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Collaborative information seeking (CIS) has gained greater attention in recent years. While most of the previous research and systems design have been done with the individual information seeker in mind, it has become apparent that there is a greater need to study the information seeking practices of groups. This study is focused on the information-seeking practices of undergraduate students. These students were invited to participate in a survey asking about the last time they participated in collaborative information seeking. They were asked detailed questions about this event to get a better understanding of the CIS process. The study found that undergraduate students, while a different population than what is studied in much of the current CIS literature, has similar needs, difficulties, and processes as other populations.

Headings:

Collaborative Information Seeking

Collaboration

Information Seeking

UNDERSTANDING THE COLLABORATIVE INFORMATION-SEEKING PRACTICES OF UNDERGRADUATE STUDENTS

by
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Introduction

Information retrieval activities and behaviors have been studied often since information gathering is encountered frequently in both personal and professional environments (Prekop, 2002). This is especially true at a time when the internet provides more information than can be realistically processed during a simple web search. Research has been done for many years on the process of information seeking, and seeking models and theories have been developed representing the process (Hyldegård, 2009). Many aspects of information seeking have been studied, including how a person formulates an information need, what types and lengths of queries are used during a search, and when a person decides that their information need has been satisfied (Belkin et al, 2003; Prabha, C., Connaway, L. S., Olszewski, L., & Jenkins, L. R., 2007; Taylor, 1968). In addition, research has led to the development of systems and features to support the process of information seeking and to make it more effective and successful (Morris & Horvitz, 2007).

While much research has been done on individual information-seeking behaviors, information seeking in a collaborative setting has been gaining greater attention as its importance to a variety of fields and professions is realized. The complexity of information seeking is possibly increased when it is approached in a collaborative fashion; not only does the appropriate information have to be retrieved, but participants need to find common ground on the information need and end goal. Add to this a variety

of personalities, abilities, and individual motivations and it is easy to see why collaboration potentially makes information seeking more complicated.

Recent research has often focused on exploratory methods and understanding the collaborative information seeking process in general (Fidel, Pejtersen, Cleal, & Bruce, 2004; Hansen & Järvelin, 2005; Hyldegård, 2009; Prekop, 2002; Spence, Reddy and Hall, 2005). While some research has identified basic patterns to the process these conclusions have often been based on small samples or preliminary data gathering and are not yet generalizable to information seekers as a whole. In addition to the overall process, some research has been done on systems design and the functions that would be most useful to collaborating groups (Morris & Horvitz, 2007). Further research needs to be done to determine how different populations approach the collaborative process to see if study results can be generalized between the groups. Methods from previous studies on why people are motivated to participate in collaborative information seeking or what functionality could be most useful in an information retrieval system could be used to conduct research on other populations to validate the results.

The research questions proposed in this paper will attempt to further existing research on collaborative information seeking (CIS) or retrieval (CIR) by gaining an understanding of how people approach the collaborative process. Rather than studying the effectiveness of any one retrieval system, this study will attempt to determine basic attitudes and strategies people use in the collaborative process and explores the following research questions: (1) What types of situations require collaborative information seeking or what triggers CIS? (2) What difficulties are experienced during a collaborative

information seeking event? (3) How do people seek information when a collaborative effort is required?

The purpose of studying the research questions identified will be to strengthen the current understanding of collaborative information seeking as a whole. Existing research will be used to inform the approach used here for studying collaborative groups and how they interact.

Importance of Study

Collaborative information seeking is an important topic to study because it plays a role in many different fields and professions. Regardless of the career, collaboration is often necessary to solve problems or simply to gain more information on a topic related to the field or specific job. Finding out more information on how people approach CIS (both their attitudes toward the process and the actual steps taken while collaborating) could help managers better prepare, train, or mentor their employees in how to make collaboration more successful. By finding out which tools people think are helpful to collaboration or even their ideas on potentially beneficial functionality could provide ideas for systems designers on how to plan and design practical and useful information retrieval and organizational systems. Further study in CIR would certainly contribute to library and information science in the aspects of information retrieval and how people approach the retrieval process as well as for the design of systems. It could benefit the field of business in terms of training employees on how they can be successful in CIS events.

There are a variety of populations that would be appropriate for studying collaborative information seeking. Using a different population outside of emergency department staff (as used in the Reddy & Spence article) or a design or customer-service team (as used in the Fidel, et al article) would be valuable as it could strengthen the conclusions made in these two articles if it was found they were applicable to additional populations and environments.

Literature Review

Overview

Collaborative information seeking and retrieval (CIS or CIR) has started gaining greater attention in recent years. Much of the literature points out that information seeking and retrieval has been primarily focused on the individual in the past, but this has changed since collaboration is required in most, if not all, fields of work (Chi, 2009; Hansen & Järvelin, 2004; Hyldegård, 2009; Sonnenwald & Pierce, 2000). Collaborative processes are difficult to study because of the number of participants and aspects involved. As more information is gathered, the more difficult it can be for a group to process this information and use it for the shared information goal. Current researchers do not have one widely-accepted definition of what "collaborative information seeking" means and how it can or should be studied. Bruce, et al. (2003) define CIR as "any activity that is undertaken by members of a work team to collectively resolve an information problem" (p. 140). While this definition gives a broad picture of what is involved in collaboration, delving into exactly how to study this process can be difficult. The literature on CIS is presented here to gain an overview of current research in the field and to serve as a starting point for the research questions that will be addressed in this article. Researchers have been looking at similar questions in the last few years while attempting to determine what the process of collaborative information seeking consists of and the difficulties involved in the process.

Approaches and Needs in CIS

Many studies have been done simply to identify the basic components of CIS since the process is not fully understood (Evans & Chi, 2008; Prekop, 2002; Spence, Reddy, & Hall, 2005). Some of the important aspects of collaborative information seeking studied in the past are the motivations for a person to seek out collaboration to solve an information need, the types of information needs collaborating groups have, and the challenges to collaborating. Understanding these interconnected aspects of CIS could possibly give insight into the attitudes that people have towards collaborating and how collaboration is approached. Evans and Chi (2008) studied "social search" using a survey advertised through Amazon's Mechanical Turk (p. 485). Participants were asked a series of questions about their last search experience and the survey tried to identify whether the searcher interacted with others at any point during the search. In addition, participants reported some basic background information and whether the search was similar to or different from other search experiences. The study identified places in the search process where social interactions took place and Evans and Chi combined their findings with previously established models of information seeking. The responses were broken up into three types of searches: transactional, "performing a transaction and extracting information after a source or website is located"; navigational, "following a series of steps to identify a known fact or website"; or informational, "searching for information assumed to be present, but otherwise unknown" (p. 487). Evans and Chi found that before searching participants had some type of social interaction to either try to understand the information need more clearly or to refine the requirements of the search. This was particularly the case when the searcher was asked to locate information for someone else, rather than executing a self-initiated search. During the search, they found that whether

social interactions occurred often depended on the type of search. Social interaction did not occur during transactional or navigational searches, but did during informational searches. In particular, informational searches were affected by social interactions when participants needed feedback on their search results so they could conduct additional, refined searches or so that they could make sense of the final search results. Many of the participants reported that after their search the information was first organized in a meaningful way and then often distributed to others. Most of the distribution of information was to co-workers or others close to the searcher, rather than some unknown, public audience. It was found that in most of the cases, information was not exchanged during face-to-face communication but through some other means such as email or phone conversations. Evans and Chi took these findings about how searchers commonly interacted with others and why they sought out some type of interaction to suggest design improvements in systems that would support this kind of search behavior.

In Spence, Reddy, and Hall (2005), a survey was done of academic researchers at a small research university. The study aimed to find out the triggers most likely to lead to CIS activities, the communication method used for collaboration, and the success of the collaboration. For the survey, the authors listed three triggers they had identified during a previous study (lack of expertise, complex information need, and information not easily accessible) to try to determine which was the most important. The authors also mentioned that they did not know of any previous research that used a survey to gather data on CIS from a larger population. For this study, it was determined that the academic researchers most often collaborated when the information required an expertise different from their own. They also found that the researchers preferred "traditional" media for

communication, which they defined as email, face-to-face communication, and telephone (p. 87). The authors concluded that the researchers tended to use the communication methods that were already familiar to them. To determine if the researchers thought the collaborative information seeking event was successful, they were asked questions about whether the desired information was found, whether CIS was easier than individual searching, whether more relevant information was found with CIS, and whether information was found more quickly with CIS than during individual searching. It was generally determined with these questions that the researchers felt collaborative information seeking was successful. They did note that one participant added a warning that success can depend on the team of seekers. The questions asked in this survey as well as the responses could be useful questions to ask in future surveys about CIS and could serve as a basis for further information gathering about CIS in the academic research environment.

