users language seems to differ extremely in comparison with art professionals.

**Tags and controlled vocabulary**

<u>*Tags and AAT*</u>

When tags were compared to terms in the *Art and Architecture Thesaurus* (AAT), 25978 (70.2%) terms matched in full or in part. Nevertheless, when distinct terms (unique character strings, without stemming or other matching of synonyms) were considered for the comparison, the ratio reverses to 37.2%

<u>*Tags and ULAN*</u>

When tags were compared to the Union List of Artists Names (ULAN),23800 (64% ) terms did not match neither full nor in partial. When distinct tags are considered only 1811 terms of the 11944 (15%) distinct terms matched in both ways.

2) Staff members opinion about the tags usefulness:

The tags found to be useful by museum staff were 32609 (88%) from the 36931 terms reviewed. The usefulness percentage in every work ranges from 65% to 100% and is also depended on the object type and its dimensional type (two or three-dimensional). It was found that almost the half (46%) of the users in dataset always assigned useful tags.

3) User tags and museum documentation's correlation to search terms in on-line art museum collections:

The correlation between users' tags and museum documentation to search terms was not possible to be established as tags and search terms were compared on the basis of distinct terms, and matches to museum documentation are based on term/work pairs.

Also it was impossible to establish a correlation between search terms, tags and usefulness because of the fact that usefulness was depended of the context of particular works.

Still, the connection among tags and search terms does not come out to be as close as was hypothesized.

4) Tagging interface and tags:

When only tags were shown, the number of new tags was decreased but the novel tags were increased because users wanted to enter something different. When showing both tags and metadata, it was produced the lowest percentage of useful terms probably because there was nothing left to say. Also, users assigned more tags when they saw sets of related works, whether selected by the museum or by themselves.

***Table 10:*** *Users by environment (Trant, 2009b)*

| Environment | no sets, metadata | sets, no metadata | sets metadata | no metadata no sets | no metadata sets + tags | metadata + sets + tags | metadata choice - I | tags choice -I | metadata choice -w | tags choice -w | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Users | 109 | 265 | 258 | 122 | 150 | 137 | 163 | 147 | 151 | 155 | 1621 |
| Anonymous | 81 | 187 | 171 | 84 | 83 | 84 | 114 | 93 | 96 | 98 | 1091 |
| Registered | 28 | 78 | 87 | 38 | 67 | 53 | 49 | 54 | 55 | 57 | 530 |

Although sets impact was a quit difficult to judge, it was obvious that the least effective presentation was showing randomly unrelated works.

## 3.5 Social Tagging Evaluation Methodology in "CALIBRATE" project

CALIBRATE[4] (European Community founded project) is a supporter of collaborative use and exchange of learning objects in schools by allowing teachers to access resources in a federation of learning repositories supported by six Ministries of Education (Austria, Estonia,

[4] http://calibrate.eun.org/ww/en/pub/calibrate_project/home_page.htm

Hungary, Lithuania, Poland and Slovenia (Vurikari et., 2007). One of the main goals of the project was to facilitate the reuse of learning resources among primary and secondary schools in Europe and beyond.

As European education, and mainly that of K-12 education, is by nature multilingual and multicultural, the supply of educational resources and services in other languages is equally important as their exposure in the native language. For this purpose, the procurement of learning resources available across national and linguistic boarders was proposed. The CALIBRATE portal was released within the CALIBRATE project and it was available in all the languages of the pilot.

CALIBRATE as MELT project was designed in order to make available a collection of learning resources/assets to schools via a new Learning Resource Exchange (LRE) service for schools within European Schoolnet. Both of the projects, Calibrate and Melt, were focused on how well content and its metadata can be understood by other systems and users.

### *3.5.1 Research Question*

The aim of the evaluation based on CALIBRATE portal, was to shed light on a community of users who share a common educational interest to use a Social Tagging system across country and language borders, but does not necessarily share one common language, as the users are free to choose the language(s) in which they apply tags (Vuorikari et al., 2007).
In order to explore the multilingualism of tags, the evaluation focused on two objectives:

- The measurement of the apparent descriptiveness, usefulness and quality of traditional metadata, expert classification keywords and multilingual tags.
- The exploration of users' reaction when confronted with tags in multiple languages that they did not have knowledge of.

### *3.5.2 Evaluation instrument*

Tagging Interface

The tagging interface (Figure 13) is always in the language that the user had preferred. Because of this, when a user assigns a new tag to a resource, the tag is considered as a metadata linked to its own language. Further, a function is supported by which if the user's interface language is in English, only tags of English language are exposed, even if tags of others languages exist.

When user is tagging, he may choose a tag by clicking on it or by typing in a new one into the empty text box. In addition, tags must be separated with the use of comma, if not, they emerge as compound terms. All the personal tags of the user are displayed with a number in parenthesis that shows how frequently have been applied.


***Figure 13:*** *Social Tagging Interface in Calibrate Portal (Vuorikari & Ochoa, 2009)*

### *3.5.3 Dataset: Description*

Participants

The selected participants of the evaluation were 13 teachers who belong to the MELT focus group.

Learning Resources

The number of the learning resources to which the participants have faced was 5. The resources came from various areas of both primary and secondary education and were related to subjects of health education, social science, physics, mathematics and biology.

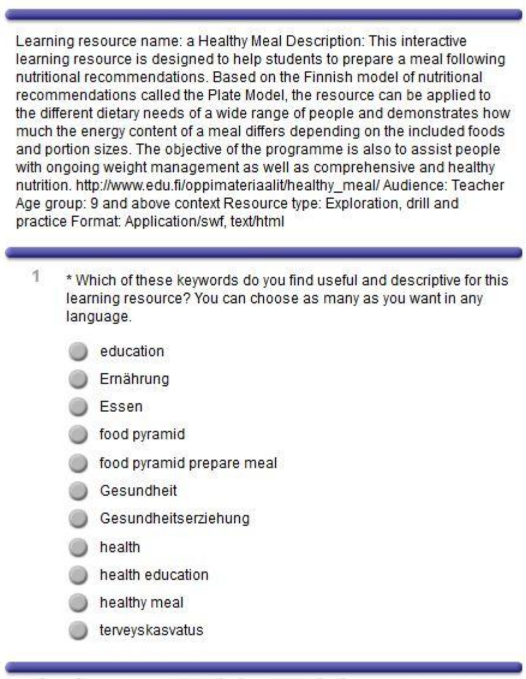
All the learning resources had metadata description and especially title, description, age range. Those were in English language. In addition, each of the learning resources was also described by keywords containing mixed multilingual tags and thesaurus terms, which were displayed alphabetically to the participants.

Twenty of the keywords were added by an expert and constitute English classification terms while the rest 39 of the keywords were multilingual tags added by pilot teachers throughout the previous months of the project.

The keywords were in the following languages: Hungarian (11), German (7), English (7), Polish (6), Estonian (4) and Finnish (1).

### 3.5.4 Evaluation Method and Process

For the evaluation an online questionnaire was released with 18 questions for each of the learning resource. In the figure 24 there is a small part of the questionnaire.


Learning resource name: a Healthy Meal Description: This interactive learning resource is designed to help students to prepare a meal following nutritional recommendations. Based on the Finnish model of nutritional recommendations called the Plate Model, the resource can be applied to the different dietary needs of a wide range of people and demonstrates how much the energy content of a meal differs depending on the included foods and portion sizes. The objective of the programme is also to assist people with ongoing weight management as well as comprehensive and healthy nutrition. http://www.edu.fi/oppimateriaalit/healthy_meal/ Audience: Teacher Age group: 9 and above context Resource type: Exploration, drill and practice Format: Application/swf, text/html

1 * Which of these keywords do you find useful and descriptive for this learning resource? You can choose as many as you want in any language.

- education
- Ernährung
- Essen
- food pyramid
- food pyramid prepare meal
- Gesundheit
- Gesundheitserziehung
- health
- health education
- healthy meal
- terveyskasvatus

***Figure 14:*** *Calibrate Evaluation Questionnaire (Zoomerang, 2012)*

The participants were asked to review all the learning resources and get through the assigned metadata. Afterwards, they were exposed in questions concerning both of the abovementioned objectives: the descriptiveness of the keywords and their contribution in using the learning resources in teaching.

Question included in the questionnaire were:

- "Which of these keywords do you find useful and descriptive for this learning resource? You can choose as many as you want in any language."
- "Indicate terms, if any, that would help you to use this learning resource in your teaching."
- "What do you think when you see the keywords in many languages?"

The questionnaire was repeated for each of the 5 learning resources and at the end the participants were asked to rate the overall quality of both traditional metadata and keywords.

After reviewing all the resources, the participants were also asked to give information for their language competencies and to describe their feelings when keywords in other incomprehensible languages exist. Finally, participants had the choice to leave free comments about their experience during the experiment.

### *3.5.5 Evaluation Results*

The results of the evaluation for each objective were the following:

Descriptiveness of the keywords

- On average, only 35% of the presented keywords, both thesaurus and tags, were found descriptive for the learning resources.
- The thesaurus terms were found more descriptive than tags with proportions of 58% and 25% of the cases respectively. That makes thesaurus terms more popular.
- Nearly all of the most popular tags were in English, which was also the most spoken language among the focus group.
- The proportion of the keywords that were found descriptive was higher than the proportion of keywords in a language within users' competencies. That was caused because of the "travel well" keywords (figure 15).

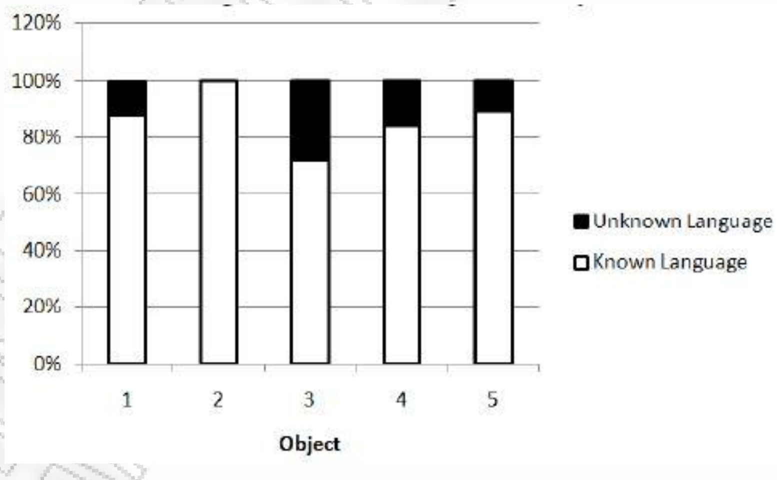



***Figure 15:** Keywords found descriptive in known and unknown language (Vuorikari et al., 2007)*

Contribution of keywords in using the learning resources in teaching

- Only 27% of the keywords were found useful
- The useful thesaurus were 50% while the useful tags were only 18%

- A keyword in a known language had usefulness percentage of 83% while in an unknown language only 15%.

Moreover, when users were asked to express their opinion for the issue of multilingual tags, when the tag is in an unknown language to them, they were divided into categories where a number of them loved it (2), many found it confusing (6), some found it useful (4) and one participant hated it.

## 3.6 Social Tagging Evaluation Methodology in "ALEF" project

ALEF (Adaptive Learning Framework) constitutes a full-featured e-learning portal and it has been designed and implemented in order to provide students an interactive environment in which they will be able to collaborate and participate in content creation (Móro et al., 2011).

ALEF portal allows the creation of various content types since it is equipped with collaborative content creators (commentator, external resources inserter and questions creator). Apart from those tools, there is also the “tagger tool”.

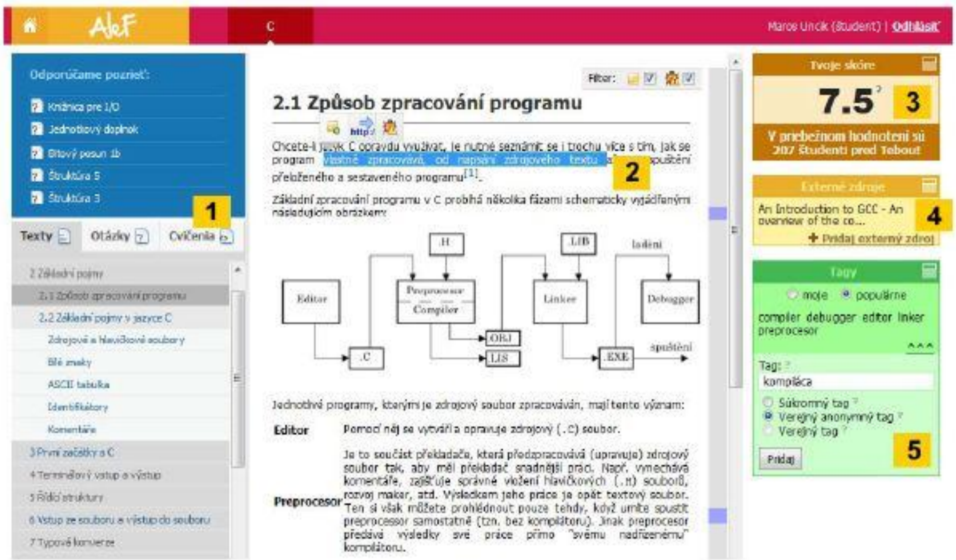



***Figure 16:*** *ALEF Tagging tool within collaborative content creators tools(Móro et al.,2011)*

In order to describe the learning objects in ALEF, the metadata layer is used. Metadata includes annotations and concepts, which are knowledge domain elements. Tags were considered as a special kind of annotation.

### 3.6.1 Research Question

The research has focused on the potential of Social Tagging in learning as even if Social Tagging proved to be successful, the prospective of this relatively new technology in the domain of learning has not been investigated thoroughly.

A remarkable notice concerning the tagging system, is the fact that when a user assings tags, is not implying only its interest on a specific subject but also its knowledge and attitude. The hypothesis derived from this statement is the following:

"Tags can be used to derive domain model, or to find users (students) with similar knowledge (and interests), which is important for creating virtual study groups".

### 3.6.2 Evaluation Instrument

Users can assign tags in learning objects by using the "tagger". The added tag may be a keywords or a multiword phrase, restricted by maximum character length.

In addition, the user is able to choose whether he wants the tag to be private or anonymous. Private tags are not visible from the other students while private are visible but without information for its creator. Moreover, the tags can be deleted, but only from their creators.

Also, there are two options in the tool, "in my tags view" and "in popular tags view", providing access in personal and popular tags respectively. A tag is popular when it is assigned at least 3 times in a learning object as an anonymous tag.

The most important feature of the tagging tool is its service as navigation in learning objects space. Thus, when a tag is selected a list of all learning objects with the tag selected is shown. This feature depends on the "tag view". For instance, "in my tags view", only learning objects tagged by the user are shown while "in popular tags view", only learning objects tagged with popular tags are shown.

### 3.6.3 Dataset: Description

The evaluation was based on an uncontrolled experiment, including the following dataset:

Participants

The participants of the evaluation were students-users of the ALEF portal. From the total of 82 students using the portal, only 35 of them tagged learning resources and consequently the number of evaluation participants is 35.

Learning Resources

From a total of 795 learning resources, students tagged 613 learning objects.

Tags

The tags derived from the 613 learning objects reached the number of 2272 tags.

### 3.6.4 Evaluation Method and Process

Towards the evaluation experiment, students were asked and motivated to use ALEF and to tag learning objects to prepare themselves for final exam in programming course. The experiment lasted for 15 days.

The aim was the creation of a social network of users which has been implemented indirectly by their cooperation and explicitly by grouping students into courses and virtual study groups. Due to the evaluation the following steps were considered:

1) The isolation of unique tags after normalization (marks removal, lowercase conversion, lemmatization and translation);
2) The overall distribution of tag occurrence;
3) The tags distribution regarding the learning objects;
4) Average number of tags per student;
5) Capability of tags to cover important concepts defined by the experts in the domain model of the course: for this step the overlay ratio was calculated through the metric below.

$$\varphi = \frac{\sum_{lo=1}^{|LO|} |Tags(lo) \cap Concepts(lo)|}{\sum_{lo=1}^{|LO|} |Concepts(lo)|}$$

***Figure 17:*** *Overlay Ratio ALEF*

In the equation in figure 17, |LO| is a number of tagged learning objects, while Tags(lo) and Concepts(lo) are sets of tags and concepts associated with the learning object lo respectively . The aim of the ratio, is to compare the normalized tags to normalized concepts associated to the same learning object.

### 3.6.5 Results

The findings of the evaluation process were the following:

- The initial number of the unique tags was 947 but after the further isolation due to the normalization, only 755 unique tags remained all in Slovak language.

- Students usually used tags to describe the content and not as a means for personal notes (only 15% private tags).
- The overall distribution of tag occurrence followed the power low as a tag occurred many times and many tags only once.
- The overall distribution of tags regarding the learning objects followed the power low. That happened because one learning object was tagged with 28 tags while 131 were tagged only once.
- The average number of tags per student was 63.6. However, the number of tags varies significantly from student to student and the distribution does not follow the power law
- The overlay ration result found to be 27,76%. The low result may be derived from the shortage of the method related to the normalization of the semantically similar words.

The general conclusions and suggestions of the evaluation were positive. The researchers encourage the use of folksonomies either to enrich existing domain models or to build them from the beginning. Furthermore, the research conclusion underlines the fact that semantic network of the domain is derived from users' social networks and it can be a bidirectional process, benefitting the users' social networks in the same way.

## 3.7 Social Tagging Evaluation Methodology in "AML"

Librarians in Alumni Medical Library (AML) of Boston University Medical Center teach the university students the Medical Subject Headings (MeSH), which is used to index the premier biomedical database, MEDLINE.

The use of MeSH is important to health care professionals while searching the biomedical literature (Lowe & Barnett, 1994). Therefore during these education sessions, the librarians in AML, introduce and demonstrate the use of MeSH, within the MEDLINE search. Librarians explain the structure of the MeSH hierarchy and the indexing processes as they perform a search. At the same time, students follow along by practicing at their own computers.

While MeSH is the main concept for a successful search, the instruction and comprehension of this controlled vocabulary is a challenge. Students have often difficulties to understand and apply the complicated controlled vocabulary of MeSH when searching biomedical literature and librarians give a battle to explain MeSH without referring to library terminology.

Due to the exploration of new ways of MeSH usage teaching, libarians of AML integrated Social Tagging into their instruction (Maggio et al., 2008). To this end, two things were considered: a) the majority of the students are persons in a specific age in which the use Web

2.0 Technologies as Social Tagging is very familiar and b) it has been found to provide useful tools for positively impacting students' information literacy and librarians' connection with students (Godwin, 2007).

### *3.7.1 Research Question*

The query derived from the case was: Tagging and controlled vocabulary in the library literature are presented to have connections. Therefore, Social Tagging may be able to engage students into the information management of the biomedical database MEDLINE.
Therefore, librarians state the following hypothesis:
"Social Tagging would better enable students to understand controlled vocabularies".

### *3.7.2 Dataset: Description*

Course

The research took place in the context of a 2-credit, letter graded mandatory course in the program of master's of arts in medical sciences degree offered by Boston University School of Medicine's Division of Graduate Medical Sciences. The name of the course was: ''MS 640: Introduction to Biomedical Information" and its curriculum aim was to show students ''where they are, so that libraries and librarians are seen as relevant and become part of their experience''. The course was implemented through combination of small group and large lecture sections.

Participants

1) University Students: the course was delivered to 186 students with an average age of twenty-three and a great part of them were recent college graduates. According to demographic data, most of them were Web 2.0 users. the majority of the students were also Generation Y members.
2) Librarians: the course was led, developed and taught by 5 librarian instructors of AML.

### *3.7.3 Evaluation Instruments*

HTML FORM

The assignment of the tags took place in a hypertext markup language (HTML) form. After the submission of the tags, the data included in the form, were saved in a table in AML's MySQL database.

The web coordinator used Macromedia ColdFusion 8 to query tags submitted by students in the table.

Survey

An evaluation instrument was an anonymous online survey that asking questions related to the success of the intervention.

### *3.7.4 Research Process*

The evaluation was divided into three parts:

1) Pre-class exercise
2) Intervention
3) Post-class evaluation

Pre-class exercise

This session took place prior to the intervention. It was a homework assignment presented online via interactive forms, designed and maintained by the library's web coordinator. The digital object presented to the students was a set of: an image, a short movie clip and a MEDLINE article. Students were required to supply 5 natural language tags to describe each digital object. The aim of the task was to tag the article without taking into account and being influenced by the other objects. This assignment accounted for 5% of the students' grades.

The submitted tags provided user-generated data that could be used to illustrate inconsistencies and disadvantages of natural language description. Tags were saved in AML's MySQL database and stripped to be anonymized.

Afterwards, the duplicate tags were grouped together with Macromedia ColdFusion 8 as to constitute a weighted list of terms. Then, CSS was used in order to represent the weighted list as a tag cloud, distinguishing the terms used and their frequency customizing the size and color of each tag.

Intervention

Initially, a discussion related to the tag clouds was made referring to pros and drawbacks of natural language tags. Students stated three problems: synonymy, spelling mistakes and variations and specificity. Afterwards tags were compared to controlled vocabularies.

The discussion provide librarians the opportunity to start a discussion about the application of controlled vocabularies like MeSH to MEDLINE, but without alienating library science terms.

In addition it was a chance for librarians to introduce major MEDLINE concepts as:

- PubMed in-process citations
- MeSH Mapping Tool

- Scope Note:
- Full Record and Explode

<u>Post-class evaluation</u>

After the intervention, students were asked to tag again the particular article. The article had not any annotation to prevent students from finding what the proper MeSH would be. In contrast to the previous time, students were asked to assign 5 MeSH terms instead of 5 tags by using the Ovid's MeSH mapping tool. The instrument of the tagging was the same as before.

At the end of the post-class evaluation, it was asked to complete an anonymous online survey.

### *3.7.5 Evaluation Method*

For the evaluation the following steps were made:

1) Librarians retrieved the tags that students submitted for both the pre-and post-class activities;
2) Tags for the article from both the pre-class exercise and post-class evaluation were anonymized and stored in a new table in the database;
3) Each tag was checked in order to find out whether it was a MeSH term, using the MySQL Count Function and the Ovid MeSH mapping feature;
4) A comparison of the results of step 3 among the pre-and post-class tags was made to determine the value of the instructional intervention;
5) Data from survey were collected and analyzed

### *3.7.6 Results*

<u>Survey:</u>
The optional survey was completed by 171 students and the findings from the survey were divided into 3 answers:

- The MeSH controlled vocabulary and indexing process as the clearest concept (46%);
- The MeSH as the least clear concept (12%);
- The MeSH wasn't mentioned at all (42%).

The survey's results and the comparison made in step 4 indicated that integrating Social Tagging could be used to convey the complex concept of controlled vocabulary in relation to searching the biomedical literature, confirming the initial set hypothesis. The students' ability to recognize and prefer MeSH terms increased from 9.2% to 78.2%.

Throughout the intervention students were taught the importance of a controlled vocabulary and especially MeSH. The obtained skills will lead to improve searches not only in MEDLINE but also in other databases.

## 3.8 Summary

Evaluation methodologies are developed in order to fulfil plenty of queries in relation to Social Tagging practice and potential.

During the chapter several reasons of applying evaluation in Social Tagging were identified. The most frequent seemed to be a) the usefulness of Social Tags in order to describe a resource and b) the effectiveness of social tags in searching process. Also, other quite repeated research questions laid c) on the matching of Social Tags to the formal vocabulary terms, d) the influence of multilingual tags in learning objects descriptions and e) the affection of the tagging interfaces to the resulting folksonomy

Furthermore, some evaluation methodologies were laid by most educational-oriented research questions dealing with issues like the usage of Social Tags within a learning environment in order to enhance f) the formation of domain models and g) the creation of social networks including students with common interest. In addition, h) Social Tagging was also considered as a mean of engaging students into the information management.

Methods of evaluating the Social Tagging folksonomy in each abovementioned case were:

- MySQL - Log data processing and measures
- Quality and quantity metrics
- Matching comparisons between Folksonomy, Thesaurus and other Formal Classification Vocabularies
- Interviews from users for their satisfaction
- Repository owner's evaluations on scales
- Close-ended questionnaires to users and experts including questions about the suitability of specific terms in order to describe a learning object
- Tag cloud for synonymy and grammatical issues detection

After the evaluation of Social Tagging practice several positive and negative conclusions were generated. Some of the results argued the utility of Social Tags in benefitting social networks and domain models and some other claimed that Social Tags are not always useful in contributing to the learning resources usage in teaching.

Moreover, some results targeted to more specific issues like the satisfaction or dissatisfaction in relation to the existence of multilingual tags and the influence of the tagging interface to the resulting folksonomy.

# Chapter 4:
# Proposed Social Tagging Evaluation Methodology

## 4.1 Introduction

In this section, there is a presentation of the proposed Social Tagging Evaluation Methodology for identifying different types of users' tagging motivation and evaluating their possible influence to the metadata descriptions and the resulted folksonomy.

Afterwards, there is the description of the existing Learning Object Metadata Repository's Dataset on which the proposed evaluation methodology was applied as well as the steps of the implementation. The LOR is the OpenScienceResources Repository which was developed in the framework of an EU-funded project, referred to as "OpenScienceResources: Towards the development of a Shared Digital Repository for Formal and Informal Science Education" (http://www.openscienceresources.eu/).

## 4.2 The Proposed Social Tagging Evaluation Methodology

Zervas and Sampson (2011), have proposed a Social Tagging Evaluation Methodology that aims to evaluate whether users' tagging behaviour can influence:

- the enhancement of metadata descriptions of digital educational resources
- the resulted folksonomy compared to formal vocabularies used for characterizing the digital educational resources

The research questions of the proposed Social Tagging Evaluation Methodology based on the above quests are the following:

- **Research Question 1**: Does the user's tagging style affect the different tags added by the users for describing the context of use of digital educational resources?
- **Research Question 2**: Does the user's tagging style affect the resulted folksonomy compared to formal vocabularies used for characterizing the digital educational resources?

Throughout the Social Tagging Evaluation Methodology three steps are taken into account.

1. The **first step** of the evaluation methodology is to Identify different underlying behaviours for users' tagging and proceed to the distinction of users in categories according to their tagging behaviour.
2. The **second step** is to calculate similarity between social tags and educational metadata. During this step we calculate the similarity between social tags (offered by end users) and educational metadata (offered by metadata experts or content providers) in order to identify whether the different tags added by each type of taggers influence the context of use of the Digital Educational Resources.
3. The **third step** is to compare folksonomy with formal vocabularies of educational metadata. During this step, we compare the resulted folksonomy produced by the social tags with formal structured vocabularies of educational metadata to identify if there are new useful tags within the resulted folksonomy.

The methodology chosen for the **first step** is proposed by Korner et al. (2010) and it is based on quantitative study applying some metrics and measures on the dataset.

The methodology identifies the different underlying behaviours for users' tagging (first step), recognizes two particular types of taggers, Categorizers and Decribers (Korner, 2009; Korner et al., 2010).

Categorizers are users whose aim is to categorize resources. For this purpose, they use tags to maintain a navigational aid to those resources, establishing a steady vocabulary. Categorizers avoid tags which have related semantic meaning replacing in some way the semantic taxonomy and smoothing the progress of navigation and browsing (Korner et al, 2010).

Describers are users whose aim is to describe the resources. By this intension, they tag resources describing them accurately and precisely. The tag vocabulary of describers typically contains a lot of infrequently used tags and lots of synonyms and it supports the process of searching and retrieval (Korner et al, 2010). As a result, in contrast to a categorizer's vocabulary, describer's vocabulary tends to be larger and unstable.

***Table 11:*** *Two Types of Taggers (Korner et al, 2010)*

| Type | Categorizer | Describer |
|---|---|---|
| Goal of Tagging | later browsing | later retrieval |
| Change of Tag Vocabulary | costly | cheap |
| Size of Tag Vocabulary | limited | open |
| Tags | subjective | objective |

Therefore, for the distinction of the users in two types, "Categorizes" and "Describers" by identifying their tagging behaviour, the following proposed measures occurred by the abovementioned methodology are going to be used (Korner et al., 2010):

1. Tag/Resource Ratio: relates the vocabulary size of a user to the total number of Educational Resources annotated by this user.
2. Orphaned Tag Ratio: shows the level to which taggers produce orphaned tags (infrequently assigned).
3. Overlap Factor: measures the phenomenon of an overlap produced by the assignment of more than one tag per resource on average.
4. Tag/Titles Intersection Ratio: is an indicator of how possible is for users to choose words from the educational resources' title in order to tag.

The research method which is proposed to be used for the accomplishment of the **second and third step** and by extension of the research questions, is similarity calculations between:

(a) the Educational Metadata and the Social Tags added by users with different tagging style (addressing research question 1);

(b) the OSR structured vocabulary and the Social tags added by users with different tagging style (addressing research question 2).

During the second step, the comparison between the Educational Metadata and the Social Tags added by users with different tagging style, the similarity is calculated for social tags added by describers, as well as for social tags added by categorizers based on the users' discrimination performed in step 1. At the end of this step, we would be able to identify digital educational resources enhanced with social tags offered by describers and/or categorizers that are different by the formal metadata descriptions offered by metadata experts or content providers.

During the third step, the comparison between the OSR structured vocabulary and the Social tags added by users with different tagging style is performed with the folksonomy produced by describers, as well as with the folksonomy produced by categorizers following the users' discrimination performed in step 1. At the end of this step, we would be able to identify new useful tags offered by describers and/or categorizers that can enhance the formal structured vocabularies of educational metadata.

The proposed Social Tagging Evaluation Methodology was applied to the **OpenScienceResources (OSR) Repository.**

## 4.3 Applying the Proposed Social Tagging Evaluation Methodology: The OpenScienceResources (OSR) Repository

The OSR approach builds on the strength of the informal learning taking place in science centres and museums to engage school students, their teachers as well as all lifelong learners in playful learning (Sotiriou et al., 2010). The OSR Repository contains plentiful educational materials from collections from all over the European science centres and museums like lesson plans, images, videos, student projects and educational pathways and is available for anyone to access or share their own learning objects.


***Figure 18:*** *OpenScienceResources Repository*

Additionally, content is enriched with standardised semantic educational metadata and it is also provided the opportunity to enrich the content with Social Tags of specific categories or of user's choice.

### *4.3.1 OpenScienceResources Educational Metadata*

The structure of the OSR education metadata is formed by OSR IEEE LOM Application Profile. The OSR Application Profile is based on the IEEE LOM (IEEE LTSC, 2002) specifications and is developed in that way as to provide the appropriate vocabulary for the metadata elements reflecting the need for annotation of the (online or in science museum/centres) available science learning digital content. Through this metadata structure the organizing, searching and retrieving of the digital science museum/centre learning resources are facilitated.

