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# Collaborative Tagging of Knowledge and Learning Resources

Ronald Maier
*Innsbruck University School of Management University of Innsbruck Innsbruck Austria*, ronald.maier@uibk.ac.at

Silke Retzer
*School of Information Management Victoria University of Wellington Wellington New Zealand*, silke.retzer@vuw.ac.nz

Stefan Thalmann
*Innsbruck University School of Management University of Innsbruck Innsbruck Austria*, stefan.thalmann@uibk.ac.at

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Ronald Maier
Innsbruck University School of Management
University of Innsbruck
Innsbruck
Austria
Email: ronald.maier@uibk.ac.at

Silke Retzer
School of Information Management
Victoria University of Wellington
Wellington
New Zealand
Email: silke.retzer@vuw.ac.nz

Stefan Thalmann
Innsbruck University School of Management
University of Innsbruck
Innsbruck
Austria
Email: stefan.thalmann@uibk.ac.at

## Abstract.

*This research paper reports part of a larger international study that employs collaborative tagging for effectively describing knowledge and learning resources (KLR) in an institutionalised setting. The number of these resources has increased enormously within organisations over time and with an increasing variety of quality standards, maturity and granularity of resources, the description of content with metadata becomes more and more challenging. Automatic extraction services and professional metadata authoring tools could not deliver the expected results. Therefore, this research project investigated and discussed collaborative tagging as a means to successfully tag KLR. This paper presents results of an online survey distributed to first-year Information Systems students at Victoria University of Wellington, New Zealand. The results report on the study's key themes of commitment and convergence towards generally accepted collaborative tags. Commitment and convergence could be confirmed, but there is a need for further exploration with a higher number of participants. Collaborative tagging is suggested as a solution to facilitate the development of ontologies for describing organisational metadata.*

**Keywords**
Collaborative tagging, knowledge and learning resources, metadata, ontologies, online survey.

## INTRODUCTION

Collaborative tagging appears as a key theme and one of the most interesting technical aspects that appeared out of the Web 2.0 area. The idea of collaborative tagging defines the description of resources with keywords, called tags. Later, these tags and tags assigned by other users can be used for searching resources more effectively. "In other words, searching becomes the fundamental method of organisation, and tagging is a way of adding some additional information (sometimes called 'metadata') to data objects" (Treese 2006, p16). Besides interactivity, social networking and Web Services, tagging can be seen as a main category of Web 2.0. In addition, collaborative tagging might be able to substitute or complement traditional methods for defining ontologies (Lassila and Hendler 2007). Ontologies represent metadata schemas that provide a controlled vocabulary of concepts (Maedche and Staab 2001). Metadata, in turn, is defined as "data about data" (Berners-Lee 1997). Therefore, metadata can be used for describing other data or resources. Moreover, ontologies can support communication, including the exchange of both semantics and syntax, among people and between machines (Maedche and Staab 2001). Hence, the effective construction of ontologies is significant for the emergence of the Semantic Web, which has the goal of creating machine consumable knowledge (Berners-Lee et al. 2001). The traditional mechanisms for defining ontologies by small expert panels or, more recently, automatic extraction services did not become accepted methods, or have at least proven to be cumbersome. Folksonomies, which are emerging results from collaborative tagging efforts, and ontologies were described as two different approaches for classification (Shirky 2005). Folksonomies follow a bottom-up, grassroots approach using uncontrolled vocabulary. Ontologies, in turn, use controlled vocabulary and therefore a top-down approach. Some authors (e.g. Gruber 2007; Hamasaki et al. 2008; Noy et al. 2008) now argue for their co-existence or even the application of ontologies to collaborative tagging. However, this research study was undertaken with the underlying philosophy that states that “every ontology is a treaty – a social agreement – among people with some common motive in sharing” (Gruber 2004).