The study done by Prekop (2002) was qualitative in nature. Rather than asking a set of survey questions, the researcher wanted to determine the dimensions or components of collaborative information seeking. This study, done in the Command and Control Support (C2S) domain, studied 28 participants during meetings and interview sessions. The data analysis showed that there were three components important to collaborative information seeking activity: information seeking roles, information seeking patterns, and the contexts in which the roles and patterns are performed. Prekop describes context as "the collection of events, histories, culture, knowledge and understanding, which exist together at a point in time" (p. 535). A variety of roles were identified through the data analysis: information gatherer, information referrer, information verifier, information seeking instigator,

information indexer/abstracter, group administrator, group manager. The following patterns were identified as well: information seeking by recommendation, direct questioning, and advertising information paths. Similar to the Bruce et al. (2003) study of the Microsoft and Boeing teams, this study identified particular contexts as being important to a collaborative information seeking event. The roles and patterns in Prekop (2002) directly inform the research question in this study as potential approaches or methods of CIS.

Hansen and Järvelin (2005) sought to answer some of these basic questions about collaborative information retrieval as well. They studied a Swedish Patent and Registration Office through interviews, electronic diaries kept by the study participants, and observations. Through the study, they developed a basic framework of CIS. This framework defines two types of collaboration: document-related collaboration activities that involved creating or using documents and human-related collaboration activities that attempted to use knowledge held by someone else on the team. The specific activities identified as document-related were: sharing information objects or documents; sharing contextual information between objects; sharing representations of information need; sharing information seeking and retrieval strategies; sharing decisions, judgments and assessments; sharing opinions; sharing the history of information objects; using log history from team members searches; and using link history from other team members searches. Human-related activities were specified as: task cooperation; sharing divisions of PA tasks; sharing search strategies; external or internal domain expertise; end product creation; sharing opinions; and sharing internal experience. Hansen and Järvelin also defined different stages of the CIS process, including the work-task level, which involves

receiving a task (initiation), preparing and planning for a task, or completing a task. The information seeking task level is where basic information about the task is collected and the task needs are determined. The information retrieval task level is the stage in which queries are formulated (and possibly reformulated) and relevance judgments made. The framework developed by Hansen and Järvelin could be used to determine what activities are commonly experienced in CIS in other domains.

Fidel, Pejtersen, Cleal, & Bruce (2004) and Reddy & Spence (2007) both explored CIS by trying to understand what motivations a person would have to initiate CIS, rather than attempting to find the information on their own. In both articles, the populations studied were actively involved in the collaborative process so that researchers could observe first-hand much of the communication that was taking place. The researchers in each article used different methodologies for analyzing the collected data and focused on different populations, but had similar conclusions about why someone would initiate a CIS event.

Fidel, et al. (2004) found possible motivations for the "actor" to initiate the CIR process, defined in the Actor, Task Situation, and Organizational Analysis dimensions. Some of these motivations included: the actor was new to the organization or was looking for some kind of informal feedback/opinions about a decision they needed to make (Actor's dimension); the task required close collaboration among team members or the information was not structured in a way that was easy to understand and required some analysis or speculation (Task Situation dimension); the information needed was not documented or a decision had to be made that would affect the work of the entire team (Organizational Analysis dimension). The study also found potential challenges to CIR as

part of the Actor's dimension, including: actors have different stakes in the CIR process; it was necessary to decide which actors to include in the process (who would be the most helpful); information was often retrieved simultaneously by different actors; CIR was often initiated by a novice while the others involved are experts. The article concluded that these findings were just the beginning of the understanding of the nature of CIR and its motivations and challenges. The Fidel, et al. (2004) study serves as a starting point for the research questions on CIR posed in this paper. The methods and sample questions would be useful in formulating additional questions for surveys or interviews. The list of potential motivations for and challenges to CIR are useful for further studies looking at the motivations of why someone might seek out or initiate a CIR event.

The research in the Reddy & Spence (2007) article was done in the attempt to identify team information needs as well as situations that trigger collaborative information seeking. The study focused on an urgent care team in an emergency department (ED) of a small, rural hospital. The team in this department consisted of a variety of staff members (including physicians, nurses, technicians, and unit secretaries) that were all involved in some way with patient care or in support of the team members providing the patient care. For this study, collaborative information seeking was defined as "an information access activity related to a specific problem solving activity that, implicitly or explicitly, involves human beings interacting with other human(s) directly and/or through texts (e.g., documents, notes, figures) as information sources" (p. 243).

This study found that the information needs of the ED staff were primarily patient-specific, which included the plans for care of those patients (70.1%). They also found that 26.1% of the information needs expressed by the team members were related to

organizational issues (such as policy, procedures, coordination of resources/care within the unit). While the patient-related information needs most likely could not be generalized to other non-medical populations, the fact that many of the questions were oriented towards organizational issues could be potentially useful in other environments. In addition to identifying specific information needs, the study also found that CIS was triggered by: a lack of expertise, a lack of immediately accessible information, and high complexity of an information need. These motivations for CIS were similar to the motivations found in the Fidel, et al. (2004) study.

Developing Shared Understandings

Another important aspect of the CIS process is how members of a team develop a shared understanding of the project, problem, or task (Hertzum, 2008; Ntuen, Munya, & Trevino, 2006; Sonnenwald & Pierce, 2000). This concept of developing a shared understanding, while given a different name by different authors, has frequently been identified as important and appears to be essential to the CIS process. Hertzum (2008) defined CIS similar to the definition above but added the component of "collaborative grounding." He defined collaborative grounding as "the active construction by actors of a shared understanding and reflects available information" (p. 958). Developing this shared understanding, often referred to as "common ground", seems to be an important part of the collaborative process (p. 958.) Hertzum posits that as information is gathered by the group members it must be continually shared. Once the information is passed on, the group must develop a shared understanding of the information or the chances increase that the collaborative effort will not succeed.

Similarly, Sonnenwald and Pierce (2000) describe the process of finding a shared understanding as developing an "interwoven situational awareness" (p. 463). They break this down to different levels of awareness: individual, intragroup, and intergroup, and hypothesize that teams will benefit when they develop shared understandings on all of these levels. The study they performed focused on information behavior in the Command and Control (C2) domain. After analyzing different aspects of the C2 environment in terms of collaboration, they came to the conclusion that interwoven situation awareness was an aid to task completion. This was especially true in the C2 environment studied, as each individual on the team had specialized knowledge important to the overall functioning of the group. Team members needed to collaborate to determine how to best collectively absorb and understand information so that the group could benefit. On another level, different groups in the battalion had to work together as a whole since teams were performing separate functions but aimed at completing a shared objective. Sonnenwald and Pierce contend that a shared understanding on each of the three levels may be necessary since no one person can acquire or maintain a situational awareness over the complex range of teams and domains.

A related concept to collaborative grounding and interwoven situational awareness is collaborative sensemaking. Ntuen, Munya, and Trevino (2006) define collaborative sensemaking as "a social construction of knowledge". They cite references that indicate developing shared knowledge is essential to a team's effectiveness and ability to collaborate. The authors describe four elements or processes that are imperative to sensemaking. The first is the communication process, which is simply that knowledge held by individuals must be communicated to others in the group for the transfer of

knowledge to be possible and effective. The second element is the knowledge management process, which is making sense of information in a particular context. For CIS, it involves two types of knowledge: tacit knowledge and social knowledge. Tacit knowledge is knowledge of an individual that they may not even realize they possess, making the sharing of the knowledge extremely difficult. Social knowledge is knowledge that can be shared and distributed in a group. The third element is a shared situational awareness and understanding. In a team this happens by developing a shared mental model or "organized knowledge that members have in common regarding the task". The last element is the actual process for developing collaborative knowledge. By understanding the elements of this concept, the authors went on to develop a framework for system development to support collaborative sensemaking.

Though not focused exclusively on how a group develops a shared understanding, one of Hyldegård's (2009) study findings was that members of the groups were actively involved in finding a shared focus of the problem they were attempting to address. This study focused on three small groups of library and information science students as they worked to complete a group project. Hyldegård's study primarily focused on determining how collaborative information seeking differed from the process as approached by an individual. While it focused on collaboration from a different angle, the study found that developing a shared understanding was a motivation for much of the communication that took place in the group. One of the groups in the study had a difficult time finding a shared focus, resulting in feelings of "uncertainty, frustration, stress and disappointment" (p. 156). It was unclear exactly why this occurred in only one of the groups, but Hyldegård pointed out that the members of this group did not know each other

beforehand whereas the other group members did have some familiarity with one another before the group project began. There was not enough research on this particular aspect of the group interactions to draw definite conclusions, but it was mentioned as a potential aspect of CIS that needed further study.

Regardless of the name given to the process, there is plenty of research that indicates it is important for a group to develop a shared understanding of a situation or information problem for effective collaboration to take place. Having an understanding about how groups develop shared understandings of information could be an aid in determining how to better support this process. Also, it would be useful to find out if people involved in CIS feel that this is an important part of the process as well.