Metadata information can be added to a digital learning object (photo, text, web page, etc.) by choosing pre-defined vocabulary terms in each metadata category. In addition there is an open-ended text to enter user-based keywords.

The searching mechanisms of the repository provide the users the capability to search for science education resources with science curriculum related searching criteria as the resources are tagged with educational metadata following the Science Education LOM-AP. (Sampson et al., 2011)

Due to the Educational Objectives pre-defined vocabulary, there was a combination of Bloom's Taxonomy and its revisions and extensions and Gammon's typology (2003). Despite the fact that Gammon originates in the world of science museums and centres, focusing on the assessment of learning taking place in museum environments, Bloom's taxonomy (Anderson & Krathwolh, 2001) contributed to a greater extend. Thereby, the OSR vocabulary classification of education objectives includes the three domains of learning: cognitive, affective and psychomotor where each domain has a choice of four items (Table 11).

***Table 12:*** *Educational Objectives Vocabulary in OSR Repository*

| **Cognitive Domain - Knowledge** | **Cognitive Domain Process** | **Affective Domain** | **Psychomotor Domain** |
|---|---|---|---|
| **Factual knowledge** | To remember | To pay attention | To imitate and try |
| **Conceptual knowledge** | To understand | To respond and participate | To perform confidently following instructions |
| **Procedural knowledge** | To apply | To recognise values | To perform independently, skilfully and precisely |
| **Meta-cognitive knowledge** | To think critically and creatively | To form and follow a system of values | To adapt and perform creatively |

The full metadata elements and their realisations into the specific OSR cognitive Educational Objectives vocabulary lists or open text fields are presented in APPENTIX A.

In order to tag the material with metadata tags, the content providers of OSR portal use the OSR Learning Objects Metadata Authoring Toolkit (OSR ASK-LOM-AT) after installing it in their personal computers. The OSR ASK-LOM-AT is based on OSR IEEE LOM Application profile and aims to ease the authoring of science education related metadata by providing a step by step authoring wizard, a local educational metadata repository of the metadata records and finally export of the XML file containing the metadata. Afterwards the XML file must be imported in the OSR repository.

### 4.3.2 *OpenScienceResources Social Tagging Options*

The OSR repository beyond the standardized metadata elements of the OSR IEEE LOM Application Profile, provides users the Social Tagging option. Thus, the user contributes to the vocabulary by adding in the learning material tags of its own perspective. The contributed tags may be either free terms occurred from user's experience or user's view of certain standardized metadata elements of the 'Application Profile' like 'Educational Objectives' and 'Context' (Figure 19).

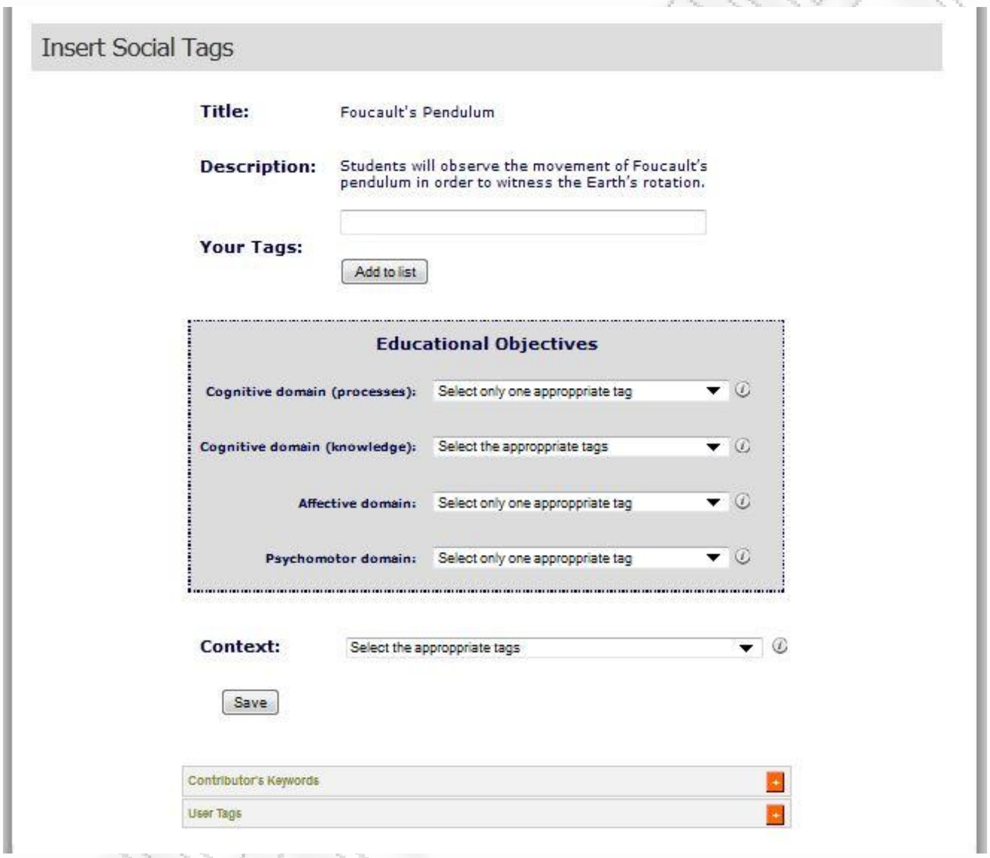



***Figure 19:*** *OSR - Insert Social Tags*

Apart from adding tags, OSR users are also able to see tags added to the object by other users as well as how many times each tag has been added on the current object or other objects. In addition to that, users can browse all the additional information derived from a tag as:

- Relative learning material which is of their interest by browsing all objects assigned to the specific tag.
- Finding other users of their understanding and subsequently objects of their common interest.

In table 12 below there is a brief description of all the facilities provided by Social Tagging in the OSR repository.

***Table 13:*** *OSR folksonomy activities (Sotiriou et al., 2010)*

| Folksonomy activity | Description |
|---|---|
| Tag a resource | The user will be able to socially tag a resource both free from the predefined vocabularies, as well as by making selections from the OSR vocabularies for selected metadata elements. The system will propose similar existing (and possibly also most popular) tags while the user types free keywords. |
| Search resources based on a tag | The user will be able to select a tag and find all resources already tagged with this term. Results may additionally include resources annotated with similar tags. |
| Search users based on a tag | The user will be able to identify all users that have tagged a resource with the same tag. Additionally, they will be able to find all users that have used a particular tag on different resources. |
| Search tags based on a resource | The user will be able to see all tags associated with a particular resource, so as to observe different relations and potential learning paths. |
| Create a community based on a resource | Users associated with a resource may be provided with additional Web 2.0 tools, so that the creation of 'resource-originated' communities may be fostered. |

The Social Tags are assigned through the OSR Social Tagging Authoring Tool which is based on the ASK Educational Content Social Tagging Toolkit[5] developed by CERTH.

## 4.4 The Data Set: Description

Towards the evaluation of the Social Tagging in OSR and the investigation of the hypotheses set, several aspects of the OSR Project were also examined.

The basic elements participating in the evaluation are the users, the objects and the tags. Each of these elements is further analyzed in sub-elements considering a variable. The variables are going to be combined in several ways in order to fulfil the scope of the Social Tagging evaluation methodology.

### *4.4.1 Users*

The users of OSR Repository are members of the public with a professional or personal interest in Education and particularly in Science Education Resources. Particularly, the main OSR stakeholders are defined according to their roles as users of the OSR service as follows:

[5] http://www.ask4research.info/ask-lost/

- Teachers: educators looking for enriching their teaching with the use of digital learning resources.
- Learners: School students and life long learners looking for digital learning resources for their curricular learning, or out-of-school learning of personal interest through enjoyable science learning experiences.
- Visitors: people who may visited the OSR Repository by chanc and are roaming through leisure activities.
- Science museum educators or science communication professionals: Staff who prepare science learning or awareness raising experiences for the visitors/users of their institutions (science museums and centres). An additional subgroup here might also be other professionals too related to science communication, including journalists who may search for content relevant to the promotion of informal science learning.

### *4.4.2 Objects*

The learning objects of OSR Repository are divided into two categories based on their aggregation level: the educational content and the educational pathways.

Educational content are small size objects like pictures, videos, etc., while educational pathways are organized combinations of various individual science Educational Resources in order to constitute a meaningful science educational activity for a specific user group in a specific context of use (Sotiriou et al., 2010).

The contexts of use of the OSR learning objects are organised into the following three categories:

- In the school (combined with one of the following two categories)
- In the science museum/centre (physical visit)
- On the web (virtual visit)

Educational Pathways correspond to a variety of a blend of contexts and users (described in 4.4.1 chapter) sharing an interest in using formally or informally the available digital learning resources for learning purposes.

Moreover, the educational pathways are separated in two groups:

- Pre-structured pathways: a strict predefined “route” is provided, where there is a set of science learning resources that the recipient must follow. This type of pathway is mostly addressed to formal learning contexts.

- Open Pathways: a more flexible "route", that allows the recipient to explore the science learning resources as s/he wishes. It provides the users the opportunity to involve in an open-ended investigation and address mainly to informal learning.

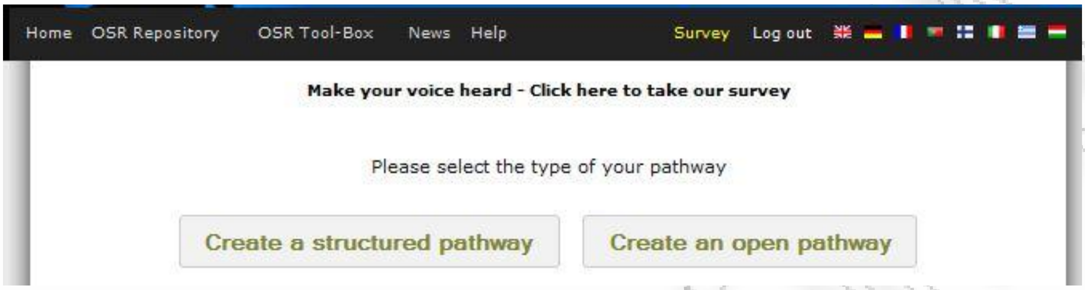



***Figure 20:*** *Types of Educational Pathways*

The existence of Pre-Structured and Open Pathways is derived from the OSR Educational Pathway Patterns which are templates that facilitate the design and presentation of Educational Pathways. Thus, there are two types of patters, the Pre-Structured and the Open Educational Pathway Pattern. The Educational Pathway Patterns are organized into three steps: pre-visit, visit and post-visit (Figure 21).


***Figure 21:*** *OSR Portal - Steps of Educational Pathway Patterns*

In general, Educational pathways whithin the OSR repository are considered as dynamic rather than static conceptual tool. The OSR users are able to revisit, modify and expand their Pathways as they can also re-use others' pathways to create their own version. Through this practice on the one hand there is an enhancement of social learning within the OSR learning community and on the other hand there is a strengthened possibility of educational resources reuse.

In figure 22 there is a presentation of an OSR learning object as the user can browse it. Both in educational contents and pathways there is a presentation of the objects display information as "Original Title", "Classification", "Short Description", "Educational Objectives" and "Given Metadata", while there are also options of navigating to "Educational Material", "Report Inappropriate Content", "Comment the Educational Pathway" and "Add to Favourites". In addition, on the right side of the presentation the assigned to the object *Social*

*Tags* can be found and the two alternative options of metadata: "Add your tags" and "Full metadata record".


***Figure 22:*** *Display of OSR Learning Object*

### *4.4.3 Tags*

OSR Repository explores the enrichment of the science learning digital resources through both standardised and social educational metadata.

Therefore, the tags of the OSR repository are comprised by:

a) The OSR standard-based educational metadata structure by the OSR IEEE LOM Application Profile (APPENTIX A), including the science education vocabulary (APPENTIX B).

b) The pre-defined options of Educational Objectives (Table 13) and learning object's context (Table 14) available in both standards-based educational metadata structure and Social Tagging toolkit;

c) The OSR resulting folksonomy offered by the free terms of Social Tagging option.

***Table 14:*** *Educational Objectives of the OSR Learning Objects*

| Educational Objectives Category | Options |
|---|---|
| **COGNITIVE DOMAIN - KNOWLEDGE** | Conceptual Knowledge |
| | Factual Knowledge |
| | Procedural Knowledge |
| | Meta-cognitive Knowledge |
| **COGNITIVE DOMAIN - COGNITIVE PROCESS** | To remember |
| | To understand |
| | To apply |
| | To think critically and creatively |
| **AFFECTIVE DOMAIN** | To pay attention |
| | To respond and participate |
| | To recognise values |
| | To form and follow a system of values |
| **PSYCHOMOTOR DOMAIN** | To imitate and try |
| | To perform confidently following instructions |
| | To perform independently, skilfully and precisely |
| | To adapt and perform creatively |

***Table 15:*** *Contexts of use of the OSR Learning Objects (Sotiriou et al., 2010)*

| In the science museum/centre (physical visit) | On the web (virtual visit) |
|---|---|
| **In connection with the school** | **In connection with the school** |
| **In *no* connection with the school** | **In *no* connection with the school** |

In order to enable the Social Tagging evaluation methodology, the tagging data was gathered through the OSR Social Tagging Authoring Tool. The data are recorded in a MySQL database and is available for retrieval and analysis. The information was gained through a table containing User ID, Learning Object ID, Learning Object Type, Tag and Tag Category.

As the OSR Repository is a European Portal, is available to people from many countries and it's reasonable to be multilingual with a user interface that supports 8 languages (English, German, Greek, French, Portuguese, Finnish, Italian, Hungarian). Consequently, the Social Tags provided by users involve a multilingual aspect to a greater degree as there aren't any boundaries of any language use. Therefore, before proceeding in any kind of analysis, a translation in English language upon all the Social Tags was conducted.

## 4.5 Social Tagging Hypotheses in OpenScienceResources Project

The aim of the Social Tagging Evaluation is to recognize significant matters concerning the use of Social Tagging in science museum/centre digital learning content and specifically the OSR Repository.

Towards the present Social Tagging Evaluation, the different tagging options and trials within the user community will be considered in order to investigate new opportunities and potential of Social Tagging tools in such content-exchange communities. The findings of this kind of evaluation will contribute in enhancing the learning materials' context of use through an "on-site" metadata tagging approach. Consequently, the evaluation of the OSR project focuses mainly on comparative studies of OSR expert and emerging non-expert vocabularies.

Having in mind that the resulting tags and folksonomies are influenced by user's tagging behaviour (Heckner et al., 2008; Zollers, 2007), prior to the comparison a distinction of type of users motivation takes place within the OSR Repository. The types of users' motivation in OSR repository, are discriminated into "categorizers" and "describers" (Korner et al., 2010).

The hypotheses are based on the abovementioned research questions of the Proposed Social Tagging Evaluation Methodology (Chapter 4.2) and lead the structure of the evaluation methodology dividing it into two experiments:

**Experiment # 1:** Does the user's tagging style affect the different tags added by the users for describing the context of use of digital educational resources?

- Hypothesis # 1: "The resulting folksonomy enhances the context of use of the Learning Objects stored in the OSR Repository"
- Hypothesis # 2: "The type of users' motivation affects the enhancement of the context of use of the Learning Object stored in the OSR Repository"
- Hypothesis # 3: "The type of the learning object (Learning Content, Educational Pathways) affects the enhancement of the context of use of the Learning Objects."

**Experiment # 2:** Does the user's tagging style affect the resulted folksonomy compared to formal vocabularies used for characterizing the digital educational resources?

- Hypothesis # 4: "Within the OSR resulting folksonomy, new useful terms can be identified"
- Hypothesis # 5: "The type of users' motivation affects the contribution to the new useful terms"

## 4.6 Evaluation Metrics and Measures

The metrics and measures cited in this chapter were used in order to examine and come up with some valid and useful conclusions on the assumptions. Nevertheless, prior to the application of the metrics and measures in OSR data, some preliminary operations related to proper structure of data were preceded.

### *4.6.1 Dataset Preliminary Preparation*

Firstly, the data were exported from OSR MySQL database to CSV files and afterwards were imported in Microsoft Excel as XLS files, creating structured folded and organized by categories files. The necessary tables for the evaluation, included information related to the OSR Social Tagging data and the OSR educational structured metadata.

As it was mentioned above, an important first step of data proceeding was the translation of all the formal and informal tags in their equivalents in English language. The translation was essential in order to be able to compare the tags generated from various languages.

The next step after the translation was to normalize the tags, removing any diacritic marks and other characters like brackets, exclamations marks, etc and checking for spelling issues. Finally, all the tags were converted to lowercase.

Due to the chapters 4.5 and 4.6 the word “tag” is used for the terms occurred by the OSR folksonomy and the word “metadata” is used for the tags raised by the metadata standardised structure.

The first step in the evaluation methodology, after the preliminary preparation of the dataset, was to proceed in the distinction of users in categories according to their tagging behaviour. Throughout the results of this technique, the types of taggers found, are going to become variables by which part of the hypotheses set will be determined accordingly.

The methodology chosen for this procedure was proposed by Korner et al. (2010) and it is based on quantitative study applying some metrics and measures on the dataset.

### *4.6.2 Tag/Resource Ratio*

The Tag/Resource ratio relates the vocabulary size of a user to the total number of educational Content and educational pathways annotated by this user.

The elements used for this ratio were “User_ID”, “Object_ID” and “Tags”. The structure of the data was modified in order to present a table measuring all the tags and all the objects assigned by a single user.

For measuring the number of tags and objects per user a pivot table in Excel was used. Through a function of the pivot table applied in the initial data table, first the number of the existing tags (from column Tags) when the User_ID matches with the specific user's ID was measured. Afterwards, the same activity happened in column "Object_ID", measuring the number of the objects assigned to each user's ID.

The tags were not filtered as to isolate the unique tags, because the ratio requires the number of all the tags assigned to each user for each resource. So, the same tag may be used from the same user for another resource.

Thereupon, a last table was created including the "User_ID", the "number of Tags" per User_ID and the "number of Objects" per User_ID.

Taggers, who will score higher values for this measure, are characterized as "Describers" as they employ a hypothetically boundless vocabulary. Conversely, taggers who use fewer tags and thus employ a limited vocabulary achieve a lower score in this measure and are characterized as "Categorizers".

The following equation shows the formula used to estimate the ratio between the number of the tags and the number of educational Content and educational pathways which were annotated by each user. In fact, it shows the average number of assigned tags per resource.

$$trr(u) = \frac{|Tu|}{|Ru|} \qquad (1)$$

In the equation, "Tu" denotes the set of tags in a user's vocabulary (number of Tags) and "Ru" denotes the set of learning objects, educational Content and educational pathways (number of Objects), annotated by the user.

When applying the measure on the final table, a divisive formula undertook to divide the number of tags to the number of objects assigned to each user.

### *4.6.3 Orphaned Tag Ratio*

The orphaned tag ratio shows the level to which taggers produce orphaned tags. An orphaned tag is the tag that is used infrequently as it is assigned only to few resources.

The current ratio is used to measure the percentage of tags in a user's vocabulary that can be characterized as orphaned.

Describers as they assumed to tag resources with a more evocative and descriptive way, they are expected to bring in orphaned tags to a greater extend in their personomy. On the other hand, Categorizers are expected to keep their vocabulary as simple as possible, so they establish a stable vocabulary, avoiding orphaned tags because they would add noise to their personomy.

The ratio results range from 0 to 1, where Describers are anticipated to score values near to 1 and Categorizers near to 0.

$$orphan(u) = \frac{|Tu^0|}{|Tu|}, Tu^0 = \{t||R(t)| \leq n\}, n = \left\lceil \frac{|R(t_{max})|}{100} \right\rceil \quad (2)$$

The equation 2, allows measuring the proportion of orphaned tags related to a user's u personomy, where $T^o u$ represent the set of orphaned tags in a user's personomy Tu, based on a threshold n.

The threshold n is consequent from each user's individual tagging style in which tmax represents the tag that are used the most. Also, R(t) represents the number of resources which are tagged with tag t by the user. At the original measure, the R(tmax) factor is divided by 100, but because of the smallest population of the research and consequently the smallest data, there was a reducing of the denominator into the half of its value.

In order to apply the Orphaned Tag ratio to the dataset, some steps were preceded. First of all, a table consisted by User_ID and unique Tags was created. Then, a third column was added which was measuring the frequency of each tag per user from the initial data table. Thus, if the User_ID field and the Tag field of the initial data table matched to the given User_ID and Tag, the function was counting it and the frequency was increasing.

A next step was to calculate the threshold n for each user. A pivot table took over the procedure, by finding for each user the maximum frequency that a tag was assigned by each user. Subsequently, the maximum frequency found for each user was divided by 50 to deliver the threshold n for each User_ID.

According to the equation, the orphaned tags are these lying under the threshold. Therefore, a function applied on a table containing User_ID and Tags Frequency, counting in a third column ($T^o u$) how many of each user's tags had frequency under the threshold n.

In the end the number of the orphaned tags per user was divided by the number of the total number of tags assigned to the particular user, resulting to the orphaned tag ratio of each user.

### *4.6.4 Overlap Factor*

The overlap factor measures the phenomenon of an overlap produced by the assignment of more than one tag per resource on average. The formula relates the number of all resources to the total number of tag assignments of a particular user.

It is expected that the users characterized as Describers, as they don't use tags for navigation but for later retrieval, they will not care in keeping overlap factor low while Categorizers in their attempt to produce discriminative categories free from intersections will keep overlap low. Therefore, Categorizers score values near to 0 and Describers near to 1.

$$overlap = 1 - \frac{|R_u|}{|TAS_u|} \qquad (3)$$

In the equation 3, Ru denotes all the objects (educational Content and educational pathways) annotated by a user and TASu denotes the total number of the tags that are assigned to the particular user.

For the application of the overlap factor to the dataset, a table including User_ID, Object_ID and Tags was created. Then, a pivot table containing these elements was structured in order to present the "number of objects" and the "number of tags" assigned to each User_ID. In an additional column, a function was calculating the quotient of "number of objects" to "number of tags" assigned by each user. In the end the scores were deducted from 1, resulting in this way to the final outcome of overlap factor of each user.

### *4.6.5 Tag/Titled Intersection Ratio*

Tag/Title intersection ratio is an indicator of how possible is for users to choose words from the educational resource's or educational pathway's title in order to tag. For this purpose, the measure calculates the intersection between the tags and the resource's title words for each tagger. The ratio results range from 0 to 1 and the result of the ratio shows how objective or subjective may the tags are.

It is expected that Categorizers introduce tags taken from the title words and they score near to 1 in the ratio and Describers using words not existing in the title, score near to 0.

$$ttr = \frac{|T_u \cap TW_u|}{|TW_u|} \qquad (4)$$

In the equation 4, Tu refers to the tags that are assigned to the particular user and TWu indicates a set of title words of resources assigned to the user. The titles are split into separated words and then tags are checked one by one whether they match to the separated words.

For normalization purposes the resulting absolute intersection size is related to the cardinality of the set of title words.

A basic step for calculating the tag/titled intersection ratio of each user, was to break into words both the tags and the titles. However, the first step taken was to create a table with columns contacting the user, the titles of the objects that the user added tags and the tags assigned (User_ID, Title, Tags).

Quite often the tags as the titles were containing more than 1 word making up a two-word tag or a phrase and less often the tag may be a whole sentence. For the separation of the tags and titles into words, a script within the Excel was run which was separating the tag when there was a space between the words (the diacritic marks had already been removed in the preliminary preparation of the data). Consequently, for each User_ID there was a list of all the words derived from the tags he added and a list of all the words derived by the titles of the objects in which the tags were added (User_ID, Title Words, Tags Words). .

The next step was to control whether and in what level the Tags Words were match to Title Words. At this point, a column near to Tags Words column was added checking for the possible match of the each tag word to any of the title words. The matching proceeding presupposed a full match among the tag and title word as the dataset was previously checked in preliminary preparation for spelling and punctuation marks. The function was returning the answer “match” if the tag word was existing in the title words and “no match” if it was absent.

Subsequently, a final table was structured, containing “User_ID”, “Intersection” and “Number of Title Words”. In the column “Intersection” a function calculated the frequency of “match” per user. Thus, how many times a user added a tag word matched to a title word. In the column “number of title words” a function calculated the number of title words assigned to each user.

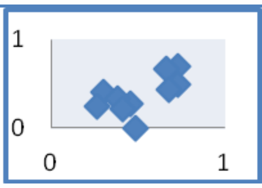
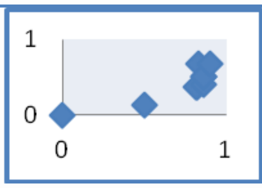
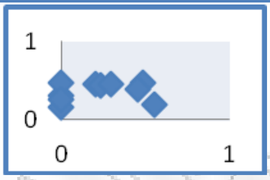
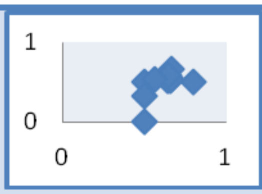
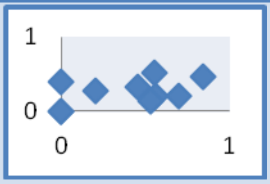
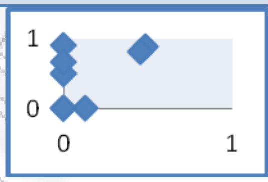
In the end, the tag/titled intersection ratio results derived from the division of elements of “Intersection” column with the elements of “Number of Title Words” column for each user.

### *4.6.6 Correlation Between Measures*

Since the measures will determine the classification of the taggers into Categorizers or Describers, a correlation took place to see whether the measures are expressed each other in a high level of harmony.

Therefore, a spearman rank correlation of the measures for OSR Repository taggers’ behaviour was calculated and at the same time a pairwise distribution was created (table 16). For each couple of measures, 5 describers and 5 categorizers were randomly drawn from the OSR Repository dataset.

*Table 16: Pairwise Correlation of Measures*

| | | | |
|---|---|---|---|
| **Tag/Resource Ratio** |  |  |  |
| **0,63** | **Tag/Title Intersection Ratio** |  |  |
| **0,83** | 0,55 | **Overlap Factor** |  |
| **0,09** | 0,11 | 0,06 | **Orphaned Tag Ratio** |

Throughout the correlation's findings, it is noteworthy that the most of the measures correlate in a sufficient way. Specifically, Tag/Resource Ratio show the highest correlation coupled with Overlap Factor. Additionally, Tag/Title Intersection Ratio has a relatively great correlation with Overlap Factor and Tag/Resource Ratio. Orphaned Tag Ratio reacted with a lower level of correlation coupled with all the measures. The measures represented by high correlation between them, confirmed each other in giving identical type of tagger in the evaluation.

Taking into consideration the above, the characterisation of each user as a "Describer" or a "Categorizer" made by the agreement of at least 3of the measures into the specific type of user, nearly always the "Orphaned Tag Ratio" was excluded. Therefore, two tables were created. The first table contained the User_ID and four columns, one for each measure. The columns were draining data from the measures' results and were labelling accordingly the user as "Describer" or "Categorizer". The second table contained the "User_ID" and the "Behaviour Type" columns where in the later column a function was applied determining the behaviour type of each user by using the information given from the first table. So, the "Behaviour Type" column defined as "Describer" the user whose 3 or 4 measures labelled him as a "Describer" and vice versa.

In case that a user was labelled as Describer from two measures and as Categorizer by other two measures, a further analysis for the user's behaviour is made, giving particular importance to the Tag/Resource Ratio which reveals the vocabulary size of the user.

## 4.7 Experimental Setup

Following the aforementioned measures, the different types of taggers (categorizers and describers) in the OSR Repository are identified. The next level of the evaluation methodology is the experimentation through the variables in order to conclude in valid results for the hypotheses set.

Through the first experimental setup the first three hypotheses of OSR project which are related to the context of use of the OSR learning objects are examined. Alongside, the factors derived from the type of users' motivation and the types of learning object are considered.

For the second experimental setup, the last two hypotheses of OSR project are going to be examined. The goal of this experiment is related to the tracing of new terms generated from the user-based vocabulary.

The necessary variables for the proceeding of both of the experiments are:

- Types of users' tagging motivation: Describers, Categorizers
- Types of learning objects: Educational Content, Educational Pathways
- Types of metadata: Tags, Metadata
- Types of pre-defined vocabulary: Educational Objective, Context, Classification

### *4.7.1 Experiment #1 Design: Identifying user-based descriptions of the context of use of Educational Content and Educational Pathways*

The first experiment will focus on analyzing the resulting folksonomy and provide conclusions about how the user-based descriptions influence the context of use of the OSR learning objects. This first part of the experiment is linked to the first hypotheses set in Chapter 4.5.

In addition to the main objective of the experiment, a sore point is to detect whether the different tagging style affects the folksonomy related to the context of use of the OSR learning objects. The current operation is related to the second hypothesis.

Finally, a last analysis is focused on whether the type of the learning objects influences the user-based descriptions of the context of use. The results of this analysis are associated to the third hypothesis.

The experiment procedure was handled through comparisons between the tags and the metadata of OSR Repository. For each one of the comparisons different variables participated.

**H1: "The resulting folksonomy enhances the context of use of the Learning Objects stored in the OSR Repository"**

Due to the first hypothesis, there was a comparison between the tags (user based descriptions) and the metadata (expert's description). Therefore, the variables that took place to the comparison are several types of tags and metadata.

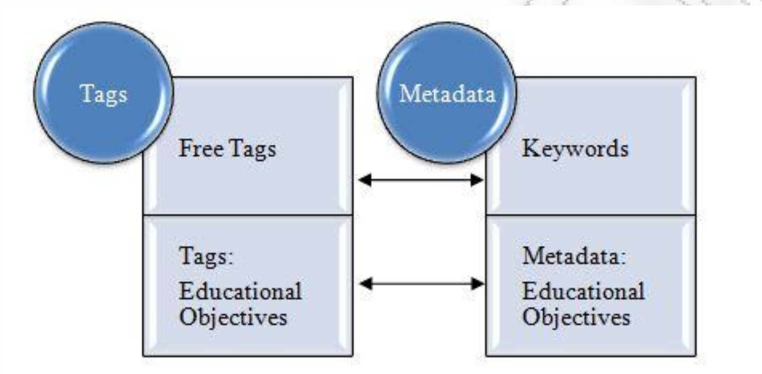



***Figure 23:*** *Tags and Metadata Comparison*

The comparison of tags and metadata was divided into three phases (Figure 23):

- Free tags were compared to metadata keywords
- Tag Educational Objectives were compared to metadata Educational Objectives
- Context (tags) were compared to context (metadata)

In order to measure the enhancement of the context of use of OSR learning objects, some ratios were applied along to the variables' comparison.