Although tagging might be able to be completely undertaken by humans, this also does not appear practicable (Cardinaels et al. 2005; Motelet et al. 2006). The tagging task consumes extra time, humans do have different mental models that may influence formalising and structuring of knowledge and technical barriers may lead to the effect that humans neglect tagging as an additional task. Therefore, a blend of both approaches, automatic generation of metadata and collaborative tagging, extended with user-friendly technologies and appropriate incentive schemes could be a solution (Bauer et. al. 2008). This could comprise automatic metadata generation for more technical aspects and a human-centric approach for the more context-specific metadata generation. For the human-centric approach solutions such as social software in general which enables a rich capturing of context (Klamma et al. 2006) and collaborative tagging in particular have been suggested. Collaborative tagging presents an easy-to-use technique of adding descriptions to resources such as pictures, web sites or email messages (Maier and Thalmann 2008; Treese 2006). The application of collaborative tagging tools appears promising in order to attain valuable metadata, as these tools may ease the time-consuming tasks of designing, mapping and merging ontologies (Maier and Thalmann 2008). For knowledge management in general, collaborative tagging represents a tool for knowledge organisation and resource discovery (McGregor and McCulloch 2006).

The overall goal of this study is to discuss tagging as a participatory approach to gain metadata, present an approach to establish collaborative tagging in an institutionalised setting and report the results of this study in relation to two central aspects of the institutionalization of collaborative tagging: commitment and convergence. This paper is a replication of a study conducted in 2007 in Austria (Maier and Thalmann 2008) with significant modifications related to the study design and the organisational setting of the data collection scenario. As the focus was on investigating how knowledge and learning resources are described by tags in an organisational setting, this study started with free tagging only compared to Maier and Thalmann’s study which started with predefined tags. Without this predefined structure, collaborative tags represent the conceptual structure of the user community. In addition, this study was undertaken with students in New Zealand as the target group. The main argument of both, the original and the replicated study is that collaborative tagging might be a better solution to approach the description of KLR in organisations compared to the design of ontologies by a small number of experts or by automatic extraction services. It discusses tagging as a participatory approach to gain metadata in an institutionalised setting. The paper focuses on the results of an online survey that asked participants to tag a number of online resources. These collaborative tagging efforts were then analysed and interpreted in order to give recommendations for the design of an institutionalised collaborative tagging solution. Moreover, this study is part of a larger international research project with the overarching aim to compare aspects of collaborative tagging behaviour in an institutionalised setting. This includes study replications in Innsbruck, Austria and New Orleans, the United States. Both studies are currently in progress.

After a brief literature review that explains the study’s background, the study’s key themes that were investigated will be outlined. This will be followed by a methods section that extensively describes the data collection scenario. After presenting the results, the paper concludes with an outlook for further research.

## RELATED WORK

Knowledge and Learning Resources (KLR) are digital, modular and readily reusable resources (Maier and Thalmann 2008). They comprise digital resources in the form of knowledge elements and learning objects. A knowledge element represents the smallest unit of atomic, explicit and formally defined knowledge content. It indicates a single organised unit that comprises a conceptual as well as a technical perspective (Maier 2008). A knowledge element is part of a knowledge activity. A learning object is defined as a (non-) digital entity that may be used for learning, education or training (IEEE 2002). Learning objects can be digital or non-digital in nature and may form a whole course or a single graphic or table only. In E-learning research however, learning objects are restricted to digital resources that may be reused in a specific context (Hodgens 2002; Wiley 2001). This reusable KLR require well defined descriptions that represent appropriate characteristics in terms of content and context of a KLR. This description should then support the search for and selection of KRL. Although these descriptions are very important for reusability, authors of KLR often do not invest additional efforts to thoroughly describe their resources (Duval and Hodgins 2004). In order to reuse KLR from an organisational knowledge base, contextual information in the form of metadata that semantically describes the resources is needed (Pawlowski and Bick 2006).