Environmental Differences

In addition to seeking a shared understanding of an information problem, which seems to be a general goal regardless of the field of the subjects, Bruce, et al. (2003) believe that the particular type of organization or environment can affect collaborative information seeking. Two teams were analyzed in this study, a software development team from Microsoft and an aircraft system design team from Boeing. The natures of the projects were very different: the software design project did not have well-defined requirements whereas the Boeing design team had very strict regulations. In addition, the Boeing team faced very serious consequences to any failure that had to be considered including the quality and safety of an aircraft. The study did identify some similarities between the two environments: design specifications, sequence, and schedule were extremely important, and both organizational cultures were based on direct communication between people. For both teams the design process was iterative and

highly interactive; meetings were often used for information exchange and to identify needs and strategies for meeting those needs. Both teams had a distinct division of labor between teams and individuals. While both teams had this division of labor, the way these divisions were achieved was very different. The Boeing team developed roles based on knowledge and expertise, whereas the Microsoft team roles could often be self-defined and based on where a person decided to get involved in the design process. The information used by the different teams was also very different and matched the nature of the projects they were working on: the Boeing team utilized more formal resources such as standards and relied heavily on documentations, while the Microsoft team had more informal resources. The environment of the Boeing team was also more conducive to collaboration than that of Microsoft, in that team members were in an open workspace where they could easily communicate with one another. The Microsoft team members on the other hand had individual offices that were not necessarily located together. The article does not make any judgments as to which team was more successful in collaborative information retrieval, only that there are many organizational factors that can affect how collaborative information retrieval is approached. The differences between the environments for teams engaged in CIS in this study could serve as a basis for future research into what environmental factors have a large impact on the collaborative information retrieval process.

Systems for CIS

Research in CIS has not only been done on the basic concepts and stages involved in the process but in developing actual systems that will enhance collaboration. Current systems are designed primarily for the support of the individual user. While useful, there

are potential situations where adding a new element to the system could greatly enhance the collaborative experience. One earlier study by Twidale and Nichols (1997) focused on what activities would be useful to support in digital libraries. They first concluded that rather than "searching" the process could be more accurately defined as "browsing" (p. 762). They cited previous research to support the fact that browsing involves the formulation and refining of an information need as additional resources are discovered. Though seemingly a small change in the definition of the process, understanding that users may not have a well defined need to begin with but instead refine it as they search could have a bearing on how systems are designed. Twidale and Nichols identified several areas where future systems design could focus: performing a search, sharing personal recommendations, adding value to the database (such as through annotations or relevant links), allowing ratings of results, and sharing the search process (through saving a particular search and sharing successful queries and results sets).

Morris and Horovitz (2003) built a test search system that incorporated some of the design ideas also identified by Twidale and Nichols. They first conducted a survey and found that there were three key features that would support collaborative searching: awareness, division of labor, and persistence. They developed a test system called SearchTogether that incorporated these features. The "awareness" feature was supported by showing users the query histories of others in their group and by allowing users to see team member comments and ratings of results (p. 9.) To support "division of labor" they included an instant messaging mechanism within the search interface to allow for discussion between the group members (p. 8). They also allowed users to send specific recommendations to others in the group and created a feature that allowed for query

results to be split between those members of the group that were online. Query results could also be split from multiple search engines if desired, so that work would not be duplicated between group members. Lastly, the "persistence" feature was supported by automatically creating a summary of a search so that others in the group could go back and review the search results (p. 8). Their user study of the SearthTogether system, though limited to a size of 14 participants, yielded positive feedback on the functionality created to support collaborative searching. These additional features would likely be useful in a wide-variety of settings and fields where it is necessary for searchers to collaborate in some capacity.

Conclusion

Current literature in collaborative information seeking has focused on a variety of subjects, though not enough research has been done to determine whether the results of the studies can be generalized to teams in other professions or domains. Developing a shared understanding has been found to have a great importance on the success of the collaborative process. A variety of motivations, triggers, information needs, and organizational factors have been determined to affect the collaborative process in some way. By taking the conclusions put forth by the research described here towards studying an additional subject domain could help to strengthen these conclusions and add to their validity. It may be determined that some of the aspects will have different levels of importance in different domains. Continued study of collaborative information seeking is important; by gaining a better understanding of the process it can only help in determining how this process can be better supported by managers, corporations and team leaders in the future.

Method

General Description and Justification

This study is focused on the collaborative information seeking practices and habits of undergraduate students. To study this group, a survey was used to ask participants whether they have ever searched for information with others or for someone else. If so, they were asked to recall the last time they did so and then additional questions were administered to find out about this particular experience in greater detail. The survey method was chosen in this case to collect a relatively large number of responses about collaborative information seeking practices; individually interviewing or observing groups performing this type of activity would have taken a great deal of time and not allowed for the variety of responses that a survey did. Surveys are useful in all kinds of research purposes, including descriptive, explanatory, and exploratory research and useful when an individual person is the unit of analysis (Babbie, 2007).

The study here is loosely based on work done by Evans and Chi (2008). In this study, Mechanical Turk was used to recruit participants for a survey about the last time they searched for information. In addition to questions about the basic search, the survey asked whether there was any interaction with others before, during, or after the search. The Evans and Chi study chose to ask about general information seeking experiences first and then tried to get an idea of how collaboration played a part in the searches. Rather than asking about information search in general and trying to determine if any

collaboration took place, this study of undergraduate students asked participants directly about the last time they participated in collaborative search.

Study Population

The population under evaluation in this study is undergraduate students enrolled at a university. The sample consisted of 96 undergraduate students from the University of North Carolina at Chapel Hill. To recruit participants for the study, a mass email was sent out to all undergraduate students notifying them of the opportunity to participate if they desired.

Participants in the study were entered into a random drawing for one of five $20 Amazon.com gift certificates. The funding for the gift certificates was obtained through a Carnegie Grant available to masters students in the School of Information and Library Science at UNC-CH. Costs borne by participants include their time spent taking the survey, which was estimated to be approximately 10-15 minutes.

Data Collection Instrument

This study used a survey to collect data from participants. See Appendix A for the complete survey. The survey asked for a variety of information, including participant background information, how the participants have searched collaboratively in the past in general, and specific information on the last instance of group information search.

Survey Background and Basic Participant Information. The first four questions in the survey asked for some basic background information from each participant, including whether they were currently registered, their current year in school (Freshman, Sophomore, Junior, Senior, or Other), their major, and whether they were full or part time students. The question about which major the participant was in was the only question of

these four that was open-ended, allowing participants to enter any response they felt was appropriate.

Collaborative Information Seeking Basics. The next question identified whether the participant ever participated in collaborative information seeking by asking: Have you ever searched for information online with others or for someone else? If the participant answered No, they were asked two additional open-ended questions including why they have not done this before and also if there are any situations where they think this would be useful. If the participant responded that they previously searched online for information with others or for someone else, they were first asked three general questions about their previous experiences. These questions were used to get an idea for what situations they have participated in collaborative information seeking. Each of these questions had a list of choices given to participants to select.

- Have you ever looked for information on the web with someone else in any of the following ways? Select all that apply.
- Of these methods of searching for information with others, which have you done the most often? Select only one.
- For which types of tasks below have you searched for information with others? Select all that apply.

Purpose and Type of Information Searches and Why Participants Chose CIS. The participants were asked to think of the last time they searched for information with (or for) others. The remaining questions in the survey pertained to this particular experience. The participant was first asked some basics questions about the experience, including what information was being searched for and the purpose of the search as well as how the

participant decided to search with others. These questions aimed to understand the types of searches being done and what triggers or motivations participants had for searching with others. The questions about the type of information, purpose of the search, and why participants chose CIS were all open-ended questions.

Quantitative Survey Questions. Another group of survey questions mainly presented participants with a list of options to choose from or required only a simple answer. One question asked participants when the search occurred and they were given the following options: a few days ago, last week, last month, or last year. Another question asked how many people were in the group involved in the search; participants selected either 2, between 3 and 4, between 5 and 6, or more than 6. Participants were also asked two yes or no questions about whether they searched for information on their own prior to the group search and also whether they searched for information on their own after the group search.

Another question asked participants how many sessions were required to complete the overall search task. This question was open ended, allowing participants to elaborate if needed. Participants were also asked how long it took them to complete the overall search task and they were presented with the following options: one hour or less, a few hours, a day, a few days, a week, a month, or a few months (or a semester). The last question in this group asked participants how much information was needed to resolve the information need and they were given the following options: a single answer, a single document, multiple documents, or other, in which case they were asked to specify the amount of information needed.

Information Needs and Search Outcomes. The next series of open-ended questions dealt with changes in information need and the search outcomes from the group searches. Participants were asked whether their original information need changed at all during their search and if so, they were asked to explain how this happened. They were also asked to explain how they determined whether the search results were useful and then how also they determined when to stop searching. Lastly, participants were asked whether they thought the group search was successful and then to explain why they felt this way. These four questions aimed to gather more details about how participants executed the search process within a group.

Group Interactions – Satisfaction, Difficulties, and Division of Work. These open-ended questions asked participants for additional information about the actual group interactions that took place. The first question asked whether the participants were satisfied with the group interactions. Next, they were asked what difficulties the group encountered during the search. Finally, participants were asked whether the work required for the search was divided in any way. If the work was divided, the participants were asked to describe how they did this. If the work was not divided, the participants were asked to explain why they chose not to divide it between the group members.

Basic Search Steps. Outside of the other questions asked in the survey, participants were asked an open-ended question to describe the basic steps they took in the group search process. In particular, they were asked to "…describe the steps you took to resolve the search tasks, including the tools you used (such as search engines, communication tools, organizational tools, etc.)". This question was asked to gather any additional

information about the search process to see if there were any overall patterns between the survey participants.