The first step was to cut off from the table, which included the folksonomy information, the elements "Object_ID", "Tag" and "Tag_Type". The "Tag_Type" takes the values "Free" when the tag is not chosen by a pre-defined vocabulary. A second step was to isolate from the table of objects' description the elements "Object_ID", "Keywords", "Context" and "Classification".

1) Comparison # 1: Keywords and Free Tags

For the **first** comparison there was a filtering of the tags based on their tag type, isolating only the tags with tag type "Free". Therefore, a new table containing the "Object_ID" and the wanted "Tags" was created.

Then, the tags which were assigned by the content provider of each object were removed. For the removal, a table including the User-ID and the Object_ID of the objects that the specific user created, were used to filter the information and remove the appropriate lines.

Finally the remaining elements of the table were used to form a pivot table showing for each Object_ID the tags assigned to it.

Similarly to the tags' preparation, a metadata preparation took place too. First step was isolating the elements "Object_ID" and "Keywords" from the table and afterwards creating a pivot table showing for each Object_ID the metadata assigned to it.

In the end, a script was applied to merge (based on Object_ID) the two pivot tables into one. The final table was presenting for each Object_ID the tags and keywords assigned to it. When the preparation of the data was done the next step was to go on with the ratio:

Keyword/Free Tag ratio

The Keyword/Free Tag ratio indicates the correlation between the assigned keywords and free tags in an object (educational Content and educational pathways). The ratio results range from 0 to 1. If the score of the ratio is low then there is low correlation between the keywords and the free tags and vice versa.

$$kfr = \frac{|F_r \cap K_r|}{|F_r|} \qquad (5)$$

In the equation 5, Fr refers to the free tags that are assigned to the particular object and Kr indicates the set of keywords which were tagged in this object. Free tags and keywords are checked one by one whether they match.

For the match controlling, a column next to the tags column was created, in which the function "match" was applied. Thus, every single tag was checked whether matches to any of the keywords assigned in the particular object. If the match was negative then the "no match" answer was appeared. Else, the token "match" was appeared and the result by the counter function was increased. The result corresponds to the intersection between the free tags and keywords assigned to the current Object_ID ($Fr \cap Kr$).

For normalization purposes the resulting absolute intersection size is related to the cardinality of the set of free tags. In this way, the results show the percentage of the free tags match to the keywords.

2) Comparison # 2: Metadata/Tags Educational Objectives

For the **second** comparison the OSR vocabulary classification of Educational Objectives of both tags and metadata were necessary. The Educational Objectives as it was mentioned in

Chapter 4.2 include the three domains of learning: cognitive, affective and psychomotor (Table 13).

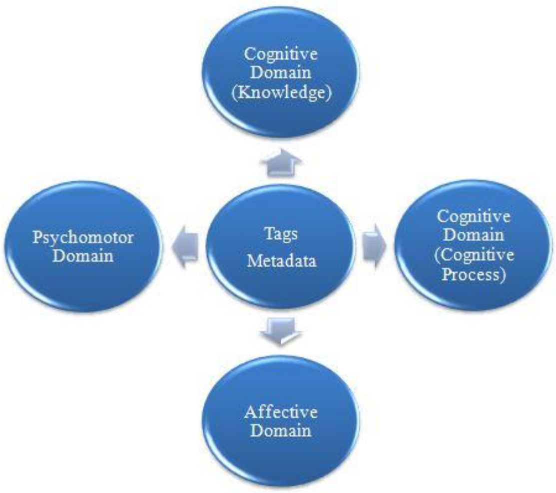



***Figure 24:*** *Variables in second Hypothesis - second Comparison*

The Tag_Type in the table of folksonomy information except for the database value "Free", takes also values based on the Educational Objectives (Table 17).

***Table 17:*** *OSR Database Values of Educational Objectives*

| Educational Objective Category | Database Value |
|---|---|
| **Cognitive Domain [Knowledge]** | KD |
| **Cognitive Domain [Cognitive Process]** | CPD |
| **Affective Domain** | AFF |
| **Psychomotor Domain** | PS |

Consequently, there was a filtering of the tags based on their tag type, isolating only the tags with the appropriate tag type every time. Therefore, four new tables containing the "Object_ID" and the wanted "Tags" were created. Then, these tables were used to form four pivot table showing for each Object_ID the tags of the specific educational objective category assigned to it.

In the same way, there was also a procedure in metadata table, where the element of "Object_ID" and "Classification of Educational Objectives" were isolated. Afterwards, there was an extra isolation in classification of education objectives, separating them in tables based on their categories. In the end, four pivot tables were created, showing every time the metadata of the educational objective category assigned to each Object_ID .

In the end, the script mentioned in the first comparison was applied to merge into one the tables of tags and metadata of each educational objective category for each Object_ID. The final tables presented for each Object_ID the tags and metadata Educational Objectives assigned to it. After the data preparation, the Educational Objectives Metadata/Tag ratio was applied to the information:

Educational Objectives Metadata/Tag ratio

The Educational Objectives Metadata/Tag ratio shows the correlation between the assigned Educational Objectives (Cognitive Domain-Knowledge, Cognitive Domain-Process, Affective Domain, and Psychomotor Domain) metadata and tags in an object (educational Content and educational pathways). The ratio is implemented separately for each one of the four categories of Educational Objectives. The ratio results range from 0 to 1. If the score of the ratio is low then there is low correlation between the two elements and vice versa.

$$EOr = \frac{|ET_r \cap EM_r|}{|ET_r|} \qquad (6)$$

In the equation 6, ETr refers to the Educational Objective tags that are assigned to the particular object and EMr indicates the Educational Objective metadata of resources which were tagged in this object. The elements are checked one by one whether they match.

For the match controlling, a column next to the tags column was created, in which the function “match” was applied. The procedure of matching was the same as in the first comparison. The result of the match counter in this ratio, corresponds to the intersection between the tags Educational Objectives and the metadata Educational Objectives assigned to the current Object_ID (ETr ∩EMr).

For normalization purposes the resulting absolute intersection size is related to the cardinality of the set of Educational Objective tags. In this way, the results show the percentage of Educational Objective tags match to the Educational Objective metadata.

3) Comparison # 3: Context-Tags and Context-Metadata

For the **third** comparison the context of the learning object derived from the folksonomy and the context derived by metadata were used.

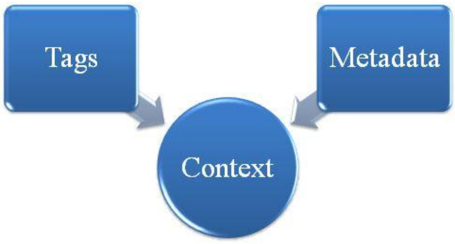



***Figure 25:*** *Variables in second Hypothesis - third Comparison*

The types of context were mentioned in chapter 4.4.2. The database value of the context in the folksonomy table is "CON" and the pre-defined vocabulary contains the options:

- On the web, unrelated to school
- On the web, related to school
- In the science museum/centre, unrelated to school
- In the science museum/centre, related to school

Consequently, context of tags and metadata were isolated from the corresponding tables as it has been done in the first two comparisons and a final table was created containing the context-tag and context-metadata for each object ID.

For the comparison of the context generated from tags and metadata the Context metadata/tag ratio was used:

<u>Context metadata/tag ratio</u>

The Context metadata/tag ratio demonstrates the association between the assigned context metadata and tags in an object (educational Content and educational pathways). The ratio results range from 0 to 1. If the score of the ratio is low then there is low association between the two elements and vice versa.

$$Cr = \frac{|CT_r \cap CM_r|}{|CT_r|} \qquad (7)$$

In the equation 7, CTr refers to the context tags that are assigned to the particular object and CMr indicates the context metadata of resources which were tagged in this object. The elements are checked one by one whether they match.

For the match controlling, a column next to the tags column was created, on which the function "match" was applied. The procedure of matching was the same as the previous comparisons. The result of the match counter in this ratio corresponds to the intersection between the context generated from tags and from metadata (CTr ∩CMr).

For normalization purposes, as in equation 5 and 6, the resulting absolute intersection size is related to the cardinality of the set of context tags. In this way, the results show the percentage of context tags match to the context metadata.

**H2: "The type of users' motivation affects the enhancement of the context of use of the Learning Objects stored in the OSR Repository"**

Due to the second hypothesis, there was a comparison between the types of users' motivation, Categorizers and Describers, defined in the borrowed methodology in Chapter 4.5.

The comparison was made in two phases:

- The whole data set was examined to discover and evaluate how each type of taggers' style influences the resulting folksonomy.
- The context of use of the learning objects was examined to discover and evaluate how each type of taggers' style affect it.

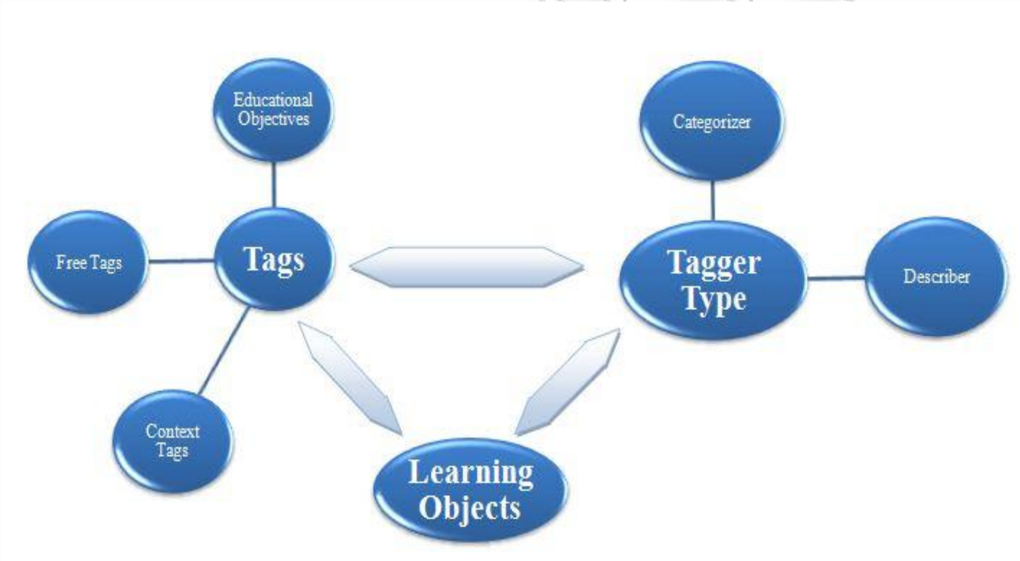



***Figure 26:*** *Variables in second Hypothesis*

1) Phase # 1

Towards the **first** phase some questions were set in order to evaluate the overall behaviour of Categorizers and Describers in relation to the whole data set. The questions were treated through some measures. The questions are:

- How many tags on an average has a Describer/Categorizer achieved?
- How many learning objects (educational Content and educational pathways) on an average a Describer/Categorizer tagged?
- What is the frequency of different category of Social Tags (free tags, Educational Objectives tags, context tags) for a Describer/Categorizer?

Below there is a brief explanation of the measures linked to each one of the above questions.

Average Vocabulary Size per Tagging Style Category:

This measure is associated to the first question and its aim is to determine how many tags on average are assigned per tagging style category.

$$AvT(a) = \frac{|Ta|}{|Na|} \qquad (8)$$

In equation 8, Ta is the set of tags assigned to a particular tagging style Type (Categorizers/Describers) and Na is the number of the users belonging in this type.

The results of this measure (one for each tagging style) are expected to show that tagging style type "Describers" score higher in comparison to Categorizers' score. This derives from the results of evaluation methodology described in Chapter 4.2 where it was stated that the describers have not a limited size of tag vocabulary.

Average Tagged Objects Size per Tagging Style Category:

This measure is associated to the second question and its aim is to determine how many objects on average are assigned per tagging style category.

$$AvR(a) = \frac{|Ra|}{|Na|} \qquad (9)$$

In equation 9, where Ra is the set of learning objects assigned to a particular tagging style Type (Categorizers/Describers) and Na is the number of the users belong in this type. It is expected that tagging style type "Describers" will score higher in comparison with Categorizers' score as Describers' tagging goal is later retrieval of the object.

Average Tag Category Size per Tagging Style Category:

This measure is associated to the third question and its aim is to determine how many tags in each tag category on average are assigned per tagging style category.

$$Av(a) = \frac{|Ka|}{|Na|} \qquad (10)$$

In equation 10, Ka is the set of tags belong in a particular tag category (free tags, Educational Objectives tags, context tags) assigned to a particular tagging style Type (Categorizers/Describers) and Na is the number of the users belong in this type. It is expected that tagging style type "Describers" will score higher in comparison with Categorizers score. Every category is measured separately.

2) Phase # 2

Towards the **second** phase there was an evaluation of the behaviour of Categorizers and Describers in relation to the context of use of the learning objects. From the results of this phase, it will be determined whether the context of use is affected by each type of taggers and in what extend. In order to proceed to the abovementioned evaluation some steps were taken.

The aim of the first step was the creation of two lists where in each list there are the learning objects assigned only by Categorizers or Describers. Due to the first step, a list with all the learning objects assigned to each tagger category was made and afterwards the intersection of the two lists was found. Then, the intersected learning objects were erased from the both lists, leaving in each list the objects assigned only to the current tagger category.

In the second step, the ratios which were applied in the first hypothesis were borrowed (Keyword/Free Tag ratio, Educational Objectives Metadata/Tag ratio and Context metadata/tag ratio) and applied in almost the same way, but this time were used to compare the tags and the metadata assigned to learning objects existing exclusively in Categorizers' or Describers' list.

In order to isolate the results of the learning objects assigned only by Categorizes or Describers, the columns "User_ID" and "Object_ID" of the initial table with the overall folksonomy dataset were isolated and filtered through the list of Describers/Categorizers ID. Hence, the result was a list including only the learning objects assigned by each type of tagger. The next step was to filter the results of phase # 1 as to form two separate tables, one for each type of tagger.

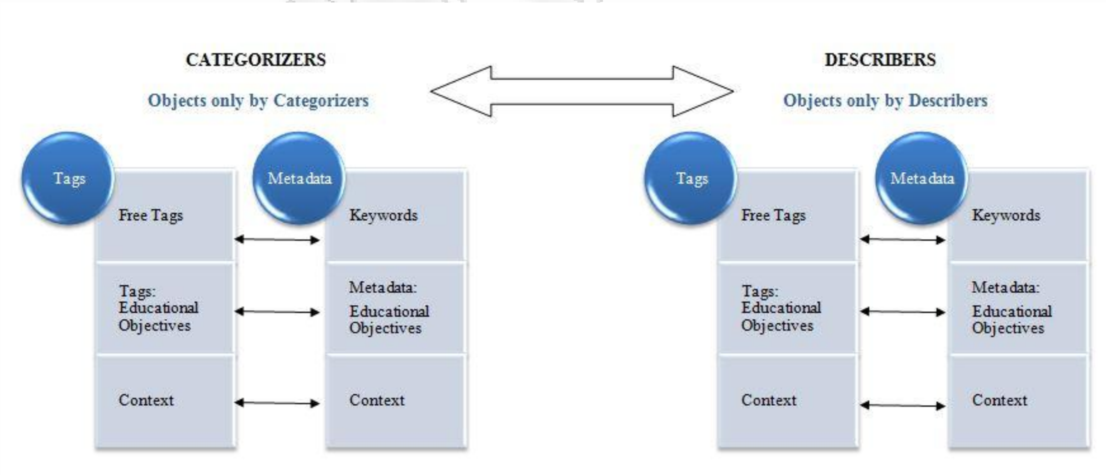



***Figure 27:*** *Categorizers and Describers' Tags and Metadata Comparison*

The results of the ratios for each one of the type of taggers specify not only if the context of use of the learning object was affected but also by comparing them, are seem to indicate whether the type of the taggers' style influences this affection.

**H3: : "The type of the learning object (Educational Content, Educational Pathways) affects the enhancement of the context of use of the Learning Objects."**

Due to the third hypothesis, there was a comparison between the different types of learning objects (Educational Content and Educational Pathways). Further information for the learning objects' categories can be found in the chapter 4.4.2.

The comparison was made in two phases:

- The influence of the OSR folksonomy to the context of use of Educational Content was compared to the influence of the folksonomy to the context of use of Educational Pathways.
- The influence of the OSR folksonomy to the context of use of each type of learning object (Educational Content and Educational Pathways) was further examined in order to discover and evaluate how each type of taggers' style (Categorizer and Describer) can affect it.


***Figure 28:*** *Variables in third Hypothesis*

1) Phase # 1

In order to prepare the investigation of the assumption, some steps were preceded. First of all, the elements "Object_ID" and "Type" were isolated from the table which contains the information for the learning objects. By filtering this table, two lists were created. The first list contained learning objects of only "Educational Resource" type and the second list contained learning objects of only "Educational Pathway" type.

The next step was to take the results which derived from the measures in the first hypothesis (the metadata/tag comparison for each learning object) and filter them in order to separate the learning objects and their ratio results into two tables containing the Educational Content/ Educational Pathways and the related comparisons' results concerning the OSR folksonomy influence to the context of use.

The milestone of this phase was to find out if there are differences between educational pathways (objects of high granularity) and educational Content (objects of low granularity) regarding the context similarity of metadata and Social Tags

2) Phase # 2

For the **second** phase, the tables which contain a list of learning objects assigned only by Categorizers or Describers were exploited (the tables were borrowed from the second phase of the second hypothesis). The tables were filtered by the list which included the learning objects of each specific learning object type resulting in that way to the creation of four new tables:

1) Educational pathways tagged from Categorizers
2) Educational Content tagged from Categorizers
3) Educational pathways tagged from Describers
4) Educational Content tagged from Describers

Subsequently, the findings of the first phase were filtered in order to provide results only for "Describers" or "Categorizers". Through the comparative results the tagging behaviour of Describers and Categorizers against each type of object (Educational Content/Pathways) was determined.

### 4.7.2 *Experiment #2 Design: Identify new tags that do not exist in the formal vocabularies*

The OSR repository is characterised by the combination of the following hybrid approaches of taxonomy and folksonomy (Chapter 2.4.3):

- Co-existence: Taxonomy and folksonomy are used side by side with not any relationship; and
- Taxonomy-directed folksonomy: A controlled set of terms is provided to taggers in order to add meaning to the objects enhancing at the same time the search and retrieval.

The current experiment, investigates whether a third hybrid approach is able to be added in the abovementioned combination. The under examination hybrid approach is *Folksonomy-*

*directed taxonomy* where the tags are used in order to enrich the taxonomy and after the evaluation and approval, the resultant tags are used in combination with taxonomy.

**H4: "Within the OSR resulting folksonomy, new useful terms can be identified"**

For the identification of new tags not existing in the formal vocabularies (APPENTIX II) several actions have been made.

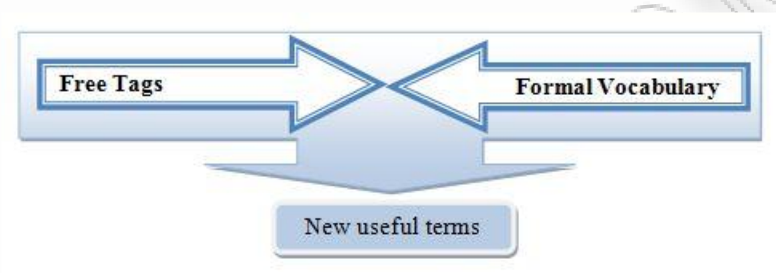



***Figure 29:*** *New useful terms generated*

Firstly, the column "Tags" was isolated from the initial table which included the folksonomy-related information. Then, a function that removes the duplicate entries was applied, structuring a list containing only unique terms.

Then, both the list with the unique tags and the list containing all the terms occurred from the OSR formal vocabulary were put together side by side in columns. Along to the columns, another column was added, controlling the matches between the two lists of tags and formal vocabulary. Particularly, the automatic "match" comparison, checks whether each of the tags is contained in the list of the formal vocabulary. If the tag was already included in the formal vocabulary, the "match" function returns the result "match", else it returns the result "no match".

The next step was to collect all the tags labelled as "no match" during the match control. Thus, a filter was applied on the table, isolating only the tag terms that were not existed in the formal vocabulary and creating a new list of terms. Thereafter, a column calculating the occurrence frequency of each tag of the new list within the OSR dataset was added.

According to the literature in a folksonomy-directed taxonomy the user-based tags are evaluated based on their salience within the context (Leimeux, 2009). Led by this statement, the first step to be done was to isolate and keep the most used tags according to their occurrence frequency.

The next step was to check one by one the few remaining Social Tags in the list for several issues like:

- The semantic similarity to the OSR formal vocabulary in order to scan for synonymies occurred and exclude them.
- The ability to stand alone as terms and describe meaningfully a context
- The fitting of the content of terms to the  Formal Vocabulary of OSR Repository.

In the end, the "left over" terms were examined to be located in the right category of the OSR formal vocabulary.

**H5: "The type of users' motivation affects the contribution to the new useful terms"**

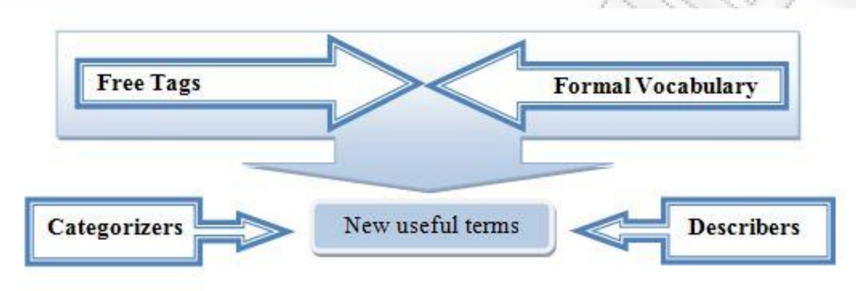



***Figure 30:*** *New terms generated from Catecorizers or Describers*

In order to examine the fifth hypothesis several steps were made. Initially, the elements"User_ID" and "Tags" were isolated from the initial table included the folksonomy information and form a new table. Then, the later table was filtered based on the list with new useful terms which were succeeded in the evaluation which took place due to the previous hypothesis.

Therefore, the final table consisted of the "User_ID" and the tags recognized as new useful terms. A pivot table based on the final table was structured as to present for each tag the users who assigned it one or more times to a learning object.

In a second column next to the list of users' column, a function detecting the type of user's motivation was added. The function was recognising if the User_ID existed in the table containing a list of all Categorizers and if there was a match then the field was labelled as "Categorizer", else as "Describer".

Finally, a counter function was implemented in order to count how many times a Categorizer or a Describer tagged each term and additionally to sum up the total assignments of tags for each users' tagging type, leading to an inevitable comparison.

## Summary

OpenScienceResources project seeks to bring closer hybrid approaches of standardized metadata and folksonomies providing egregious flexibility to the use and reuse of the digital learning objects.

The resulting folksonomy of the OSR Repository was collected and structured in order to become available for Social Tagging evaluation, revealing the potential of Social Tagging practice.

The evaluation methodology of the OSR folksonomy is put through specific assumptions surrounded by variables related to the OSR Social Tagging options and it is carried out by using mainly comparative quantitative studies between Social Tags and standardised metadata.

The ultimate goal of the applied evaluation methodology is to highlight whether the Social Tags which derive from the pre-defined vocabulary bring about changes to the usage of the learning objects and also to examine the existence of new useful terms generated by Social Tags.

# Chapter 5: Social Tagging Evaluation Results

## 5.1 Introduction

In this chapter, the results generated from the evaluation methodology implementation of Chapter 4 are presented and analyzed.

The analysis of the results starts with findings from the processing of the OSR Repository dataset, continues with the determination and examination of the hypotheses laid within the experiments of the evaluation methodology and finishes with a set of conclusions exported from the entire evaluation outcomes.

## 5.2 Dataset Processing

Prior to the experiments and the processing of the Hypotheses validity, an analysis of the variables which were included in the experiments was made. The scope of this analysis was an acquaintance with the variables themselves before "blending" them with other variables. Therefore in this chapter, there is a deepening in the OSR Dataset (users, learning objects, tags, metadata) in order to get familiarized with their properties.

### *5.2.1 Users and Social Tags*

A total of 1934 registered users can be identified in the OSR Repository until March 2012. The tagging behaviour was evaluated during an uncontrolled experiment, where the users were not asked to tag the learning objects. This may led to the fact that a large number of the users in OSR Repository did not engage in tagging, so the taggers population is equivalent to 434 taggers.

Until March 2012, 14707 tags were assigned to the learning objects of the OSR Repository data set. After normalizing the tags and removing the double entries, 3589 unique tags remained. However, due to the evaluation's demands, all the dataset of tags were considered since we are not only interested in the number of tags but also in the tags' relationship with the rest dataset.

The number of tags entered per user varied from a low of 1 to a high of 4426 and a mean of 10. The standard deviation was near 200 showing the wide range of tags per user. Because of the high standard deviation the median was considered as a more conservative way to determine the average tags per user, with the median to reach 5 tags per user - the half of the mean.

***Table 18:*** *Tags per Tagger Analysis*

| **Tags per tagger** | **Total** |
|---|---|
| **High** | 4426 |
| **Low** | 1 |
| **Mean** | 10 |
| **Median** | 5 |

The phenomenon of the asymmetrically distributed data derived from the existence within the dataset of both supertaggers and users assigned only one tag. For instance, 8714 tags (59%) from the whole dataset of 14707 tags were assigned by 4 taggers, with the first entering 4426 (30%), the second 2941 tags (20%), the third 760 (5%) and the fourth 587 (4%).

Unlike the contribution of the 4 taggers, there were 96 taggers assigning only 1 tag each, contributing all together to the 1 % of the tag dataset. In table 18 there is a distribution of the tags per user, without the Super Taggers.

The tags assigned by the most users (over 30 users), were all of them tags chosen from the pre-defined vocabulary related to the Educational Objectives and the Context. The free tags assigned by over 20 users were the terms “light”, “energy”, “x-rays” and “psysics”. Finally, 2899 tags were assigned by only 1 user.

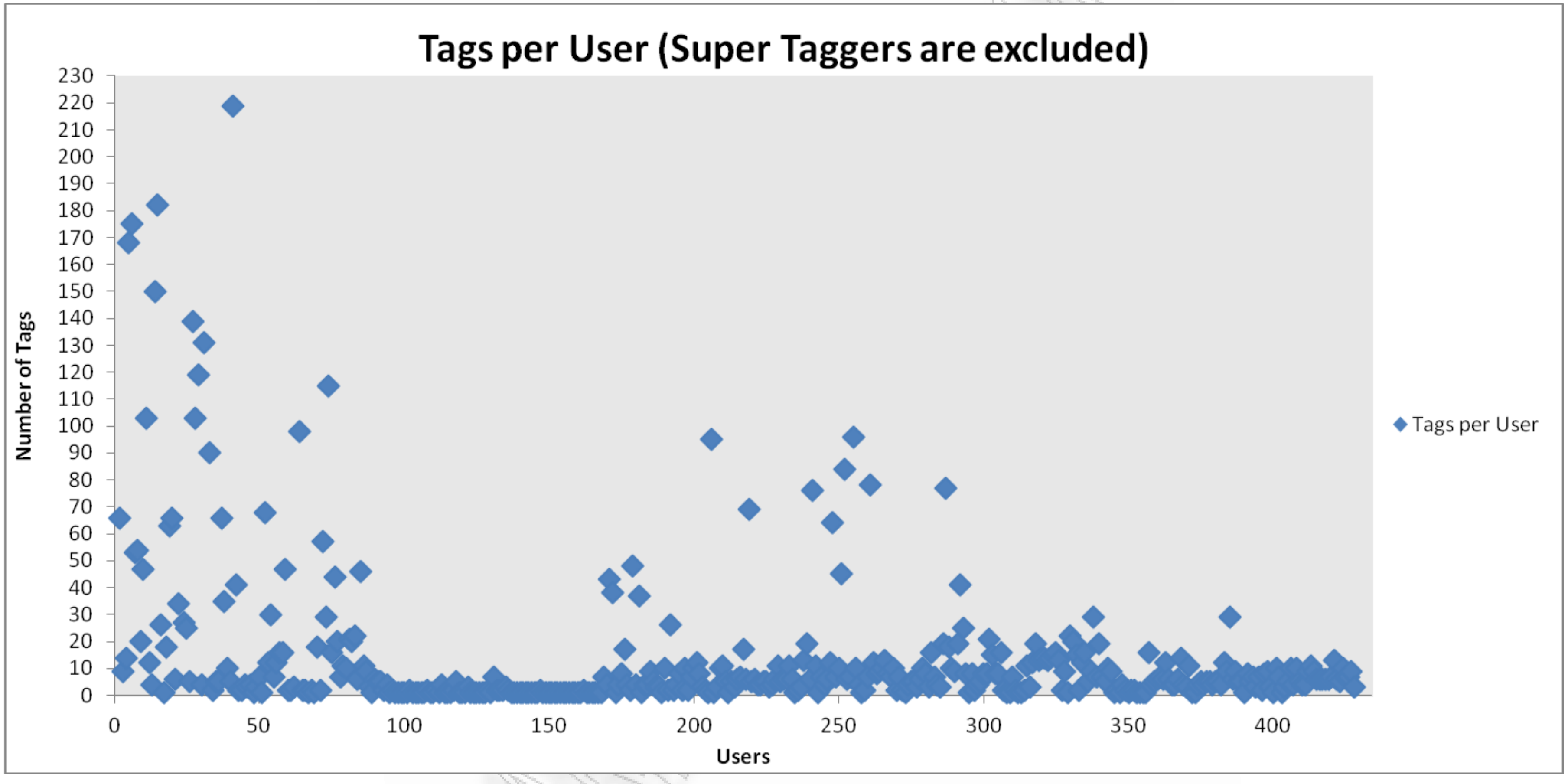



***Figure 31:*** *Tags per User (Super Taggers excluded)*

### *5.2.2 Learning Objects and Social Tags*

During the data collection a total of 1877 learning objects were tagged. The tagged learning objects were consisted of 241 Educational Pathways from the total of 542 existed in the OSR repository and 1636 Educational Content from the total of 1698. This makes the Educational Pathways to constitute the 13 percent of the tagged learning objects and Educational Content the 87 percent.

