FINDING SCIENTIFIC MEDICAL INFORMATION THROUGH COLLABORATIVE TAGGING SYSTEMS: A TASK-ORIENTED EVALUATION PERFORMED BY HEALTHCARE PROFESSIONALS

Valérie Durieux[1]

[1]*Université Libre de Bruxelles, Brussels, Belgium*

Corresponding author: Valérie Durieux, vdurieux@ulb.ac.be

Abstract

Introduction: Finding relevant scientific information is crucial for healthcare professionals. But with the exponential number of resources published on the Internet, the task has become a lot more difficult and time-consuming. Collaborative tagging systems, such as CiteULike, allow Web users to store and organize their bookmarks of online content by assigning them metadata in the form of tags.

Aim: The study investigated the extent to which tags assigned in the collaborative tagging system CiteULike contribute to the finding of relevant medical scientific papers by healthcare professionals.

Methods: A task-oriented evaluation was designed and conducted with a sample of 22 physicians from various specialisations at different career levels. Their information behaviour in PubMed/Medline and CiteULike was observed and compared. The evaluation was followed by a semi-structured interview.

Results: Relevant tags are assigned in CiteULike but their number is too low to efficiently contribute to the searching process. Nevertheless the study also showed that CiteULike helped physicians to find relevant papers thanks to its social bookmarking features. In addition to measuring the efficiency of collaborative tagging systems for healthcare professionals in their information seeking process, the study also presents various observations and insights into the information behaviour of physicians.

Key words: Information Seeking Behavior; PubMed; Information Systems.

Introduction

With the exponential increase of resources available on the Internet in the health sciences and elsewhere, it has become crucial to sort this mass of documents in order to retrieve the information relevant to a particular need. The description of the resources with metadata, such as MeSH descriptors assigned to scientific references in PubMed, provide researchers with the ability to find distributed information more efficiently (1). Besides metadata generated by information specialists, a new practice called collaborative tagging is considered as an alternative to professional indexing and controlled vocabularies (2, 3).

Collaborative tagging describes a practice whereby users assign tags (or keywords) to online content. The choice of tags is totally free; it is not based on controlled vocabulary (4). Once assigned, the tags are immediately available to other users who can use them to search for information. The emergent list of all the assigned tags constitutes a folksonomy, short for "folk taxonomy" (5). In comparison to controlled vocabularies, folksonomies can be described as anarchic; because taggers are allowed to assign any word or even any group of characters, folksonomies do not handle semantic problems (polysemy, synonymy and basic level variation), inflected forms of words, abbreviations, acronyms and misspellings as controlled vocabularies do (4, 6-9). Nevertheless, thanks to their lack of structure, folksonomies can evolve fast and readily, to integrate a neologism, for instance, contrary to controlled vocabulary whose creation and update are extremely time-consuming and thus expensive (6, 10, 11). Finally, collaborative tagging gives certainty to meet the users' needs since taggers are indexers and searchers at the same time, while professional indexers have to predict the terms that will be used by users to search for the same resources (2, 10, 12)

A growing number of websites allow users to tag bookmarks, photographs, videos, or music. The present study focuses on the social bookmarking service CiteULike (http://www.citeulike.org) founded in 2004 by Richard Cameron. It differs from the popular Delicious by its users and its contents. Indeed, while Delicious allows any user to save and organize bookmarks of any online resource, CiteULike is aimed to help scientists, researchers and other academics to do the same for scientific articles (11). Given that everyone's library is stored on a server, CiteULike users can access their own bookmarks from any computer as well as share them with others. Through a search by tag, users can indeed retrieve article references from their own library and from other users' collection of bookmarks and in this way, discover new articles that have been tagged by other users with similar research interests. Groups can also be created allowing users who collaborate on a publication, for example, to share their bibliographic references. (13).
To add resources in their library (or in the library of a group to which they belong), users can either copy a reference already in the system by clicking on the "Copy" button beneath each record listed or import a reference by using the "Post to CiteULike" button they have previously installed in their browser toolbar. This import from an external source is possible only if compatible with CiteULike, which is the case of many bibliographic databases such as PubMed, Scopus, ISI Web of Science, ScienceDirect, Cambridge University Press, JSTOR or Google Scholar (14). According to CiteULike website, the system contains more than seven million articles.