Other Interesting Information about Collaboration. The last question in the survey asked for any additional information the participant can provide that might be useful in terms of the collaborative information seeking process. Then all participants, whether they answered that they had participated in collaborative information seeking or not, were asked at the end to enter their email address if they wanted to be entered into the drawing for one of the Amazon.com gift cards.

Procedures

The participants were asked to complete an online survey and were able to complete the survey from the location most convenient for them where they had access to the internet.

The following is a step-by-step procedure on how the study was conducted:

1. Complete and submit application for Carnegie Grant.
2. Complete and submit IRB proposal, making any requested modifications and resubmitting.
3. Create the online version of the survey in Qualtrics. (See Appendix A for the final survey.)
4. Once IRB approval was given, submit the online form for a campus-wide informational email to go out to all undergraduate students. (IRB approval given on 9/15/2009, IRB ID 09-1654).
5. Close the survey when no additional students decide to participate.
6. Conduct the random drawing for the five Amazon.com gift certificates.

7. Analyze the gathered data.
8. Write up the results and discussion for the final paper.
9. Submit receipts for the gift cards as required by the Carnegie Grant.

Ethical Issues

The ethical issues related to this study primarily include protecting the privacy of the participants involved. The only identifiable information that was collected was the participant's email address, which was voluntary and only required to enter the gift card drawing. Once the drawing was complete, the email addresses collected were removed from the question responses.

The questions asked in the survey were not expected to engender any discomfort in the participants; if this happened, though, the participants had the option to skip any question that they did not wish to answer.

Results

Survey Background and Basic Participant Information

For this survey on collaborative information seeking 72 people completed the survey, though some of them may have skipped questions they did not want to answer. In addition, 18 participants stopped taking the survey before the end and 6 people accessed the survey but did not answer any questions. Throughout the survey, participants were allowed to skip any questions that they did not wish to answer. The data presented below includes the responses from participants when they were provided even if they only partially completed the survey. The total number of responses for the questions will vary based on the number of participants that provided an answer for each question.

Of the 18 participants that did not complete the entire survey, all but one of them stopped just before answering the following question: "First, describe the steps you took to resolve the search tasks, including the tools you used (such as search engines, communication tools, organizational tools, etc.)" It is possible that the participants felt that the survey was beginning to take too much time, and perhaps they were unsure of the time and effort the remaining questions would require. This particular question was very open-ended and asked the participants to describe their search experience in detail.

Of the 90 participants that either fully or partially completed the survey, 88 reported that they were currently enrolled in the Fall 2009 semester. Eighty-seven participants indicated they were full-time students, while 2 indicated they attended school part-time and one person did not respond. The participants also identified their current year in

school, shown in Figure 1. Sixty-three participants (71%) reported that they were either a Junior or Senior. One participant responded with "Other" and indicated that he or she was an Alum, and one person did not respond to this question.

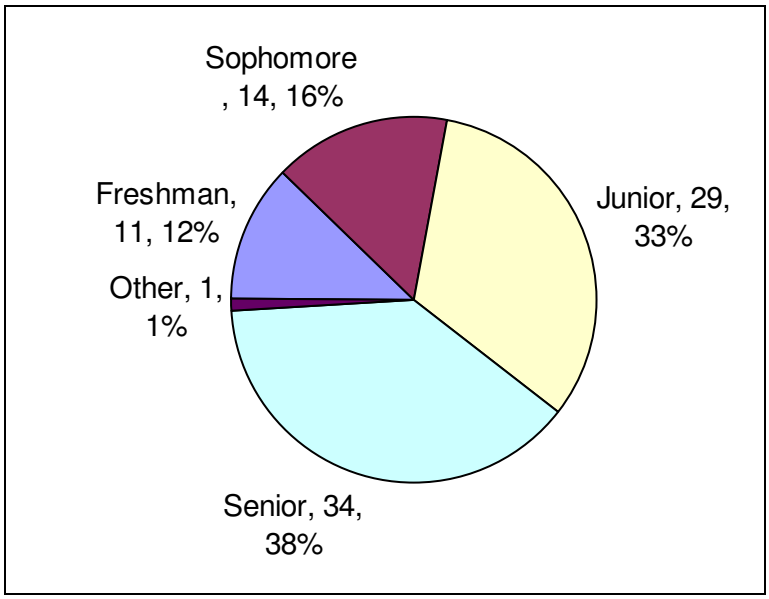

Figure 1. Participants current year in school

Participants also reported their current major; since this was an open-ended question the participant could freely type in whatever they wished. There were a variety of responses, and some participants included double majors. In the frequency calculations, the double majors were counted individually, for a total of 105 responses for the 90 participants. Figure 2 below displays the different majors; only majors with 3 or more participants were included in the chart.

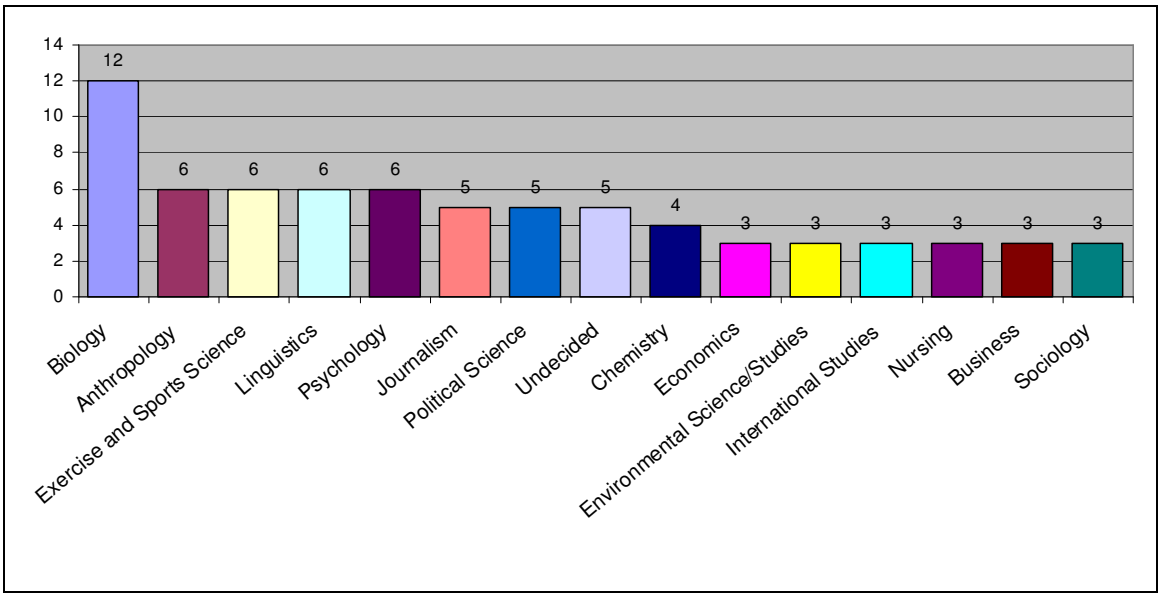

Figure 2. Current major as reported by the participant

Collaborative Information Seeking Basics

After collecting the background information of the participants, they were asked if they had ever searched for information with (or for) someone else. Of the 90 participants, only 2 participants responded with "No". These two participants were asked two additional questions about why they have not ever searched collaboratively and if they could think of situations where this type of information seeking could be beneficial. Neither participant gave useful or noteworthy answers for either of these questions. It is possible that these participants did not fully understand what the survey questions were asking or what was meant by "searching online with others or for someone else". One of the "No" participants did respond to the question about whether there are instances where he or she thought searching for information with or for others would be useful. It may be that this searcher did not fully understand the concept of searching that the survey was trying to gauge. He or she responded with the following: "if you are looking for a [sic] an old friend you may use the web and search for them on facebook." The response seems to

indicate that the participant understood "searching for someone else" to mean actually searching online for information about another person, rather than searching online for information that would be given to another person (for example, if they were unable to complete the search themselves due to lack of skill, resources, etc, or for any other reason). The other 88 participants responded that they had participated in collaborative information seeking, and the remaining results presented are based on the responses from these participants.

People that indicated they had participated in collaborative information seeking were first asked some general questions about their past experiences. The first question presented five collaborative information seeking scenarios and asked participants to identify all the ones in which they have participated. The responses of this question are presented in Figure 3. Most participants indicated they had participated in all of the five scenarios, with searching for the information separately and then discussing it later as the most frequently reported.