The tags assigned to the Educational Pathways were 3443 while in Educational Content were 11264.

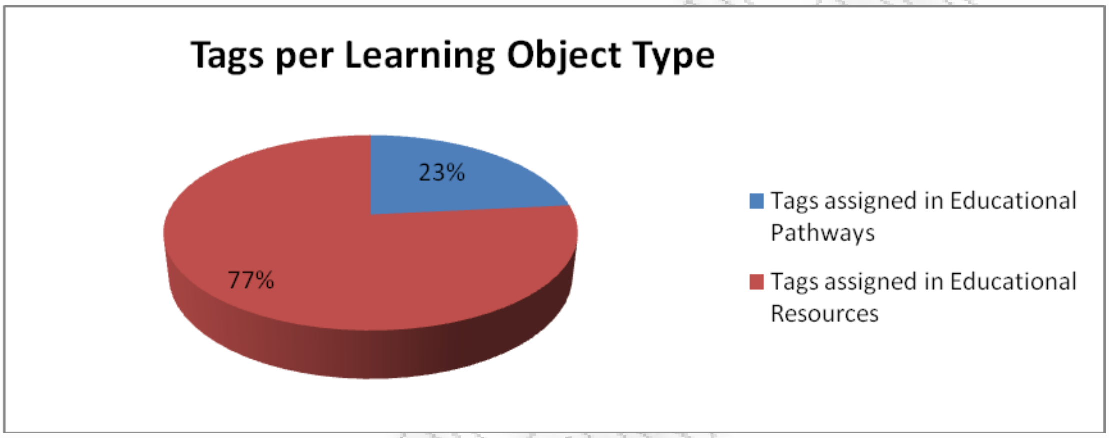



***Figure 32:*** *Tags per Learning Object Type Proportion*

In table 19 there is the number of objects and tags and the ratio of tags per object type. According to the results of the tags/object type ratio, we can say with confidence that the number of tags assigned to Educational Content is greater than the number of tags assigned to Educational Pathways even if the tags per object ratio is higher in Educational Pathways.

***Table 19:*** *Tags and Objects per Learning Object Type*

| **Object Type** | Educational Pathways | Educational Content |
|---|---|---|
| **Number of Objects** | 241 | 1636 |
| **Number of Tags Assigned** | 3443 | 11264 |
| **Tags/Object Type Ratio** | 14,29 | 6,88 |

### *5.2.3 Users and Objects*

The 434 users tagged the 1877 learning objects for an average of 7,84 taggers per learning object. The standard deviation of taggers per learning object is quite high (10,86) as the distribution is not equal across the set of learning objects. This happens because of the uncontrolled evaluation experiment and the personal preferences of each tagger to specific learning objects.

The learning object with the maximum users' contribution gathered tags from the 49 percent of the users (214) while 78 learning objects was assigned only by 1 user.

### *5.2.4 Social Tags*

In the folksonomy of 14707 tags entered, there were tags of 6 different tag categories as shown in table 20:

***Table 20:*** *Number of Tags per Tag Category*

| **Tag Categories** | | | | | |
|---|---|---|---|---|---|
| **Free Tags (FREE)** | Educational Objectives | | | | Context (CON) |
| | Cognitive Domain – Knowledge (KD) | Congitive Domain– Process (CPD) | Affective Domain (AFF) | Psychomotor Domain (PS) | |
| **12675** | 505 | 414 | 371 | 300 | 442 |

The resulting folksonomy of the OSR repository was mainly consisted of Free Tags (86 percent of the whole tags dataset) . Educational Objectives followed with a total of 1590 tags (11%). Finally, context comprised the rest of the tag data set with 442 tags (3%). Although users had the option of selecting terms from a pre-defined vocabulary through drop-down menus, they preferred to enhance their tags with user-based descriptions of their choice.

In figure 33 it is shown how many taggers made use of each Tag Category. As it was reasonable almost all of the taggers (87%) used free tags. Also, 153 taggers (35%) assigned tags from the pre-defined vocabulary related to the Educational Objectives (in different proportion for each Educational Objective Type) and 126 taggers (29%) used the Context pre-defined vocabulary option.

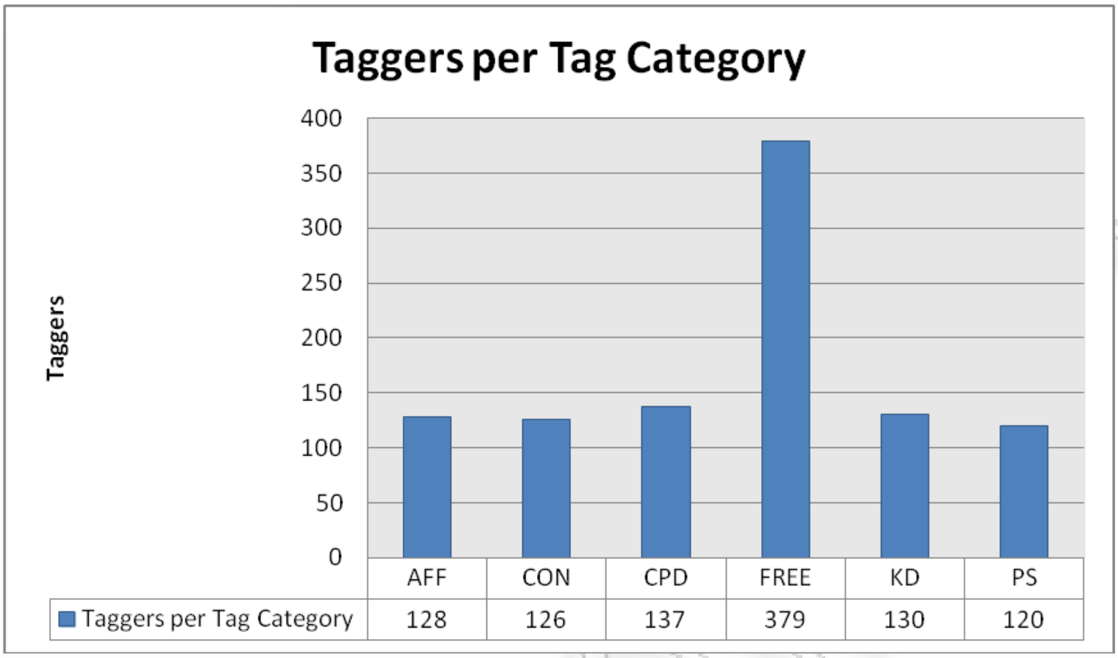



***Figure 33:*** *Taggers per Tag Category*

The most of the taggers (285) used only one of the Tag Categories (AFF, CON, CPD, FREE, KD, PS) to assign their tags, 12 taggers used 2 Tag Categories, 8 taggers used 3 Tag Categories, 22 taggers used 4 Tag Categories, 43 used 5 Tag Categories and finally 64 taggers used 6 Tag Categories to assign their tags (Figure 34).

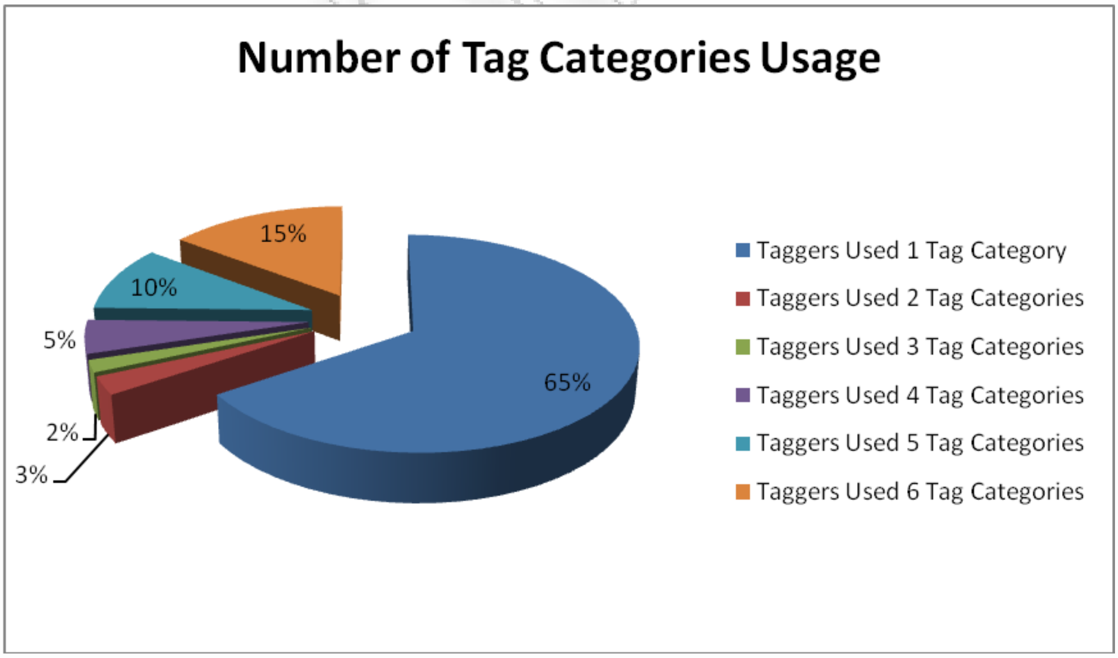



***Figure 34:*** *Proportions of Taggers per Number of Tag Categories Used*

From the taggers who chose to assign their tags by using only one tag Category, the 99 percent (281 taggers) selected Free Tags and only 1 percent (4 taggers) selected the pre-defined vocabulary of Context.

The Tag Category of Context included 4 choices in order to describe the context of the learning object. Table 21 shows how many times each of them has been chosen as a tag.

***Table 21:*** *Number of Context Metadata*

| CONTEXT | Total |
|---|---|
| **In the science/museum centre** | 117 |
| **On the web** | 169 |
| **Related to school** | 207 |
| **Unrelated to school** | 79 |

The most popular choice of context was "related to school" with 36% of the total Context Tag Category while the less popular was "unrelated to school" with 14%.

In the same way, the Tag Categories of Educational Objectives contain from 4 choices each in order to provide options to the tagger to determine the educational context of use of the learning object. The options existing in the drop-down menu of the pre-defined vocabulary for Educational Objectives for every Tag Category and number of tags which derived from each one of the Tag Categories' options are in table 22.

***Table 22:*** *Number of Tags in Educational Objectives Categories*

| Tag Category | Options | Number of tags |
|---|---|---|
| **COGNITIVE DOMAIN - KNOWLEDGE** | Conceptual Knowledge | 144 |
| | Factual Knowledge | 146 |
| | Procedural Knowledge | 142 |
| | Meta-cognitive Knowledge | 73 |
| **COGNITIVE DOMAIN - COGNITIVE PROCESS** | To remember | 68 |
| | To understand | 167 |
| | To apply | 48 |
| | To think critically and creatively | 131 |
| **AFFECTIVE DOMAIN** | To pay attention | 82 |
| | To respond and participate | 72 |
| | To recognise values | 55 |
| | To form and follow a system of values | 62 |
| **PSYCHOMOTOR DOMAIN** | To imitate and try | 49 |
| | To perform confidently following instructions | 79 |
| | To perform independently, skilfully and precisely | 60 |
| | To adapt and perform creatively | 112 |

In Cognitive Domain – Knowledge, three of the four options were used equally to the “Factual Knowledge” taking the lead with 29%. “Meta-cognitive Knowledge” was the less used with just 14% of the total usage of the Tag Category.

In Tag Category of Cognitive Domain – Cognitive Process, two of the options gathered the most of category’s tags, while the other two options reached lower proportion. The option with the most tags assigned was “to understand” with 40% of the total and the option with the less tags was “to apply” with 12%.

The options in Affective Domain Tag Category have been used with no significant deviation as the most used “to pay attention” achieved a 30% of the total tags used within the Tag Category and the less used “to recognise values” reached a 20%.

Psychomotor Domain Tag Category has a leading option - “to adapt and perform creatively” - attaining the 37% of the total set while the less used option “to imitate and try” holds a 16%. The other two options, range in the middle with a slight difference on their proportions.

### *5.2.5 Metadata*

Some of the structured metadata set, have also been examined in relation to their quantity as they will be used in following sessions as a base for the Social Tags’ evaluation.

The tagged learning objects had the following quantity of metadata in relation to the “Keywords”, “Educational Objectices” and “Context” Metadata Categories (Table 23).

***Table 23:*** *Number of Metadata per Metadata Category*

| **Metadata Categories** | | | | | |
|---|---|---|---|---|---|
| **Kewords** | Educational Objectives | | | | Context (CON) |
| | Cognitive Domain – Knowledge (KD) | Congitive Domain– Process (CPD) | Affective Domain (AFF) | Psychomotor Domain (PS) | |
| **9285** | 190 | 249 | 138 | 123 | 3786 |

The dataset learning objects were assigned by 13771 metadata terms which came mostly from Keywords (from the OSR controlled Vocabulary) and to a lesser extent from Context. Educational Objectives were used as well but not in the same level of frequency.

Consequently, Keywords attained the 67% of the whole set, Context the 27% and Educational Objectives (in different proportion for each Educational Objective Type) the 6%.

The Metadata Category of Context includes 3 options in order to proceed on learning objects' context description by the content provider. Table 24 shows how many times each of the option has been chosen as a metadata for learning objects context description.

***Table 24: Number of Context Metadata***

| CONTEXT | Total |
|---|---|
| **In the science/museum centre** | 1231 |
| **On the web** | 1224 |
| **School-Connected** | 1331 |

The most popular choice of context was "school - connected" with 35% of the 3786 metadata produced by Context Metadata Category while the "in the science/museum centre" and "on the web" options have been used in proportions of 33% and 32% respectively.

In the same way as the Tag Categories of Educational Objectives, Metadata Categories of Educational Objectives provide options to the content provider to determine the educational context of use of the learning object. In table 25, there is the number of metadata assigned to each Metadata Category of Educational Objectives.

***Table 25:*** *Number of Metadata in Educational Objectives Categories*

| Metadata Category | Options | Number of Metadata |
|---|---|---|
| **COGNITIVE DOMAIN - KNOWLEDGE** | Conceptual Knowledge | 58 |
| | Factual Knowledge | 80 |
| | Procedural Knowledge | 40 |
| | Meta-cognitive Knowledge | 12 |
| **COGNITIVE DOMAIN - COGNITIVE PROCESS** | To remember | 55 |
| | To understand | 123 |
| | To apply | 20 |
| | To think critically and creatively | 51 |
| **AFFECTIVE DOMAIN** | To pay attention | 34 |
| | To respond and participate | 72 |
| | To recognise values | 13 |
| | To form and follow a system of values | 19 |
| **PSYCHOMOTOR DOMAIN** | To imitate and try | 16 |
| | To perform confidently following instructions | 28 |
| | To perform independently, skilfully and precisely | 24 |
| | To adapt and perform creatively | 55 |

In Cognitive Domain – Knowledge the “Factual Knowledge” achieved a 42% of the Category Set and “Meta-cognitive Knowledge” was used the less with a minor of 6% of the total usage of the Tag Category.

In Category of Cognitive Domain – Cognitive Process, the option “to understand” had the leading usage proportion of 49% while the option “to apply” reached the 8% of the Category dataset. The remaining two options lay in the middle with no significant deviation between them.

The most used option in Affective Domain Tag Category was “to respond and participate” holding a 52% of the total tags used within the Tag Category and the less is the option “to recognise values” achieving a 9%.

In Psychomotor Domain Tag Category the option “to adapt and perform creatively” reached the 45% of the total set while the less used option “to imitate and try” achieved a 13%. The other two options’ ranges are in the middle with a slight difference on their proportions.

### *5.2.6 Social Tags and Metadata*

When applying a quantitative comparison among the total tags and total metadata assigned to the whole set of learning objects, the results shows that:

- The tags assigned are more than metadata in categories of “Keywords/Free Tags” and “Educational Objectives”
- The metadata assigned to” Context” category are much more.

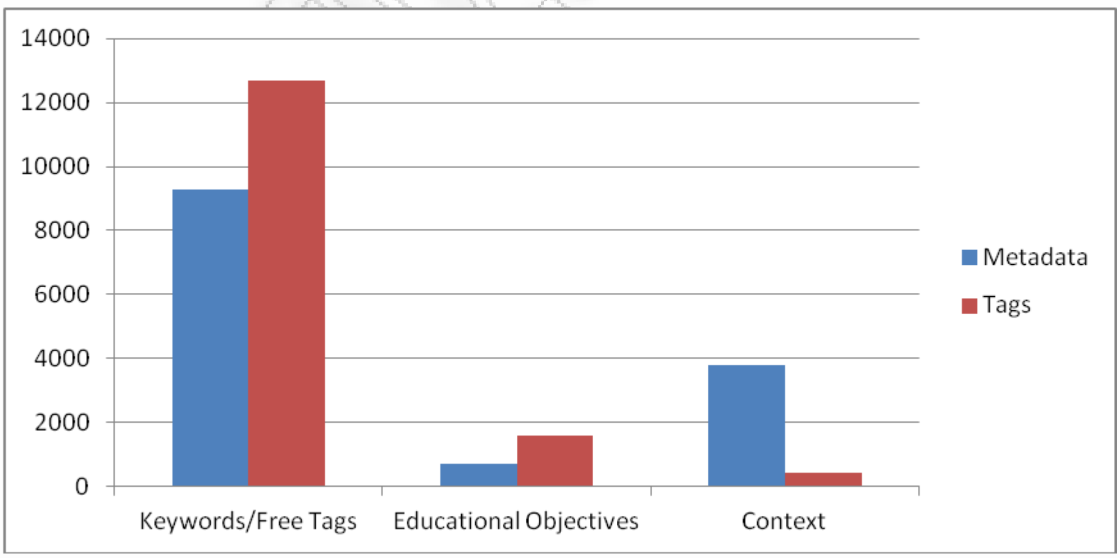



***Figure 35:*** *Overall Metadata/Tags Comparison Results*

Particularly the proportion of the tags and metadata assigned to each category indicates that:

- The tags in category of "Keywords/Free Tags" are 15% more than the metadata assigned to the same category.
- The tags assigned in all the Educational Objectives category are 39% more than the corresponding metadata.
- The metadata of "Context" category are excessively more in relation to tags with a major proportional difference of 79%.

## 5.3 Describers/Categorizers

Taggers characterization as Describers and Categorizers is a prerequisite to the proper proceeding in the experiments.

In this chapter, the results of each measure which has been used to determine the type of the taggers is presented and analyzed, concluding to a single characterization for each user through the outcomes combination.

### *5.3.1 Tag/Resource Ratio*

Towards the results of Tag/Resource Ratio a maximum ratio of 69 tags per resource was identified in 1 user while the minimum result of 1 tag per ratio was found in 105 users. The average of the ratio's results was calculated on 4,45 with a standard deviation of 4,36.

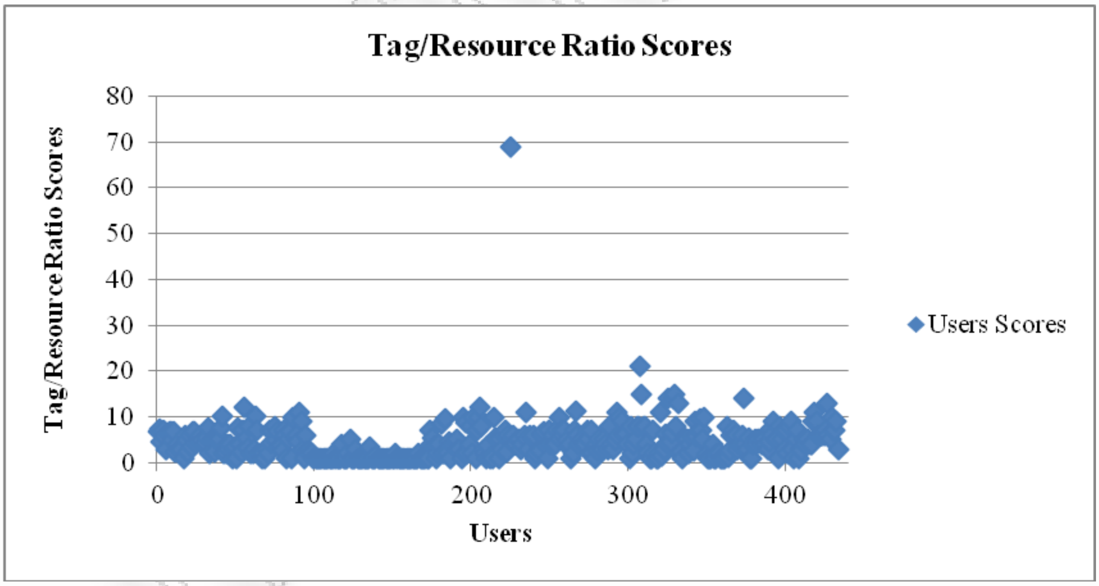



***Figure 36:*** *Tag/Resource Ratio Scores*

In Figure 36 the graph is showing the distribution of the users' ratio. It is obvious that a user achieved a high degree of variation compared to the rest users of the dataset. However the specific tagger is not one of the supertaggers identified in the previous chapter within the tags per user calculation. The reason of its high score in tag/resource ratio was the assignment of 69 tags to a single resource.

The super taggers of the "tags per user" calculation reached much lower scores (Table 26)

***Table 26:*** *Super Taggers - Tag/Resource Ratio Scores*

| | **Super Tagger #1** | **Super Tagger #2** | **Super Tagger #3** | **Super Tagger #4** |
|---|---|---|---|---|
| **Tags assigned** | 4426 | 2941 | 760 | 587 |
| **Resources assigned** | 438 | 556 | 111 | 85 |
| **Tag/Resource Ratio** | 10,11 | 5,29 | 6,85 | 6,90 |

According to the ratio results, 105 of the users had a tag/resource ratio score equal to 1. Most of them (89%) are taggers assigned only one resource with one tag. The remaining percentage corresponds to taggers assigning one tag in each of two objects.

The number of the taggers holding a high score between 10 and 21 (where 21 is the second higher score) equals to 27. The 81% of the 27 taggers succeeded a high score because they assigned 10 to 21 tags to a single learning object, the 15% by assigning 20-77 tags to 2-7 learning objects and the remaining percentage corresponds to the Super Tagger #1.

Since the standard deviation is high and the scores are quite spread, it was considered best to use the median in order to label the users into "Categorizers" and "Describers". Thus, the threshold of someone to be characterized as a Categorizer set to be the median.

Taggers, whose scores lay over the median are seem to employ a boundless vocabulary even if they tag a sole learning object. In contrast, taggers with scores under the median use fewer tags even if they assign tags to a lot of learning objects.

In Figure 37 there is the proportion of "Describers" and "Categorizers", as revealed from the scores. Therefore, based on Tag/Resource Ratio, 200 taggers were characterized as "Categorizers" and 234 as "Describers".

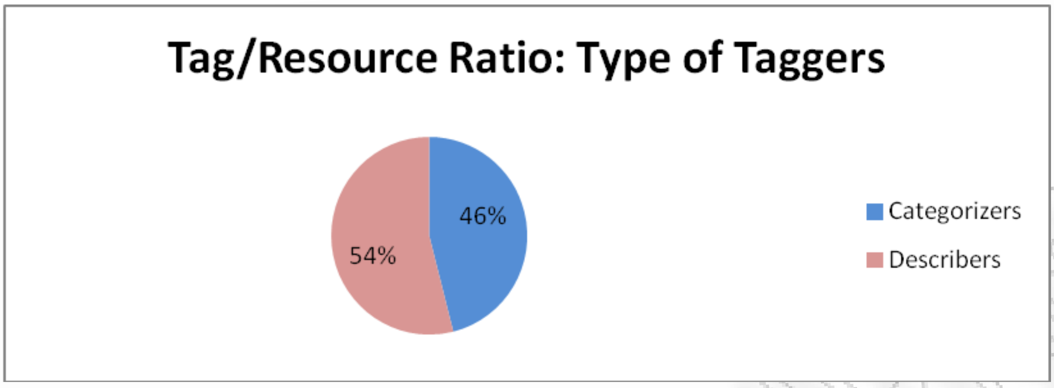



***Figure 37:** Overall Tag/Resource Ratio Result*

### *5.3.2 Orphaned Tag Ratio*

The results of the Orphaned Tag Ratio have two attributes:

- A high standard deviation with the scores spreading out over a large range of values;
- The scores ranging in very low values

Therefore there is a maximum of 0,78 and a minimum of 0 with the mean barely reaching the 0,01. In Figure 38 there is the graph demonstrating the Orphaned Tag Ratio Scores.

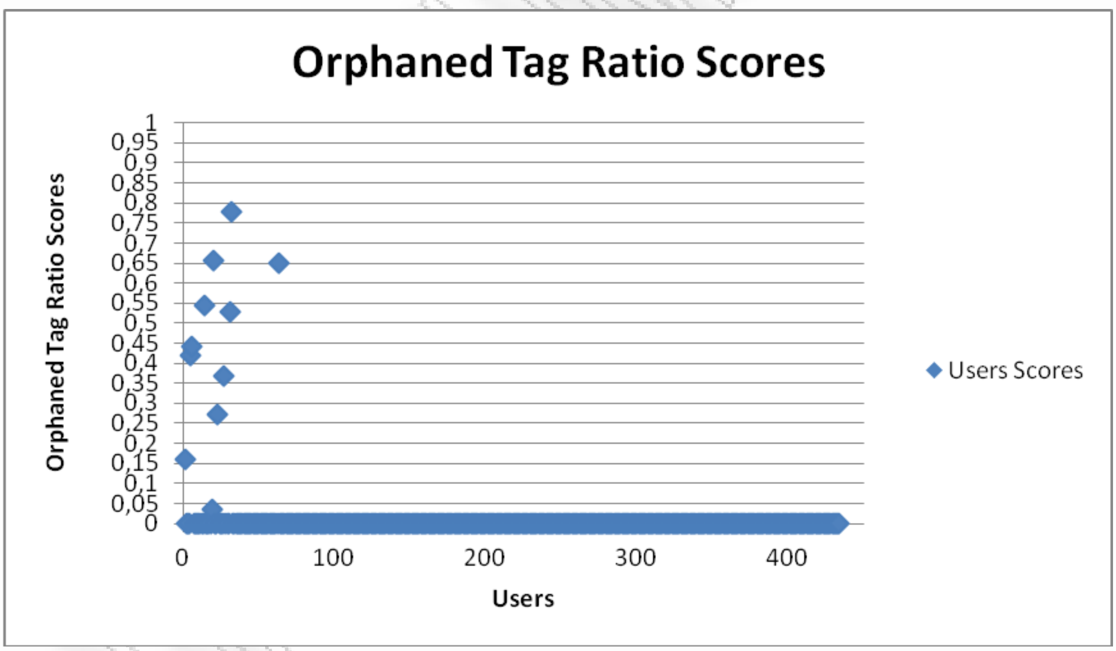



***Figure 38:** Orphaned Tag Ratio Scores*

It is obvious from the graph that almost all of the taggers obtained scores equal to 0 while only 11 taggers managed to loose from 0. The four Super Taggers were included in the high score group of 11 taggers while the most of them (82%) had assigned a three-digit number of tags. In addition, all the taggers of this group were at the 5% of the top taggers based on the number of learning objects they tagged.

The reason of such low scores in the Orphaned Tag Ratio was the fact that OSR taggers don't use in high frequency the same terms resulting to a very low threshold -the most of the times under 1. Thus, when counting tagger's orphaned tags, the frequency of each tag doesn't allow the tag to enter the Orphan Tag group.

For instance, a tagger with dataset of 219 tags and 29 objects assigned no orphaned tags at all according to the ratio. Even if the number of tags assigned by the tagger was a three-digit number, the maximum frequency of a tag assigned was 10 times (the terms "rotation" and "technology"). Consequently, the threshold allowing tags to be considered as orphaned was 0,2 (which is impossible).

Accordingly to the OSR Orphaned Tag Ratio scores, only the 11 taggers who succeeded a high level result can be considered as "Describers". The remaining taggers (423) are labelled as "Categorizers". However, the characterization is done with some caution because of the disproportionate scores. Figure 39 shows the analogy between the two type of taggers.

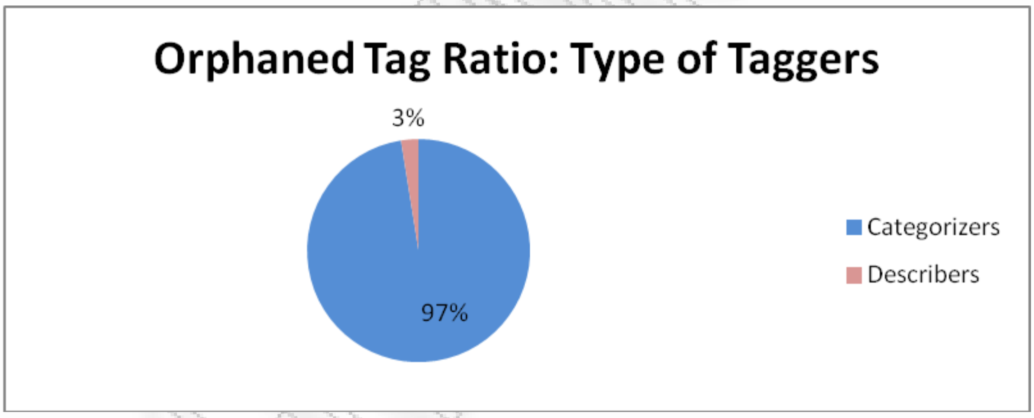



***Figure 39:*** *Overall Orphaned Tag Ratio Result*

### *5.3.3 Overlap Factor*

The results of the Overlap Factor were quite spread, having a range of score from a maximum of 0,99 and a minimum of 0. The average holds a 0,57 and the median reaches the 0,75 verifying how much spread out are the scores.