Related studies

Tag analysis

Mathes was the first to propose a theoretical comparison of folksonomies and controlled vocabularies in order to identify their strengths and weaknesses (6). Shortly after, Shirky completed Mathes' study and claimed that the collaborative tagging would eventually surpass professional indexing and controlled vocabularies (2). More pragmatic research comparing tags and descriptors soon followed. Kipp compared tags from CiteULike to authors' keywords and descriptors assigned by librarians to scientific articles in the field of Information Sciences (15). The comparison revealed that the indexing terms differ greatly depending on whether they are assigned by the authors, librarians or users. The study also showed that user tags could provide additional access points to those created by controlled vocabulary. Previous studies conducted by

the author, comparing tags from Delicious and CiteULike to MeSH descriptors from CISMeF and PubMed, confirmed some findings but challenged others (16,17). In both studies, the majority of tags were relevant and useful for information retrieval. Moreover, numerous tags provided the tagged resources with additional access points compared with descriptors. Nevertheless, there were a high proportion of useless tags and a low added value provided by the tags in comparison with the descriptors. Both studies thus concluded that users' tags complement librarians' descriptors and even compete with them but can in no way be substitute for them. To actually compete with professionals' descriptors, more articles have to be tagged and more tags have to be assigned per article, especially in the healthcare field.

Physicians' information behaviour

Searching for information is an essential and central activity in the practice of medicine. Indeed, finding the relevant information is crucial to diagnose, prescribe treatment or conduct scientific research on a population. It is therefore not surprising that many studies have looked at the information behaviour of health professionals. The majority of these studies come from and concern Anglo-Saxon countries (18, 19). As regards to data collection methods, the majority of original research articles employ interview or questionnaire survey, which allows to gather information from a large number of individuals leading therefore to generalizable results. Studies focussing on query formulation and search sequences generally use transaction log analysis that is less intrusive than the first two (20-22). In addition to the numerous original articles, some literature reviews provide an interesting perspective (23-26). They are usually distinguished by their central themes, which most frequently are the information needs of physicians, the information sources used to meet them and the barriers to accessing information.

Physicians' use of collaborative tagging systems

Although abundant literature exists on collaborative tagging and the resulting tags, no study has investigated the use of collaborative tagging systems by health professionals. Several studies present and promote the use of such systems for physicians but do not provide data about their actual adoption (27-30). Surveys have also been conducted on the use of collaborative tagging systems by students and researchers, but not in the medical field (31-33).
In the unique study fairly similar to this one, Kipp and Campbell examined information behaviour of students in Library and Information Science when searching PubMed and CiteULike in order to measure the usefulness of tags for information searching (34). The study showed that participants employ search terms similar to tags assigned in CiteULike. It also showed that they particularly enjoy browsing the system through various hyperlinks (i.e. tag, user, group and author). Despite a methodology and a research question relatively similar, the study conducted by Kipp and Campbell differs from this one in the population surveyed. While they analysed students in Library and Information Science, this study look at the "real" end-users of the scientific medical information, that is, physicians. It is therefore difficult to compare the results obtained in both studies.

Research questions

This study addresses the following research questions:

- To what extent do tags assigned by CiteULike users help physicians to find relevant scientific articles?
- To what extent could the collaborative tagging system CiteULike be useful for physicians when searching for scientific medical information

compared to the more traditional bibliographic database PubMed?
- To what extent could the collaborative tagging system CiteULike be integrated into physicians' information behaviour?

Methodology

Data were gathered through individual sessions combining task-oriented evaluation in laboratory settings and semi-structured interview. As part of the author's doctoral thesis, the individual sessions were conducted with physicians working at "Hôpital Erasme" – the academic centre of the "Université libre de Bruxelles" – from February to June 2012 (35). Physicians were mainly recruited by email for participation. Personalised emails were sent to physicians actively involved in scientific research from various specialisations at different career levels. In addition, the research project was briefly presented during training sessions provided by the academic library at the hospital. Little information on the individual sessions was provided: the terms "PubMed", "CiteULike" and "Collaborative tagging" were never mentioned in order to prevent physicians from preparing (36). To encourage participation, each participant received a personalised tutorial providing instructions on how to construct search queries associated with their main research topic and how to set alerts in several bibliographic databases.

Every session, lasting approximately an hour and a half, followed the same scenario (see Table 1).

Table 1
Scenario of individual session

Activity	Description	Approx. length
Welcome	Initial greeting and introduction to session and to tasks to perform.	5 min.
Search task 1 (PubMed)	Participant searches PubMed for scientific articles on its main research topic.	15 min.
Debriefing 1	A semi-structured interview involving a discussion of the first search task and the participant's usual seeking behaviour.	15 min.
Introduction to CiteULike	A brief presentation of the collaborative tagging process and the CiteULike system	10 min.
Search task 2 (CiteULike)	Participant searches CiteULike for scientific articles on its main research topic.	15 min.
Debriefing 2	A semi-structured interview involving a discussion of the second search task and the participant's perception of CiteULike.	15 min.
Conclusion	Final comments	5 min.