Metadata can generally be described as data over data . However from a database perspective, metadata are structural descriptions of data elements (Heuer and Saake 2000). In more detail, metadata illustrate subjective descriptions of entities by individuals and are dependent on the context of creation (Nilsson et al. 2002; Tannenbaum 2002). Often authors of KLR are responsible for describing their resources with metadata, but they rarely take advantage of them, whereas learners or educational professionals may benefit from these descriptions (Motelet et al. 2007). Traditionally, a small group of experts categorises and indexes resources as a result of an agreement on a structured catalogue of keywords, a taxonomy, with the aim to make resources accessible for the organisation (McGregor and McCulloch 2006). However, a number of issues have impeded this traditional process. Firstly, the time exposure and cost for organisations to deal with a rapidly increasing number of KLR are unsustainable (Lyman and Varian 2003; Maier and Thalmann 2008). Secondly, authors of KLR do often not take any advantage of metadata compared to other users of KLR. Therefore, their interest does not primarily lie in describing those resources. Thirdly, experts are challenged by describing KLR from various domains, not just from their own domain, in which they are particular experts (Shipman and McCall 1994). In order to solve some of these issues, automatic processes could be utilised to help humans to overcome the workload (Duval and Hodgins 2004).

Together with expert groups and automatic processes that both describe resources with metadata, tagging might be a solution to overcome some of the mentioned barriers. Tagging generally describes the activity of adding keywords to web resources (Rollett et al 2007). One of the most important benefits that tagging provides for users can be found at the personal level with the use of bookmarking services. With bookmarking, a web link can be saved in the user's account and can be retrieved from any web-connected device by using any of the previously given tags for describing the link. This way of tagging has existed in applications, such as web browsers, photo repository software, and other collection organisation systems for many years (Furnas et al. 2006). The significant difference for tagging compared to these traditional applications appeared with the Web 2.0 development combining multiple contributors and their social interaction with traditional tagging systems, which resulted in collaborative tagging applications. Current popular collaborative tagging systems on the web include, for example, Flickr (http://www.flickr.com) or Del.icio.us (www.del.icio.us.com). Collaborative tagging systems link, for example, individual bookmarking activities to other users' bookmarking activities, thus tags and resources are shared among multiple users. This tag sharing allows for adding benefits in discovery as well as retrieval (Furnas et al. 2006). Discovery uses the tag as an anchor for finding relevant resources, whereas retrieval may become easier using collaborative tags. The workload for tagging resources can be shared among many contributors and a shared pool of tagged resources may enhance appropriate metadata for all users. "When a resource has been tagged by many users, it is more likely that the tag used for search will match one of the previously assigned tags" (Furnas et al. 2006). Without a predefined structure, tags in collaborative tagging systems represent the conceptual structure of the user community. Therefore, collaborative tags can be the foundation of folksonomies which define comments that do not depend on a controlled vocabulary and thus represent different kinds of structures (Rollet et al. 2007). The formula that describes such a tag is the following (Cattuto et al. 2007a):

*tag = (user, resource, keyword).*

Tags can be statistically analysed and may lead to tag clusters, tag networks or tag clouds (Rollett et al. 2007). A tag cloud, which may be one of the most popular forms, is an illustration that defines a set of related tags. Easy-to-use collaborative tagging systems can reduce time required for tagging and motivate users to contribute.

Moreover, collaborative tagging might be a solution to overcome the "Vocabulary Problem", which refers to the issue that a number of different users employ diverse terms to tag the same resources (Furnas et al. 1987).

There are also a number of challenges for collaborative tagging. For example, when presenting potential users with a controlled predefined vocabulary for tagging, they are less motivated to participate (Shipman and McCall 1994). Tagging with unrestricted opportunities, in turn, can reduce this participation barrier and has been successfully applied by Web 2.0 applications on the Internet (Maier and Thalmann 2008). In addition, an emerging concept of 'collective intelligence' has been discussed as being a promising topic for further research (Surowiecki 2004). Nevertheless, unrestricted tagging opportunities also have their downsides. For example, a general issue of structuring electronic resources without a given vocabulary are homonyms, synonyms, plurals, and diverse levels of aggregation of the descriptions (Golder and Huberman 2005). Over time, accurate descriptions of resources decline and affect the quality of tagged resources (Klamma et al. 2006).