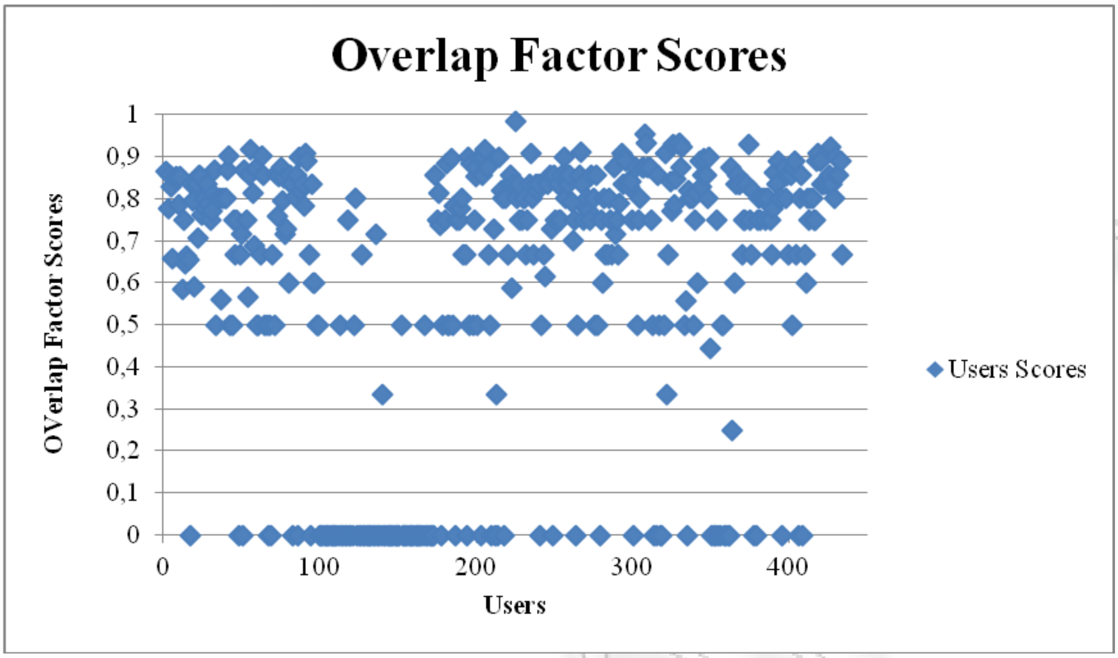



***Figure 40:*** *Overlap Factor Ratio Scores*

The low scores reveal users whose the number of tags and the number of learning objects assigned were near each other and vice versa. The fact that in a range of 0 to1 the OSR taggers achieved the high median of 0,75 indicates that the variance between the number of tags and objects assigned is very high. The results of the users dataset at the current ratio emerged mainly from the phenomenon of tagging a small number of objects with a relatively large number of tags.

For instance, from the 28 taggers who achieved the highest scores – specifically over 0,9 - 82% of them tagged only one object with 10-69 tags, 14% tagged 2 to 7objects with 20 to 77 tags and the remaining percentage belongs to the Super Tagger #1 who tagged 438 objects with 4426 tags. Taggers with such high scores considered to be characterized as "Describers".

Moreover it is noteworthy that the score of 105 taggers (24% of the user dataset) was equal to 0. The 86 percent of them tagged 1 object with 1 tag and the 14 percent tagged 2 objects with 1 tag each. Taggers of these scores are certainly characterized as "Categorizers" as they care in keeping the overlap factor low.

The division of taggers in two types in Overlap Factor was based on the scores and adjusted accordingly to the OSR taggers' behaviour. Therefore the characterization of a tagger as a "Categorizer" or "Describer" is depended on the median of the scores. Figue 41 shows the resulting proportion of the two types of taggers, where 200 taggers achieved scores under the median and labelled as “Categorizers” and 234 taggers over the median and labelled as “Describers”.

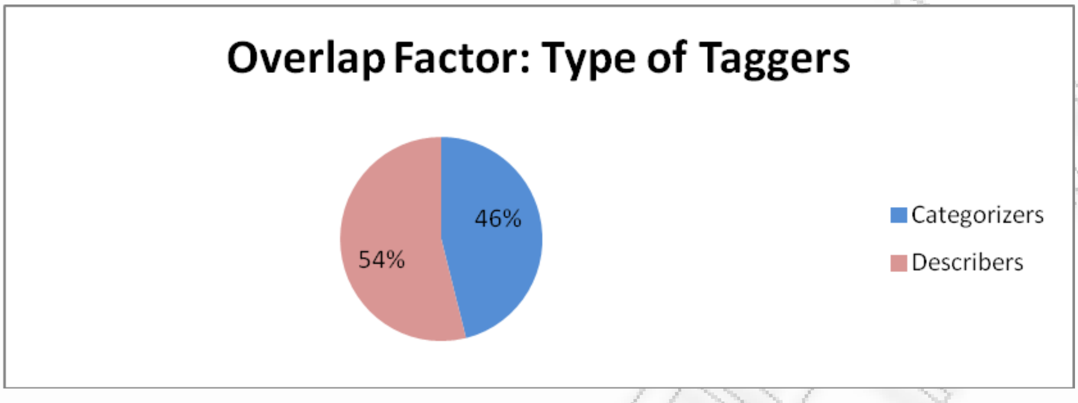



***Figure 41:*** *Overall Overlap Factor Result*

### *5.3.4 Tag/Title Ratio*

Towards the results of Tag/Title Intersection Ratio, a maximum score of 1 and a minimum of 0 covered the entire range of the ratio potential outcomes. The average was quite low reaching the 0,23 and the median 0,13.

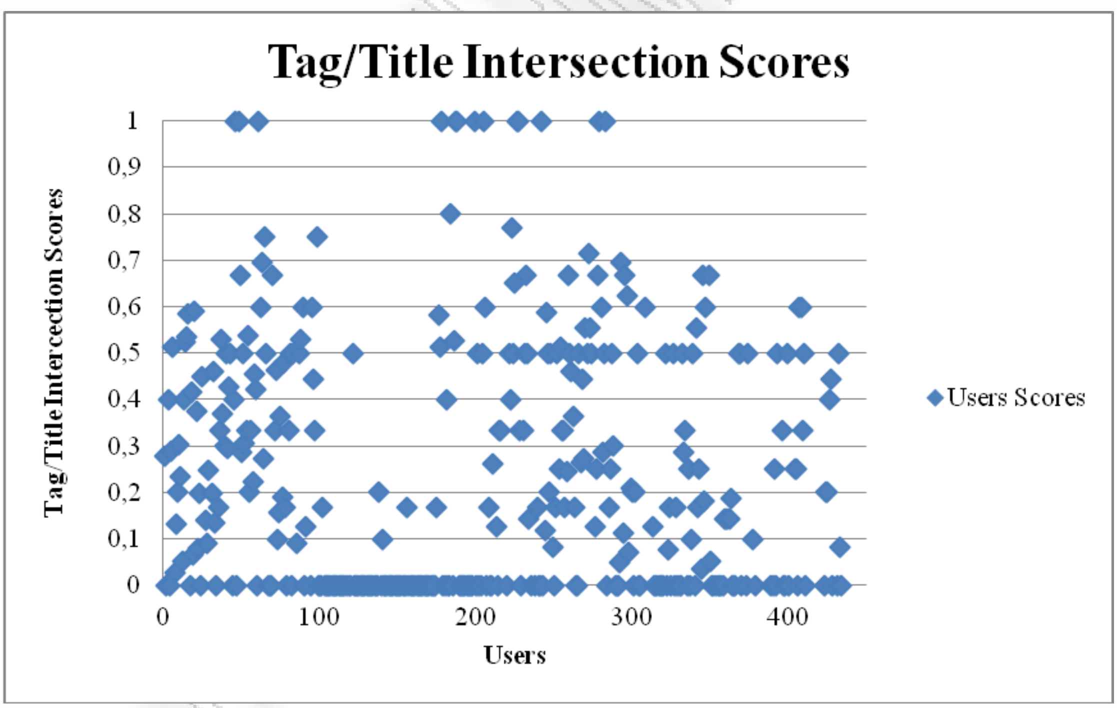



***Figure 42:*** *Tag/Title Intersection Scores*

In Figure 42 the scores of the tag/title intersection are spread in all over the graph. As it was supposed from the median, the scores seek to gather in lower region of the graph.

A noteworthy fact is that 55 taggers (13% of the users dataset) assigned no free tags at all. Thus, no "match" comparison happened.

Fourteen users scored 1 at the ratio where all of them matched exactly a tag to a Title Word. The 93% of these users assign 1-10 tags to a single object and the remaining 7% assigned 48 tags to 5 objects.

A large percentage of 38% of the taggers had score equal to zero. The 44% (73) assigned a single tag to a single object and 27% (44) of them assigned 2 to 4 tags to 1-2 objects. In general, this group's identification is the assignment of few tags to few objects.

The law median indicates that OSR taggers are not used to tag by borrowing words from the title and this is the reason of the low scores in the Tag/Titled Ratio. The labelling of "Categorizers" and "Describers" considers this OSR tagging behaviour and customize the division in relation to the median.

Consequently, 190 taggers who achieved scores over the median of 0,13 are characterized as "Describers" and the rest of the users dataset (189 taggers) are labelled as "Categorizers".

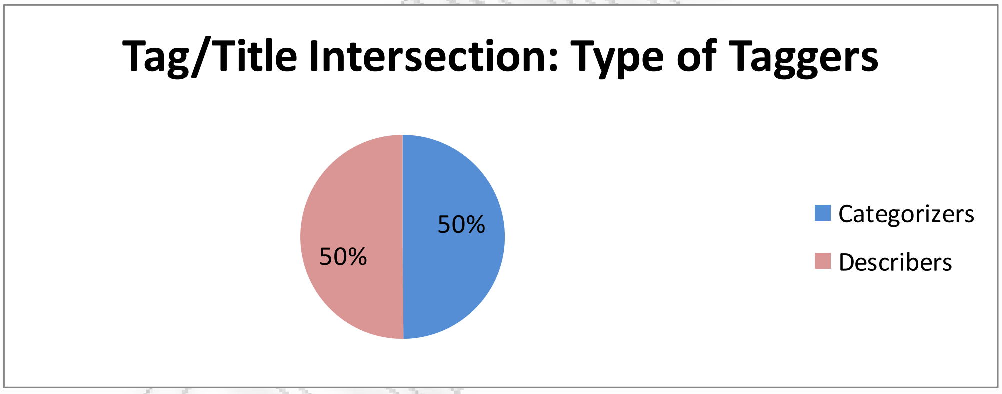



***Figure 43:*** *Overall Tag/Title Intersection Result*

### *5.3.5 Type of Taggers Establishment*

Based on the results of each measure per user, the characterization of each user was formed as follows in Figure 44:

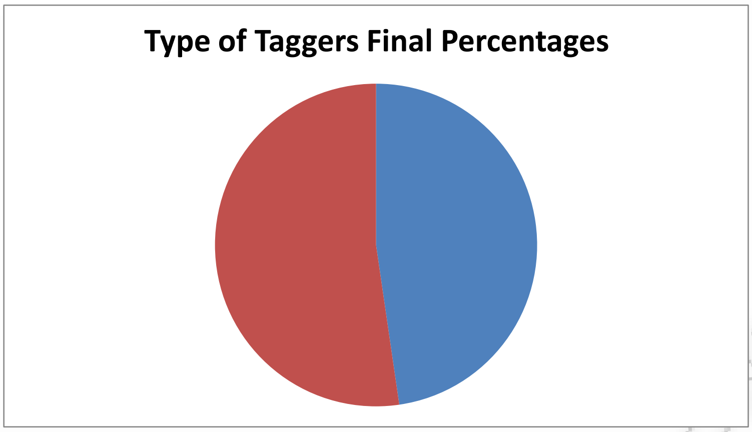



***Figure 44:*** *Describers/Categorizers Final Percentages*

The proportion of the "Describers" is linked to 208 taggers and of "Categorizers" to 226. In APPENTIX C there is a detailed list with all the users' results and characterizations (per measure and finals).

## 5.4 Experiment #1 Results: Identifying user-based descriptions of the context of use of educational Content and educational Pathways

Towards the first experiment, the first three hypothesis regarding the content of use by the resulting folksonomy are examined.

The experiment is structured in three phases representing the hypotheses set. In each phase, participate variables as the category of the tags, the type of taggers and the type of Learning Objects..

The investigation of the hypotheses were transacted through matching comparisons between the structured metadata and the Social Tags assigned in each learning object.

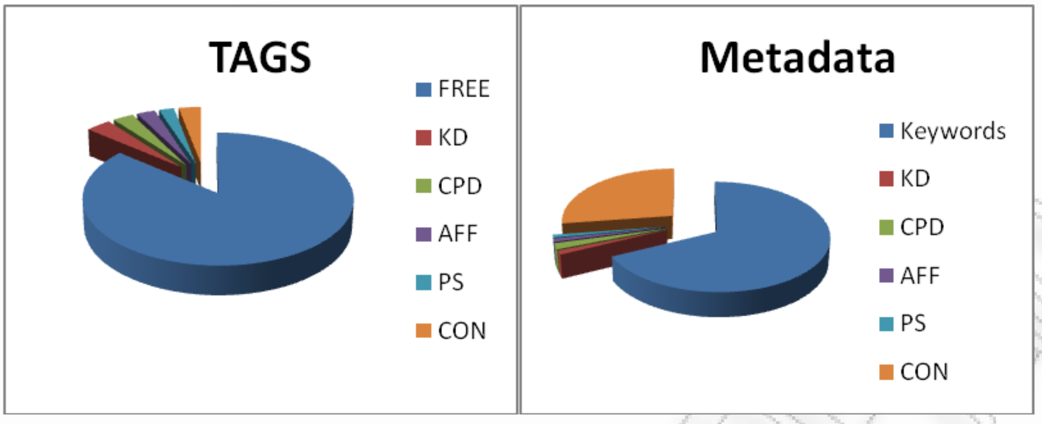



***Figure 45:*** *Proportion of Metadata/Tag Categories in Tags and Metadata*

### *5.4.1 Hypothesis # 1*

**H1: "The resulting folksonomy enhances the context of use of the Learning Objects stored in the OSR Repository".**

The results of the H1 are described in three steps where each step represents a "match" comparison between "tags" and "metadata" of the same categories. The first "match" processing laid on the Keywords/Free Tags comparison, the second was addressed to the Metadata/Tag Educational Objectives comparison and the third was a comparison of Context-Tags and Context-Metadata.

1) Comparison # 1: Keywords/Free Tags

The dataset used in the first match processing was18214 metadata words and 16731 tag words. Since 90 from the whole set of 1877 objects had not any metadata assigned, the object dataset was decreased to 1777.

The results of the match process contributed to the high mean of 0,85 match. Thus, the most of the tag words fit to the metadata words. As a result, more than half learning objects (940) had a matching score equal to 1.

The most of the tags (89%) assigned to the full match learning objects, were consisted of terms already existed in metadata words but translated in other languages. Because of this practise the tags and terms were matched not only in a qualitative way but also in a quantitative way as the exact number of the metadata terms was transferred to tags. The remaining percentage was addressed to learning objects assigned by only 1 to 2 metadata and 1 to 2 tags perfectly matched.

However, objects with zero matches were not absent; thirty of the learning objects had no match . The 77% of them, had metadata terms assigned in a language different than English, a fact that may prevented the taggers from adding a translation of the metadata as tags. The phenomenon was also observed on the 184 learning objects with match result 0,5 and below. The 87% of the learning objects had metadata terms in a language which was not English and is propapably a language less comprehensible than English for the most of the users.

2) Comparison # 2: Metadata and Tag Educational Objectives

The comparison was separated in four phases covering all the Categories of Educational Metadata (Cognitive Domain – Knowledge, Cognitive Domain – Cognitive Process, Affective Domain and Psychomotor Domain):

**Cognitive Domain – Knowledge**

The dataset derived from the pre-defined vocabulary of "Cognitive Domain – Knowledge" category was 164 metadata and 190 tags. Since the aim is to examine the matching ratio of metadata and tags in every learning object, an isolation of the learning objects assigned by both metadata and tags was made. Thus, the dataset used for the comparative study were 23 learning objects, 26 metadata and 49 tags.

The mean of the entire scores showed a matching of 52% with results range from 0 to 1 (Figure 46).

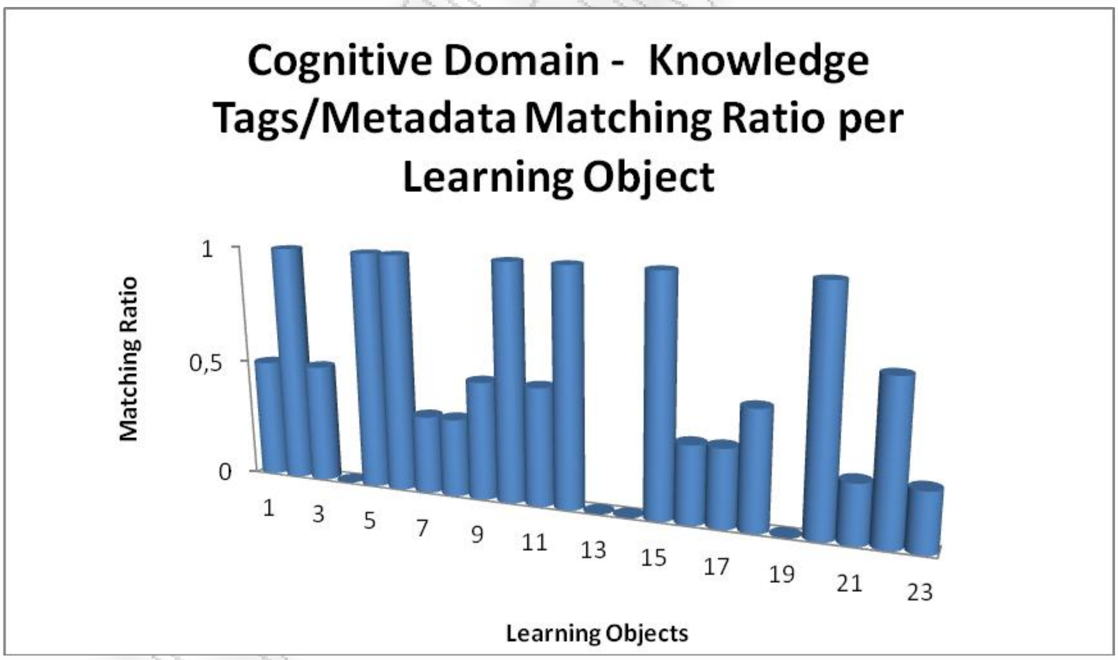



***Figure 46:*** *KD - Metadata/Tags Matching Ratio*

Learning objects with full matches were the 35% of the whole dataset and learning objects with no matches reached almost the half proportion.

An example of a learning object with zero matches contains the metadata educational objective "Procedural Knowledge" and the tag educational objective "Conceptual Knowledge". An example of a learning object achieved 50% match between the metadata and tag Educational Objectives, has been assigned by the metadata "Factual Knowledge" and the tags "Conceptual Knowledge" and "Factual Knowledge".

**Cognitive Domain – Cognitive Process**

The dataset which derived from the pre-defined vocabulary of "Cognitive Domain – Cognitive Process" category was 24 learning objects assigned by 27 metadata and 39 tags. The mean of the entire scores showed a matching of 53% with results range from 0 to 1 (Figure 47).

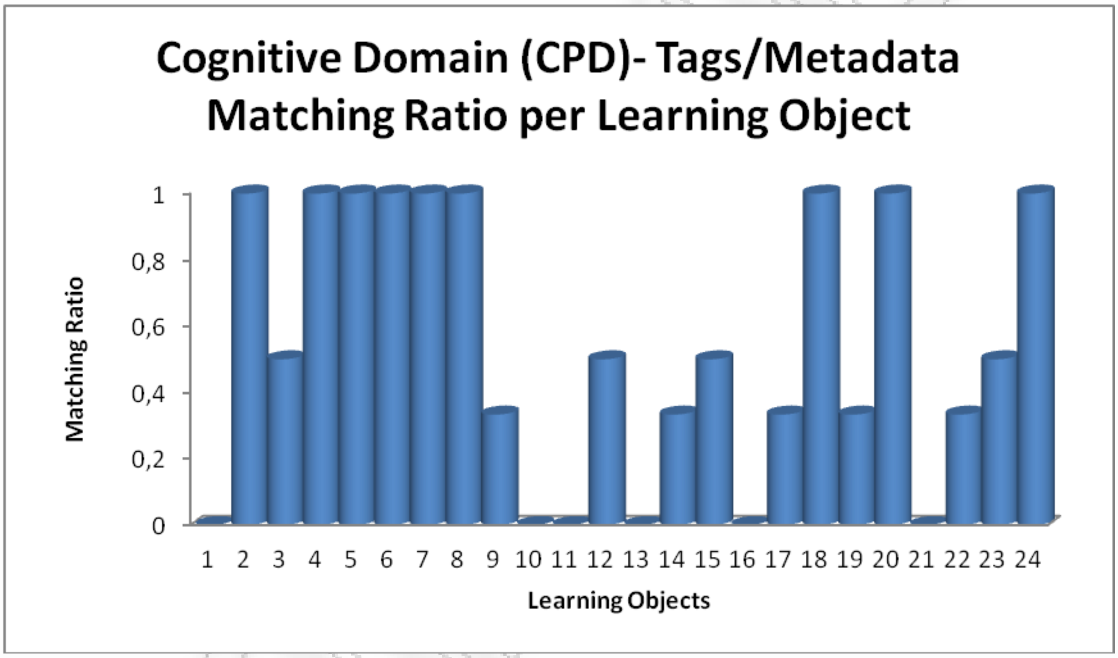



***Figure 47:*** *CPD Metadata/Tags Matching Ratio*

Learning objects with full matched Educational Objective metadata and objects have a proportion of 38% while in the opposite case the learning objects are 25%.

A case of zero matches: the learning object is assigned by the metadata Educational Objective "to think critically and creatively" and by the tags "to remember" and "to understand".

A case of moderate matching (50%): the learning object is assigned by the metadata "to understand" and the tags "to remember" and "to understand".

**Affective Domain**

The dataset of the comparison made in Affective Domain Educational Objectives are 23 Learning Objects assigned 28 times by metadata and 44 times by tags Educational Objectives.

The mean of matching results is lower in comparison to the previous 2 Educational Objective Categories and equals to 0,38 with the scores ranging from 0 to 1.

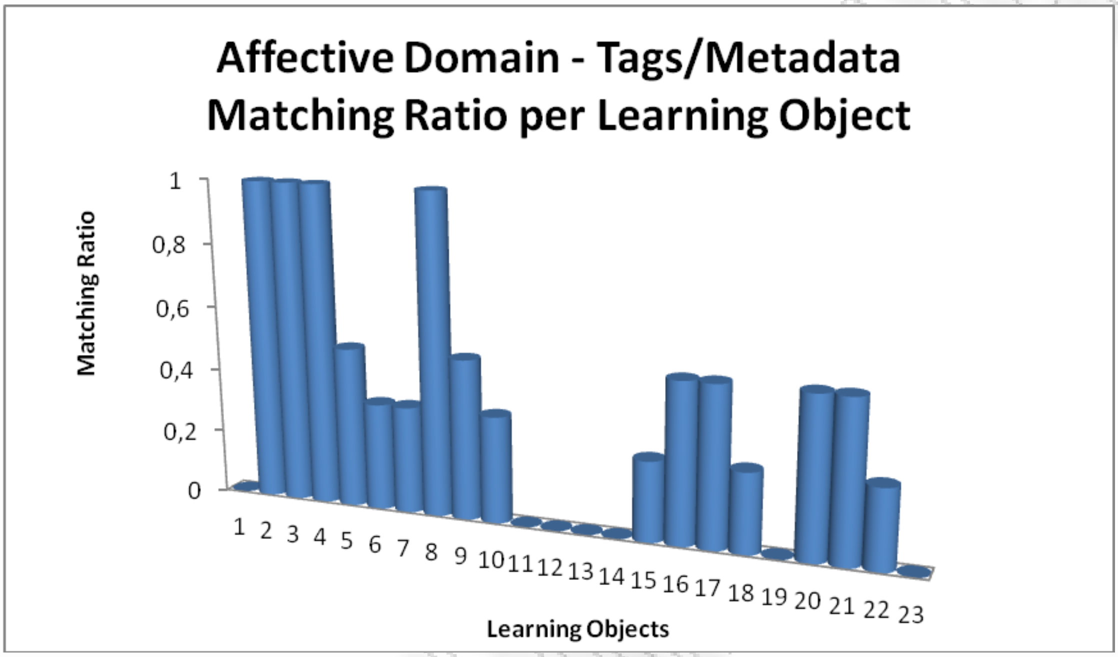



***Figure 48: AFF** - Metadata/Tags Matching Ratio*

Learning objects achieving a full matching were quite few, attaining the 17% of the whole learning objects set. In the opposite case 30% of the learning objects had no matches at all.

An example of no match: the learning object is described by the metadata educational objective "to respond and participate" while it is also assigned by the tag "to recognise values".

An example of a rather low matching (33%): the learning object is assigned by the metadata "to form and follow a system of values" and "to recognise values", while the tags assigned to it are "to form and follow a system of values", "to pay attention" and "to respond and participate".

**Psychomotor Domain**

In order to carry out the comparison of the tag and metadata Educational Objective of this Category, 23 Learning Objects were examined. The metadata and tag Educational Objectives assigned to them were 25 and 43 respectively.

The mean of the resulting matching was 0,28 with scores covering all the possible range of matching.

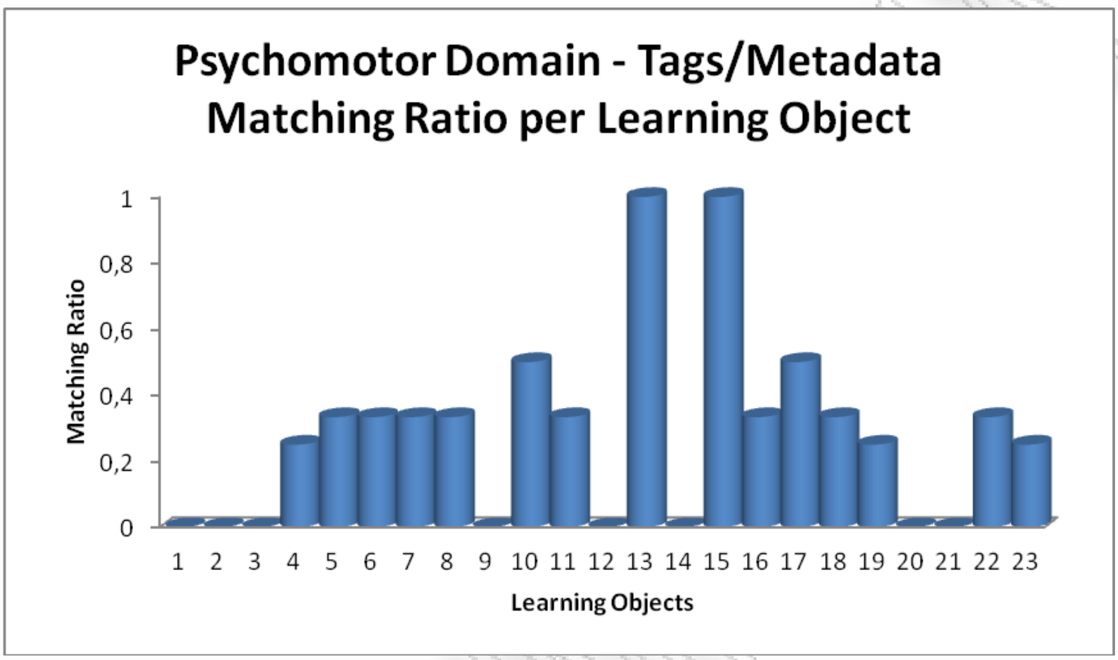



***Figure 49: PS** - Metadata/Tags Matching Ratio*

In Figure 48 it is obvious that only 2 learning objects (9%) had a full match between the metadata and tag Educational Objectives and 8 learning objects (35%) had no matches at all.

For example in a learning object with no matches 2 metadata Educational Objectives have been assigned ("to adapt and perform creatively" and "to perform confidently following instructions") and 1 educational objective tag ("to imitate and try"). The differentiation made by the tag leads to a change on learning object's Psychomotor Domain.

In another learning object, a single metadata educational objective "to perform confidently following instructions" is assigned, but after the object's tagging all of the four Educational Objectives of this category were added in its description.

Compared to the other three categories of the Educational Objectives, the Psychomotor Domain achieved the lower scores in the matching process of metadata and Educational Objectives and thus formed the lower matching mean.

In Figure 50 there is a comparison of all the Educational Objectives Categories' mean. It is obvious that the higher scores in matching metadata and tag Educational Objectives are assigned to the Categories of "Cognitive Domain – Cognitive Process" and "Cognitive

Domain – Knowledge” with means 0,53 and 0,52 respectively. Nevertheless, even if these categories have succeeded higher matching averages, they still have moderate matching.

Considering the results of the matching process throughout the entire Educational Objectives dataset, the mean of the Educational Objectives metadata and tag matching is equal to 0,43.

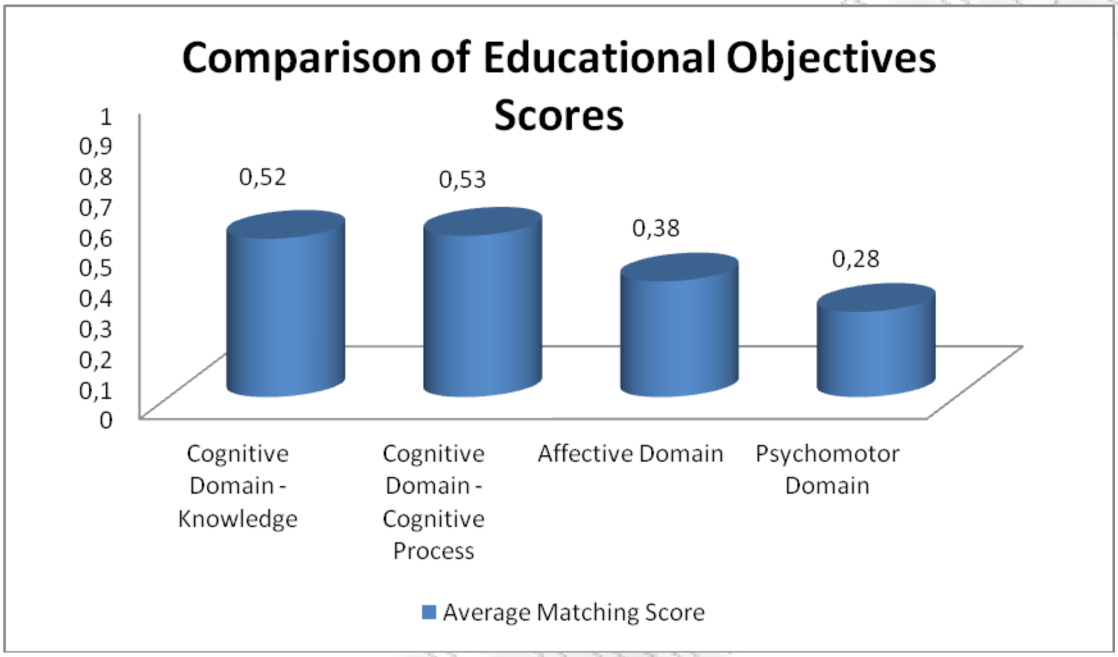



***Figure 50:*** *Comparison of Educational Objectives Matching Scores*

3) Comparison #3: Metadata/Tags Context

The dataset used in order to make a comparison between the Context-Tags and Context-Metadata were 165 learning objects assigned by both tags and metadata of this category. The metadata and tags assigned in the learning objects set are 480 metadata and 472 tags.