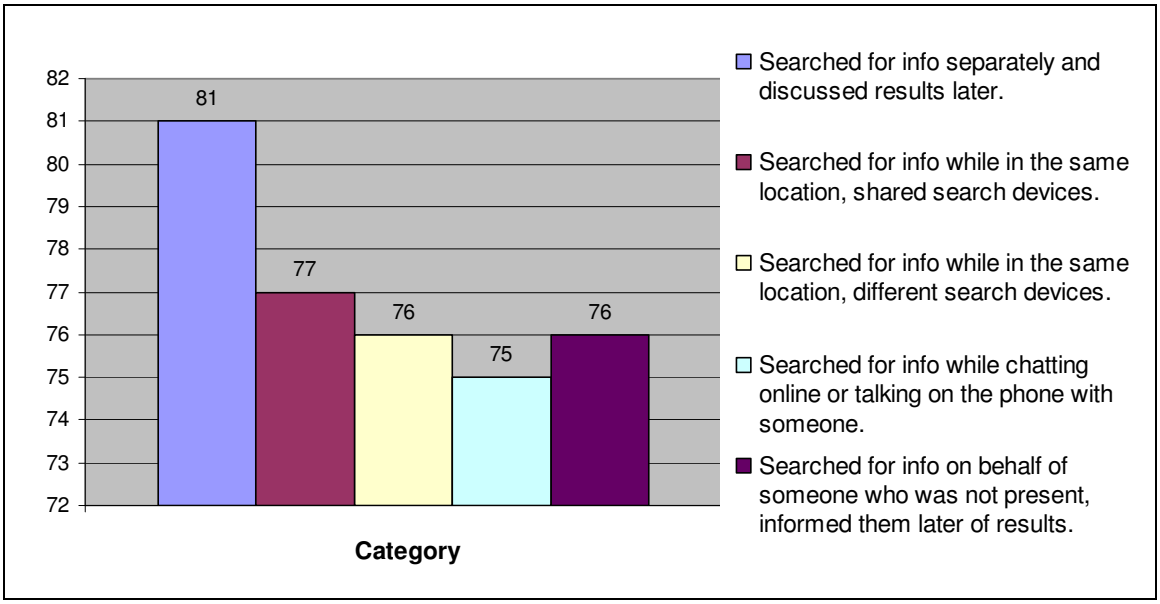

Figure 3. Participants select all CIS scenarios they have been involved in before.

The second general question asked participants to identify which of the same five scenarios they participate in the most, selecting only one. As with the previous question, more participants said that they searched for information separately and then discussed the results later than any of the other four CIS scenarios. The results are presented in Figure 4.

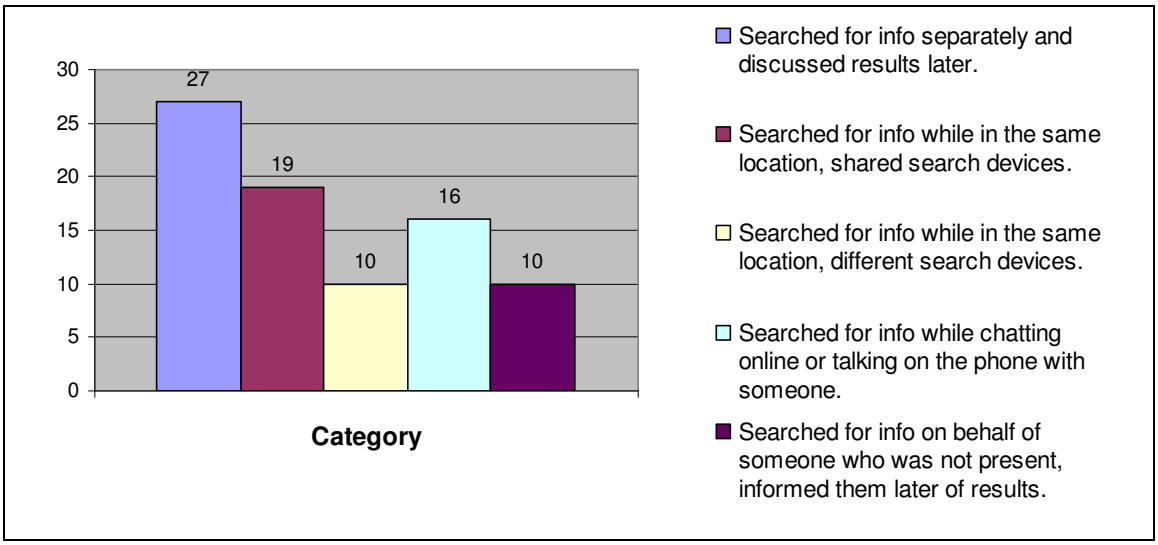

Figure 4. Participants selected which scenario they have been involved in most.

The last question regarding general practices with CIS asked which types of tasks the participants had searched with others. They were asked to select all of the types of tasks that applied to them. Figure 5 shows the responses from participants, with school tasks, entertainment and hobbies, and news and current events being the types of tasks that they most frequently searched for with other people. Participants were also allowed to add their own responses to this question for types of tasks. While these questions were focused on general CIS habits, the remaining questions in the survey were geared towards a specific instance of collaborative information seeking in which participants last engaged.

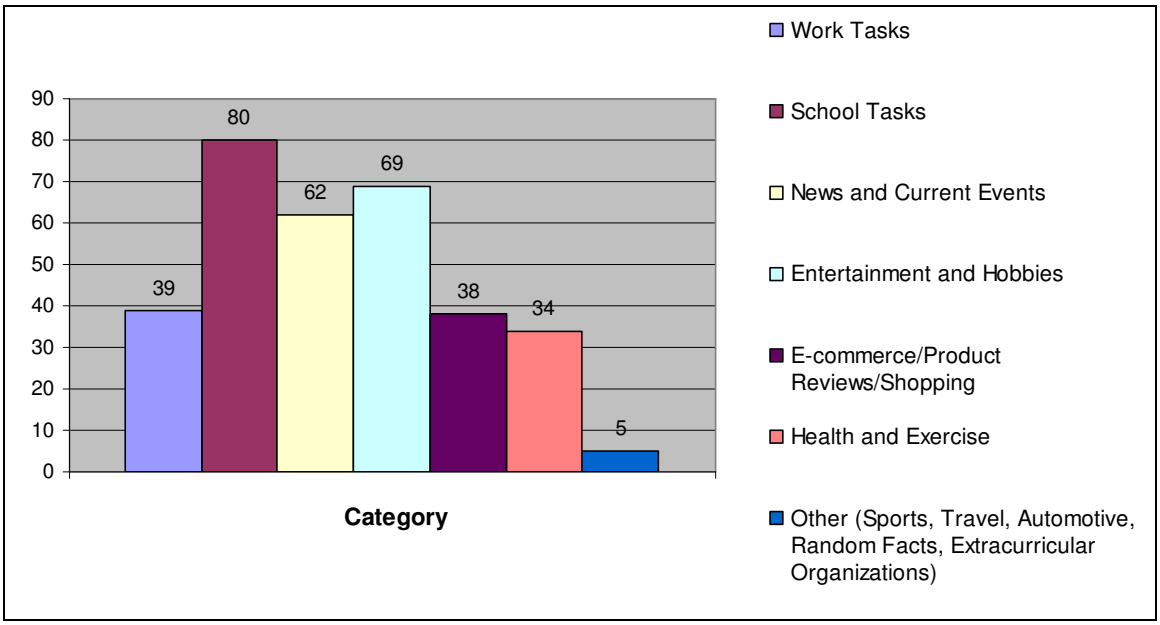

Figure 5. Participants select which types of tasks they collaborated on in the past.

Purpose and Type of Information Searches and Why Participants Chose CIS

Participants were asked to recall the last time they participated in collaborative information seeking, and to give some basic information about the search. In particular they were asked two questions: What was the purpose of the search? and What type of information were you trying to find? By analyzing the responses to these two open-ended questions, responses were broken up into search categories based on the type of information the person was seeking out (see Table 1). Of the 88 participants that responded to this question, 45 of the participants (51.14%) searched for information related to Entertainment/Hobbies, Assignment/Class-Related information, or Travel.

Frequency	Purpose/Type of Information	Percent
20	Entertainment/Hobbies	22.73%
15	Assignment/Class-Related	17.05%
10	Travel	11.36%
6	Local Information	6.82%
6	School/Campus-Related	6.82%
4	Online Shopping	4.55%
4	Directions/Maps	4.55%
3	Current Events/News Articles	3.41%
3	Medical/Health Information	3.41%
2	Relationships	2.27%
2	Social Networking	2.27%
2	Sports	2.27%
1	Historical Information	1.14%
1	Technology	1.14%
1	Definition/Dictionary Lookup	1.14%
8	No Response/Unspecific	9.09%
88	Total	100.00%

Table 1. Purpose and type of information for group searches

Participants were also asked why they chose to search in a group, rather than attempting the search on their own. See Table 2 for a breakdown of the reasons reported by participants. In total 88 participants responded to this question, but some participants reported multiple reasons for choosing CIS. These responses were counted in separate categories where applicable for a total of 91 responses. For many of the participants the searches performed were fairly simple and seemed spur of the moment. The highest number of responses (15) indicated that they searched with others because they were already together discussing the question when they decided to search, so it is assumed that it was simpler to also perform the search together so that the results could be discussed as well. In addition, 12 participants reported that they were asked by someone else to search for information, and 12 other participants reported that they chose to search

with someone else because it was more efficient and results could be found faster than searching alone.