In online applications, such as del.icio.us or cannotea (http://www.cannotea.org) users are able to either tag resources by using free-text descriptions or by using tags of a predefined selection list that shows the most frequently used tags by other users. These most frequently used tags represent generally meaningful tags in comparison to a few other specialised tags (Golder and Huberman 2005; Guy and Tonkin 2006). Cattuto et al. (2007b) describe these commonly top-ranked tags as a measure of the 'semantic breadth' of a resource. Organisations might be more interested in the frequently used tags as they indicate a common agreement within the respective community and can therefore be used to describe KLR on an institutional level (Maier and Thalmann 2008). Therefore, this aspect of commitment to most frequently used tags appears significant for this study. Besides looking for appropriate descriptions of KLRs, organisations are also interested in durable descriptions (Maier and Thalmann 2008). Therefore, commonly accepted tags should converge to a stable set of tags. In an organisational setting with an almost stable number of contributors and a slowly growing number of topics over time, the number of tags used in a given domain might converge. As this study investigates collaborative tagging in an institutionalised setting, convergence is also a key aspect for this study.

The process of collaborative tagging in this research is based on Fisher et al.'s (2001) SER model. This model is based on the concept of seeding, evolutionary growth and reseeding (SER) for collaborative design of content and systems (Fischer et al. 2001). The SER model is an evolutionary model. There are three steps, which comprise of seeding, evolutionary growth and reseeding that may be applied repeatedly in collaborative tagging (Maier and Thalmann 2008). Figure1 illustrates this idea.

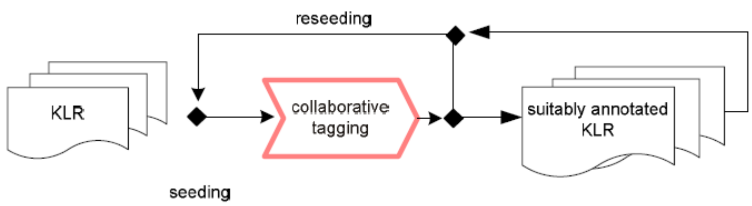


Figure 1: The process of collaborative tagging (Maier and Thalmann 2008).

The process is started with seeding of content (tags) in which domain experts predefine initial content (tags). Besides using initially created tags by authors, domain experts or automatic techniques, in the context of this research, KLR can initially be presented to users without predefined tags. These diverse methods for the initial seeding of tags might influence users' choices and therefore the future development of metadata for KLR. Secondly, during the evolutionary growth process, users add tags to resources until there is a need for reorganisation. This is signalled by either no usefully harvested tags or by the fact that existing tags are not suitable any more for the given resource. Reseeding of tags and an additional collaborative tagging process are then important as subsequent steps (Maier and Thalmann 2008). Finally, for the last process step of reseeding, tags can be reorganised and/or reformulated in order to fit to a new or changed requirement (Fischer et al. 2001). By modifying the initial set of tags, the newly selected list of tags by users might be influenced, thus demonstrating a collaborative tagging process that is sensitive for new influences (Maier and Thalmann 2008).

## RESEARCH THEMES

In regard to the related work outlined, two key themes were formulated for investigation in this research (Maier and Thalmann 2008). They examine significant topics related to collaborative tagging, namely, *commitment and convergence*.

*Commitment* defines the agreement of a number of users on the suitability of a number of tags for describing a specific resource. This process is supposed to separate generally accepted tags from specialised tags over time.

The first key theme investigates *whether taggers commit to a stable set of generally meaningful tags that can be easily separated from specialised tags used only by a few users.*

*Convergence* describes the process of achieving a stable set of keywords over time, therefore a stable commitment over time. The second theme examines *whether the number of diverse tags for one resource converges to a stable set in an organisational setting.*

The following section describes the methods used to undertake the study as well as the research setting for data collection. Finally, results are presented and an outlook for further research is given.

## METHODS

An online survey was conducted to investigate the two themes commitment and convergence in relation to collaborative tagging. All INFO 101 (Introduction to Information Systems at Victoria University in Wellington, New Zealand) students who attended lab sessions for the practical part of the course during week 8 of trimester 1 in 2008 were invited to participate in the online survey. Students were informed about the study and the online survey prior to week 8 and were asked for their participation at the beginning of each lab session. Participation in this online survey was voluntary and anonymous. There was limited control over the full participation of students in the lab. Although participants were asked and reminded to complete the survey, they did not always complete the survey in full. The motivation of students was reflected by their personal interest in participating in this important international research project as well as their corporate feeling to participate together as the group of INFO 101 students. Overall, 116 of 224 first year Information Systems students participated in the online survey. This represents a participation rate of 51.8%. Participating INFO 101 students represented 24 different nations and around one third of students were female students.