The mean of the matching scores is equal to 0,62 and the scores are spread throughout the matching range from 0 to 1.

An issue which occurred in the course of comparison was that the metadata “school-connected” and the tag “related to school” had to obtain a single name. Thus, Both of the elements were named as “related to school”.

Moreover the tag “unreleated to school” had not any corresponding data and therefore the existence of the term within the metadata context was counted as a mismatch.

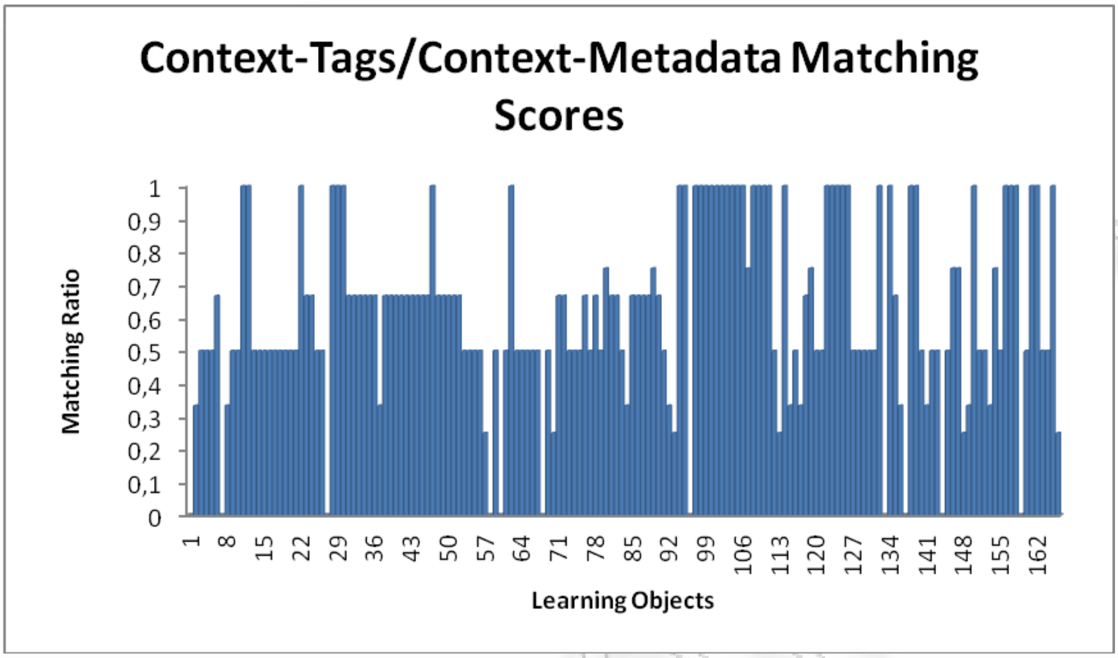



***Figure 51:*** *CON - Metadata/Tags Matching Scores*

In Figure 51 it's observable that only a small proportion (6%) of the learning objects had no matches at all. At the same time, one fourth of the total objects achieved a full match between the context-tags and context-metadata.

Examining the dataset of the comparison, a learning object with no matches at all can be assigned with context-metadata "on the web" by the content provider while the taggers propose the context of "related to school" and "in the science museum/centre".

Another learning object with moderate matching results (0,5) has the context-metadata "on the web", which is assigned as context-tag but in addition to this, the tag "unrelated to school" is also assigned, enhancing in this way the context of the learning object.

In general, the mean of the Metadata/Tags Context Matching Comparison, places the category in the second position in relation to the Keyword/Free Tags and Educational Objectives Matching Comparison averages (Figure 52).

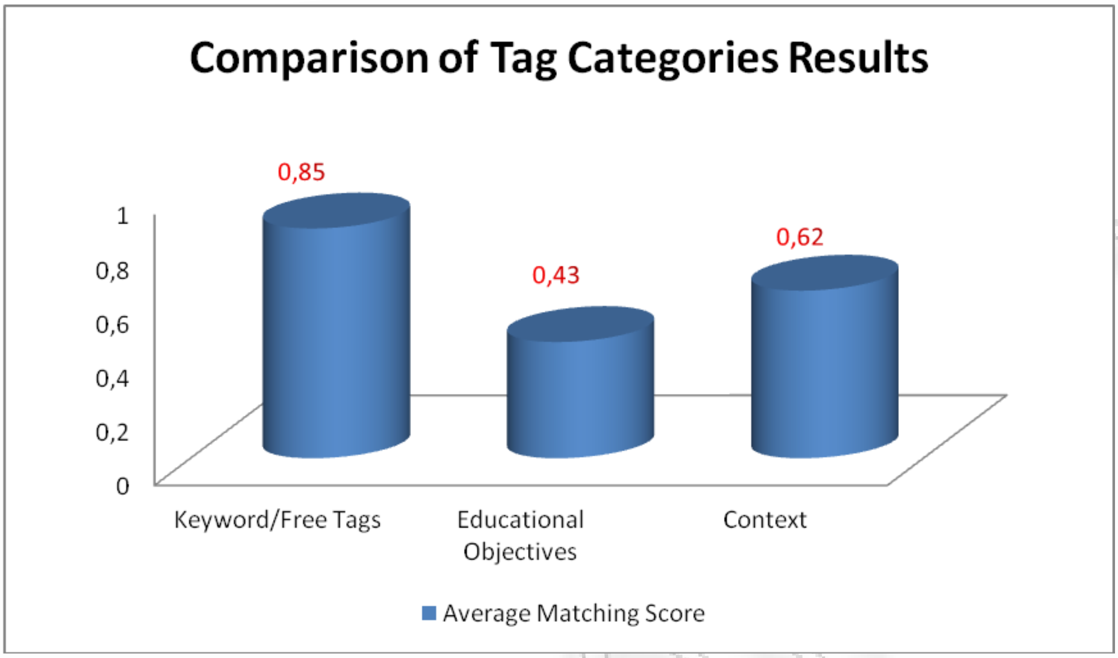



***Figure 52:*** *Comparison of Metadata/Tag Categories Scores*

The results of the three comparisons reveal that:

- Free Tags are influencing the usage context the less as they hold a high mean score in the metadata-tags comparison. By achieving a mean of 0,85 the tags are very close to the metadata assigned in the objects and thus, the context of use remain nearly the same.
- The mean score (0,43) derived from all the categories of Educational Objectives indicates the different aspect of the taggers for the Learning Objects' Educational Objectives. The mean of this category is the lower, changing and enhancing the usage context of the learning objects.
- Tag and metadata context matching comparison with a mean of 0,62 shows that in comparison to the Comparison #1 the context-tags are not standing excessively off the metadata but also give space to the usage context of learning objects to be expanded to some extent.

However the overall average which was generated from all the comparisons and dataset is equal to 81% pointing out a general review of the impact of the the user-based descriptions to the context of use of learning objects.

### *5.4.2 Hypothesis # 2*

**H2: "The type of users' motivation affects the enhancement of the context of use of the Learning Objects stored in the OSR Repository"**

The hypothesis was examined in two phases, where in the first phase there is an analysis of each type of users' behaviour and in second phase is investigated how this behaviour influences the context of use of the educational objects.

1) Phase # 1: Evaluation of the impact to the resulting folksonomy (Describers/Categorizers)

As it was expected, the results of the ratios revealed that Describers are more active taggers in relation to the Categorizers. Table 27 shows the result of the tagging behaviour of both of the taggers' types.

***Table 27:*** *Tags and Objects per Categorizer/Describer*

| Type of Taggers | Number of Taggers | Tags | Tags per Tagger | Objects | Objects per Tagger | Tags per Objects |
|---|---|---|---|---|---|---|
| **Categorizers** | 225 | 1960 | 8,71 | 1852 | 9,08 | 1,06 |
| **Describers** | 209 | 12647 | 60,51 | 630 | 2,81 | 20,07 |

Describers are seemed to score high in the ratio of tags per tagger and tags per object. They use a large number of tags to describe a small number of objects. Instead, categorizers assign tags more conservatively, keeping low the number of tags and high the number of objects they tagged.

Consequently, tags per Describer are 86% more than tags per Categorizer while the average of objects per Describer is 69% lower than the Categorizers' corresponding. Finally the variance between Describers and Categorizers' Tags per Objects reaches the 95% with the Describers to hit higher score.

A significant factor contributing to the above whopping scores of Describers is the inclusion of the four Super Taggers in the Describers' group.

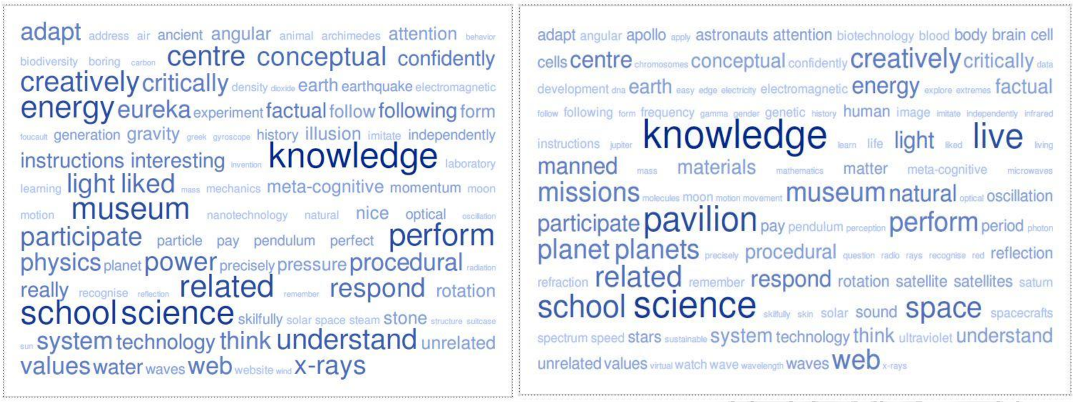



***Figure 53:*** *Left - Categorizers' Tag Cloud, Right - Describers' Tag Cloud*

A more detailed report related to the tags assigned by each type of users can be found in Table 28 and Table 29, where there is an outline of the number of tags assigned by each users' type and the tagging mobility in each tag category.

***Table 28:*** *Tags per Describer*

| **Describers** | | | |
|---|---|---|---|
| **Tag Category** | **Number of Tags** | **Number of Taggers** | **Average: Tags per Taggers** |
| **FREE** | 11129 | 173 | 64,33 |
| **KD** | 401 | 91 | 4,41 |
| **CPD** | 328 | 92 | 3,56 |
| **AFF** | 296 | 86 | 3,44 |
| **PS** | 230 | 85 | 2,71 |
| **CON** | 363 | 85 | 4,27 |

The tags preference of Describers lies in a descending order on Free, Cognitive Domain – Cognitive Process, Cognitive Domain – Knowledge, Affective Domain, Context and Psychomotor Domain. However, some tag categories even if they were tagged by less users, achieved higher ratio. For instance, the second higher ratio of tag per tagger was captured on Cognitive Domain – Knowledge and the third in Context.

A noteworthy fact is that 19% of the Describers have no Free Tags. Furthermore, Categorizers as Describers, tend to assign Free Tags. In comparison to Describers the proportion of the Categorizers without any Free tag is a low of 2%.

*Table 29: Tags per Categorizer*

| Categorizers | | | |
|---|---|---|---|
| **Tag Category** | Number of Tags | Number of Taggers | Average: Tags per Tagger |
| **FREE** | 1546 | 206 | 7,5 |
| **KD** | 104 | 39 | 2,67 |
| **CPD** | 86 | 45 | 1,91 |
| **AFF** | 75 | 42 | 1,79 |
| **PS** | 70 | 35 | 2 |
| **CON** | 79 | 41 | 1,93 |

In general, when excluding the category of free tags, Categorizers showed about the same concern of tagging by using all the tag categories. Consequently, the tags per user ratio range on the same area.

In Figure 54 there is a comparison of the Describers and Categorizers ratio of tags per tagger.

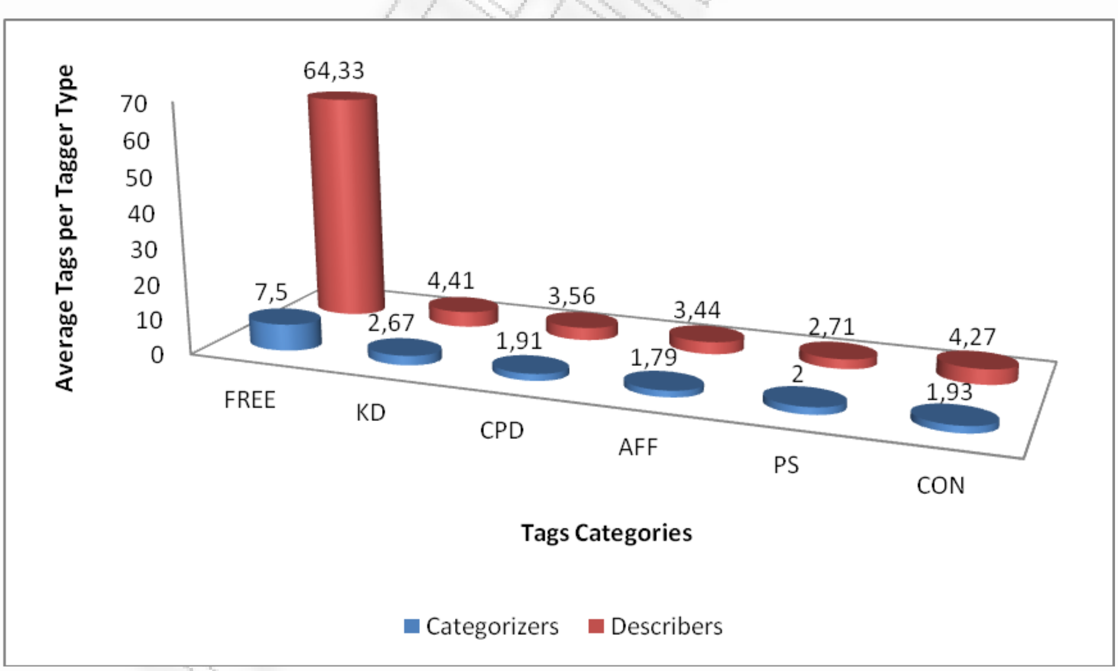



***Figure 54:** Describers/Categorizers Tags per Tag Category*

It is obvious that Describers had the precedence in all the tag categories with the larger difference laid on Free tags with a variation of 88% and then in Context with 55%. The percentage difference between Describers and Categorizers' scores on the rest of the Tag Categories were 51% in Affective Domain, 48% in Cognitive Domain – Cognitive Process, 39% in Cognitive Domain – Knowledge and 26% in Psychomotor Domain.

2) Phase # 2: Evaluation of Describers and Categorizers impact on the usage context of learning objects

The initial dataset of 1852 learning objects assigned by Describers and 630 assigned by Categorizers were reduced to 655 and 284 respectively in order to isolate and process dataset including objects assigned entirely by the under evaluation type of users.

Within the evaluated learning objects of the Describers' dataset 99% of the objects had Free Tags, 13% had Context Tags and 3% of them had Educational Objectives, equal for all the Educational Objective Categories). The impact of the resulting folksonomy in each one of the abovementioned categories was examined separately.

The learning objects which were tagged only by Describers showed the following behaviour in relation to their usage context (Table 30)

***Table 30:*** *Describers - Tag/Metadata Matching Ratio Results*

| Describers | |
|---|---|
| **Tag Category** | **Tag/Metadata Matching Ratio** |
| **Keyword/Free Tags** | 0,76 |
| **Cognitive Domain – Knowledge** | 0,55 |
| **Cognitive Domain – Cognitive Process** | 0,5 |
| **Affective Domain** | 0,42 |
| **Psychomotor Domain** | 0,34 |
| **Context** | 0,34 |

The influence of the resulting folksonomy in the context of use of the learning objects as was detected through the tag/metadata matching ratio was more obvious in the Tag Categories of Context and Psychomotor Domain which hold score equal to 0,34. The meaning of this low ratio result is that Describers are seemed to enhance the related to these categories context of use of the learning objects.

At the same time, the high ratio keyword/free tags, indicates the tendency to preserve the context of use derived by the metadata keywords.

The overall average of the tag/metadata matching ratio (after considering the weighted factor of each category according to its entries) equals to 0,71 which is quit lower from the average of the whole users dataset (0,81).

The Categorizers' learning object dataset had tags of the following proportions: the 98% of the objects had assigned Free tags, 12% of the objects had Context and 2% had Congitive Domain – Knowledge, Cognitive Domain – Cognitive Process, Affective Domain and Psychomotor Domain tags.

The learning objects which were tagged only by Categorizers showed the following behaviour in relation to their usage context (Table 31)

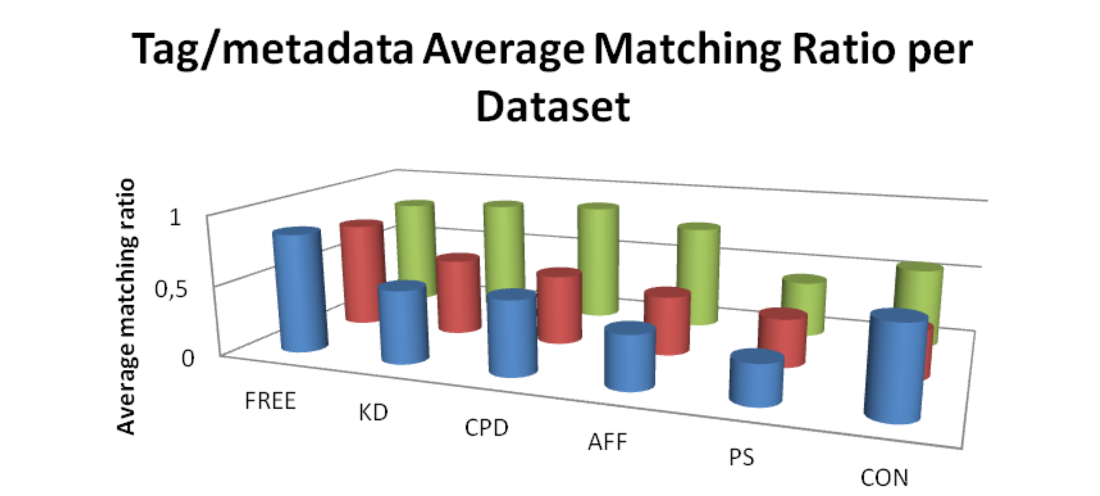
***Table 31:*** *Categorizers - Tag/Metadata Matching Ratio Results*

| Categorizers | |
|---|---|
| **Tag Category** | **Tag/Metadata Matching Ratio** |
| **Keyword/Free Tags** | 0,79 |
| **Cognitive Domain – Knowledge** | 0,83 |
| **Cognitive Domain – Cognitive Process** | 0,86 |
| **Affective Domain** | 0,75 |
| **Psychomotor Domain** | 0,4 |
| **Context** | 0,56 |

The higher tag/metadata matching ratio was achieved in tag categories of Cognitive Domain with 0,86 and 0,83 while the lower ratio was observed on Psychomotor Domain.

In general, all the matching ratios are considered increased as only one of them lies under 0,5 and the total average reaches the figure of 0,76.

In Figure 55 there is a comparison of all the total users' dataset of metadata and tags average matching score to the Categorizers and Describers average matching ratio.




| | FREE | KD | CPD | AFF | PS | CON |
|---|---|---|---|---|---|---|
| Total Users | 0,85 | 0,52 | 0,53 | 0,38 | 0,28 | 0,62 |
| Describers | 0,76 | 0,55 | 0,5 | 0,42 | 0,34 | 0,34 |
| Categorizers | 0,79 | 0,83 | 0,86 | 0,75 | 0,4 | 0,56 |

***Figure 55:*** *Tag/metadata Average Matching Ratio per Dataset*

As shown in the graph, categorizers tend to keep up the learning objects' context of use offered by the content provider in almost all the cases. Because of this, they achieved the higher average in tags/metadata matching ratio.

In addition, compared to describers' results, categorizers' results are certainly higher at all the tag categories. Furthermore, categorizers succeeded higher scores than total users' dataset in all tag categories except Context.

Keywords/Free tags matching ratio is high in all cases in contrary to Psychomotor domain matching ratio which is always the lower of all the categories in all datasets. The tag categories intriguing the interest in this comparison are the Educational Objective categories which in Describers dataset obtained a total average of 0,45 matching ratio while within Categorizers dataset have launched into the quite high average ratio of 0,71. This illustrates the loyalty of the Categorizers in keeping the usage context of Educational Objectives.

### *5.4.3 Hypothesis # 3*

**H3: "The type of the Learning Object (Educational Content, Educational Pathways) affects the enhancement of the context of use of the Learning Objects."**

In hypothesis # 2 the context of use of all the learning objects was examined in conjunction to variables related to the categories of tags and the type of taggers. Hypothesis # 3 aims to make a further evaluation of the folksonomy impact to the learning objects' context of use by adding one more variable to the evaluation process.

The evaluation of hypothesis is separated in two phases. In the first phase the dataset is consisted of the set of learning objects and the resulting folksonomy included in each type of objects in order to determine whether the current variable is considered as crucial to the context of use enhancement from the user-based descriptions. In the second phase, findings of the first phase are used and formed as to reveal the impact of each type of taggers to the context of use of each learning objects' type.

1) Phase # 1: Context of Use enhancement of Educational Content and Educational Pathways.

Table 32 shows the dataset assigned to each type of Learning Object in general, before the excluding of learning objects with no assigned metadata available for matching comparisons.

***Table 32:*** *Educational Content/Pathways - Tags and Objects per Tag Category*

| **Learning Object Type** | **Educational Pathways** | **Educational Content** |
|---|---|---|
| **Number of the Objects** | 241 | 1636 |
| **Number of Tags** | | |
| **FREE** | 2178 | 10497 |
| **KD** | 325 | 180 |
| **CPD** | 348 | 66 |
| **AFF** | 224 | 147 |
| **PS** | 224 | 76 |
| **CON** | 244 | 198 |
| **TOTAL** | 3443 | 11264 |
| **Number of Objects Assigned by Each Tag Category** | | |
| **FREE** | 239 | 1633 |
| **KD** | 61 | 181 |
| **CPD** | 63 | 133 |
| **AFF** | 57 | 120 |
| **PS** | 54 | 77 |
| **CON** | 61 | 117 |

In order to compare the influence of context of use in each Learning Object Type, the dataset of Hypothesis # 1 was elaborated in order to separate the Learning Objects (including their matching scores in every Tag Category) into Educational Content and Educational Pathways.

Table 33 shows the valid learning objects participated in the matching comparison of each Category:

*Table 33: Educational Content/Pathways Matching Comparison Dataset*

| Type of Learning Object | Educational Pathways | Educational Content |
|---|---|---|
| **FREE** | 226 | 1561 |
| **KD** | 20 | 3 |
| **CPD** | 18 | 7 |
| **AFF** | 21 | 3 |
| **PS** | 18 | 3 |
| **CON** | 60 | 106 |

The overall results of the comparison (Figure 56) showed a matching ratio of 85% revealing the tendency of taggers to keep the context of use of the Educational Content as accrued from the content provider's metadata description. The corresponding ratio of the Educational Pathways was quite lower, attaining a 63% of tag/metadata matches.

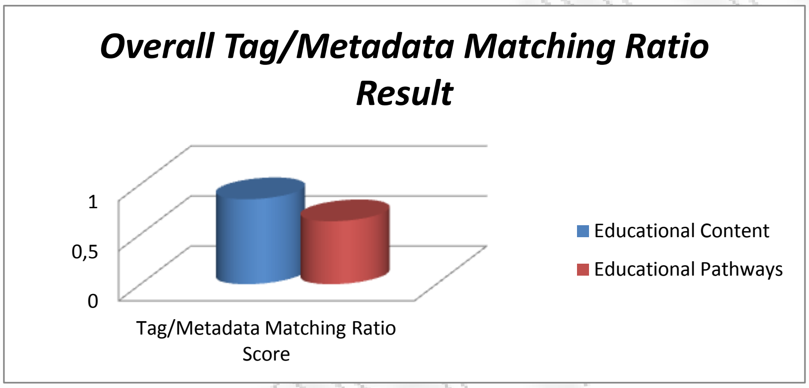
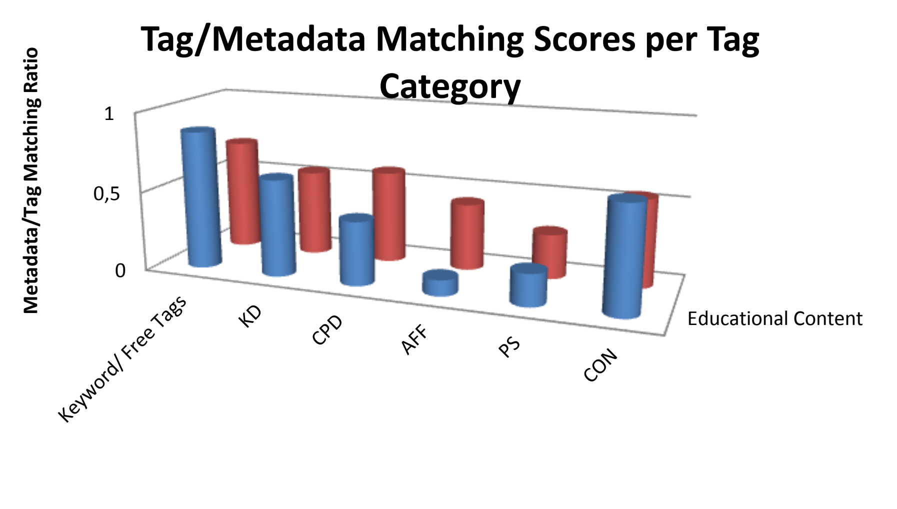



***Figure 56:*** *Educational Content/Pathways – Overall Tag/Metadata Matching Ratio Result*

Consequently there are two noteworthy observations related to the above results:

- Educational Content according to the literature (Chapter 2.4.2) can be used in many contexts as they are objects of low aggregation. However the high result of 85% indicated that even if they can be more contextual Educational Content haven't received a large proportion of enhancement in their context of use.
- Educational Pathways despite the fact of being learning objects of high granularity, they can be described through Social Tags in a different way, enhancing the context of use.

However, it is of great importance to determine how each one of the metadata/tag categories contributes to the usage context. In Figure 57 there is a more detailed presentation of the context of use enhancement for each type of learning object in relation to the metadata/tag categories.



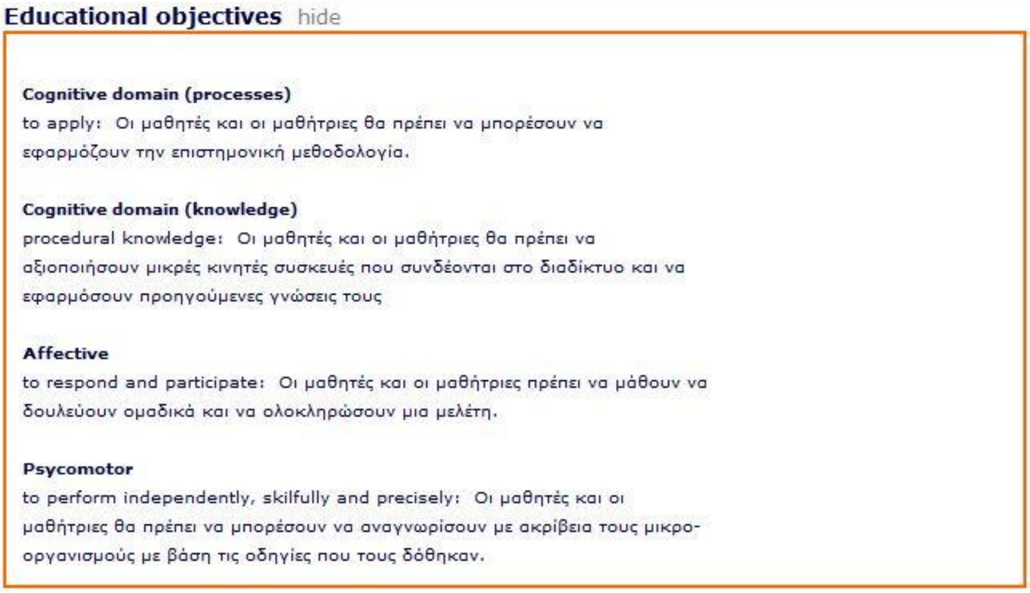

| | Keyword/ Free Tags | KD | CPD | AFF | PS | CON |
|---|---|---|---|---|---|---|
| Educational Content | 0,87 | 0,61 | 0,4 | 0,1 | 0,2 | 0,66 |
| Educational Pathways | 0,7 | 0,54 | 0,58 | 0,42 | 0,28 | 0,55 |

***Figure 57:*** *Educational Content/Pathways: Tag/Metadata Matching Ratio Scores*

Educational Content has scored much higher than Educational Pathways at the category of Keyword/Free Tags and slightly higher in categories of “Context” and “Cognitive Domain – Knowledge”. However, even if the matching ratio in the latter category was comparatively higher, in the rest of the Educational Objectives’ Categories the score was particularly low.

In contrast to Educational Content’s matching results of Educational Objectives, Educational Pathways scored higher with the exception of “Cognitive Domain – Knowledge” Category. Nonetheless, even if Educational Pathways scores were higher in these categories, were still moderate to low, causing the enhancement of the usage context to a great extend.

An example of Educational Pathway with enhanced Educational Objectives usage context is “River of Life”. In Figure 58 are the Educational Objectives assigned by the pathway provider.



**Educational objectives** hide

**Cognitive domain (processes)**
to apply: Οι μαθητές και οι μαθήτριες θα πρέπει να μπορέσουν να εφαρμόζουν την επιστημονική μεθοδολογία.

**Cognitive domain (knowledge)**
procedural knowledge: Οι μαθητές και οι μαθήτριες θα πρέπει να αξιοποιήσουν μικρές κινητές συσκευές που συνδέονται στο διαδίκτυο και να εφαρμόσουν προηγούμενες γνώσεις τους

**Affective**
to respond and participate: Οι μαθητές και οι μαθήτριες πρέπει να μάθουν να δουλεύουν ομαδικά και να ολοκληρώσουν μια μελέτη.

