Search Tactics in Collaborative Exploratory Web Search

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ABSTRACT
This paper presents a user study to investigate search tactics involved in collaborative exploratory Web search. Both process and products related search tactics were examined through the analysis of transaction logs, chat logs and interview transcript. We found the search tactics employed by the participants vary on different search tasks.

Author Keywords
Collaborative web search, exploratory search, collaborative information behavior, search tactics

ACM Classification Keywords
H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces – Collaborative computing, Computer-supported cooperative work

INTRODUCTION

Collaborative information seeking has been studied in various environments including both organizational and Web setting [4][7]. Our study focuses on collaborative exploratory search in the Web search environment. A collaborative web search system needs not only support the interaction between a user and the system, but also support the interaction among users. Studies which seek to describe collaborative search process can help developers understand the range of behaviors and activities that systems need to accommodate.

Search strategies and tactics have been important research topics in information seeking studies since they reveal meanings behind users' interactions with an IR system [12]. Bates [1] proposed the notion of search tactics which consist of a move or moves applied to advance the search process. The design of IR systems therefore needs to facilitate essential search tactics. Significant research work has examined search tactics in the search process that a single user interacting with the IR system [12]. There also have been a few efforts investigating search tactics in collaborative information seeking. Twidale et al. [11] proposed two sets of collaborative search tactics related to search process and search products based on the observation of how students used computer systems in a university library to find information. Morris [7] conducted a survey aiming to reveal collaborative activities in Web searches. Similarly to [11], she also summarized collaborative activities into two categories: collaboration on search process and collaboration on search products.

Investigating search tactics can help us to understand user behavior and activities in Web search. User actions involved in collaborative exploratory search are more complicated than that in individual search. In collaborative search, users do not only need to take actions toward the completion of search task, but also need to take actions to facilitate the collaboration. Therefore, revealing the collaborative search tactics behind user actions is a challenging task. There have been initial efforts to investigate search tactics related to collaboration. In this study, we present a user study to investigate search tactics involved in collaborative exploratory Web search when users interacting with an integrated collaborative Web search system.

EXPERIMENT DESIGN

Our study was designed as a set of control experiments with human participants using CollabSerach, a collaborative search system developed by the authors.

System Design and Rational

In this study, we need a system that could facilitate user to conduct Web search collaboratively. On the one hand, it should have basic functions that make collaborative search possible. On the other hand, it should not be too sophisticated so that users have certain flexibility on exploring various search tactics. Recently, several systems have been described in the literature to be designed for supporting explicit collaboration, including SearchTogether [6], Coagmento[10], Cerchiamo [9] and Querium [2]. We built our prototype system CollabSearch[1] based on the examination of features in these systems. Some features that had been reported to be very important, such as chat and shared workspace were implemented. As shown in figure 1, the left side of the system's interface is the space for chat. And the main interface contains three frames: topic statement, Web search and team workspace. The topic statement frame shows the task description on which the user is currently working. Team members can also post their comments below the task description. The search frame connects the user's query to Google, and displays the Google search results. Users can also see their search

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[1] http:// crystal.exp.sis.pitt.edu:8080/CollaborativeSearch/

histories (queries) as well as those of their teammates. Users examine search results for relevant information, and can save a whole Web page or a snippet of the page. All the saved web pages and snippets, collected by the user and the teammate, are stored in the team workspace frame.

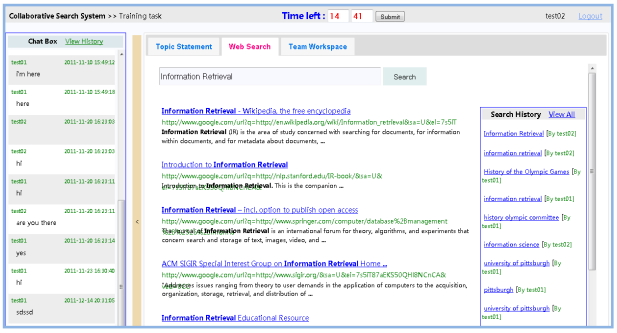

Figure 1: The web search frame of CollabSearch

Design Rational for Process Collaboration

Coordinated searching is an important search tactics observed by [11]. Using CollabSearch, users in the same team could communicate with each other by sending instant text messages to coordinate their search process. We didn't implement advanced features such as split search in SearchTogether because the coordination process can be accomplished through communication and users can be creative in how they want to complete the search tasks collaboratively.

Design Rational for Products Collaboration

Besides the collaboration on search process, sharing search products have been recognized as very important search tactics. In CollabSearch, the team workspace is designed for user to share the relevant search results. Users can click to view more details of an item in the workspace, comment on or assign tags to any item. Users can also decide whether certain items been visible to other team members or not.