*Data collection procedure*

This section describes the data collection scenario as well as the procedures followed for each data collection session. Each student who was willing to participate had to tag ten different KLR comprising two short videos from previous lectures and eight lecture presentations slides (containing three slides with text only, two pictures and three slides showing figures, but no text). Two tracks of data collection with three sessions each were conducted in one of the university's computer labs. After the initial session, session 2 and then session 3 followed subsequently. Two separate tracks were run to allow for comparison of results. Table 1 depicts the data collection structure and a summary of the number of tags assigned per track and session.

Table 1: track and session structure for data collection

| | track 1 (1,192 assigned tags) | track2 (1,132 assigned tags) |
|---|---|---|
| session 1 (337 assigned tags) | 15 participants | 14 participants |
| session 2 (952 assigned tags) | 22 participants | 21 participants |
| session 3 (1,035 assigned tags) | 24 participants | 20 participants |

The first session started with free-text tagging only which allowed students to enter suitable keywords in a textbox provided below each resource. Initially, there was no opportunity to select predefined tags presented in combination with checkboxes. Overall, 337 tags were assigned to the 10 resources in the first session by using the textbox only feature. After session 1, the most frequently entered tags were identified and prepared to be easily selected by participants ticking checkboxes in the following sessions. In comparison to session 2 and session 3, fewer people took part in the first session. This together with the easier assignment of tags in sessions 2 and 3 explains the fewer number of tags assigned in both initial sessions. The checkbox feature is common standard and is also available in other tagging tools. In particular, the most frequently assigned tags from session 1 were defined by a greater than or equal to 5% frequency of occurrence. Based on previous research in the field (Maier and Thalmann 2008), this 5% threshold was used to separate generally accepted tags (most frequently occurring tags) and specialised tags. However, referring to the low number of participants, and therefore tags in the first sessions, a most frequently assigned tag also needed to occur at least twice. In contrast to the first sessions, the second and third sessions provided participants with two different tagging possibilities. Firstly, the text box option for free-text tagging was provided again. In addition, the most frequently occurring tags from session 1, and session 2 respectively, were illustrated by checkboxes.

All three sessions of this study offered unrestricted tagging to participants provided by the textbox for entering keywords. As pointed out in previous literature (e.g. Golder and Huberman 2005), this may lead to vocabulary issues such as homonyms, synonyms, plurals, and diverse levels of aggregation of the descriptions. To overcome some of these issues when identifying most frequently used keywords after session 1, and session 2 respectively, a number of actions were undertaken to make the vocabulary more manageable. For example, plurals were adjusted to singulars, capital and lower case descriptions did not represent different tags and some obvious typing errors were also corrected. In summary, 2,324 tags were assigned to the 10 resources whereas 715 different tags occurred.

## RESULTS

The summary of collected keywords indicated that students predominantly selected content-based keywords rather than context-based keywords for lecture slides. However, for describing videos, they used a certain number of context-based keywords such as the lecturer's name or the name of the lecture.

The threshold for separation between generally accepted and specialised tags was set at 5% during the data collection. This was found not an optimal criterion in all cases of KLR. A better criterion could be to use a sharp decline of the frequency of occurrence of all assigned tags for the separation. Table 2 outlines the distribution of all tags assigned to the ten KLR in track1 over three sessions. The tags were ranked by frequency of occurrence until Rank 7. All remaining tags were represented by the category 'others'. Tags were sorted by the relative and absolute frequency of assignments provided by participants. For example in relation to Resource 1, tags ranked 1st and 2nd showed an occurrence of over 20%, and all lower ranked tags showed less than 6% occurrence which marks a sharp decline.

