

Exploratory Information Search by Domain Experts and Novices

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ABSTRACT

The arising popularity of social tagging system has the potential to transform traditional web search into a new era of social search. Based on the finding that domain expertise could influence search behavior in traditional search engines, we hypothesized and tested the idea that domain expertise would have similar influence on search behavior in a social tagging system. We conducted an experiment comparing search behavior of experts and novices when they searched using a traditional search engine and a social tagging system. Results from our experiment showed that experts relied more on their own domain knowledge to generate search queries, while novices were influenced more by social cues in the social tagging system. Experts were also found to conform to each other more than novices in their choice of bookmarks and tags. Implications on the design of future social information systems are discussed.

Author Keywords

Social search, exploratory search, domain expertise.

ACM Classification Keywords

H.3.3 Information Search and Retrieval: Search Process.
H5.4. Information interfaces and presentation (e.g., HCI):
User Issues.

General Terms

Experimentation, Human Factors, Performance

INTRODUCTION

As information search is becoming one of the most prominent activities for Web users, Web search has evolved into a social activity that involve exploring, learning, and sharing of information [9] in addition to simple query-based fact retrieval. Though search engines are good for direct fact retrievals, exploratory search often involves an iterative process of exploration and goal refinement as knowledge is incrementally acquired during the process [3, 7]. Previous

research suggested that social search environment could facilitate users' information search by providing information cues (e.g., social tags) from others that direct users to the right information (e.g., [4, 7]). It is therefore reasonable to assume that for exploratory search, social information systems such as delicious (www.delicious.com) may be more desirable than traditional search engines such as Google (www.google.com).

Results from prior research have already shown that domain expertise would influence users' search behavior, reflected on their search queries and success rate. White et al. [10] found that domain experts generated longer queries and used more domain specific vocabularies. They also suggested that domain experts are more successful in their search than novices. Duggan and Payne [2] suggested that greater knowledge could increase the ability of users to select more related information. Similarly, Hsieh-Yee [6] found that subject knowledge would play an important role affecting experienced searchers' reliance on their own language, indicating that when users were searching in their domain, they used more of their own terms. However, none of these results shows how experts and novices search differently in a social context. Some researchers [8] proposed that social search systems can potentially improve learning compared with the keyword-based search engines, but there is still a lack of understanding on how domain expertise of users may affect their exploratory search behavior in a social search environment.

As social tagging systems allow users to see other users' interpretation of the same information contents, we hypothesize that domain expertise will impact not only what information they select from the Web, but also influence how they interpret contents tagged by others, and how they assign tags to the information contents. In other words, domain expertise may play a pivotal role in influencing the *sharing and understanding* of information in the iterative exploratory searching cycles as users are interacting with a social tagging system.

METHOD

We used a 2×2 between-subject design to investigate users' search behavior when users with different levels of domain expertise searched in different search environments. While Google provides a traditional search environment for keyword-based queries, delicious provides a social search

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environment with tagged bookmarks saved by other users, which allow users to conduct either tag-based or keyword-based queries. Under the assumption that domain expertise might influence users' exploratory search process, we expected that experts and novices could have different search performance when they performed exploratory search using the two interfaces.

Participants

48 participants were recruited for the study (22 female, 26 male, $M = 24.4$ years). All participants were skilled computer users with more than 10 years of computer usage experience. All participants reported Google as their most familiar search engine and that they performed Internet searches with an average frequency of 3.95 on a 5-point scale (interpreted as "use search engine several times a day"). 24 of the participants claimed to have expert knowledge in finance or related area (such as holding an advanced degree or have employment experiences in the finance industry). The other 24 did not have any professional knowledge in finance or related fields. Expert and novice participants were randomly assigned to one of the two interfaces. Each condition has 12 subjects.

We designed a short survey with 5 questions to test their knowledge of finance and economics as well as their familiarity of the current financial crisis on a 5-point scale. A sample question is: "I know the causes and backgrounds of the current financial crisis". We found a high reliability for the self-report questions (Cronbach's $\alpha = 0.921$). A knowledge test was then used to test participants' domain knowledge about the financial crisis. Questions in the knowledge test were generated from online quizzes and textbooks on financial crisis. The test was reviewed by two graduate students major in finance and one professional who had been working in a financial holding company for more than 15 years.