To introduce the first search task, the participant received the following instruction: "Using PubMed, find three to five new – i.e. you don't already know about – scientific articles relevant to your main research topic. Copy-paste the references in the Word document on the computer. When you are done, close the PubMed window. You have 15 minutes to achieve the task." When the task was completed, a semi-structured interview was conducted exploring three main topics: Usage information technology (frequency and

familiarity with the use of a PC/internet, equipment available, etc.); Information seeking skills and behaviour (frequently used resources, reference management techniques, information sharing habits, etc.); Usage and perceptions of PubMed (frequently used functionalities, knowledge and usage of the MeSH thesaurus, perceived usefulness, perceived ease-of-use, etc.). Prior to the second search task, a prerequisite training in the use of CiteULike was provided to participants in order to raise their skills to a rather similar level (37). The second search task began with an instruction that is identical to the first one, except for the system to use: find three to five new scientific articles using CiteULike. As with the first search task, it was followed by a semi-structured interview focusing on collaborative tagging process: Familiarity with and usage of a collaborative tagging system; Perceptions of CiteULike (perceived usefulness, perceived ease-of-use, intention to use, etc.). To close the individual session, the participant was asked to express any additional remarks about the search tasks performed or the debriefing sessions.

In order to motivate physicians to participate, the individual sessions were conducted in the academic library that is close to the medical centre they are working in. The author's office has been reorganised like a kind of usability laboratory with the existing material. The participants performed the search tasks on a laptop connected to the interviewer's computer screen. The interviewer was positioned in the same room but at another desk, so she could directly observe the search tasks without distracting the participants (37). "BSR Screen Recorder 5" was used to capture the search tasks performed on the laptop. Recorded video of the search tasks and audio debriefing sessions were transcribed in order to provide deep analysis of the participants' seeking behaviour. The combination of two distinct qualitative methods allowed to control the coherence and validity of the gathered data through triangulation process.

Results

Participants

Thirty-nine personalised emails were sent to physicians actively involved in scientific research, 18 of them took part in the study. Four more physicians were recruited during training sessions provided by the academic library at the hospital. Among the 22 participants were 10 trainees, 8 residents and 4 heads of department, from 13 different specialisations.

Search behaviour in PubMed

Based on the observations of search tasks and comments gathered during debriefing sessions, the majority of participants search PubMed in a very simplistic way and make little use of advanced features, such as field search, filters, or search history. This finding is somewhat disconcerting given the frequency of use; 14 participants said that they search PubMed daily, and 3 several times a week. During the search task, all participants entered their search terms in the basic search box displayed on the homepage and on the results pages. In addition to querying, more than half of the participants used browsing features, mainly the "Related citations in PubMed" links that lead to similar article references.

An analysis of the queries showed that many participants seem to know little about the default Boolean operator and how to search for an exact phrase. One of the most significant evidence of this lack of knowledge is the use of Booleans operators as delimiters instead of quotation marks (e.g. *sickle cell disease and nephropathy*). It has been observed in 11 participants.

An analysis of the entire sequence of queries entered during a search task revealed a lack of understanding of set theory from three participants. As an example, while only three search results were found, the participant entered an additional query term. Conversely, another participant decided to remove two terms from a query that returned nearly three thousand results.

The vast majority of participants viewed only the first results provided by PubMed. Eight participants looked past the first results page (i.e. 20 articles).

Regarding knowledge and usage of the MeSH thesaurus, one participant attempted to use the MeSH Database during the search task but never succeeded because of the updated user interface, as the participant later explained. During the debriefing sessions, 13 participants said that they knew what the MeSH thesaurus is. Only three of them actually used it to search PubMed. The main reasons for non-use are: the participant did not know how to use it (anymore); it is too difficult and/or time-consuming to use; the search results are unsatisfactory.

Search behaviour in CiteULike

The use of advanced features was quite small, only four participants searched by fields (i.e. author, year, title and tag). Three participants used tag search without any result, except for one of them. However, it is important to underline that the formulation of multiword tags was not explained to participants during the prerequisite training. CiteULike tags may not contain space character and there is no clear rule on which character to use instead; thus searching for a multiword tags requires to consider any possible form (e.g. human_biology, human.biology, human+biology). It was inevitable that queries such as *tag:sickle cell disease* and *tag:"friedrich ataxia"* failed to return any results. Only one participant got results using single word tags (e.g. *tag:emergency AND tag:decision*) but he did not select any article found that way.