Table 2: Ranked distribution of tags (all sessions of track 1)

| | Resource 1 | | Resource 2 | | Resource 3 | | Resource 4 | | Resource 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Rank 1 | 27 | 26.2% | 44 | 27.2% | 38 | 31.1% | 22 | 20.1% | 18 | 16.7% |
| Rank 2 | 21 | 20.5% | 34 | 21.0% | 28 | 23.0% | 21 | 19.0% | 18 | 16.7% |
| Rank 3 | 6 | 5.9% | 24 | 14.8% | 16 | 13.1% | 15 | 13.5% | 11 | 10.2% |
| Rank 4 | 2 | 1.9% | 6 | 3.7% | 5 | 4.1% | 11 | 10.0% | 11 | 10.2% |
| Rank 5 | 2 | 1.9% | 5 | 3.1% | 4 | 3.3% | 6 | 5.5% | 8 | 7.4% |
| Rank 6 | 2 | 1.9% | 5 | 3.1% | 3 | 2.5% | 5 | 4.5% | 7 | 6.5% |
| Rank 7 | 2 | 1.9% | 4 | 2.5% | 2 | 1.6% | 5 | 4.5% | 6 | 5.5% |
| others | 35 | 39.8% | 39 | 24.6% | 26 | 21.3% | 25 | 22.9% | 29 | 26.8% |
| sum | 103 | 100% | 162 | 100 | 122 | 100% | 109 | 100% | 108 | 100% |
| | | | | | | | | | | |
| | Resource 6 | | Resource 7 | | Resource 8 | | Resource 9 | | Resource 10 | |
| Rank 1 | 35 | 28.2% | 37 | 36.6% | 52 | 45.2% | 24 | 20.2% | 29 | 19.5% |
| Rank 2 | 31 | 25.0% | 14 | 13.9% | 14 | 12.2% | 20 | 16.8% | 26 | 17.4% |
| Rank 3 | 19 | 15.3% | 11 | 10.9% | 13 | 11.3% | 17 | 14.3% | 22 | 14.7% |
| Rank 4 | 3 | 2.5% | 6 | 5.9% | 7 | 6.1% | 15 | 12.6% | 19 | 12.7% |
| Rank 5 | 3 | 2.5% | 6 | 5.9% | 6 | 5.2% | 10 | 8.4% | 19 | 12.7% |
| Rank 6 | 2 | 1.6% | 4 | 4.0% | 5 | 4.4% | 3 | 2.5% | 3 | 2.1% |
| Rank 7 | 2 | 1.6% | 3 | 3.0% | 3 | 2.6% | 3 | 2.5% | 3 | 2.1% |
| others | 29 | 23.3% | 20 | 19.8% | 15 | 13.0% | 27 | 22.7% | 28 | 18.8% |
| sum | 124 | 100% | 101 | 100% | 115 | 100% | 119 | 100% | 149 | 100% |

Although generally accepted tags could be separated from specialised tags by the decline of their occurrence, the exact threshold for separation differed among the ten resources. With a difference of 14.6% and only two generally accepted tags, Resource 1 showed the sharpest decline between generally accepted tags (over 20% frequency) and specialised tags (below 6% frequency). With a difference of 5.9% or 10.6%, five generally accepted keywords could be extracted from Resource 9 and Resource 10. Summing up, we propose to study this criterion in subsequent studies in order to test its supposed superiority.

The number of changes in the highly ranked tags decreased as Figure 2 outlines. These changes occurred either between session 1 and session 2 or between session 2 and session 3. In track 1 of data collection, 17 changes (out of 25 possible changes) between session 1 and session 2, and respectively 11 (out of 40 possible changes) changes between session 2 and session 3 were made by participants. Track 2 showed similar results with 13 changes after the first session and 9 changes after the second session. In addition, the number of new tags assigned to each resource also decreased. These results indicate a relatively stable set of the most highly ranked tags can be achieved over time.