**Psycomotor**
to perform independently, skilfully and precisely: Οι μαθητές και οι μαθήτριες θα πρέπει να μπορέσουν να αναγνωρίσουν με ακρίβεια τους μικρο-οργανισμούς με βάση τις οδηγίες που τους δόθηκαν.

***Figure 58:*** *OSR Educational Pathway - River of Life*

The specific Educational Pathway was found to have a low matching ratio between its metadata and tag Educational Objectives. The analysis showed thefollowing differences:

***Table 34:*** *The river of Life - Comparison of Metadata and Tag Educational Objectives*

| **Educational Objective Category** | **Metadata** | **Tags** |
|---|---|---|
| Cognitive Domain – Process | To apply | • To apply<br>• To think critically and creatively<br>• To understand |
| Cognitive Domain – Knowledge | Procedural knowledge | • procedural knowledge<br>• conceptual knowledge<br>• factual knowledge |
| Affective Domain | To respond and participate | • To form and follow a system of values<br>• To recognise values<br>• To respond and participate |
| Psychomotor Domain | To perform independently, skilfully and precisely | • To adapt and perform creatively<br>• To perform confidently following instructions<br>• To perform independently, skilfully and precisely |

Because of the assigned tags, the usage context of every Educational Objective Category was enhanced linking the Educational Pathway to more than one Educational uses.

1) Phase # 2: Context of Use enhancement of Educational Content and Educational Pathways by each Type of Tagger.

The dataset of Phase # 1 was elaborated as to be divided into four lists combining the variables of Type of Taggers and Type of Learning Objects.

***Table 35:*** *Educational Content/Pathways - Tag/Metadata Comparison Dataset*

| Type of Learning Objects | Educational Content | | Educational Pathways | |
|---|---|---|---|---|
| Type of Taggers | Describers | Categorizers | Describers | Categorizers |
| Number of Objects Assigned by Each Tag Category | | | | |
| FREE | 550 | 243 | 100 | 40 |
| KD | 3 | - | 5 | 3 |
| CPD | 7 | - | 8 | 4 |
| AFF | 2 | - | 5 | 4 |
| PS | 2 | 1 | 4 | 3 |
| CON | 45 | 18 | 17 | 16 |

In table 60 there is a presentation of the available for comparison Objects in every metadata/tag Category.

The average matching scores derived from the entire dataset of each type of taggers' tags were:

- Educational Content Tag/Metadata average matching ratio: Describers 77%, Categorizers 80%
- Educational Pathways Tag/Metadata average matching ratio: Describers 64%, Categorizers 65%

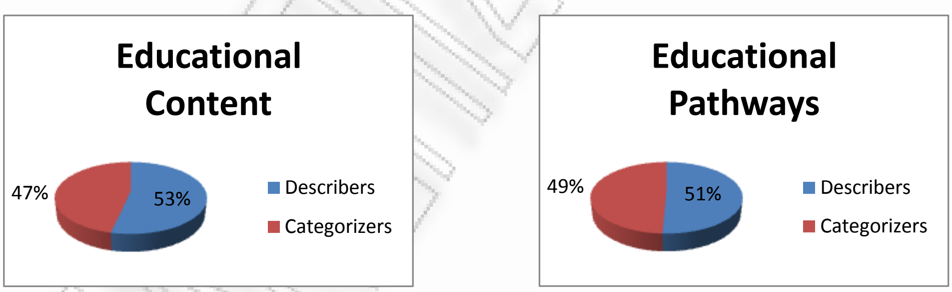
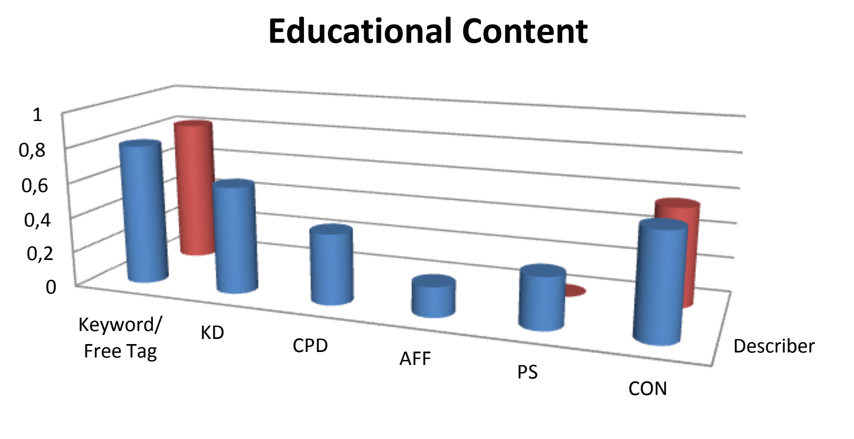



***Figure 59:*** *Educational Content/Pathways - Describers/Categorizers Overall Context Usage Influence Proportions*

As it is shown in Figure 60 the context of use of both Educational Contents and Educational Pathways has been enhanced in larger proportion by Describers. However the difference between the type of taggers' contribution to the context usage enhancement is negligible.

In Figures 61 and 62, there are more detailed presentations of the type of taggers' contribution to the context of use. The figures are representing the matching ratio of metadata and tags in each tag category.



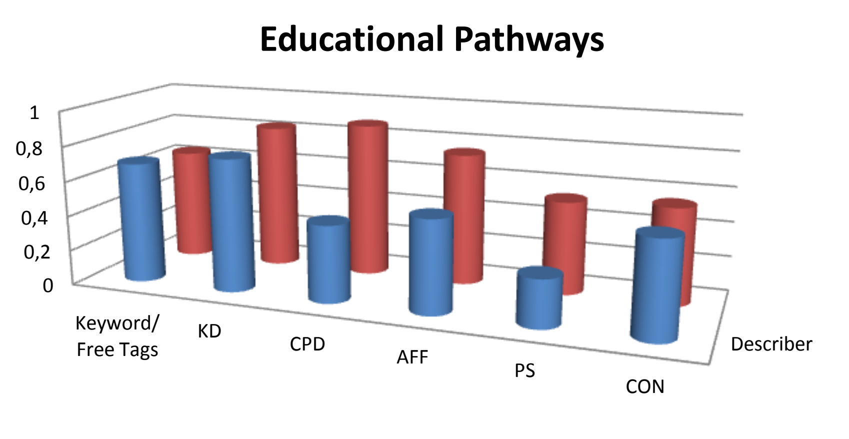

| | Keyword/ Free Tag | KD | CPD | AFF | PS | CON |
|---|---|---|---|---|---|---|
| Describer | 0,8 | 0,61 | 0,4 | 0,17 | 0,29 | 0,59 |
| Categorizer | 0,82 | | | | 0 | 0,56 |

***Figure 60:*** *Educational Content - Describers/Categorizers Matching Ratio Scores*

User-based description which derived by both categorizers and describers have preserved to a great extend the existing context of use in categories of Free Tags and Context. However, there weren't any available metadata in order to examine the Categorizers' contribution to the context of use of "Cognitive Domain – Knowledge", "Congitive Domain – Cognitive Process" and "Affective Domain" categories.

Still, the sole comparison of Describers and Categorizers' matching scores in relation to the Educational Objective of "Psychomotor Domain", indicated that Categorizers had no matches at all and Describers scored also low as well as in other Educational Objectives' scores (CPD and AFF).

Consequently, the range of the scores in the two type of taggers range from low to very high ratios, but on average both of them tend to preserve the context of use of the Educational Content.




| | Keyword/ Free Tags | KD | CPD | AFF | PS | CON |
|---|---|---|---|---|---|---|
| Describer | 0,69 | 0,76 | 0,44 | 0,53 | 0,27 | 0,54 |
| Categorizer | 0,64 | 0,83 | 0,88 | 0,75 | 0,53 | 0,55 |

***Figure 61:*** *Educational Pathways - Describers/Categorizers Matching Ratio Scores*

Categorizers are seemed to achieve higher tag/metadata matching scores in almost all of the tag categories. Describers have the only higher score in the matching comparison of keywords and free tags.

The observation of Describers' high matching score in the particular category is also noticed in Learning Objects' usage context evaluation. This achievement may derives from the fact that Describers use an unlimited vocabulary in order to describe a learning object and for that reason it could be more possible to match a tag with a metadata term.

Significant is also the fact that in three of the four Educational Objective categories the variation between Categorizers and Describers' average matching ratio is ranging up to 50%. At the same time the variation of scores in categories of Free Tags, KD and CON ranges at about the same level.

In general, both Describers and Categorizers tend to keep in moderate levels the matches between tags and metadata in almost all the cases. However, Categorizers are the users who insist in preserving the existing context of use of Educational Pathways to a greater extend in relation to Describers.

### 5.4.4 *Summary and Discussion*

The evaluation regarding the identification of user-based descriptions influence to the context of use of the Educational Object, involved analysis of several variables participating in the OSR resulting folksonomy.

These variables included the structured metadata and Social Tags' descriptions of the learning objects, the participation of type of taggers' motivation and the separation of learning objects into Educational Content and Educational Pathways.

The evaluation methodology has been structured into three hypotheses starting from the enrollment of two variables into a comparative study and adding in each phase more variables generating increasingly more specialized outcomes.

The outcomes of the first hypothesis investigation regarding the usage context enhancement by the folksonomy, pointed out that Free Tags have the least impact (15%) to the usage context of the learning objects, Context Tags has a moderate effect of 38% and Educational Objectives tags have the greatest influence by changing the Learning Objects usage context by 57%. The overall matching ratio between the tags and the metadata is quite high (81%) and therefore the general usage context of use is preserved to a great extend.

The second hypothesis analysis included the variable of "type of tagger's motivation" and revealed the preferences of each type of tagger to specific Tag Categories (average tags per tagger). Both of the two groups had a great tendency in assigning Free Tags. The order of precedence of other Tag Categories was Cognitive Domain – Knowledge Tags, Context Tags and Cognitive Domain – Cognitive Process Tags. Thereafter, Categorizers in contrast to Describers, had assigned more Psychomotor Domain Tags than Affective Domain Tags.

The overall results showed that Categorizers' tags comparatively to Describer's tags facilitate to a greater extend the preserve of usage context of Learning Objects in all cases of Tag Categories. Hence, Describers' tags tend to enhance the usage context of Learning Objects and particularly the context related to Educational Objective.

Due to the third hypothesis, the influence of learning object type to the Social Tags usage context was examined. The overall outcomes indicated that the context of use of Educational Content is less influenced than this of the Educational Pathways. However in Tag Categories of Educational Objectives, the usage context of Educational Pathways has influenced less in comparison to Educational Content's but enough to enhance the Educational objective usage context.

Categorizers' tags are seemed to keep up the context of use of both Educational Content and Educational Pathways more than Describer's tags, even though the proportional difference between the two types of taggers' results is negligible.

The absence of sufficient dataset of Categorizers' Educational Objective metadata/tag matching comparison assigned in Educational Content didn't offer the opportunity for valid comparisons between the Categorizers' and Describers' tags. Although, Describers' tags, are seemed to enhance to a great extent the Educational Content's Educational Objectives usage context.

Regarding to context of use of Educational Pathways, it was noteworthy that Describers' tags affected twice the Educational Objectives usage context in comparison to Categorizer's tags which preserved heavily the specific usage context.

In general the experiment results revealed through the hypothesis investigations that, user-based descriptions as Social Tags are able to influence and enhance the context of use of Learning Objects to a greater or lesser degree in each case even if are drawn from a pre-defined vocabulary.

## 5.5 Experiment #2 Results: Identify new tags that do not exist in the formal vocabularies

Towards the second experiment the Hypotheses #4 and #5 are examined in order to confirm or refute the existence of new useful terms within the resulting folksonomy not included in formal classification vocabularies. The classification vocabulary of OSR Repository is the Science Learning Content Vocabulary (APPENTIX B).

Additionally, the list of the OSR Folksonomy Useful Terms is going to be examined further in relation to Describers and Categorizers contribution. Thus, a comparison between Describers and Categorizers useful terms occurrence frequency takes place and verifies whether the type of taggers' motivation has some influence to the useful terms' generation.

### *5.5.1 Hypothesis # 4*

**H4: "Within the OSR resulting folksonomy, new useful terms can be identified"**

Following the evaluation methodology, the first step was to collect the 3489 unique terms derived from the resulting folksonomy of OSR and calculate the average frequency per tag which turned to be equal to 4. The next step was the isolation of the tags with frequency greater than 4. After the isolation 496 tags remained.

Subsequent to the evaluation, the match processing between the lists of Social Tags and OSR formal vocabulary took place allowing the number of 296 tags to move to the next step of a "tag by tag" qualitative study.

A first issue related to the comparative evaluation of OSR formal vocabulary and OSR folksonomy was the omission of including the OSR Formal Vocabulary's Category Titles. A later addendum of the titles in the dataset, excluded a considered number of Social Tags. In Table 36 there are some examples of tags excluded.

***Table 36:*** *OSR Folksonomy Useful Terms - Exclusion Phase # 1*

| | **OSR Vocabulary Term** | **Social Tag** |
|---|---|---|
| **Example # 1** | Atoms and molecules | atom |
| **Example # 3** | Forces and motion | Force<br>motion |
| **Example # 4** | Variation, inheritance and evolution | inheritance |

After the consideration of this group of Social Tags, 53 Social Tags were excluded (18%).

Some other observations bring forward the "synonymy issue". For instance, the social tag "stone" which was assigned 13 times is synonymous to the OSR term "rock". The same thing happened to 97 Social Tags (33%). In Table 37 there are a number of Social Tags and OSR vocabulary terms synonymy examples.

***Table 37:*** *OSR Folksonomy Useful Terms - Exclusion Phase # 3*

| | **OSR Vocabulary Term** | **Social Tag** |
|---|---|---|
| **Example #1** | Angular velocity | Angular speed |
| **Example #2** | Properties of light | Light attributes |
| **Example #3** | Spaceship | Spacecrafts |

Moreover, many of the Social Tags with high frequency occurrence correspond to elements which form a single OSR formal term. Social Tags of this group equal to 27 (9%). Examples can be found in Table 38:

*Table 38:* *OSR Folksonomy Useful Terms - Exclusion Phase # 3*

| | OSR Vocabulary Term | Social Tag |
|---|---|---|
| **Example # 1** | Planets | Venus<br>Mars<br>Uranus (etc.) |
| **Example # 2** | Satellites: natural satellites | Europa<br>Io<br>Kallisto (etc.) |
| **Example # 3** | Astronauts | armostrong<br>neil (1930-) |

A considerable "problem" was also the existence of subjective tags (Golder & Huberman, 2006). Some Social Tags of this category were found in the OSR folksonomy of the current dataset in the form of comments as "perfect", "I like it", "amazing", "educational useful" etc. This type of terms counts 19 (6%) entries.

After the abovementioned exclusions of Social Tags from the list of the "candidate" new useful terms, 100 Social Tags remained. Therefore the next task was to evaluate the Social Tags in relation to their context and whether are considered appropriate to be included in a formal vocabulary of a repository containing science educational material. For instance, an excluded social tag could be a non stand-alone tag due to its inability to provide a comprehensible description or an informative context of use: "touch", "love", "boom", "young", "fresh", "an interactive tool enabling people to locate natura 2000 sites and access related information", etc. The tags of this group equal to 44.

Consequently, a final list with the 56 possible new useful terms from the OSR folksonomy was created (Table 39). The numbers in the brackets represent the occurrence frequency of each tag within the folksonomy.

*Table 39: OSR Folksonomy Useful Terms*

| New Useful Terms Identified in OSR Folksonomy | | |
|---|---|---|
| Manned Space Missions (137) | Earthquake (20) | Arthropods (13) |
| Frequency (48) | Mendel (20) | Insects (13) |
| Photon Energy (36) | Power Generation (20) | Star Formation (12) |
| Vermin (31) | Oscillation level (19) | Recycling (12) |
| Optical illusions (31) | Lhc/Accelerator (19) | Space Technology (12) |
| Geological Periods (29) | Illusion (18) | Water power (12) |
| Apparent movement (28) | Visual Stimuli (18) | Mechanical Vibration (11) |
| Sound wave (28) | Red Blood Cells (17) | Angular momentum (11) |
| Vertical plane (28) | Game (16) | Dihybrid (11) |
| 3D (26) | Artery(15) | Double slit (10) |
| Animation (24) | Genes (14) | Centre of gravity (9) |
| Image Processing (24) | Mendelian (14) | Virtual Reality (9) |
| Unmanned space missions (23) | Vein (14) | Vibration (9) |
| Automation (22) | Vascular (14) | Sound Digitalization (8) |
| Gravity (22) | Virtual World (14) | Star clusters (7) |
| Genetic Information (21) | Cern (13) | Latitude (7) |
| Relative Motion (21) | Auditory Stimuli (13) | Colour illusion (6) |
| Volume (21) | Proteins (13) | Nasa (5) |
| Image Digitalization (21) | Pollen (13) | |

After isolating the OSR Folksonomy Useful Terms, there was an attempt to classify the above tags into the corresponding categories (Table 40).

*__Table 40:__ OSR Folksonomy Useful Terms in Categories*

| **Astronomy** |
|---|
| Manned Space Missions, Unmanned Space Missions, Space Technology, Red Giants , Star Formation, Star Clusters |
| **Earth science** |
| Earthquake, Geological Periods, Latitude |
| **Energy** |
| Lhc/Accelerator, Power Generation, Photon Energy, Water power, Double Slit |
| **Energy and nutrient transfer** |
| Proteins |
| **Environment** |
| Recycling |
| **Forces and motion** |
| Apparent movement, Oscillation level, Angular Momentum , Vertical Plane, Relative Motion, Centre of gravity, Frequency, Gravity, Volume |
| **Humans and other animals** |
| Vascular, Vein, Red Blood Cells, Artery, Vermin, Arthropods, Insects |
| **Life processes** |
| Pollen |
| **Light** |
| Optical illusions, Illusion, Colour illusion, Visual Stimuli |
| **Sound** |
| Auditory Stimuli |
| **Variation, inheritance and evolution** |
| Mendel, Mendelian, Genetic Information, Genes, Dihybrid |
| **Waves** |
| Vibration, Mechanical Vibration, Sound wave |
| **Technological applications** |
| Automation ,Image Digitalization, Sound Digitalization, Image Processing , Virtual Reality, Virtual World, 3D, Game, Animation |
| **History of Science and Technology** |
| Cern, Nasa |

### *5.5.2 Hypothesis # 5*

**H5: "The type of users' motivation affects the contribution to the new useful terms"**

In Hypothesis # 5 is examined the question whether the type of users' motivation affects the assignment of new useful terms not included in formal classification vocabularies to the OSR learning objects.

The useful terms identified in Hypothesis # 5 were examined in order to reveal which type of users contributed the most to the production (Figures 63 and 64).

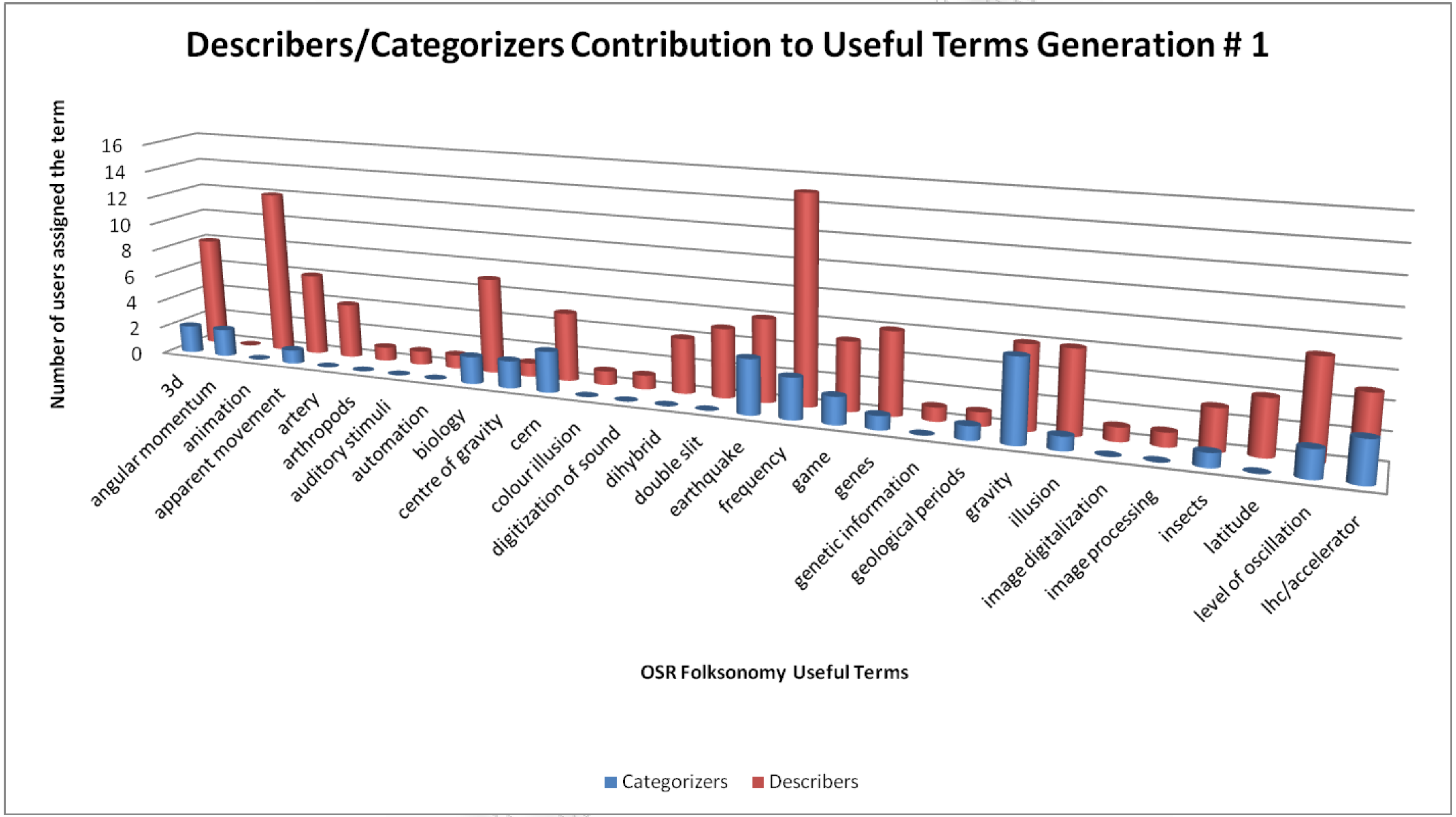



***Figure 62:*** *Describers/Categorizers - OSR Folksonomy Useful Terms Contribution # 1*

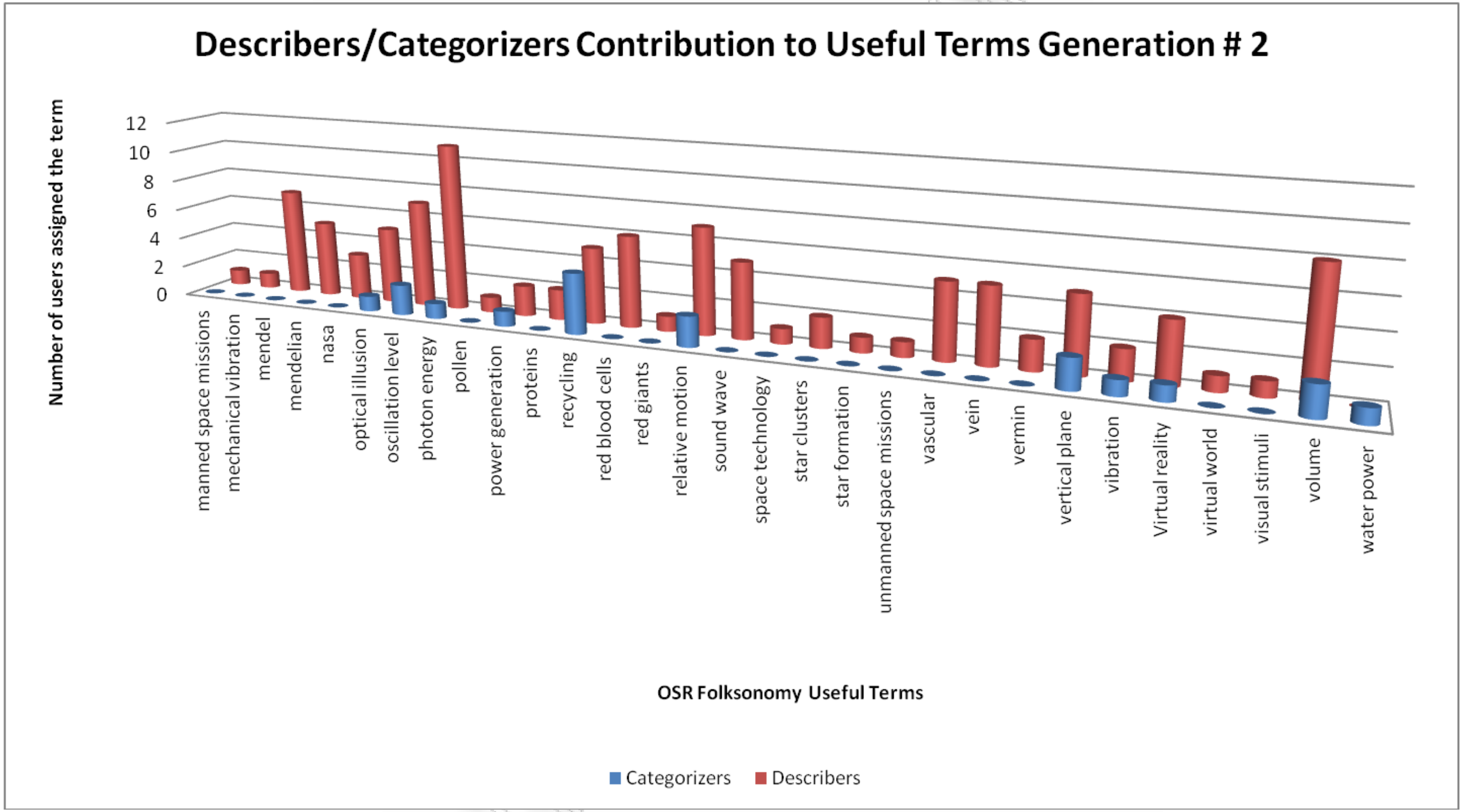



*Figure 63:* *Describers/Categorizers - OSR Folksonomy Useful Terms Contribution # 2*

The contribution of Describers to the entire set of the OSR folksonomy useful terms is obvious. Describers are seemed to contribute the most to almost all the terms. The only exceptions of the rule is the term "gravity" in which both of the taggers types contributed equally, the terms "centre of gravity" and "angular momentum" in which Categorizers obtained higher contribution proportion and finally the term "water power" which has derived from only a single Categorizer.

In reference to the last-mentioned exception, a noteworthy observation is that an adequate number of terms are linked only to 1 tagger even if they obtain a high frequency. This phenomenon is observed in 19 cases (the one third of the useful terms). Though, the single taggers used the terms with occurrence frequency ranging from 6 (term: Colour Illusion) to 137 times (term: Manned Space Missions) in each individual case.

In general, the influence of Describers to the formation of the OSR Folksonomy Useful Terms is undeniable (Figure 65).

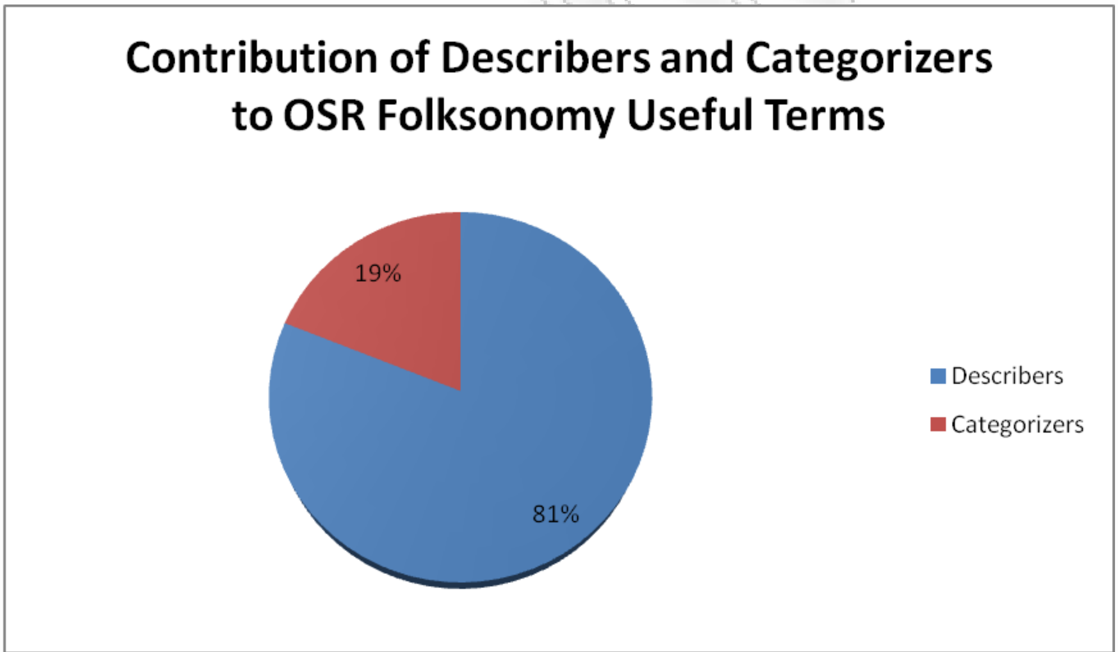



***Figure 64:*** *Describers/Categorizers - Overall Contribution*

The proportion of the contribution of Describers equals to a huge 81% while Categorizers follow with 19%. The results of this study leads to conclusion the type of taggers influences the generation of useful terms. Moreover confirms that the open size of tag vocabulary describers can be beneficial to an OSR hybrid *"Folksonomy-directed taxonomy"* approach.

### *5.5.3 Summary and Discussion*

The evaluation methodology regarding the identification of new useful terms within the OSR folksonomy, was carried out with the participation of some variables which have already been examined in Experiment # 1.

The variables participated in the current experimental setup were the OSR formal Vocabulary Classification terms, the OSR Social Tags and the type of taggers' motivation (Describers/Categorizers).