Frequency	Response	Percent
15	Searchers already in the same location, discussing question	16.48%
12	Asked by someone to find information	13.19%
12	Efficiency/Finding results faster or more results	13.19%
11	All searchers had a stake in the results	12.09%
8	Mutual curiosity	8.79%
7	Wanted feedback/Desired other input to make a better decision	7.69%
6	Easier to discuss results/Convenience	6.59%
5	Required by school assignment	5.49%
2	Lack of access to the internet/computer	2.20%
1	Difficulty with searching alone	1.10%
1	Worked well with other searcher(s)	1.10%
11	No response/unspecific	12.09%
91	Total	100.00%

Table 2. Why participants chose to search collaboratively

Quantitative Data Collected from the Survey

The survey included seven questions that collected quantitative data about the collaborative information seeking process as undertaken by the participants. This includes the number of people that were in the group, when the search described in the survey questions occurred, whether the participant searched on their own apart from the group either before or after the group search, how much time was required to complete the search, the number of search sessions required for the search, and the amount of information that was needed from the search.

Of the 83 participants that responded to when they last participated in CIS, 44 (about 53%) indicated that they completed their last collaborative search within the past few days. Twenty-six participants (about 31%) indicated they had completed their last collaborative search in the last week. The remaining 13 participants reported they had

either completed the search within the last month or within the last year. The majority of the study participants were involved in collaborative search in the recent past, indicating that this is probably something that happens often for these undergraduate students.

The next question asked participants how many people, including themselves, were in their group. An overwhelming number of participants (69 of the 83 that answered this question, or about 83%) indicated they searched with only one other person. The remaining 14 participants indicated they searched in groups of 3-4 people including themselves. No participants responded that they were in groups of 5 or more.

Two questions in the survey asked participants about their behaviors before and after the group search and whether they spent any time searching on their own. Eighty-two participants responded to these two questions; the responses to whether the person searched by alone either before or after the group search were split fairly evenly. Forty-one people indicated they searched prior to the group search and 41 indicated they did not. Responses as to whether the participant searched after the group search were similarly split, with 37 reporting they did search on their own after the group search and 45 indicating they did not.

Participants were also asked to report how long it took them to complete the search task (see Table 3 for the reported results). Of the 81 participants that responded to the question, 47 (about 58%) said that it took one hour or less. While a few participants reported other answers, most of the remaining participants indicated it had taken them either a few hours or a few days to complete the search (about 16-17% in each category).

Frequency	Response	Percent
47	One hour or less	58.02%
14	A few hours	17.28%
13	A few days	16.05%
5	A day	6.17%
2	A few months (or a semester)	2.47%
0	A week	0.00%
0	A month	0.00%
0	More than a few months	0.00%
81	Total	100.00%

Table 3. Time to complete the search task

To determine what amount of information would satisfy the information need, participants were asked to report how much information they were expecting to have at the end of the search. Participants were asked to choose from the following options: multiple documents, a single document, a single answer, or other, in which case they were asked to specify an answer. See Table 4 for a breakdown of the answers. Of the 82 participants that responded to the question, the majority of participants reported they were looking for multiple documents (40 participants, or about 49%). Two participants reported "Other"; in these two cases, one participant indicated he or she was looking for a photo which could potentially be classified as "A single document". The other participant indicated he or she was looking for "a list of google results". In this particular case, after reviewing the other responses given by this particular person he or she was actually looking for a single answer with a list of results being the means to finding this single answer. It is possible that this question was not completely clear in terms of what encompasses the actual "information need"; the intent of the question was to find out what end result the participant was seeking out, rather than what was required to get to the end result.

Frequency	Response	Percent
40	Multiple documents	48.78%
28	A single answer	34.15%
12	A single document	14.63%
2	Other	2.44%
82	Total	100.00%

Table 4. Amount of information needed from search

The last quantitative question asked of the participants was about the number of sessions required to complete the search. Similar to the question of how long it took to satisfy the information need, this particular question tried to determine how many search sessions were required to complete the search. See Table 5 for a breakdown of the responses provided. Over 50% of the participants (41 out of 81 total) responded that it only took them one search session to complete the overall task. The other responses ranged from between 2 and 6 sessions, with the majority needing between two and three sessions. This question was open-ended, and in some cases participants reported a range of session (for example, 3-4 sessions). In these cases, the response was counted with the lower number; so if a participant reported that it took 3-4 sessions, the response was counted in the "Three sessions" category. The one "Unclear" response was reported as "Two hours"; this could potentially be adjusted to fit into the "One Session" category, but this is not clear from the response given and could have been broken up into multiple sessions over a total of two hours.

Frequency	Response	Percent
41	One session	50.62%
20	Two sessions	24.69%
11	Three sessions	13.58%
2	Four sessions	2.47%
4	Five sessions	4.94%
1	Six sessions	1.23%
1	Many sessions	1.23%
1	Unclear	1.23%
81	Total	100.00%

Table 5. Number of sessions required to complete the search task

Information Needs and Search Outcomes

The survey asked a series of open-ended questions to get a little more data on the information needs and the outcomes for the described search. The question responses were all analyzed to find common patterns and categories that described most participant responses. The first question asked participants whether at any point in time during the search the information need they had initially expressed changed. This could be due to a change in desires and opinions or based on information discovered during the search. Almost 81% of participants (51 out of 63 responses for this question) reported that the information need they started with did not change as they searched. Eleven participants (almost 18%) reported that their need did change. When also specifying how the information needs changed, these participants reported some of the following reasons:

- Opinion changed as more research was done
- Additional search criteria became apparent as research was done
- Decided more detailed information was needed after reviewing initial results
- Shifted focus of topic

One participant reported "Somewhat" for this question, and said the "Topic was narrowed down as research was done." This is very similar to the other Yes answers given by participants for this question, and could likely be included in this group.

In addition to whether the information need changed as the search went on, participants were asked to specify how they determined whether items found during their searching were actually useful. For the 72 responses for this question, the way the participant determined whether the search results were useful was spread widely across a range of answers. See Table 6 for the reasons given by participants. For certain participants multiple reasons were stated, so these responses were counted multiple times if they fell into different categories.

Frequency	Response	Percent
11	Validity/reliability/reputation of the source.	15.28%
9	Question was answered by website.	12.50%
8	Information was related to topic.	11.11%
7	Cheapest price determined most useful result.	9.72%
7	Multiple sources reported the same/similar information.	9.72%
6	Based on personal interest/opinion/prior knowledge.	8.33%
5	Through group discussion/agreement.	6.94%
5	Information was organized/useful/easy to understand/previously unknown.	6.94%
3	By reading through the results.	4.17%
3	Results were appropriate for final product/task.	4.17%
3	Visual appeal/security of website.	4.17%
2	Directions were correct/made it to destination.	2.78%
1	Amount of information provided.	1.39%
1	Information was accurate.	1.39%
1	Read reviews.	1.39%
72	Total	100.00%

Table 6. How participants determined search results were useful

The survey also asked participants how they determined when they should stop searching. A little over 27% of participants (20 out of 73) answered that they found the exact answer to the question or they found all the information they needed. The

remaining participants responded in a variety of ways, similar to the previous question about determining the usefulness of the search results. See Table 7 for the entire list of response categories. The remaining responses varied from answers like "Tired of Searching" or "No time was remaining" to "Exhausted all search possibilities".

Frequency	Response	Percent
20	Found exact answer to question/all information needed.	27.40%
8	Able to complete the assignment/task.	10.96%
7	Able to make a decision/purchase with the information found.	9.59%
6	Found sufficient information/variety of sources.	8.22%
5	Exhausted all search possibilities/didn't know where else to search.	6.85%
5	Sources started to repeat the same information/stopped finding useful information.	6.85%
5	Tired of searching.	6.85%
4	Found best price we thought we would find.	5.48%
3	Able to understand the question/information.	4.11%
3	Satisfied with the results found.	4.11%
3	Team members were able to agree.	4.11%
2	No time was remaining/had no time to do additional searching.	2.74%
1	Searched many times with no success.	1.37%
1	After reasonable amount of time searching.	1.37%
73	Total	100.00%

Table 7. How participants decided when to stop searching

The last question in this group asked participants whether they thought the search was successful, and asked them to describe why they determined the search event was successful or not. Of the 80 responses for this question, 77 of the participants (over 96%) felt that the search was successful. One participant felt the search was somewhat successful and two participants felt the search was unsuccessful. The "somewhat" successful responding participant felt that the search was successful, but that the reliability and credibility of the information was unclear. The two participants who felt

the search was unsuccessful both responded similarly in their reasoning in that they did not find the information they sought.

Of the 77 participants responding that their searches were successful, some gave multiple reasons for determining their search to be a success; these reasons were counted separately, for a total of 82 responses. The participants who felt that the search was successful primarily cited the fact that they found the desired information as the reason; this was the case in 50 of the 82 responses (almost 61%). See Table 8 for a complete list of the reasons given by participants. In some cases, this was very search specific; for example, for those participants searching for travel related information, they may have felt the search was successful because they found the cheapest rates available. One particular response was interesting in that the person did NOT find the information they were searching for, but still considered the search successful. In this case the searcher determined after searching that the desired information did not exist.