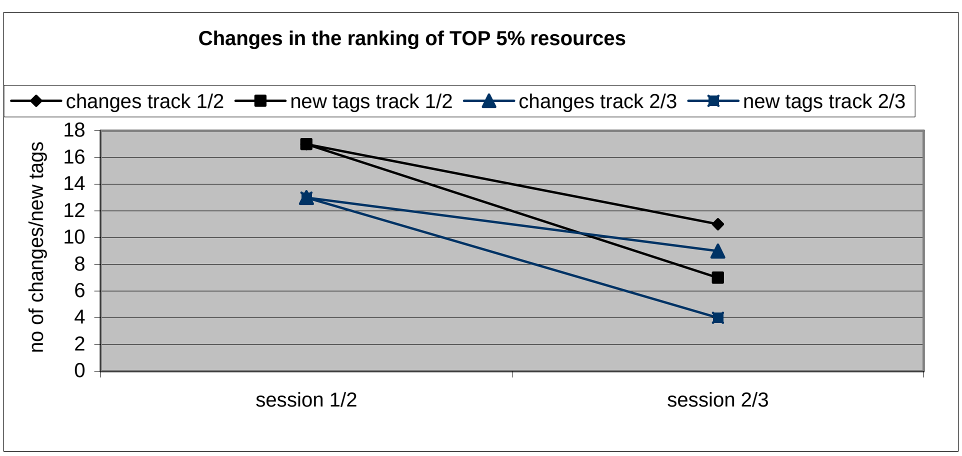


Figure 2: Changes in the ranking of TOP 5% resources per session

According to Cattuto et al. (2007a), the rate of new tags monotonically declines and might become zero in an unlimited setting. Nevertheless, it was also acknowledged that a set of possible tags in reality as well as in research study settings may be too large to achieve a stable set of keywords without any new tags.

Figure 3 illustrates the number of diverse tags in relation to all tags entered or selected for all resources of track 1. Each line represents an increase of distinct tags for each KLR. The diagonal line represents the idealised run of the curve in case every tag is unique. The slope for all resources appears steady, but the curves are flat in contrast to the idealised curve. Track 2 data shows similar results.

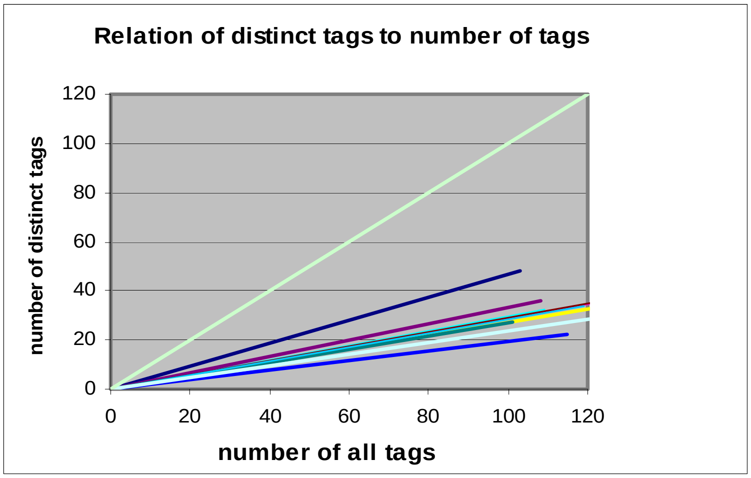


Figure 3 : Relation of distinct tags to number of all tags

In summary, the described results indicate that tags converge against a stable set over time. Changes of top-ranked keywords are minimal and do not influence the ranking order in general.

For a further comparison of results to related literature (Cattuto et al. 2007a), a distribution calculation of the vocabulary growth exponent y = log(distinct tags)/log(new tags), as defined by Cattuto et al., was undertaken and is depicted in Figure 4. This measure appears strongly connected to the vocabulary problem, which refers to the issue that a number of different users employ diverse terms to tag the same resource (Furnas et al. 1987). The vocabulary growth exponent describes exactly this phenomenon. A high exponent represents an issue in terms of the vocabulary problem whereas a low exponent relates to a stable set of vocabulary. Figure 4 illustrates the vocabulary growth exponent in relation to its distribution in this research setting. The dots appearing in the figure are not connected, as a larger number of tags and participants over a longer period of time would be necessary. In comparison to Cattuto et al.'s findings, which are based on an analysis of the online community of del.icio.us users, no normal distribution can be reported. In fact, a scattered plot as shown below is the result. This may be the result of the low number of homogenous participants (INFO 101 students only) in this study. However, another study undertaken by Maier and Thalmann also indicates similar results as in this study and no normal distribution could be observed.