The new useful terms study was structured into two hypothesis starting from the isolation of terms not exist in the OSR Formal Classification Vocabulary and concluding in which type of taggers make the greater contribution to the production of new useful terms.

Towards the detection of useful terms within the folksonomy, firstly terms not existing in Formal Vocabulary were isolated and afterwards several exclusion phases have been made as a result of a very thorough qualitative "tag by tag" study. Examples of that exclusions are exclusion of synonyms and non stand alone Social Tags.

The result of Hypothesis # 4 examination was the creation of a list with 57 OSR Folksonomy Useful Terms. The Social Tags included in the list had occurrence frequency range from 5 to 137 times. Within the final list, each of the terms was classified in categories borrowed from the OSR Formal Classification Vocabulary.

For accomplishing the experiment, in Hypothesis # 4 investigation, the users who assigned the useful terms were sought in order to determine whether the type of taggers' motivation influence the contribution to useful terms. The upshot of the study, pointed out that tagger types do matter to the contribution of new useful terms. In the case of OSR Repository, Describers are those who made the most contribution with a large percentage differentiation in comparison to Categorizers.

Hence, both Hypotheses # 4 and #5 were verified by indicating the existence of useful terms within the OSR folksonomy, forming a list of them and discovering that Describers made the greatest contribution.

# Chapter 6: Conclusions And Future Work

The dynamic establishment of Web 2.0 phenomenon affected along with other fields and the field of learning, offering new potential to the Technology-Enhanced Learning. Social Tagging, one of the newest technologies of Web 2.0 appears as an alternative way of annotating resources, contributing next to structured metadata to the management of digital content. A sort of this digital content is Learning Objects which can be retrieved through Learning Objects Repositories.

This thesis incarnated a Social Tagging evaluation methodology, examining the Social Tagging potential within a Science Learning Resources Repository. Evaluation methodologies of Social Tagging are considered very important since Social Tagging constitutes a new area of research with a lot of theoretical issues to be examined and a lot of evaluation methods under probation.

The evaluation methodology dealing in the current study, aimed to carry through some issues concerning the folksonomy and its impact to the context of use of the Learning Objects as well as its contribution to the drainage of new useful terms. The culmination of the current methodology is the investigation of the above in combination with the types of users' motivation behaviour. Towards the formation of a sufficient methodology, a review of the Social Tagging literature and an analysis of existing evaluation methodologies were preceded.

The methods used due to the evaluation methodology were mainly quantitative measures of the log data through metrics and ratios and to a lesser extend a "tag by tag" qualitative study. In the course of a fruitful evaluation, the methodology was leaded by some hypotheses based on the scope of this study, employing the proper variables of the evaluation dataset according to each hypothesis objective.

The main findings of the first experiment concerning the impact of resulting folksonomy to the context of use of learning objects revealed that the Social Tags enhance the context of use to a greater or lesser extend in each case; the user-based descriptions were much closer to the usage context in relation to the descriptions derived from the pre-defined vocabulary.

The context of use of Learning Objects was found to be influenced by the type of taggers' motivation. The evaluation among the Describers and Categorizers' tags lead to the conclusion that Describers tend to enhance the usage context of Learning Objects more than Categorizers.

Another variable influencing the context of use issue was the type of the Learning Object. It was detected that the context of use of Educational Content was less affected from the user-based tags in comparison to the Educational Pathways' usage context. Yet, the context of use of Educational Objectives was enhanced less in Educational Pathways while leaving room for expanding the usage context despite their strict structure. Observations of the same type have also been made in other studies like steve museum (Trant, 2009b) were the tags didn't match to the museum documentation affecting the context of the exhibitions. The type of the exhibition was as well a variable which influenced the tags behavior.

Each type of taggers' motivation had once again different outcomes with Categorizers and Describers' user-based tags enhancing the less the context of use of both of the Learning Objects' types, and Describers' pre-defined tags providing venue for usage context enhancement to both of the Learning Object types.

The findings of the second experiment have demonstrated that the approach of Social Tags and structured metadata co-existence, provides the opportunity of new useful terms generation. The detection of these useful terms can lead to a *Folksonomy-directed taxonomy* enhancing the Formal Classification Vocabulary of the repository.

Within the OSR Folksonomy 56 new useful terms were detected where the type of user's motivation played significant role over again, with the Describers' tags to produce almost the entire set of useful terms.

Steve museum's study for usefulness showed that the museum staff in a qualitative study found useful the most of the tags, in contrast to Calibrate study which concluded in mainly negative results. Although in some other studies (Vuorikari & Ayre, 2009) is cited that even if some Social Tags are considered as useful terms, indexers are likely not indented in adding them in Formal Classification Vocabularies. Still, the detection of the useful terms is quite difficult since a detailed qualitative evaluation is needed.

Due to the detection of useful terms and the forthcoming context usage a premature suggestion which may result to the key to this issue is the "folksontologies" (Van Damme et al., 2007) which are based in algorithms and aim to turn out the folksonomies into ontologies. Until the consummation of such innovative approaches, evaluation methods of Social Tagging are going to be enhanced revealing at the same time other perspectives of Social Tagging.

At this point, future works related to the present Social Tagging Evaluation which was applied on this Thesis, include deeper analysis to the results as to identify the effect of describers' and categorizers' social tags to the enhancement of metadata descriptions.. A type of this kind of analysis may be more complex experiments by considering different tagging interfaces for the social tagging tool.

In the course of Technology-Enhanced Learning, Social Tags can be addressed as a mirror of the human knowledge and attitude, highlighting the significance of previous knowledge to the understanding of new domains. Hence, the annotation of learning Objects with Social Tags expands the usage context of the content, makes it more easy to find, use and reuse and finally ameliorates the Technology-Enhanced Learning and by extension causes the escalation of the Learning Field.

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# APPENTIX A: The OSR Application Profile

| Metadata Element | Vocabulary | Notes and comments |
|---|---|---|
| 1. The ***Title*** of the learning resource | short open-text description | The title will be in the local language / the language of the content (Element 2). However, it may be advisable to implement an additional sub-element (1a) that will allow entering the title in English too (if English is not the original language), to facilitate possible exploitation of the content across linguistic barriers. |
| 2. The human ***Language*** used within the learning resource to communicate with the intended user | choice from a pre-defined vocabulary list:<br><br>• List of languages | It will be necessary to allow for multiple choices of languages when applicable, as there are multilingual digital objects. |
| 3. The general ***Description*** of the content of the learning resource | short open-text description:<br><br>• few sentences reflecting the content and purpose of the resource | The description will be in the local language / the language of the content. However, it may be advisable to implement an additional sub-element (3a) that will allow entering a short description in English too (if English is not the original language), to facilitate possible exploitation of the content across linguistic barriers. |
| 4. The ***Educational Objectives*** of the learning resource | ***Note:*** In the present revised version of the Application Profile, the Metadata Element of the Educational Objectives has been analysed into four sub-elements with corresponding vocabularies. | |
| 4.1.a The ***Educational Objectives*** of the learning resource: ***Cognitive Domain (processes)*** | choice from a pre-defined vocabulary list:<br><br>• to remember (to help the learner recognize or recall information)<br>• to understand (to help the learner organize and arrange information mentally)<br>• to apply (to help the learner apply information to reach an answer)<br>• to think critically and creatively (to help the learner think on causes, predict, make judgments, create new ideas)<br>AND (optionally)<br><br>short open-text description:<br><br>• one sentence concisely describing the cognitive educational objective served by the resource (expanding on the vocabulary item selected) | In the user interfaces, it will be useful to insert the following explanatory captions below the title of the element:<br><br>*The main intended cognitive process(es) in the learner as they use this resource*<br><br>&<br><br>*Note: The classification of cognitive processes should be read as a 'scale' representing a gradual move from simple remembering towards higher-order thinking. Each level builds on and subsumes the previous levels.*<br><br>It will be necessary to allow for multiple choices of Educational Objectives in the cognitive domain (processes), as one resource may serve more than one objective of this type. To avoid excessive information load, the user should be encouraged to insert the most important objective(s) only, as well as being reminded that they should concentrate on their own *perception* of the served objective(s), i.e. what and how they expect/advise users to learn using this resource. |

| | | |
|---|---|---|
| 4.1.b The ***Educational Objectives*** of the learning resource: ***Cognitive Domain (knowledge)*** | choice from a pre-defined vocabulary list:<br><br>• factual knowledge (knowledge of basic elements, e.g. terminology, symbols, specific details, etc)<br>• conceptual knowledge (knowledge of interrelationships among the basic elements within a larger structure, e.g. classifications, principles, theories, etc)<br>• procedural knowledge (knowledge on how-to-do, methods, techniques, subject-specific skills and algorithms, etc)<br>• meta-cognitive knowledge (knowledge and awareness of cognition, e.g. of learning strategies, cognitive tasks, one's own strengths, weaknesses and knowledge level, etc)<br><br>AND (optionally)<br><br>short open-text description:<br><br>• one sentence concisely describing the kind of knowledge to be learned by using the resource (expanding on the vocabulary item selected) | In the user interfaces, it will be useful to insert the following explanatory caption below the title of the element:<br><br>*The type of knowledge the learner should gain through the use of this resource*<br><br>It will be necessary to allow for multiple choices of Educational Objectives in the cognitive domain (knowledge), as one resource may serve more than one objective of this type. To avoid excessive information load, the user should be encouraged to insert the most important objective(s) only, as well as being reminded that they should concentrate on their own *perception* of the served objective(s), i.e. what and how they expect/advise users to learn using this resource. |
| 4.2 The ***Educational Objectives*** of the learning resource: ***Affective Domain*** | choice from a pre-defined vocabulary list:<br><br>• to pay attention (to help the learner focus and pay attention to stimuli, passively)<br>• to respond and participate (to help the learner react to stimuli and actively participate in the learning process)<br>• to recognise values (to help the learner attach certain values to stimuli)<br>• to form and follow a system of values (to help the learner build, and behave according to, a consistent system of values)<br>AND (optionally)<br><br>short open-text description:<br><br>• one sentence concisely describing the affective educational objective served by the resource (expanding on the vocabulary item selected) | In the user interfaces, it will be useful to insert the following explanatory caption below the title of the element:<br><br>*The main interests, attitudes, opinions, values the learner should develop through the use of this resource*<br><br>&<br><br>*Note: The classification of affective Educational Objectives should be read as a 'scale' representing a gradual move towards higher-order processes (from simple reception of stimuli through to values-based behaviour). Each level builds on and subsumes the previous levels.*<br><br>It will be necessary to allow for multiple choices of Educational Objectives in the affective domain, as one resource may serve more than one objective of this type. To avoid excessive information load, the user should be encouraged to insert the most |

| | | |
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| | | important objective(s) only, as well as being reminded that they should concentrate on their own *perception* of the served objective(s), i.e. what and how they expect/advise users to learn using this resource. |
| 4.3 The ***Educational Objectives*** of the learning resource: ***Psychomotor Domain*** | choice from a pre-defined vocabulary list:<br><br>• to imitate and try<br>• to perform confidently following instructions<br>• to perform independently, skilfully and precisely<br>• to adapt and perform creatively<br>AND (optionally)<br><br>short open-text description:<br><br>• one sentence concisely describing the psychomotor educational objective served by the resource (expanding on the vocabulary item selected) | In the user interfaces, it will be useful to insert the following explanatory caption below the title of the element:<br><br>*The movement and coordination skills the learner should develop through the use of this resource*<br><br>&<br><br>*Note: The classification of psychomotor Educational Objectives should be read as a 'scale' representing a gradual move from the simplest behaviour to the most complex. Each level builds on and subsumes the previous levels.*<br><br>It will be necessary to allow for multiple choices of Educational Objectives in the psychomotor domain, as one resource may serve more than one objective of this type. To avoid excessive information load, the user should be encouraged to insert the most important objective(s) only, as well as being reminded that they should concentrate on their own *perception* of the served objective(s), i.e. what and how they expect/advise users to learn using this resource. |
| 5. ***Keywords*** characterizing the topic of the learning resource | short open-text description:<br><br>• a limited number of words/short phases reflecting the topic | |
| 6. The underlying organizational ***Structure*** of the learning resource | choice from a pre-defined vocabulary list:<br><br>• atomic (a resource that is indivisible in this context)<br>• collection (a set of resources with no specified relationships between them)<br>• networked (a set of objects with relationships that are unspecified)<br>• hierarchical (a set of objects whose relationships can be represented by a tree structure)<br>• linear (a set of objects that are fully ordered, i.e. connected with 'previous' and 'next' relationships) | This information, although useful, may not be necessary, or it may be too demanding for some users. In subsequent project phases it will be examined whether this element should remain in the Application Profile, and whether it is adequately defined and commonly understood within the consortium. |

| | | |
|---|---|---|
| 7. The ***Aggregation Level*** of the learning resource | choice from a pre-defined vocabulary list:<br><br>• educational content (any learning resource, from a single file to a complex exhibit or a whole exhibition)<br>• educational pathway (a plan for using a meaningful combination of various instances of educational content) | |
| 8. The ***Author's Name*** of the learning resource | short open-text description:<br><br>• institution/person that has created/authored/produced the resource | |
| 9. The ***Publisher's Name*** of the learning resource | short open-text description:<br><br>• institution/person that is providing/distributing the resource, e.g. the science museum/centre, the user who generated it | |
| 10. The Metadata ***Creator's Name*** of the learning resource metadata | short open-text description:<br><br>• institution/person that has inserted the metadata | |
| 11. The Metadata ***Validator's Name*** of the learning resource metadata | short open-text description:<br><br>• institution/person that has confirmed the inserted metadata | |
| 12. The human ***Language*** of the metadata | choice from a pre-defined vocabulary list:<br><br>• list of languages | It will be necessary to allow for multiple choices of languages when applicable, as there may be multilingual metadata sets. |
| 13. The technical ***Format*** of the learning resource file | choice from a pre-defined vocabulary list:<br><br>• text/plain<br>• text/html<br>• text/css<br>• text/xml<br>• text/rtf<br>• application/pdf<br>• application/zip<br>• application/word processing<br>• application/xml<br>• application/slides presentation<br>• application/spreadsheet<br>• application/database<br>• application/asp<br>• application/java<br>• application/flash<br>• image/jpeg<br>• image/gif<br>• image/tiff<br>• image/png<br>• audio/avi<br>• audio/mp3<br>• video/mpeg<br>• video/quicktime | It will be necessary to allow for multiple choices of format when applicable, as there may be multi-format objects. |

| | | |
|---|---|---|
| | • video/mov<br>• 3D/…<br>• bibliographic records/UNIMARC | |
| 14. The ***Size*** of the learning resource file in KBs | choice from a pre-defined vocabulary list:<br><br>• up to 250KB<br>• from 250KB to 500KB<br>• from 500KB to 1MB<br>• from 1MB to 5MB<br>• more than 5MB<br>• not intended for download | |
| 15. The ***Technical Requirements*** to use the learning resource | short open-text description:<br><br>• operating system, web browser, bandwidth, etc. | |
| 16. The ***Learning Resource Type*** | choice from a pre-defined vocabulary list:<br><br>• image of object (still picture)<br>• video<br>• diagram/graph/chart/plot<br>• table<br>• index<br>• animation<br>• simulation<br>• experiment<br>• narrative/explanatory text<br>• exercise/problem<br>• self assessment test<br>• questionnaire<br>• physical visit plan<br>• virtual visit plan<br>• lesson plan<br>• project plan<br>• lecture<br>• scientific article/text<br>• other article/text<br>• whole website / web collection<br>• game<br>• other software application<br>• collection of links | It will be necessary to allow for multiple choices of learning resource type when applicable. In subsequent stages of the project it may be useful to group the elements of this list according to a classification (e.g. by distinguishing pedagogical from technological concepts). |
| 17. The ***Interactivity Type*** | choice from a pre-defined vocabulary list:<br><br>• active learning / learning by doing: user input/action/decision required (e.g. simulations, experiments, exercises/problems, tests, questionnaires,, visit/lesson plans)<br>• expositive/passive learning: user absorbing the presented information (e.g. video, audio, pictures, graphs, texts, hypertexts, lectures)<br>• mixed: a combination of active and expositive learning (e.g. hypertext with embedded simulation applet) | |

| | | |
|---|---|---|
| 18. The ***Interactivity Level*** | choice from a pre-defined vocabulary list:<br><br>• low (e.g. observation/reading, or push-button, or select-link only)<br>• medium (e.g. limited data entry by the user)<br>• high (e.g. some user controls affecting object behaviour)<br>• very high (e.g. object behaviour totally shaped by the user) | |
| 19. The ***Intended End-User Role*** | choice from a pre-defined vocabulary list:<br><br>• teacher<br>• student<br>• other learner / visitor<br>• parents / families<br>• science museum educator<br>• other science communication professional<br>• occasional information collector (e.g. journalist) | It will be necessary to allow for multiple choices of intended end-user roles when applicable. |
| 20. The ***Context*** | choice from a pre-defined vocabulary list:<br><br>• school-connected[6]<br>• in the science €museum/centre (physical visit)<br>• on the web (virtual visit) | It will be necessary to allow for multiple choices of context when applicable. |
| 21. The ***Typical Age Range*** of the intended user of the learning resource | choice from a pre-defined vocabulary list:<br><br>• less than 6<br>• 6-9<br>• 9-12<br>• 12-15<br>• 15-18<br>• 18-25<br>• 25+<br>• all ages | It will be necessary to allow for multiple choices of typical age range when applicable. |
| 22. The ***Difficulty*** of the learning resource | choice from a pre-defined vocabulary list:<br><br>• very easy<br>• easy<br>• medium<br>• difficult<br>• very difficult | The level of difficulty is subjectively understood, as defined/felt by the creator/user of the resource. |
| 23. The approximate/typical ***Learning Time*** to work with the learning resource | • up to 10 minutes<br>• up to 1 hour<br>• up to 2 hours<br>• more | This information may be too difficult to define in some cases of informal learning in the science museum/centre. It might be advisable to provide an open-text option, too. |
| 24. Whether use of this learning resource requires ***Payment*** | choice from a pre-defined vocabulary list:<br><br>• payment required | |

[6]Combined with one of the following two categories

| | | |
|---|---|---|
| | • use is free of charge | |
| 25. Whether ***Copyright or Other Restrictions*** apply to the use of this learning resource | short open-text description:<br><br>• description of restrictions, conditions to use, etc. | |
| 26. The ***Classification*** within a science learning classification system | choice from a pre-defined vocabulary list:<br><br>• see science education vocabulary in Annex II | It will be necessary to allow for multiple choices of classification categories when applicable. |

***Index 1: The OSR Application Profile (Sotiriou et al., 2010)***

# APPENDIX B: OSR Science Learning Content Vocabulary

| **Astronomy** |
|---|
| Asteroid belt |
| Asteroids |
| Astrobiology |
| Astrometry |
| Astronauts |
| Astroseismology |
| Atmospheres |
| Aurora |
| Big Bang |
| Binary stars |
| Black holes |
| Brown dwarfs |
| Comets |
| Comets and meteors |
| Constellations |
| Coordinates |
| Cosmic background radiation |
| Cosmic rays |
| Cosmology |
| Crater |
| Dark energy |
| Dark matter |
| Density waves |
| Dust |
| Dwarf galaxies |

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|---|
| Earth |
| Eclipses |
| Einstein ring |
| Elliptical galaxy |
| Escape velocity |
| Extrasolar planets |
| Extraterrestrial life |
| Formation |
| Galactic wind |
| Galaxies |
| Galaxy clusters |
| Gamma ray bursts |
| Gas |
| Giants |
| Globular clusters |
| Gravitational lenses |
| Halos |
| Hertzsprung-Russell diagram |
| HII region |
| Hubble expansion |
| Inflation |
| Intergalactic medium |
| Interstellar medium |
| Irregular galaxy |
| Jets |
| Kuiper belt objects |
| Light curve |
| Lunar eclipse |
| Main sequence |

| |
|---|
| Mass loss |
| Meteor |
| Meteorite |
| Microlensing effect |
| Milky Way |
| Moon |
| Near-earth objects |
| Nebula |
| Neutron stars |
| Nucleosynthesis |
| Open clusters |
| Orbit |
| Origin and evolution of the universe |
| Orrery |
| Phases |
| Phases of the Moon |
| Planetary nebula |
| Planets |
| Pulsars |
| Quasars |
| Redshift |
| Rockets |
| Rotation curve |
| Satellites: natural satellites |
| Satellites: artificial satellites |
| Seasons |
| Solar activity |
| Solar eclipse |
| Solar system |

| |
|---|
| Solar system - other |
| Solar-terrestrial relations |
| Space flight |
| Space ships |
| Space stations |
| Spiral galaxy |
| Star chart |
| Stars |
| Sun |
| Sunspots |
| Supernova |
| Supernova remnants |
| Theory of relativity |
| Tides |
| Universe – generally |
| Variable stars |
| Zodiac |
| Zodiacal light |
| **Atoms and molecules** |
| Atomic structure |
| Atoms – generally |
| Bonding – generally |
| Covalent bonds |
| Electrons – generally |
| Ionic bonds |
| Molecules – generally |
| Nucleus: protons, neutrons |
| Other types of bonding |
| Role of electrons in reactions |

| |
|---|
| **Changing materials** |
| Burning |
| Chemical changes |
| Physical changes |
| Solubility |
| Water cycle |
| States of matter |
| **Chemical reactions** |
| Acids, alkalis and bases |
| Catalysts |
| Conservation of mass |
| Displacement reactions |
| Enzymes |
| Equations and formulae |
| Exo/endothermic |
| Oxidation and reaction |
| Patterns in reactions |
| Reaction rates |
| Reactions with metals |
| Reactivity series |
| Reversible reactions |
| Thermal decomposition |
| **Earth science** |
| Atmosphere and oceans: biosphere |
| Chemical weathering |
| Igneous rocks |
| Lithosphere and tectonic processes |
| Metamorphic rocks |
| Physical weathering |

| |
|---|
| Rock formation - generally |
| Rocks and soils - generally |
| Sedimentary rocks |
| Weathering - generally |
| **Electricity and magnetism** |
| AC/DC |
| Ampere's Law |
| Charge |
| Circuits - generally |
| Components in circuits: batteries, etc |
| Coulomb law |
| Domestic appliances |
| Electric charge - generally |
| Electric current |
| Electric motors |
| Electrical heating and costs |
| Electrical quantities - generally |
| Electrical resistance/conductivity |
| Electricity generation/National Grid |
| Electromagnetism - generally |
| Electrostatic forces |
| Electrostatic phenomena and uses |
| Generators and transformers |
| Magnetic materials |
| Magnetism - generally |
| Mains electricity - generally |
| Mains electricity safety |
| Maxwell's equations |
| Parallel circuits |

| |
|---|
| Series circuits |
| Voltage |
| **Elements, compounds and mixtures** |
| Alkali metals |
| Chromatography |
| Compounds - generally |
| Distillation |
| Elements |
| Filtration |
| Halogens |
| Mixtures |
| Noble gases |
| Periodic table |
| Separation - generally |
| Separation - other |
| Transition metals |
| **Energy** |
| Conduction, convection and evaporation |
| Conservation and dissipation |
| Energy - using electricity |
| Energy resources |
| Energy transfer and storage |
| Kinetic energy |
| Potential energy |
| Radiation |
| Radiation transfer |
| Temperature and heat |
| Thermodynamics |
| Work and power |

| |
|---|
| **Energy and nutrient transfer** |
| Biomass |
| Carbon and nitrogen cycles |
| Energy and ecosystems |
| Food as fuel |
| Food chains and webs |
| **Environment** |
| Adaptation and competition |
| Biodiversity |
| Care of animals/plants/habitats |
| Interdependence |
| Micro-organisms |
| Pollution |
| Population abundance |
| Predation |
| Sustainable development |
| **Fields** |
| Central field |
| Conservative force field |
| Electric field |
| Electromagnetic field |
| Gravitational field |
| Magnetic field |
| Potential |
| **Forces and motion** |
| Acceleration |
| Air resistance |
| Angular acceleration |
| Angular velocity |

| |
|---|
| Centre of mass |
| Circular motion |
| Collision |
| Combining forces |
| Conservation of momentum |
| Elastic collision |
| Electric force |
| Escape velocity |
| Foucault pendulum |
| Friction |
| Gravitational force and gravity |
| Horizontal throw |
| Impulse |
| Inelastic collision |
| Inertia |
| Kepler's laws |
| Lorentz force |
| Machines |
| Magnetic force |
| Mass |
| Moment of inertia |
| Moments |
| Newton's laws |
| Nuclear force |
| Oscillations |
| Pendulum |
| Period |
| Phase |
| Pressure |

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|---|
| Rectilinear motion |
| Rigid body |
| Rotation |
| Universal law of gravitation |
| Velocity |
| Vertical throw |
| Weight |
| **Green plants** |
| Flowering plants/life cycle/parts of plants |
| Photosynthesis |
| Plant nutrition and growth |
| Seeds |
| Transport and water in plants |
| **Humans and other animals** |
| Aerobic and anaerobic respiration |
| Breathing |
| Circulatory system - blood |
| Circulatory system - heart |
| Enzymes in digestion |
| Eyes |
| Fetal development |
| Growth and life cycle |
| Homeostasis |
| Hormones - generally |
| Hormones and fertility |
| Human health - generally |
| Human health: alcohol |
| Human health: bacteria/viruses |
| Human health: defence mechanisms, including immunisation |

| |
|---|
| Human health: diet |
| Human health: medicines |
| Human health: other harmful substances, including drugs |
| Human health: smoking |
| Human health: teeth |
| Insulin |
| Menstrual cycle |
| Nervous system - generally |
| Nutrition and digestion - generally |
| Puberty/adolescence |
| Reproductive system |
| Senses |
| Skeleton and muscles |
| Stimulus and response |
| Stomach acid and bile |
| Transport of reactants/products |
| **Life processes** |
| Biotechnology |
| Cell processes - generally |
| Cell structure |
| Cell types - generally |
| Cell types - other |
| Chromosomes |
| Epithelial |
| Fertilisation |
| Meiosis |
| Mitosis |
| Organs |
| Ova |

| |
|---|
| Parts of the body |
| Root hair |
| Sperm |
| Tissues |
| **Light** |
| Colour |
| Light sources |
| Properties of light - generally |
| Reflection |
| Refraction |
| Refraction Index |
| Vision |
| **Obtaining and using materials** |
| Electrolysis |
| Extraction of metal from ore |
| Fossil fuels |
| Fossil resources - generally |
| Hydrocarbons |
| Metals - generally |
| Nitrogenous fertilizers |
| Plastics/polymers |
| Useful substances from rocks and minerals |
| **Radioactivity** |
| Alpha radiation |
| Background radiation |
| Beta radiation |
| Gamma radiation |
| Half-life |
| Nuclear decay |

| |
|---|
| Nuclear fission |
| Nuclear fusion |
| Uses of radioactivity, including radioactive dating |
| **Scientific enquiry** |
| Analogies |
| Application of science - generally |
| Asking questions |
| Benefits and drawbacks of scientific/technological developments |
| Choosing equipment |
| Contexts for science |
| Creativity in science |
| Experimental models |
| Fairness of test/comparison |
| Ideas and evidence in science |
| Identifying patterns/anomalies |
| Misconceptions |
| Prediction compared to results |
| Primary information |
| Recognising limitations of evidence/data/assumptions |
| Recording observations/measurements |
| Safety |
| Scientific communication |
| Scientific investigations - generally |
| Scientific prediction |
| Secondary information |
| SI units |
| Using or evaluating a technique |
| Using science to explain |
| **Solids, liquids and gases** |

| |
|---|
| Changes of state |
| Density |
| Gas pressure and diffusion |
| Grouping materials |
| Melting/boiling points |
| Particle theory |
| Properties of materials |
| **Sound** |
| Audible ranges |
| Hearing - generally |
| Hearing: noise |
| Loudness |
| Pitch |
| Properties of sound - generally |
| Sound sources |
| Speed in media |
| The ear |
| Ultrasound |
| **Tools for science** |
| Accelerometers |
| Detectors |
| Detectors: CCD camera |
| Dynamometers |
| Fieldwork equipment |
| Laboratory equipment - generally |
| Laboratory glassware |
| Laboratory measuring instruments, including sensors and meters |
| Microscope |
| Observatories |

| |
|---|
| Sensors |
| Thermometers |
| **Useful materials and products** |
| Everyday materials |
| **Variation, inheritance and evolution** |
| Asexual reproduction |
| Classification/keys |
| Cloning, selective breeding and genetic engineering |
| DNA |
| Environmental causes of variation |
| Evolution - generally |
| Extinction |
| Fossil record |
| Genetic causes of variation and mutation |
| Inheritance - generally |
| Inherited diseases |
| Monohybrid inheritance |
| Sex determination |
| Variation - generally |
| **Waves** |
| Diffraction |
| Doppler effect |
| Electromagnetic spectrum |
| Gamma rays |
| Information transmission, analogue and digital signals |
| Infrared |
| Longitudinal waves |
| Microwaves |
| Optics |

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| Radio waves |
| Reflection |
| Refraction |
| Seismic waves |
| Transverse waves |
| Ultraviolet |
| Visible light |
| Wave amplitude |
| Wave characteristics - generally |
| Wave frequency |
| Wave speed |
| Wavelength |
| X-rays |
| **Technological applications** |
| Horology |
| Industrial devices |
| Lifecycle of products |
| Energy production and energy resources research |
| Musical instruments |
| Nanotechnology |
| Photography and cinematography |
| Robotics |
| Sound techniques |
| Telecommunications |
| Transport (air, water and ground) |
| Writing ad press |
| Metal processing |
| Paper production |
| Textiles |

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| Pharmaceutics |
| Mining |
| Nautical tools |
| Glass production |
| Ceramics production |
| Wood production |
| **History of Science and Technology** |
| Scientists and inventors |
| First Scientific Revolution |
| Second Scientific Revolution |
| Science: historical and contemporary examples |

***Index 2: : OSR Science Learning Content Vocabulary (Sotiriou et al., 2010)***

# APPENTIX C: Characterization of Taggers

| UserID | Tag/resource ratio | Orphaned Tag Ratio | Overlap | Tag Title Intersection | 3 sta 4 |
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| 1 | Describer | Describer | Describer | Describer | Describer |
| 2 | Describer | Categorizer | Describer | Describer | Describer |
| 3 | Describer | Categorizer | Describer | Describer | Describer |
| 4 | Describer | Categorizer | Describer | Describer | Describer |
| 5 | Describer | Describer | Describer | Describer | Describer |
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| 7 | Describer | Describer | Describer | Describer | Describer |
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