INVESTIGATING THE EFFECT OF USERS' TAGGING MOTIVATION ON THE DIGITAL EDUCATIONAL RESOURCES METADATA DESCRIPTIONS

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ABSTRACT

Over the past years, several Open Educational Resources (OERs) initiatives have been emerged worldwide aiming to create, share and reuse digital educational resources among educational communities. As a result, organizing, offering and accessing these resources over the web have been key issues for both the research and the educational community. Traditionally, a popular way for characterizing digital educational resources is by using a formal and centrally agreed classification system, such as the IEEE Learning Object Metadata (LOM). On the other hand, with the emerging Web 2.0 applications, the issue of characterizing digital educational resources tends to move from the expert-based description based on formal classification systems to a less formal user-based tagging referred to as social tagging. As a result, a number of studies have been reported in the field of Technology-enhanced Learning (TeL) aiming to evaluate whether social tagging can improve the discovery of new digital educational resources and the retrieval of known ones stored in web-based repositories. Additionally, recent studies in the field of social tagging systems has provided initial evidence that users' tagging motivation has a direct influence on the properties of the resulted tags and folksonomies. Thus, in this paper we aim to propose a methodology for investigating this issue and examine whether different end-users' tagging motivations (that is teachers) could enlarge the metadata descriptions of digital educational resources. The results of our study provided us evidence that there is a direct influence of users' tagging motivation on the enlargement of metadata descriptions of digital educational resources, as well as to the resulted folksonomy when it is compared with formal structured vocabularies used by metadata experts or content providers for characterizing digital educational resources.

KEYWORDS

Educational resources, social tagging, folksonomy, user tagging motivation, evaluation methodology, evaluation results

1. INTRODUCTION

Over the past years, several Open Educational Resources (OERs) initiatives have been emerged worldwide towards the provision of open access to digital educational resources, in the form of Learning Objects (LOs) (McGreal, 2008). UNESCO (2002) has defined Open Educational Resources (OERs) as the "*technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes*". The main objective of OERs initiatives is to support the process of organizing, classifying and storing digital educational resources and their associated metadata in web-based repositories which are referred to as Learning Object Repositories (LORs) (McGreal, 2004). Within this context, a popular way for describing digital educational resources is by using a formal and centrally agreed classification system, such as the IEEE Learning Object Metadata (LOM) (IEEE LTSC, 2005).

On the other hand, the emerging Web 2.0 applications have led to an enormous increase of the digital resources available on the web today. As a result, both the discovery of new resources and the retrieval of known ones on the web, become an increasingly complex problem (Heymann, Koutrika and Molina, 2008; Yande, Jatowt, Nakamura and Tanaka, 2007). Therefore, the issue of characterizing digital resources tends to move from the expert-based description based on formal classification systems to a less formal user-based tagging (that is, adding keywords to digital resources) (Derntl, Hampel, Motschnig-Pitrik and Pitner, 2011; Bi, Shang and Kao, 2009). Adding keywords, also known as tags, to any type of digital resource by users

(rather than resources' authors) is referred to as *Social Tagging* (Bonino, 2009). The term of social tagging has emerged for those 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 individuals for their personal use (referred to as *folksonomy*) (Anderson, 2007).

In the field of Technology Enhanced Learning (TeL), social tagging has also been proposed as a mean for describing digital educational resources (Cho, Yeh, Cheng and Chang, 2011; Bateman, Brooks, McCalla and Brusilovsky, 2007). As a result, the generation of metadata is now done by individual users, who might primarily see private benefits, like an easy way to search and retrieve from LORs already used and known resources using meaningful terms (Dahl and Vossen, 2008). Thus, a number of studies have been reported aiming to evaluate the added value of socially tagging digital educational resources stored in LORs and compare it with the traditional approach of expert-based formal description based on centrally agreed classification systems, such as IEEE LOM (Trant, 2009b; Vuorikari and 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 (Korner, et al., 2010; Korner, 2009) but there are not existing studies for investigating this issue in the field of TeL.

To this end, in this paper we aim to investigate this issue and we propose a methodology that aims to evaluate whether users' tagging behaviour can influence (a) the enlargement of metadata descriptions of digital educational resources and (b) the resulted folksonomy when it is compared with formal structured vocabularies used by metadata experts or content providers for characterizing digital educational resources. The application of the proposed evaluation methodology in an existing LOR, namely the OpenScienceResources Repository (http://www.osrportal.eu/) provided us evidence that 'verbose' taggers can produce tags that are significantly different from formal metadata generated by metadata experts or content providers.