Twelve participants used browsing features such as "user links" and "group links" that respectively allow to navigate individual users' and user groups' libraries. Search tasks showed that 12% of selected articles were found with browsing features.

In terms of query formulation, few queries contained Boolean operators. When looking for an exact phrase, 15 participants forgot to use quotation marks (e.g. *heart failure AND endothelial function*). These search behaviours are problematic when using CiteULike since the default Boolean operator between search terms is "OR". Participants were thus often overloaded with thousands of results; they did not understand why and so, how to sort that out.

The vast majority of participants viewed only the first results provided by CiteULike. Four participants looked past the first results page (i.e. 50 articles), but not systematically.

The participants selected a total of 88 articles using CiteULike. Four participants failed to find at least three articles. A comparison of the articles selected by participants in both systems showed that three quarters of the articles selected from PubMed were not listed in CiteULike (see Figure 1). It confirms the incompleteness of CiteULike in terms of medical scientific resources, which many participants complained about. Conversely, only three articles selected from CiteULike were not listed in PubMed; there were published in scientific journals but not indexed for PubMed. With regard to

articles listed in the other system but not selected by the participants, they certainly would have been identified and selected if the participants would have looked past the first few results. This demonstrates the impact of results ranking on the discovery potential of articles by researchers.

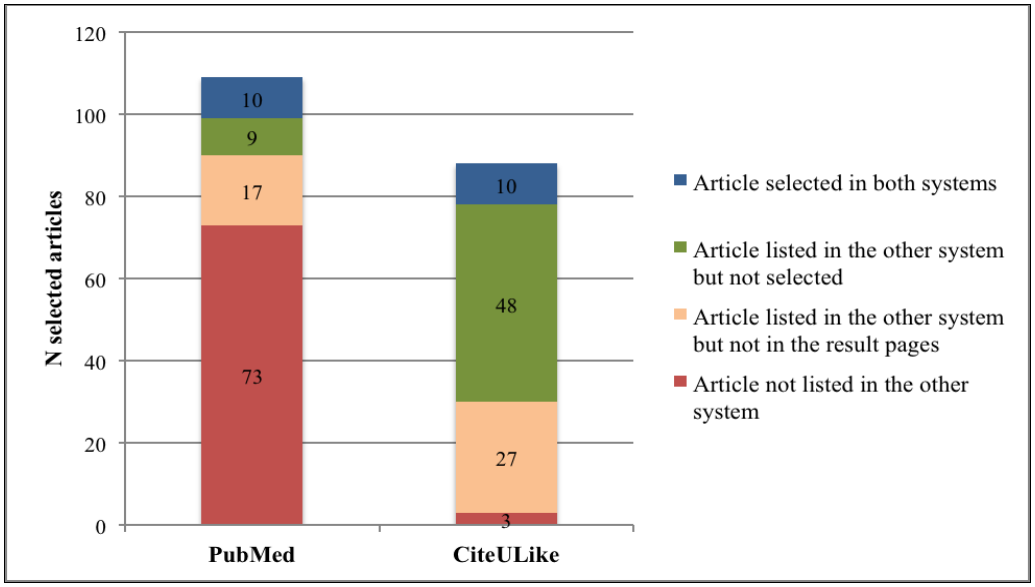

Figure 1: Comparison of the articles selected in CiteULike and PubMed

The central question of this study is to determine to what extent tags assigned by CiteULike users could help the participants to find the selected articles. To answer the question, tags assigned to the selected articles have been analysed and compared to query terms used by the participants. It is important to underline that among the 88 selected articles from CiteULike, 57 received no tag. This is explained by the fact that many articles references are automatically introduced into the system and that users may include a reference to their library without assigning any tag. This automatic insertion of references is both a strength and weakness. Indeed, while it quickly and easily increases the content of the system, the social aspect, which is its main strength, is greatly undermined. With regard to the 31 tagged articles, 25 of them received tags from a one user only; the maximum number of taggers per article is six. It comes as no surprise, then, that the answer to the main research question is not promising. Only two of the 88 selected articles were found thanks to their assigned tags. More specifically, these two items were found by one of the participants through the use of a “tag link”.

Search tasks revealed serious dysfunctional features of CiteULike. The most detrimental one, according to the participants, is the sorting function. Not only is the function complex to set up, it rarely works properly. Among the five participants who used it, only one obtained a list of results sorted by the selected criteria. Moreover CiteULike was sometimes instable during search tasks; the same query launched only minutes apart could provide different results.