Frequency	Response	Percent
50	Found desired information.	60.98%
5	Found affordable/cheapest travel rates.	6.10%
4	Used the discovered information successfully.	4.88%
4	Able to complete assignment/meet course goals.	4.88%
2	Amount of useful information found by the group was greater than what could have been found searching alone.	2.44%
2	Multiple sources confirmed information that was found.	2.44%
2	Was able to make a purchase.	2.44%
2	Learned something new.	2.44%
1	Found that the information doesn't exist.	1.22%
1	Hypothesis was proven.	1.22%
1	Received a good grade on assignment.	1.22%
1	Understood the concepts searched for.	1.22%
1	Saved time by sharing details.	1.22%
1	Found reliable and scholarly sources.	1.22%
1	Work was divided equally.	1.22%
4	No Response/Unclear	4.88%
82	Total	100.00%

Table 8. Reasons why participants felt their search was successful

Group Interactions – Satisfaction, Difficulties, and Division of Work

Another set of open-ended questions in the survey attempted to gather information about the actual group interactions, including whether the survey participant was satisfied with the interactions, what difficulties the group encountered during the search, and whether the work for the search was divided among team members or not.

Division of Work. The division of work question asked participants whether they divided the work among the team members; if they did not divide the work they were asked why not, and if they did divide the work they were asked to describe how they divided the work and how was it decided to split up the related tasks. Of the 70 responses to this question, 51 (about 73%) indicated that they did not divide the work between group members while 19 indicated that they did divide the work in some way. For those

that did divide the work, many responses indicated that they simply divided the websites between participants (6 participants, or a little over 30%). These responses were open-ended and had to be analyzed for common patterns among the participants. See Table 9 for a breakdown of all the reasons given for how participants divided the work.

Frequency	Response	Percent
6	Simply divided websites.	31.58%
4	Individual preference.	21.05%
2	Divided it by task/assignment requirement.	10.53%
2	Equally divided websites.	10.53%
2	Random selection.	10.53%
1	Each member started from either end of the list.	5.26%
2	No Response	10.53%
19	Total	100.00%

Table 9. How participants divided the search tasks

The majority of participants indicated that they did not divide the work, but instead searched together as a group. These participants were asked to indicate why they did so. See Figure 6 for a chart of the reasons given by these participants. The majority of these participants (18 out of 51, or a little over 35%) did not divide the work because they were only performing a simple search and did not feel that there was enough work to divide. About 24% of participants (12 out of 51) only had one search device, so dividing the work was not possible. The next two types of responses were similar in that the participants wanted to take advantage of the fact that multiple people were working together on the task. Seven participants (about 14%) said that they both worked separately on the same task and then compared the results together. Six participants (about 12%) said that they wanted to be able to review the results as a team; it may be that dividing the work would have interfered with doing this. These responses were somewhat different from those groups that decided to divide the work because they

wanted to take advantage of the fact that dividing the work could make searching quicker and more efficient. Working in a group can have many different advantages, depending on the priorities of the group members involved.

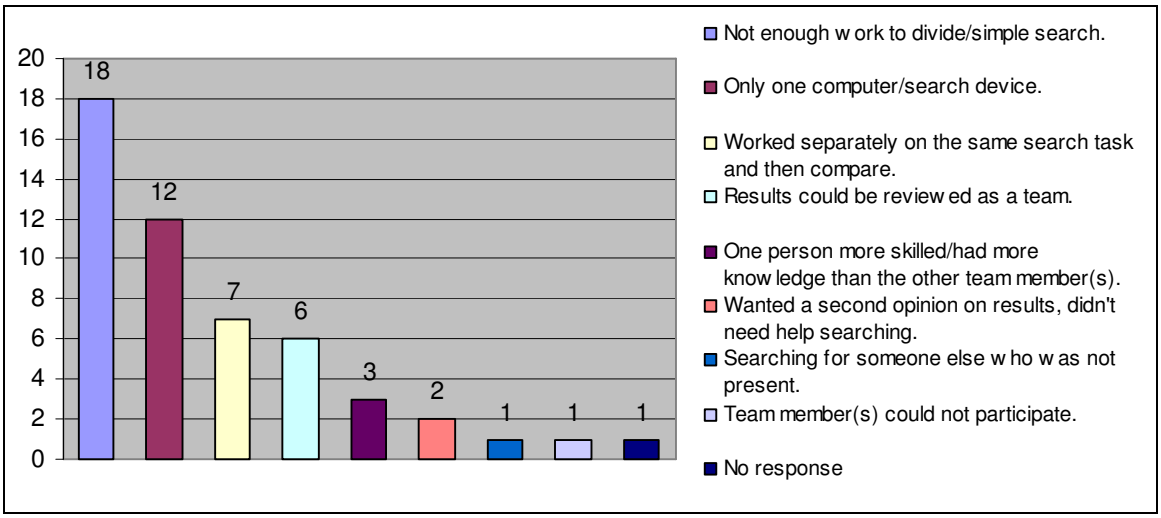

Figure 6. Reasons why participants did not divide the search tasks

Difficulties with Collaborative Search. This open-ended question asked participants whether they experienced any difficulties in working with others, and to explain why or why not. Of the 65 participants that answered this question, 50 (about 77%) reported that they did not experience any difficulties with their collaborative search. Nine people (almost 14%) reported that they did experience difficulties and 6 others (a little over 9%) reported that they sometimes experienced difficulties. Difficulties as reported by these participants are listed in Table 10.

Frequency	Response
2	Group members did not always contribute equally/fairly.
2	I prefer to work independently.
1	Sometimes it is not clear what other team members are doing/finding.
1	Group members can be indecisive.
1	Group member opinions varied.
2	No response.
9	Total

Table 10. Difficulties reported by participants

Those participants that reported that they "sometimes" experienced difficulties all seemed to misunderstand the aim of the question as asking about working with others in general, rather than as relevant to this particular searching situation. For example, one participant responded with "I sometimes find working with others difficult because the workload might not be split fairly or someone might not pull their weight." This response does not seem to be referring to a particular instance of working in a group, but a generalized response that could be applicable anytime depending on the circumstances. The other "sometimes" or "depends" responses were very similar in their wording and seemed to be applicable to group situations in general, not necessarily the situation being described in the other responses for this survey.

Satisfaction with Group Interactions. Participants were asked whether they were satisfied with the group interactions, and to explain why they answered this way. Of the 65 responses to this question, 64 participants said that they were satisfied with the group interactions. The only participant who indicated he or she was not satisfied said: "I was not satisfied with the group interactions. My partner did not offer enough assistance."

Of the participants who were satisfied with the group interactions, the majority reported satisfaction either because they accomplished their goal or the group worked

well together. See Figure 7 for all of the reasons reported by participants. For this particular question, participants may have responded in ways that fell into multiple categories; in these cases, the responses were counted in each category for a total of 69 responses.

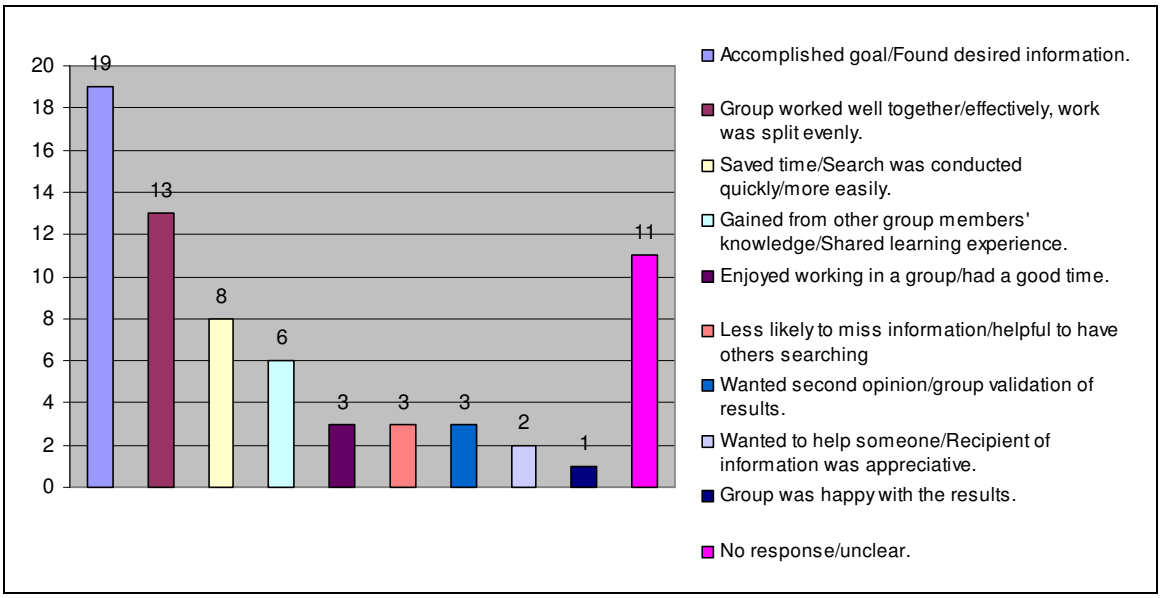

Figure 7. Reasons given by participants were satisfied with the group interactions.