The paper is structured as follows. Following this introduction, Section 2 provides an overview of existing studies from the literature, which have investigated the potential benefits of socially tagging digital educational resources. In Section 3, we present our proposed methodology for identifying different types of users' tagging motivation and evaluating their possible influence to the metadata descriptions of digital educational resources, as well as to the resulted folksonomy when it is compared to formal structured vocabularies used for metadata authoring by metadata experts or content providers. Section 4, presents the tagging approaches adopted by the existing LOR (namely OpenScienceResources) where we applied our proposed methodology, the dataset of the OpenScienceResources repository that was available at the time of our study, as well as the evaluation results and discussion of our findings. Finally, we present our conclusions and ideas for future work.

2. LITERATURE REVIEW

Within the TeL literature there are existing works that have examined the added value of socially tagging digital educational resources. An initial study towards addressing this issue has been conducted in the framework of the EU-funded project "MELT: a Metadata Ecology for Learning and Teaching" (http://info.melt-project.eu/) (Zens et al., 2009; Vuorikari and Ayre, 2009). More specifically, MELT project developed a LOR including around 153.000 digital educational resources. These resources were characterized by the resources' authors with educational metadata following an application profile of the IEEE LOM standard, as well as with social tags added by the end-users of the repository (that is students and teachers). During the evaluation study of the project, the MELT Repository included 10131 social tags, which had been added to 2008 digital educational resources. This means that on average 4 social tags were added per digital educational resource. The main issues that were investigated during the MELT project evaluation study were the following:

- **I1:** usefulness of social tags for searching digital educational resources.
- **I2:** usefulness of social tags as metadata descriptors of digital educational resources.

The evaluation results in respect to the aforementioned issues showed that:

- **I1**: 23% of searches in MELT Repository were performed based on social tags and 40% of these searches were found very useful. However, for accurate searches within MELT Repository, social tags were considered not useful.

- **I2**: 25% of social tags contained additional to authors' information, 26% unnecessary information and 49% no new information. Moreover, social tags were found to be more useful than formal vocabulary terms and most of the end-users wanted to change the original metadata description to adopt some of the social tags as indexing terms.

Another important study about social tagging has been conducted in the framework of the US-funded project "STEVE: The Museum Social Tagging Project" (http://www.steve.museum/) (Trant, 2009a). More specifically, the project developed a repository including around 97.000 digital resources of cultural heritage. These resources were characterized with metadata by professional museum experts as well as with tags added by the end-users of the repository (that is students and teachers). During the evaluation study of the project, the STEVE Repository was including 36981 tags which had been added to 1792 digital cultural heritage resources. This means that on average 20 social tags were added per cultural heritage resource. The main issues that were investigated during the STEVE project evaluation study were the following:

- **I1:** social tags correlation with museum metadata.
- **I2:** usefulness of social tags as museum metadata descriptors of the digital cultural heritage resources.

The evaluation results in respect to the aforementioned issues showed that:

- **I1:** 86% of social tags didn't match with museum metadata added by professional museum experts.
- **I2:** 88% of social tags were considered useful by the professional museum experts

As we can notice from the aforementioned studies, there is a strong interest for investigating the added value of social tagging on enlarging the metadata descriptions of digital educational resources, as well as the formal vocabularies used in expert-based metadata. However, both issues have been investigated without considering the possible implications of users' tagging motivation to the enlargement of resulting tags and folksonomies. Next, we aim to address this issue and we present our proposed evaluation methodology.

3. PROPOSED EVALUATION METHODOLOGY

In this section, we present our proposed methodology for identifying different types of users' tagging motivation and evaluating their possible influence to the metadata descriptions of digital educational resources, as well as to the resulted folksonomy when it is compared to formal structured vocabularies used for metadata authoring by metadata experts or content providers. More specifically, our methodology includes the following steps:

- **Step 1 – Identify different underlying behaviours for users' tagging**: This step includes the discrimination of the users based on their tagging motivation. For this purpose, we adopt two types of user motivations proposed by Korner (2009):
  - *Categorizers*, who are motivated by categorization and use tags to construct and maintain a navigational aid to the resources they annotate. For this purpose, categorizers aim to establish a stable and bounded vocabulary based on their personal preferences and motivation.
  - *Describers*, who are motivated by description aim to describe the resources they annotate accurately and precisely. As a result, their tag vocabulary typically contains an open set of tags.