Figure 2: The workspace frame of CollabSearch

Participants

16 participants (8 pairs) were recruited from the University of Pittsburgh for this study. 10 of these participants are male and 6 are female. All of them are experienced searchers. All the participants signed up as pairs, and the members of each pair know each other before the study so that it was reasonable natural for them to form a team. Participants in the same team worked on the same task simultaneously. As we were trying to simulate remotely-located collaboration, participants were in different cubicles and no face-to-face communication was allowed.

Search Tasks

Two exploratory web search tasks were used in this study. Both of them had been used in other collaborative web search studies [10] [8]. One task (T1) is related to academic work, which asks participants to collect information for a report on the effect of social networking service and software [10]. The other task (T2) , which is about leisure activities, asks participants to collect information for planning a trip to Helsinki [8]. Morris' [7] identified that travel planning and academic literature search are two common collaborative search tasks. Therefore, both tasks here are representative in studying collaborative web search. The task description carefully states the kind of information that the participants need to collect and the goal is to collect as many relevant snippets as possible.

Experiment Procedure

The experiment procedure was: each team worked on both tasks. The order of the two tasks was rotated to avoid the learning and fatigue effect. During the experiment, after being introduced to the study and the system, and filling out an entry questionnaire to establish their search background, these participants worked on a training task to get familiar with the system for 15 minutes. Then they worked on task 1 or task 2, depending on the task order assigned for each team. They had 30 minutes for each task. Before the end of the experiment, participants interviewed for their experience with both tasks.

DATA ANALYSIS METHODS

We investigated the search tactics by analyzing transaction logs, chat logs as well as the transcript of interview.

User Action Categorization

In order to analyze the transaction logs, we categorized user actions into 6 categories: Query, View, Save, Workspace, Topic and Chat, whose details are listed in Table 1.

Actions	Descriptions
Query (Q)	A user issues a query or clicks a query from search history.
View (V)	A user clicks a result in the returned result list
Save (S)	A user saves a snippet or bookmarks a webpage
Workspace (W)	A user clicks or edits or comments an item saved in the workspace
Topic (T)	A user clicks the topic statement or leaves comments
Chat (C)	A user sends an message or views the chat history

Table 1: User search actions

Content analysis

We used the same coding schema as in [3] to analyze the chat logs. Messages were categorized into task coordination, task content, task social, non-task and non-codable. The first two categories are important for the analysis in this study. Messages discussing about how participants want to divide the search topic, the status of their search are categorized as task coordination (CC). Messages talking about the information need and search

results are coded as task content (CN). The interview transcription was also coded to extract useful information related to participants' search tactics.

RESULTS

Collaborative actions

Among the 6 types of user actions, Chat and Workspace are actions related to collaboration. In terms of Workspace, we further recognize actions that participants review items saved by him/herself as Workspace_Self (WS) and actions that participants review items saved by their partners as Workspace_Partner (WP).

		T1	T2
Chat	**Coordination (CC)**	11.2	5.76
	Content (CN)	3.06	26
Workspace	**Self (WS)**	4.19	2.75
	Partner (WP)	4.31	2

Table 2: Average number of collaborative actions per user

From table 2 we can see that the usage of Chat and Workspace are very different in the two tasks. In T1, participants tend to use Workspace more often and in T2 they tend to use Chat more often. Most of the messages in T1 are about CC. This is because participants usually divide the search topics at the beginning and then keep each other posted about the status of their search. While in T2, participants constantly discuss with each other which place they want to visit or which restaurant they want to go to during the travel. Therefore, most of the chat messages are related to CN in T2. This reveals the nature of the differences of these two tasks. For academic task T1, the criteria of what information is relevant are objective and participants "*trust each other on the judgment of what information to collect*" *(P7a)*. The travel planning task T2, the relevance criteria are subjective, which depends on personal opinions of each team member. Therefore, participants were more involved in the discussion of their information need and search results.