Participants’ perception of CiteULike

It is first important to note that at the time of the individual sessions, none of the participants was using a collaborative tagging system. Only two participants had heard about Delicious and CiteULike, but they did not know exactly what this kind of system consisted in.

In general, participants had quite mixed opinions about CiteULike. The most frequent positive aspects mentioned by the participants were its ease of use and

its social features. Indeed, the ability to share information with their research team but also to observe the readings of other researchers was highly appreciated by the participants. Only one participant expressed a reservation on this topic; she was uncomfortable with the idea that researchers outside her team could see what she is reading or the research subjects she is working on.
As to negative aspects, almost half of the participants complained about the incompleteness of CiteULike in terms of medical scientific resources. Six participants expressed criticism regarding the inability to sort search results. Aware of the lack of research efficiency in CiteULike compared to PubMed, several participants however viewed CiteULike as an interesting tool for its social features, such as “user links” or the creation of users groups on particular research subjects. As one participant said, CiteULike should not be used as PubMed because of its incompleteness and its low research performance; it is mainly its social features that should be exploited.
With regard to search results provided by CiteULike, 14 participants have discovered references that they had never found in PubMed before. However, three of them added that they would have found them in PubMed eventually. The main criticisms regarding the search results are their incompleteness, their lack of added value compared to PubMed, and their obsolescence. Despite these criticisms, opinions were fairly positive overall; only four participants had a completely unfavourable perception of CiteULike.
As to the intention to use the system, six participants had absolutely no plans to use it again in the future. The reason most often mentioned is the incompleteness of CiteULike in terms of medical scientific resources. As for the 16 participants favourable to its adoption, they would only use the system partially. Indeed, it is important to distinguish the three actions that can be undertaken by users in CiteULike: searching, storing and sharing articles. Unlike the last two actions, searching for articles in CiteULike does not require the user to contribute to the system; there is no obligation to be a member to search CiteULike. With very little time for their research, it is not surprising that the majority of participants only considered the system to search for articles without contributing in any way. However, five participants indicated that they would search CiteULike only as a complement to PubMed. While storage features wined very little success, seven participants envisioned the adoption of CiteULike to share information, either with members of their research team or with researchers from other institutions. Of the 16 participants who considered using CiteULike in the future, 8 were interested in an extensive training but they did not have time for that.

Discussion

As revealed by the analysis of research tasks, the participants rarely used the advanced search features in both systems. The Principle of Least Effort could be invoked to explain this behaviour (38). In CiteULike, another reason for their non-use could be their complexity. Search by fields, for example, asks to respect a precise syntax and master the exact phrase search, which is lacking in the majority of participants. And even when the user fully understands such notions, the system does not become easier to handle. Indeed, students in Library and Information Science have experienced similar difficulties to understand the search functionalities of the system (34). The use of CiteULike is far from clear, especially for someone whose information literacy skills are underdeveloped.
Regarding PubMed, this behaviour confirms the results of two studies on, respectively, several hundred and more than two million queries launched in PubMed (20, 22). However, this preference of physicians for simple search features is not detrimental to search results. According to Hersh and Hickam,

advanced search techniques are not significantly more efficient than simple search ones (24). Both authors have previously demonstrated that experienced physicians get better results using simple search feature (39). A study of search engines made the same observation: the results obtained by users via advanced search features are worse than those obtained using simple search (40). It is therefore not whether to use advanced search features that matter but the information literacy skills of users. These findings confirm the importance of general training in information searching (e.g. query formulation, basic Boolean logic), not on PubMed exclusively.
Browsing features were used and appreciated by many participants in both systems. Besides "authors" and "Find similar" links that are also available in PubMed, CiteULike offers additional links (e.g. "users" and "groups") that leverage the social aspect of the system. The use of these links has also helped many participants to find relevant articles on their research subject. Indeed, the browsing features prove to be relatively efficient and, somehow, offset weaknesses in the search by keyword, whether simple or advanced.

The analysis of the queries launched in both systems revealed significant gaps in information literacy. Indeed, notions such as set theory or exact phrase search seemed unknown. While many participants were aware of the gaps, some did not want to admit it and therefore did not consider necessary to undertake training, as observed in other studies (18, 25). This lack of skills had negative effects especially in CiteULike where, among other things, the default Boolean operator between search terms is "OR". Participants were thus often overloaded with results. Given the low sorting functions offered, the dissatisfaction they expressed with the system was predictable.