  In order to discriminate between categorizers and describers we adopt a set of measures proposed by Korner et al. (2010):
  - *Tag/Resource Ratio*: relates the vocabulary size of a user to the total number of digital educational Resources tagged by this user. Describers, who use a variety of different tags for their resources, score higher values for this measure than categorizers, who use fewer tags.
  - *Orphaned Tag Ratio*: characterizes the degree to which users produce orphaned tags (that is tags assigned to few resources only, and therefore are used infrequently). The orphaned tag ratio captures the percentage of tags in a user's vocabulary that represent such orphaned tags. Categorizers vocabulary scores values closer to 0 because orphaned tags would introduce noise to their personal vocabulary, whereas describers vocabulary scores values

closer to 1 due to the fact that describers tag resources in a more verbose and descriptive way.
    - *Overlap Factor*: measures the phenomenon of an overlap produced by the assignment of more than one tag per resource on average. Categorizers are interested in keeping this overlap relatively low. On the other hand, describers produce a high overlap factor since they do not use tags for navigation but instead aim to best support later retrieval.
    - *Tag/Title Intersection Ratio*: measures how likely users choose tags from the words of an educational resource title. Categorizers use tags taken from the title and they score values closer to 1, whereas describers rarely use tags from the title and they score values closer to 0.
- **Step 2 – Calculate similarity between social tags and educational metadata:** During this step we calculate the similarity between social tags (offered by end-users, that is teachers) and educational metadata (offered by metadata experts or content providers). 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 expect to identify digital educational resources enlarged with social tags offered by describers and/or categorizers that are different by the formal metadata descriptions offered by metadata experts or content providers.
- **Step 3 - 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. The comparison 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 tags offered by describers and/or categorizers that can enlarge the formal structured vocabularies of educational metadata.

4. APPLYING PROPOSED METHODOLOGY TO AN EXISTING LEARNING OBJECT REPOSITORY

In this section, we apply our proposed evaluation methodology to an existing LOR, namely OpenScienceResources Repository (http://www.osrportal.eu/). The OpenScienceResources Repository 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/). It provides access to openly licensed (through Creative Commons) science education resources, which can be used by science teachers connecting formal science education in schools with informal science education activities taken place in European Science Centres and Museums (Sampson, Zervas and Sotiriou, 2011).

The OpenScienceResources Repository currently includes around 3000 science education resources characterized by content providers (European Science Centres and Museums) with educational metadata following an application profile of the IEEE LOM standard (Sampson, Zervas and Sotiriou, 2011). More specifically, the application profile of the OpenScienceResources Repository includes formal structured vocabularies at the Classification Element (Nr. 9) of the IEEE LOM standard for describing (a) the subject domain of science education resources that is related with the science curriculum (the vocabulary includes 400 terms) and (b) the educational objectives that science education resources intend to target (the vocabulary includes terms selected by Bloom's Taxonomy of Educational Objectives and its subsequent revisions and extensions (Anderson and Krathwohl, 2001)).

The science education resources of the OpenScienceResources Repository are also characterized with social tags added by the end-users of the repository (that is teachers). The social tags includes the following categories: (a) free tags, that are mainly used by the end-users, so as to describe the topic and/or the subject domain of a science education resource related with the science curriculum and (b) educational objectives tags, that are used by the end-users, so as to express the educational objective(s) that a science education resource can target. The educational objectives tags are selected from a predefined vocabulary following revised Bloom's Taxonomy of Educational Objectives and it is the same with the formal vocabulary, used by content providers for characterizing science education resources with IEEE LOM compliant educational

metadata. Table 1 presents the two tagging approaches of the OpenScienceResources Repository and how the metadata elements added by content providers can be compared with the social tags added by end-users.

Table 1. OpenScienceResources Repository Tagging Approaches

Educational Metadata (according to IEEE LOM)		**Social Tags**	
Metadata Element	Value Space	Tags Categories	Value Space
1.5 General.Keyword	Free text describing the topic of the science education resource	Free Tags	Free text describing the topic and/or the subject domain of a science education resource related with the science curriculum
9.2.2.2 Classification.Taxon Path.Taxon.Entry (when purpose metadata element has the value "discipline")	Structured vocabulary describing the subject domain of the science education resource related with the science curriculum		
9.2.2.2 Classification.Taxon Path.Taxon.Entry (when purpose metadata element has the value "educational objective")	Structured vocabulary describing the educational objectives that a science education resource intends to target	Educational Objectives Tags	Structured vocabulary describing the educational objectives that a science education resource intends to target

Next, we present the snapshot of the OpenScienceResources Repository dataset at the time of our study (March 2012) that was used for applying our proposed evaluation methodology described in Section 3.

Table 2. OpenScienceResources Dataset (March 2012)

Variables	**Value**
Taggers	434
Tagged Science Education Resources	1877
Social Tags	14707
Free Tags	13117
Educational Objectives Tags	1590

4.1 Describers and Categorizers

In order to cluster the taggers of the OpenScienceResources Repository we applied the set of measures described in our proposed methodology in Section 3. Table 3 presents the number of categorizers and describers resulted by applying these measures.

Table 3. Describers and Categorizers

Type of Taggers	**Value**	**% per Total Taggers**
Categorizers	226	52,07 %
Describers	208	47,92 %
Total	434	100,00 %

Additionally, Table 4 presents quantitative data about the number of tags used and the number of science education resources tagged by each type of tagger.