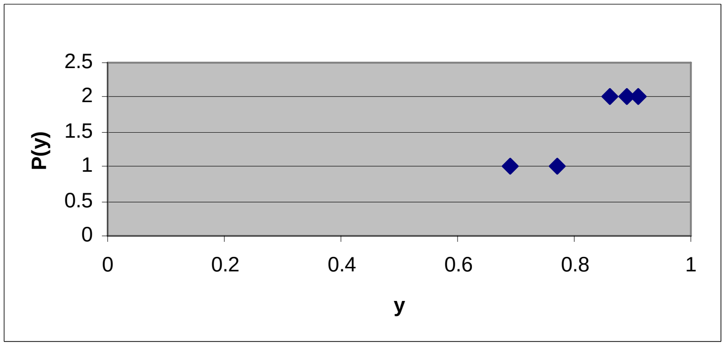


Figure 4: distribution of vocabulary growth

## CONCLUSION

This research study explored two aspects of collaborative tagging for KLR in an institutionalised setting: commitment and convergence. The first aspect examined *whether taggers commit to a stable set of generally meaningful tags that can be easily separated from specialised tags used only by a few users.* This key theme was supported by analysed data which is illustrated by Table 2. Data indicated that there is an initial commitment to generally accepted tags and that the number of specialised tags declined. As this study was a small-scale study compared to, for example, Cattuto's studies (2007a; 2007b), it could only reveal a small part of participants' collaborative tagging behaviour over time. The second key theme investigated *whether the number of diverse tags for one resource converges to a stable set in an organisational setting.* Explanations of Figure 2 and Figure 3 initially confirm a stable set and indicate convergence that might increase over time.

Although these results indicate that a relatively stable set of the most highly ranked tags could be achieved over a small period of time, a higher number of diverse participants as well as a long-term study would be necessary to fully support this second theme. However, along with a similar study undertaken by Maier and Thalmann in 2007, first empirical evidence about trends in relation to the two key themes explored, namely commitment and convergence, can be given. Although tested in a University setting, due to supposed similarities in the way of approaching KLR by students and knowledge workers, collaborative tagging might be a way for effectively describing KLR also in an organisational setting.

As research into the design of collaborative tagging processes, especially in an institutionalised setting, is only at its infant stage, this evidence needs to be verified in other research settings. Further research may also be necessary in terms of the design of tagging systems and how this design influences users' participation and tagging behaviour. For example, to organise words with multiple meanings in collaborative tagging, Wu et al. (2006) suggested a probabilistic generative model to analyse users' tagging behaviour and to automatically derive the emergent semantics of tags. Approaches that already combine both classification schemes, ontologies and collaborative tagging, include Gruber's (2007) *ontology of folksonomy*, Hamasaki et al.'s (2008) *model of integrating collaborative tagging for ontology extraction*, and Noy et al's (2008) paper that reports on investigations to combine various applications that were initially developed with different classification backgrounds. Another interesting topic for further research may be qualitative research into the motivation of users who participate in tagging. For example, it would be interesting to investigate to what extent incentive systems could be used to motivate users to participate.

There is a number of organisational specifics that need to be taken into account when comparing this study to other studies, for example, to Maier and Thalmann's study (2008) that has been undertaken with Austrian entry-level students in 2007. In terms of participant characteristics, international first year students in NZ often encounter English language problems during their first year of study which is likely to influence their tagging behaviour. Students in NZ need to pay high study fees, which may be reflected by a 'customer-mentality' of students in relation to their lecturers/tutors. The participation number in this collaborative tagging study might have been influenced by this aspect, as participation was voluntary and students' did not have an actual benefit from participating. Further research might be undertaken to investigate how students and knowledge workers can be motivated to participate in collaborative tagging.

Although this study showed some evidence for participants' commitment towards generally accepted collaborative tags in an institutionalised setting over time, there remain other issues to be solved, such as uncontrolled or, when using ontologies, "semi-controlled" vocabulary, finding the appropriate criteria for separating generally accepted tags as well as finding the right moment when to reseed a collaborative tagging process. These are some of the issues important for further research.

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