As Lowe and Barnett pointed out, the ability to use MeSH descriptors to search the biomedical literature is crucial. It is therefore worrying that a little more than half of participants knew about them and that only three actually used them (21). These results confirm those from previous studies; analyses of queries conducted by Nelson and Herskovic revealed that very few users search with MeSH thesaurus (20, 22). According to Lowe and Barnett, the main reason for this non-use is that the notion of thesaurus is difficult to understand and to master (21). Davies showed different results; MeSH descriptors are used by US physicians 46.3%, Canadian physicians 43.9%, and UK physicians 32.5% of the time (19). However, it is important to note that these statements are based on the words of the surveyed doctors and not on an analysis of actual queries. The differences in results could be explained by the social desirability bias, that is, the distortion of self-report measures resulting from the human tendency to present oneself in the best possible light (41).

Whether the search task was conducted in PubMed or in CiteULike, the majority of the participants considered the first few results. Only eight participants in PubMed and four in CiteULike looked past the first page of results. A study by Spink and Jansen on several search engines showed similar results; only two or three documents were viewed on average per query and the majority of users examined only the first page of results (42). It confirmed the influence of online information seeking through search engines (e.g. Google) on their information behaviour. This phenomenon is called the "internetalisation" of the information seeking process (43).

As regard to the participants' perception of CiteULike, its numerous dysfunctions (e.g. sorting function, results inconsistency) had strongly contributed to low intention to use it in the future expressed by the participants.

They also complained about its incompleteness compared to PubMed. Indeed, while the latter has more than 22 million references to articles in biomedical sciences, CiteULike lists about 7 million references all scientific disciplines included. The comparison of selected items in both systems had confirmed this assertion. The incompleteness of CiteULike is mainly due to the small number of "active" users contributing to its content. According to a survey of academic physicists, less than 10% of respondents have already tried a collaborative tagging system and only 1% found it useful (31). Ware et Monkman reported similar results; approximately 7% of the 3040 academic interviewed have adopted this type of system (32). A survey of undergraduates from the University of Chapel Hill in North Carolina showed that they are generally not familiar with the concept of tagging to organize information; only 15% said they use sites or services offering it (33). As expressed during the debriefing sessions, the participants followed the same trend. Few participants were willing to contribute to CiteULike by adding references and building their own library; only a "passive" use was considered. A survey conducted a few months after the individual sessions revealed that of the 16 participants who said they were interested in using CiteULike in the future, only 5 have actually used it again. Dissatisfied with the results, three of them did not finally adopt it. In other words, only 2 of the 22 participants have tried the system afterwards and were satisfied. The reasons given by the participants to explain the non-adoption of the system, whether they tested it or not after the session, are the time required to use it (that they do not have), the incompleteness of the system, and the difficulty of handling.

Finally, as for the tags assigned in CiteULike, they proved inefficient because of their limited number; 57 of the 88 selected articles had not received any tag. Moreover, the tags have only been useful as browsing feature, not as querying one. Students in Library and Information Science, who have tested CiteULike, arrived at the same conclusion (34). It is therefore not the function of tagging that proved useful for information searching and was appreciated by the participants.

Limitations of the study

The most important limit of this study is the restricted number of participants; the results can thus not be generalizable. However, a qualitative data collection methodology, such as adopted, does not require a particularly higher number. Moreover, the last interviews have not provided new data compared to previous ones; it thus indicated that the theoretical saturation was reached (44). It did not seem necessary to launch a new recruitment procedure at the end of the 22 individual sessions already conducted.

The study also presents a selection bias because the majority of participants were not randomly recruited (45). Their name was provided by a head of department at the hospital, who selected them on the basis of their research qualities, but also on the probability that they would agree to dedicate time to the study.

Finally, another limit is the fact that the participants have used both systems in the same order: PubMed first, then CiteULike. It is likely that the first task of research has influenced the second one. A random reversal of the order of the systems used would have allowed to measure a possible learning effect.

Conclusions

The analysis of the research tasks performed in both systems revealed significant gaps in information literacy. Basic notions such as Boolean logic and exact phrase search were little known and understood by many participants.

These gaps made the handling of CiteULike particularly difficult. Although the system has allowed some participants to find articles they did not know about, it was still relatively poor in terms of scientific medical resources. Indeed, much of the articles selected in PubMed were not listed in CiteULike. Besides these fairly significant weaknesses, the participants reported strengths of the system: its social aspect, especially the ability to browse libraries through various links (e.g. “user”, “group”). Some participants considered using it to share interesting references in their service. However, the majority of the participants only considered a "passive" use of the system, that is to say, without any contribution to its content by adding and managing references, mainly because of lack of time.