Process Related Search tactics

Coordinated searching

We recognized three different ways of coordinating search among the eight teams in the study. The most frequent employed method is to split the search topic in sub-topics and each team member take part of it. One example of how they split the search topic is shown as follows:

P1a *how would you like to split this one up?*
P1b *the first one is pretty large - maybe both do it and keep an eye on the search history?*
P1a *okay, good idea*
P1b *um, the impacts one and commerce one we could probably each work on separate?*
P1a *Yeah*

Table 3 shows that participants in team 1,2,7 and 8 split their search by topic for both tasks. Previous research [9] had recognized different roles of prospector and miner in collaborative search. We also had the similar finding in one of the teams. One participant in team 6 took the role of prospector who in charge of exploring the information while the other person work as a miner to examine the information found by the prospector in detail and keep updating what had been found what were still missing. We do find cases that team members do not explicitly divide the responsibilities, such as participants in team 3. They mentioned in the interview that they didn't collaborate in T1 because "*we were given so much time that (collaboration) wasn't necessary."* And in T2 *"we just stick together and plan for each activity."* However, in T1 they did check the team workspace: *"I would check if from time to time and see what he put in there".* And in T2 they conversations were like *"let's think about first activity, it should be outdoor".*

	T1	T2
Split of topic	P1, P2, P4, P7, P8	P1, P2, P5, P7, P8
Split of role	P6	P6
No explicit split	P3, P5	P3, P4

Table 3: Collaboration on search process

Pre-Chat analysis

We are also interested in what triggered the participants to explicitly communicate with each other. Therefore we conducted pre-chat analysis. Since Chat is a continuous action, we want to see what triggered the first chat message in a series of continuous chat messages. Table 4 shows the probabilities of other five types of actions as predecessors of CC and CN respectively. For pre-CC, we calculated the percentage of each of the other five types of actions as the predecessor of CC for each user and then average the percentages across all users. Others are calculated the same way. It can be seen that the most possible action that triggered CC in both tasks is Topic, which might indicate participants divide the search topics after reading the topic statement. Although the action Topic is an artifact of the experimental setup, to a certain extent it represents a typical type of behavior – define problem [5] in the exploratory search. The most possible action that triggered CN is View in T2, which is easy to understand that participants may want to discuss the items after viewing them.

		Q	V	S	W	T
Pre-CC	T1	0.06	0.10	0.18	0.25	**0.41**
	T2	0.05	0.07	0.16	0.15	**0.44**
Pre-CN	T1	0	0.13	0.13	0.15	0.15
	T2	0.06	**0.31**	0.20	0.26	0.17

Table 4: Pre-Chat Analysis

Product Related Search tactics

Share, tag and comment on products

In terms of the search tactics related to search products, we examined how participants shared, tagged and commented on the items they found. When participants save items to the team workspace, the default is set to be "*visible to everyone*". Although they were told in the system training that it can be changed it to "*visible to myself*", they chose to share every item with their partners. As showed in table 5,

100% of the items in the team workspace were shared. Some participants found it useful to organize the items they saved by assign tags. But comments were seldom used since participants were involved in synchronous search and they prefer to directly send each other message.

	T1	T2
Shared items	100%	100%
Tagged items	39%	42%
Commented items	5.2%	7.5%

Table 5: Collaboration on search products

Pre-Workspace and post-Workspace analysis

We also did analysis to see what triggered participants to check the items saved by their partners and what did they do after viewing those items. Table 6 shows that the most possible predecessors of WP is Chat in T1 and Save in T2. This difference might be caused by the fact that in T1 participants tend to update each other by chatting when important items had been saved without mention the detail content. So the other person would check the workspace for that update. However, since they directly discuss the content of search results through chatting in T2, they usually didn't need to check the workspace until they saved something themselves. After viewing the items of their partners' in T1, participants tended to check the topic statements probably to see what else are still missing. While in T2, they were most likely to discuss with their partners probably about their opinions toward the item, which might again emphasize how subjective opinions matter in T2.

		Q	V	S	T	C
Pre-WP	T1	0	0.06	0.25	0	**0.69**
	T2	0.11	0.2	**0.39**	0.12	0.18
Post- WP	T1	0.03	0.16	0.09	**0.54**	0.25
	T2	0.19	0	0	0.32	**0.49**

Table 6: Pre-Workspace and Post-Workspace Analysis

DISCUSSION AND CONCLUSION

In this study, we examined process and products related search tactics by analyzing two types of collaborative actions: Chat and Workspace respectively. Chat represents explicit communication while Workspace represents general awareness of others' activity [2]. We found the search tactics employed by the participants vary on different search tasks. General awareness of others' activity is more frequently required in T1 while explicit communication is more common in T2. Although there were only two topics tested, they represent two typical types of exploratory search task. In tasks like T1, advanced collaboration features such as task management might help users to monitor the progress of search. While in tasks like T2, features that could support users to share their opinions on search results might be more helpful. So far CollabSearch only support collaborative search on the interface level. In the future we plan to implement algorithmic mediation [2] features in the system. Further studies such as how users' queries and exploration path been affected by the communication and other collaborative activities are needed to fully understand users' collaborative search tactics and how collaborative search system should be designed accordingly.

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