The Exploratory Search Tasks

We used "financial crisis" as the topic for our exploratory search task. Participants were asked to imagine that they were to collect information from the Web to give a talk on the topic of financial crisis. They were encouraged to explore information using their assigned search tools (Google or delicious) to enrich their knowledge. During the search process they were asked to *save and tag* useful websites as bookmarks as much as they needed. In delicious, they could save websites as bookmarks in their assigned web account; in Google, they could save bookmarks into a given folder and create tags for each saved bookmark. They were instructed to search, read, and select information, but not to spend too much time on each page to keep a good balance between exploration and understanding a specific document.

Procedure

Upon their arrival at the facility, participants were first debriefed about the task and the goal of the research. They were then asked to read and sign the consent form for

participating in the experiment. Participants then filled out a general survey about experience in computer, demographics and the short survey on their background knowledge. Each participant was randomly assigned to the Google or delicious condition. Participants performed the exploratory search task individually and were given a maximum of 1.5 hours for their task. Camtasia recorder was used to record all on-screen actions of the participants. After finishing the search task, they completed the knowledge questionnaire. The knowledge questionnaire was given after the search task to avoid potential priming effect on their search performance by the knowledge questions. The whole experiment took about 2 hours.

RESULTS

Domain Experts vs. Novices

From the self-reported domain knowledge, we found significant difference between experts and novices ($M = 3.8$ and 2.87 on a 5-point scale, $p < 0.001$). Consistent with the self-reported ratings, we also found a significant difference on the knowledge test score between experts and novices ($p < 0.05$).

Search Strategy

In order to see how domain knowledge influenced their search performance in the social environment, we first looked at the search strategies of the experts and novices in the social condition. Participants could use tag-based queries (selecting tags from the popular tags list or from other users' tags attached to each website title) or keyword-based queries (entering keywords in keyword search box) in delicious; but they could only use keyword-based queries in Google. ANOVA results showed that the interaction effect of expertise \times search strategy was significant ($F(1,38) = 5.349$, $p < 0.05$). As shown in Figure 1, experts used more keyword-based search, while novices used more tag-based search. This result is consistent with results from previous research [6] that experts were more likely to come up with their own keyword-based queries to search, but novices relied more on using other users' tags to search.

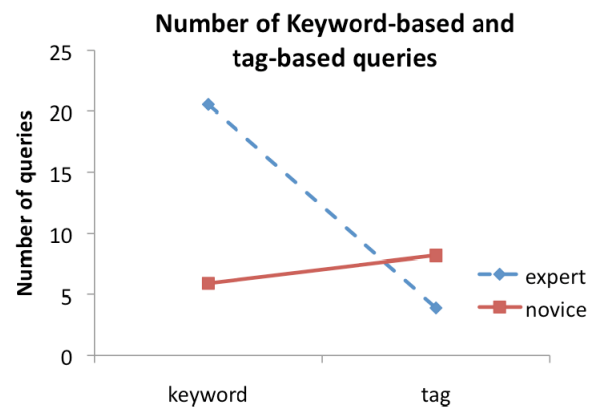


Figure 1. Search strategy of experts and novices in delicious

In other words, experts tended to rely more on knowledge in their heads and novices tended to rely more on

knowledge in the environment when they performed the information search.

Consensus on Tag Choice

As the result above indicated, domain knowledge influenced how user searched for information. We analyzed their tags in order to find out whether domain knowledge would influence their interpretation of information. Among the 48 participants, 3 participants have invalid tags (e.g., “bookmark 1”). The other 45 participants created 3046 tags in total. On average, every participant created 2.73 tags on each bookmark (SD = 1.76). After getting rid of stop words and invalid tags, the number of distinctive tags is 1384. As the number of distinctive tags was much fewer than the total number of tags, we speculated that the higher proportion of shared tags could be caused by: (1) social effect on tag choices in delicious, and/or (2) participants with similar knowledge background might have similar interpretation to information about one topic. In order to investigate which factor drove tag sharing, we performed a 2 (interface) × 2 (expertise) ANOVA using the number of users sharing each tag as dependent variable.

Results showed that the main effect of interface and expertise were significant ($F(1, 5528) = 54.75, p < 0.001$; $F(1, 5528) = 7.65, p < 0.05$). The interaction effect of interface × expertise was also significant ($F(1, 5528) = 45.75, p < 0.001$). As shown in Figure 2, the interaction effect illustrated that experts using delicious shared more tags than novices ($F(1, 2764) = 70.30, p < 0.001$), but we could not find any difference between experts and novices when they were using Google ($F(1, 2764) = 0.35, p = 0.55$).