Table 4. Quantitative Data per Type of Tagger

Type of Taggers	**Number of Taggers**	**Tags Contributed**	**Average Tags per Tagger**	**Science Education Resources Tagged**	**Average Tagged Science Education Resources per Tagger**	**Average Tags per Science Education Resources**
Categorizers	226	1960	8,67	1852	8,19	1,05
Describers	208	12647	60,8	630	3,02	20,07

As it was expected we can notice from Table 4 that describers contributed the vast majority of social tags of the OpenScienceResources dataset but they have tagged less science education resources than the categorizers. This means that describers mainly use a small set of digital educational resources, which they

want to accurately and precisely describe for later searching and retrieval. On the other hand categorizers contributed a small amount of social tags to a large set of digital resources aiming to support future browsing to as many educational resources of the repository.

4.2 Educational Metadata vs. Social Tags

The next step of our proposed evaluation methodology includes similarity calculation between educational metadata and social tags. More specifically, we calculated (a) the similarity of the metadata values added by content providers to the element Nr. 1.6 Keyword of the IEEE LOM standard with the free tags category of the social tags added by describers and categorizers and (b) the similarity of the metadata values added by content providers to the element Nr. 9.2.2.2 Classification.TaxonPath.Taxon.Entry (when purpose metadata element has the value "educational objective") of the IEEE LOM standard with the educational objectives tags category of the social tags added by describers and categorizers. Table 5 presents average similarity results for the different type of taggers, as well as the number of science education resources that achieved low similarity score in average (<0,5). This similarity threshold was selected by considering relevant thresholds used in other social tagging evaluation studies from the literature (Vuorikari and Ayre, 2009).

Table 5. Educational Metadata vs. Social Tags

Type of Tagger	Keyword vs. Free Tags	Classification.Taxon Path.Taxon.Entry vs. Educational Objectives Tags	Science Education Resources with low similarity score (<0,5)	% per total tagged science education resources
Categorizers	0,79	0,71	184 out of 1852	9,93%
Describers	0,76	0,45	307 out of 630	48,73%

As we can notice from Table 5, describers added social tags (mainly to the educational objectives tags category) that were significantly different from the educational metadata added by the content providers. Therefore, they have significantly contributed to the enlargement of the metadata descriptions of 307 science education resources. This was the 48,37% of the science education resources that they have tagged. On the other hand, categorizers added tags that were quite similar with the educational metadata added by the content providers. Therefore, this distinction between categorizers and describers is very important because it facilitates capturing enlarged metadata descriptions of digital educational resources.

4.3 Folksonomy vs. Formal Structured Vocabulary

During the final step of our proposed evaluation methodology, we compared the resulted folksonomy of free tags category of social tags added by describers and categorizers with the structured formal vocabulary used by content providers to characterize science education resources with terms related with science curriculum. In order to achieve that, we calculated the similarity of the describers folksonomy and categorizers folksonomy with the formal structured vocabulary and we kept those tags that they achieved similarity score zero. The number of these tags was 202 (from describers) and 94 (from categorizers). Finally, we excluded the semantic noise from these tags, that is synonyms and subjective tags and we concluded to 46 (describers) and 10 (categorizers) possible new terms that could enlarge the structured formal vocabulary used at the element Nr. 9.2.2.2 Classification.TaxonPath.Taxon.Entry (when purpose metadata element has the value "discipline") of the IEEE LOM standard. Finally, we investigated whether there were new terms contributed by both describers and categorizers. Table 6 presents the distribution of the new terms contributed.

Table 6. Distribution of new terms per type of tagger

Type of Taggers	New terms Contributed	% per Total Terms
Only by Describers	46	82,14 %
Only by Categorizers	10	17,85 %
By Categorizers & Describers	0	0,00 %

As we can notice from Table 6, describers outperformed categorizers by contributing 36 more new terms. Moreover, there were not common terms contributed by both describers and categorizers. These results

provided us evidence that describers have a stronger influence on the enlargement of formal structured vocabularies, whereas categorizers' contribution was limited. These findings could be relevant in LORs for indexing digital educational resources with describers' tags towards facilitating search and retrieval of digital educational resources.

5. CONCLUSIONS AND FUTURE WORK

In this paper, we investigated the influence of different tagging styles, namely describers and categorizers on enlarging the metadata descriptions of digital educational resources. The results of our study performed with the dataset of an existing LOR, namely OpenScienceResources Repository showed that describers produce tags that are significantly different from formal metadata, whereas categorizers mainly follow the formal metadata generated by metadata experts or content providers. As a result, considering tagging motivation during folksonomies analysis could facilitate capturing enlarged metadata descriptions of digital educational resources. Future work includes deeper analysis to the results of our study, so as to identify the effect of describers' and categorizers' social tags to the enlargement of metadata descriptions for digital educational resources with different granularity levels and different formats.

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