With regard to tags, which are at the core of this study, their analysis did not reveal encouraging results. Indeed, among the 88 articles selected by the participants, 57 had not received any tag. Moreover, 25 of the tagged articles only received tags from a single user. Tags have actually contributed to the discovery of two documents. It is therefore not the collaborative tagging features of CiteULike that assist the participants in finding the information they are looking for but social bookmarking features. This low contribution of tags to the information search process is due to the fact that few resources have been tagged. This is consistent with the findings of previous studies comparing descriptors and tags; more articles should be tagged and more tags must be assigned per articles to make tags truly useful and efficient when searching for information.

REFERENCES

1. Good BM, Tennis JT, Wilkinson MD. Social tagging in the life sciences: characterizing a new metadata resource for bioinformatics. BMC Bioinformatics. 2009;10:313.
2. Shirky C. Ontology is Overrated: Categories, Links and Tags [internet]. Shirky.com; 2005. [cited 2014 Mar 31]. Available from: http://shirky.com/writings/ontology_overrated.htm
3. Veres C. The Language of Folksonomies: What Tags Reveal About User Classification. *Lecture Notes in Computer Science*. 2006;3999:58-69.
4. Golder SA, Huberman BA. Usage Patterns of Collaborative tagging systems. Journal of Information Science. 2006;32(2):198-208.
5. Vander Wal T. Explaining and Showing Broad and Narrow Folksonomies [internet]. vanderwal.net; 2005. [cited 2014 Mar 31]. Available from: http://www.vanderwal.net/random/entrysel.php?blog=1635.
6. Mathes A. Folksonomies – Cooperative Classification and Communication Through Shared Metadata [internet]. Computer Mediated Communication; Dec 2004. [cited 2014 Mar 31]. Available from: http://www.adammathes.com/academic/computer-mediated-communication/folksonomies.html.
7. Guy M, Tonkin E. Folksonomies: Tidying up tags? D-Lib Magazine. 2006;12(1). [cited 2014 Mar 31]. Available from: http://www.dlib.org/dlib/january06/guy/01guy.html.
8. MacGregor G, McCulloch E. Collaborative Tagging as a Knowledge Organisation and Resource Discovery Tool. Library Review. 2006;55(5):291-300.
9. Noruzi A. Folksonomies : Why do we need controlled vocabulary?. Webology. 2007;4(2). [cited 2014 Mar 31]. Available from: http://www.webology.ir/2007/v4n2/editorial12.html.
10. Merholz P. Metadata for the Masses [internet]. Adaptativ Path; 2004. [cited 2014 Mar 31]. Available from: http://www.adaptivepath.com/ideas/e000361/.
11. Gordon-Murnane L. Social Bookmarking, Folksonomies, and Web 2.0 Tools. Searcher. 2006;14(6):26-38.
12. Trant J. Exploring the potential for social tagging and folksonomy in art museum: proof of concept. The New Review of Hypermedia and Multimedia. 2006;12(1):83-105.
13. Emamy K, Cameron R. CiteULike: A Researcher’s Social Bookmarking Service. Ariadne. Apr 2007;51. [cited 2014 Mar 31]. Available from: http://www.ariadne.ac.uk/issue51/emamy-cameron/.
14. Lee DH, Schleyer T. Social Tagging Is No Substitute for Controlled Indexing: A Comparison of Medical Subject Headings and CiteULike Tags Assigned to 231,388 Papers. Journal of the American Society for Information Science and Technology. 2012;63(9):1747–1757.
15. Kipp ME. Complementary or Discrete Contexts in Online Indexing: A Comparison of User, Creator and Intermediary Keywords. Canadian Journal of Information and Library Science.