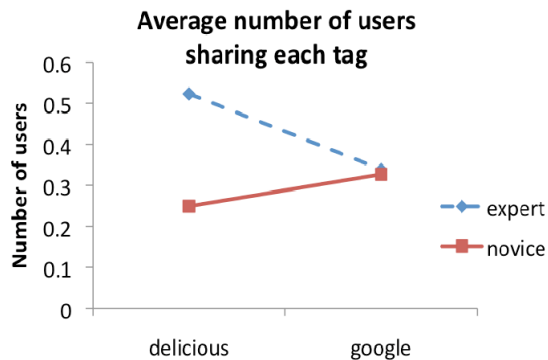


Figure 2. Sharing of tags in Google and delicious

This result indicated that experts were more likely to agree with each other than novices in tag choices. Although it might seem surprising that experts had higher level of agreement on their tag choices even though they tended to search using their own queries, the result could be explained by their specific knowledge structures that influenced them to assign the same tags to the Web documents. Indeed, experts in the same domain were likely to share more common semantic representations of the same topic [4, 5]. Therefore when experts were in a social environment, they tended to use similar tags as other experts. In contrast, novices tended to have more diverse interpretation to a topic, and might be more likely to use different tags to describe the bookmarks. In Google, experts and novices did not have this difference,

possibly because of the mediation of the query suggestions provided by Google. Given that we did not collect data on query suggestions in this experiment, their effect could not be assessed; but their effects will be studied in our future study.

Consensus on Bookmark Selection

To further explore whether or not the social search environment could benefit users, we examined the bookmarks saved by participants. 48 participants selected 1170 bookmarks in total ($M = 24.9$ bookmarks/participant, $SD = 13.4$). Among those 1170 bookmarks, 363 bookmarks were saved by more than 2 participants. The most popular bookmark was saved by 11 users (the wikipedia page on subprime mortgage crisis).

We divided all bookmarks into two groups: we called those bookmarks shared by more than two people *popular* bookmarks and the rest of them *unique* bookmarks. We were interested in finding out whether participants with different level of domain expertise and the use of different interfaces might differ in their sharing of popular or unique bookmarks. To this end, we performed a 2 (popular/unique) × 2 (interface) × 2 (expertise) ANOVA using the number of participants sharing each bookmark as dependent variables. Results from the ANOVA showed that the main effects of shared frequency and interface were significant ($F(1, 484) = 43.63, p < 0.001$ and $F(1, 484) = 21.11, p < 0.001$), but the main effect of expertise was not significant. The interaction of shared frequency × interface and expertise × interface were both significant ($F(1, 484) = 11.74, p < 0.001$; $F(1, 484) = 7.14, p < 0.05$). The three-way interaction of shared frequency × interface × expertise was not significant.

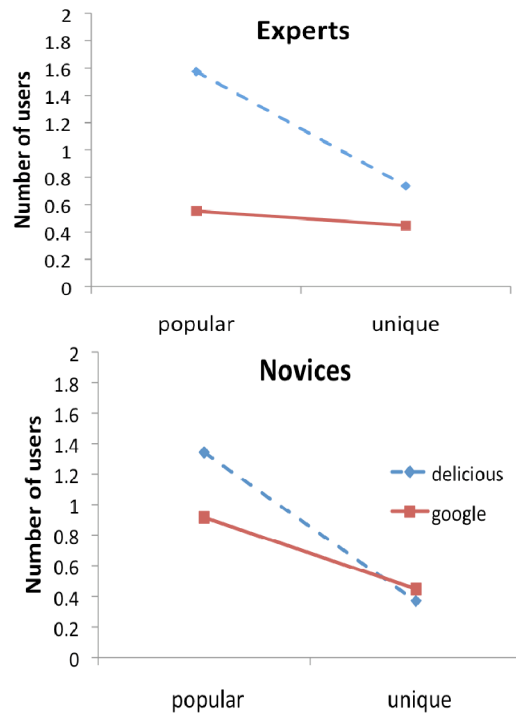


Figure 3. Bookmark sharing of experts and novices

Since the main effect of expertise did not reach significance, we carried out separate ANOVAs on each of the two

expertise groups. The interaction effect of shared frequency \times interface was significant in both experts and novices ($p < 0.05$). As shown in Figure 3, both experts and novices shared more general bookmarks when using delicious than when they were using Google ($p < 0.001$ and $p < 0.05$). For unique bookmarks, experts shared more in delicious compared to Google, though the difference was only marginally significant ($p = 0.14$). Novices did not show this difference in sharing unique information ($p = 0.42$). We also examined the contents of these bookmarks. We found that most of the unique bookmarks were either specific web sites describing a particular event, or professional websites developed for finance professionals. Therefore, the unique bookmarks were closer to experts' knowledge, which facilitated experts' bookmark selection but impeded novices' bookmark selection as novices might not have the background knowledge to judge whether or not they were relevant information [10].

In summary, delicious was able to support both experts and novices in finding general information in a particular topic domain, even though novices did not share more tags. In other words, novices in a social tagging system were still able to find information they needed, but could not interpret the information correctly, as reflected by their more diversified tag choices. Traditional search engine could help novices' information search by providing query suggestions, but could not assist experts' search.

CONCLUSION AND DISCUSSION

Based on the empirical data from a laboratory experiment, we found preliminary evidence supporting that domain expertise can facilitate exploratory information search in social tagging systems for both *sharing* and *understanding*. Specifically, we found that experts shared more bookmarks and tags related to the assigned topic in delicious compared to Google. Experts also shared more tags than novices when they were both searching in delicious.

As experts used more keyword-based queries than novices in delicious and novices used more tag-based queries, we believe that experts were more likely to utilize knowledge in their head to search for information, and novices relied more on information in the environment. The results provided further support that social information websites can facilitate sharing of useful information among novice users, and they do seem to have potential to augment the exploratory search of information, especially for users who have little knowledge on the topic. Although Google provides automated query suggestions that might be similar to social cues, how experts and novices utilize the recommended queries still needs investigation.

Our results also provided some implication to the design of future social information systems. Most current tagging systems recommended tags only based on the use frequency, which may lead to the "vocabulary problems" that make finding the right information difficult. Incorporating quality

of tags as part of the algorithm that determines which tag should be presented would definitely benefit information seekers to use high-quality tags as navigational cues to find more related information. Since domain experts have professional knowledge in their domain, it is reasonable to consider that tags created by domain experts would have higher quality. Also, tags created by experts might have greater potential to facilitate other's searching than "good tags" generated by computer algorithms, because expert-created tags can support the exchange of users' understanding to the information. As we found experts shared more information in delicious, it is possible to identify experts in a social tagging system by certain data mining techniques that match the tagging and searching behavioral patterns of users. By putting more weight into the tags created by experts, one could reduce the potential drawbacks caused by the "vocabulary problem" and increase the effectiveness of information sharing in social tagging systems.

REFERENCES

1. Cattuto, C., Loreto, V., and Pietronero, L. (2007). Semiotic Dynamics and Collaborative Tagging. *Proc. National Academy of Sciences*, 104(5), 1461-1464.
2. Duggan, G.B. and S.J. Payne. (2008). Knowledge in the Head and on the Web: Using Topic Expertise to Aid Search. *Proc. CHI 2008*, ACM, 39-48.
3. Fu, W.-T. (2008). The Microstructures of Social Tagging: a Rational Model. *Proc. CSCW 2008*, ACM, 229-238.
4. Fu, W.-T., Kannampallil, T. G., Kang, R. (2010). Facilitating Exploratory Search by Model-Based Navigational Cues, *Proc. IUI 2010*. ACM, in press.
5. Fu, W.-T., Kannampallil, T. G., Kang, R. (2009). A Semantic Imitation Model of Social Tag Choices. *Proc. 2009 IEEE SocialCom*, in press.
6. Hsieh-Yee, I. (1993). Effects of Search Experience and Subject Knowledge on the Search Tactics of Novice and Experienced Searchers. *Journal of the American Society for Information Science*, 44(3), 161-174.
7. Kang, R., Kannampallil, T. G., He, J., Fu, W.-T. (2009). Conformity out of Diversity: Dynamics of Information Needs and Social Influence of Tags in Exploratory Information Search. *Proc. HCHI 2009*, 155-164.
8. Kammerer, Y., Nairn, R., Pirolli, P. L., Chi, E. H. (2009). Signpost from the Masses: Learning Effects in an Exploratory Social Tag Search Browser. *Proc. CHI 2009*, ACM, 625-634.
9. Marchionini, G. (2006). Exploratory Search: from Finding to Understanding. *Commun. ACM* 49, 4, 41-46.
10. White, R.W., S.T. Dumais, and J. Teevan. (2009). Characterizing the Influence of Domain Expertise on Web Search Behavior. *Proc. WSDM 2009*, ACM, 132-141.