2005;24(4):419-436.
16. Durieux V, Kerdelhué G. Looking for Health Information on the Internet: Can Social Bookmarking Systems Replace Expert Gateways? Workshop of the European Association of Health Information and Libraries; 2009 Jun 2-5; Dublin, Ireland.
17. Durieux V. Le collaborative tagging ou l'organisation des ressources médicales en ligne par les internautes. In: Mustafa El Hadi W, editor. L'organisation des connaissances : dynamisme et stabilité. Paris: Hermès Science Publications; 2012. p.319-330.
18. Ely JW, Osheroff JA, Chambliss ML, Ebell MH, Rosenbaum ME. Answering physicians' clinical questions: obstacles and potential solutions. Journal of the American Medical Informatics Association. 2005;12(2):217-24.
19. Davies KJ. Physicians and their use of information: a survey comparison between the United States, Canada, and the United Kingdom. Journal of the Medical Library Association. 2011;99(1):88-91.
20. Nelson J. An analysis of transaction logs to evaluate the educational needs of end users. Medical Reference Services Quarterly. 1992;11(4):11–21.
21. Lowe HJ, Barnett GO. Understanding and Using the Medical Subject Headings (MeSH) Vocabulary to Perform Literature Searches. JAMA. 1994;271(14):1103-1108.
22. Herskovic JR, Tanaka LY, Hersh WR, Bernstam EV. A day in the life of PubMed: analysis of a typical day's query log. Journal of the American Medical Informatics Association. 2007;14(2):212-220.
23. Gorman PN. Information Needs of Physicians. Journal of the American Society for Information Science. 1995;46(10):729-736.
24. Hersh WR, Hickam DH. How well do physicians use electronic information retrieval systems? A framework for investigation and systematic review. JAMA. 1998;280(15):1347-52.
25. Davies KJ. The information-seeking behaviour of doctors: a review of the evidence. Health Information and Libraries Journal. 2007:24(2):78-94.
26. Fourie I. Learning from research on the information behaviour of healthcare professionals: a review of the literature 2004–2008 with a focus on emotion. Health Information and Libraries Journal. 2009;26(3):171-86.
27. Boulos MNK, Maramba I, Wheeler S. Wikis, blogs and podcasts: a new generation of Web-based tools for virtual collaborative clinical practice and education. BMC Medical Education. 2006;6(41). [cited 2014 Mar 31]. Available from: http://www.biomedcentral.com/1472-6920/6/41.
28. Boulos MNK, Wheeler S. The emerging Web 2.0 social software: an enabling suite of sociable technologies in health and health care education. Health Information and Libraries Journal. 2007;24(1):2-23.
29. Phillippi JC, Buxton M. Web 2.0: easy tools for busy clinicians. Journal of midwifery & women's health. 2010;55(5):472-476.
30. Cordell N. How I use it: social bookmarking. Occupational medicine (Oxford, England). 2012;62(8):673-674.
31. Ginsparg P. Next-Generation Implications of Open Access. CTWatch Quarterly. August. 2007;3(3):11-18.
32. Ware M, Monkman M. Peer review in scholarly journals: Perspective of the scholarly community – results from an international study. Information Services and Use. 2008;28(2):109-112.
33. Kramer-Duffield J. Beliefs and Uses of Tagging among Undergraduates [dissertation]. Chapel Hill, NC: University of North Carolina at Chapel Hill; 2010. 342 p.
34. Kipp ME, Campbell DG. Searching with Tags: Do Tags Help Users Find Things?. Knowledge Organization. 2010;37(4):239-255.
35. Durieux V. Le collaborative tagging appliqué à l'information médicale scientifique: Étude des tags et de leur adoption par les médecins dans le cadre de leurs pratiques informationnelles [dissertation]. Bruxelles: Université libre de Bruxelles; 2013. 291 p.
36. Norlin E. Usability testing for library websites : a hands-on guide. Chicago : American Library Association; 2002. 69 p.
37. Rubin J, Chisnell D. Handbook of usability testing : how to plan, design, and conduct effective tests. Indianapolis : Wiley Publishing; 2008. 348 p.
38. Zipf GK. Human Behaviour and the Principle of Least Effort: An Introduction to Human Ecology. Cambridge, Mass.: Addison-Wesley Press; 1949. 573 p.
39. Hersh WR, Hickam D, Haynes RB, McKibbon KA. A performance and failure analysis of SAPHIRE with a MEDLINE test collection. Journal of the American Medical Informatics Association.1994;1(1):51-60.
40. Jansen BJ, Spink A, Saracevic T. Real life, real users and real needs: A study and analysis of users' queries on the Web. Information Processing and Management. 2000;36(2):207-227.
41. Fisher RJ. Social Desirability Bias and the Validity of Indirect Questioning. Journal of Consumer Research. 1993;20(2):303-315.
42. Spink A, Jansen BJ. Web search: public searching on the web. Dorndrecht, Netherlands;

Boston: Kluwer Academic Publishers; 2004. 198 p.
43. Francq P. Internet. Tome 2: Le caractère fétiche. Fernelmont (Belgique): Ed. modulaires européennes; 2011.
44. Glaser BG, Strauss AL. The discovery of grounded theory: Strategies for qualitative research. New York: Aldine de Gruyter; 1967. 271 p.
45. Hersh W.R. Information retrieval : a health and biomedical perspective. New York: Springer; 2003. 517 p.