Basic Search Steps

The most open-ended question asked by the survey was for some basic details about the process the groups used for their search. Also, at this point in the survey, a number of participants stopped answering questions and did not give any additional responses. The question specifically asked: "Describe the steps you took to resolve the search tasks, including the tools you used (such as search engines, communication tools, organizational tools, etc.)" The responses to this question were difficult to analyze and divide into categories, but there were similarities among the survey participants.

Search Methods. The first obvious pattern was that for a majority of the searches, participants noted that their first step was to visit either a major search engine (such as

Google, Yahoo, Bing, etc), a specific online database (such as PsycINFO, ScienceDirect, or PubMed), or went directly to some known website related to their particular need (such as Ebay, Amazon.com, a travel website, or a website that provides maps and directions). In some cases the secondary search site was first located through a major search engine, but for many participants these secondary sites were already known and accessed directly.

Many participants reported that they were just doing a simple search, and locating their answer seemed fairly straightforward. Other participants used multiple search engines and then compared the results. As reported in the question about the division of work, this may have been done by searching together with the different search engines, or group members may have each used a single search engine and then compared the results after searching. Some participants reported using advanced options for the search engines, and others indicated that after reviewing the results from their initial search they were able to modify successive searches based on additional information they had obtained.

Some additional responses by participants, though not reported frequently among this sample, were interesting and worth looking at:

- Searched existing available resources: Reviewed prior class notes to prepare for teaching responsibilities, reviewed notes from a current class to find an answer to a question, asked for help through email from an instructor and then reviewed the suggested resources.
- Used non-online means to continue search: One participant reported that he or she was seeking out a local chiropractor, and did some initial searching through

Google and also through his or her health insurance website. Advice was then solicited from a friend, who suggested some additional searches to verify the initial conclusions. The participant narrowed the results down to two potential chiropractors, and then called the office of each to gather some additional information. Once this additional information was gathered, a decision was made on which doctor to select.

- Does the information exist? One searcher reported that their collaborative search was done to find out whether a dictionary for biology terms existed and could be installed in the Open Office software. The search was repeated with different terms approximately 10 times, but this type of add-on could not be located. It was determined after these repeated searches that the additional dictionary did not exist.

Communication Tools. Participants reported a few different methods for communicating with the other members in their group. Many of the participants reported that they searched with their group in person, so they did not require any other means of communication outside of group discussion. Others reported that they spoke over the phone (or through some similar mechanism such as Skype) to discuss the results or to request feedback and opinions from another person. Another popular communication method was through email; email was used either to request help or to send results back and forth in asynchronous communication. A small number of participants reported that they used Facebook or some type of Instant Messaging software to communicate with their team members. The participant that indicated they used instant messenger for communication also indicated that they saved the chat conversation logs, which would

likely be a useful source of information later on if group discussions needed to be reviewed.

Organizational Tools. A few participants also indicated particular organizational methods and tools in response to this survey question. Microsoft Word was mentioned by a few participants as a tool used to record results and compile information, as well as the software used to assemble a final product based on the information found during the search sessions. One participant indicated that he or she simply made a list of interesting results for sightseeing in Thailand, and then later group members met to discuss the results they had found individually. The last noteworthy result dealing with organization was made by a participant who was shopping for "bathing suits on clearance" with a friend over the phone. As the searcher found bathing suits, he or she created a browser bookmark as a way to save these results for later review and/or reference.

Other Interesting Information about Collaboration

The last question in the survey asked participants if they had anything additional that they wanted to share about their experiences with collaborative search. The majority of participants did not provide an answer for this question. A few participants, however, did choose to provide some interesting additional information on their experiences with CIS.

Communication Between Group Members. Three participants mentioned that in the past they found that using some type of instant messaging software or social networking tool was helpful to the collaborative effort, though they may not have used such a tool for this particular search. One person mentioned that they had in the past created a Facebook group to coordinate the interactions, but that the "group agreed this was not an efficient means of finishing our task." It may be that the overhead required to setup and then

maintain this type of communication tool would not be beneficial for most collaborative tasks, depending on the nature and scope of the project undertaken by the group.

Dividing the Work. A few participants mentioned difficulties as well as benefits to searching collaboratively in a group. These reasons echo the responses given to the survey question about the difficulties experienced during the collaborative event participants recalled for this survey. One person mentioned that it can be difficult to share the work evenly, which seems to be a common problem of group work. Another mentioned that it is better to search separately and then share results, because "I feel that it is more efficient and gathers more data in less time." Another participant echoed this sentiment, adding that it is "useful to have multiple people searching for information, to make sure you don't miss anything." Efficiency and comprehensiveness are certainly two great benefits of conducting a search task with more than one person. The last participant who added thoughts about work division had similar ideas to the previous two, but added that searching independently has benefits for individual team members as well who may need more time than others to complete similar tasks. This person summed their thoughts up well, saying:

> … searching independently allows individuals of the group to do the work at their own pace on their time maximizing the groups effectiveness when together while minimizing the time needed to meet to accomplish tasks.

Deciding how to divide the work for a collaborative search task can be difficult and may vary depending on the individual preferences and abilities of those involved.

Group Member Experience and Interest. The last main category of additional information given by participants relates to the amount of experience as well as interest

that the group members have about the topic in question. Two participants both mentioned that the collaborative process may help those group members that have less experience in searching, or that it can be frustrating to try to search with someone who has little experience in online search. In addition it can be difficult if the person has less experience or knowledge about the search topic or the group has little actual interest in learning more about the topic in question. Another participant mentioned that an additional benefit to searching in a group is that "Different people have different ways of finding information, and it is helpful to find new avenues to gaining information." While it can be difficult working in a group that has different levels of experience with searching online, the undergraduate student participants did find benefits to group work since team members may have unique ways of searching and organizing that could help the other members.

Discussion and Conclusions

The purpose of this study was to explore how undergraduate students participate in collaboration while they are searching online. This included attempting to find out the types of situations that require collaboration or potential triggers for collaborative information seeking, the difficulties involved in collaborative information seeking, and basic approaches to how people seek out information collaboratively.

Situations and Triggers for CIS. When participants were asked why it was decided to search collaboratively rather than on their own, the majority (almost 80%) responded with one of the following reasons (see Table 2 for the statistical breakdown of responses): Searchers already in the same location, discussing question; asked by someone to find information; efficiency/finding results faster or more results; all searchers had a stake in the results; mutual curiosity; wanted feedback/desired other input to make a better decision; easier to discuss results/Convenience.

Difficulties with CIS. The majority of participants in this study said that they did not find working with others to be difficult. Those that did find group work difficult reported the following reasons (see Table 10 for a breakdown of these results): group members did not always contribute equally/fairly; I prefer to work independently; sometimes it is not always clear what other team members are doing/finding; group members can be indecisive; group member opinion varied.

Basic Steps. The participants in this study reported a number of search methods, communication tools, and organizational tools as being utilized during the search process.

Searches mainly took place from a major search engine, an online database, or a known website where additional searching could be done. For some participants the work was divided based on a pre-determined list of keywords or subjects, and others split up the work and searched for the same items but on different search engines. Communication took place often through in-person group discussion. Other methods included email, phone conversations, instant messenger, and even Facebook as reported by one participant. Participants that were collecting a significant amount of information or needed to save the information used some method to organize their results. Microsoft Word was reported as used frequently to keep track of results or to assemble a final product if one was required. Infrequently reported methods also included using browser bookmarks to save results for later or simply making a list so that results could be discussed later (it was not specified if this was a paper or electronic list).

Discussion of Study Results

Comparison to Evans and Chi work. Since this study was loosely based on work by Evans and Chi (2008), it is important to look at how the results of this study compared to their work. As described in greater detail previously in this paper, Evans and Chi designed a survey around information seeking in general, asking participants to recall the last time they searched for information. Then they asked whether there were any interactions with other people before, during, and after the search event. Based on these additional questions, they tried to determine how often during searches the participants had some kind of interaction with others for any reason.

Evans and Chi found that before search, participants sought out others either while refining the search requirements or because they were asked to search by someone else.

During search, they found that the majority of searchers did not have any social interaction for transactional searches (a type of search where the user can subsequently carry out some transaction, such as finding driving directions or movie times) or navigational searches (a type of search where someone "performs a series of actions to identify content from a particular, often familiar, location"). The last type of search they described, informational search, involved someone searching for information that they may or may not already be familiar with. Over half of the participants in the Evans and Chi study performed this type of search. During the informational searches, participants reported some type of social interaction to get feedback or additional refinement of the search. This could be offering up some kind of advice, such as additional keywords that could be tried, so that the desired results could be located. Evans and Chi referred to this process as "foraging" (p. 490). Participants also noted social interactions during a "sensemaking" process that occurs after foraging, where the searcher users some of the information they have discovered to further modify the search or need (p. 490). After searching, they found that participants were interacting with others to both organize information and to distribute information.

Basically, the Evans and Chi study found that participants interacted with others for the following reasons: to get a request for information from someone else, to refine the search requirements during foraging, to seek out another opinion during sensemaking, to distribute information, or to organize information after searching. There are similarities in the Evans and Chi article to the results of this study on why participants chose to search collaboratively rather than on their own (see Table 2 in the results section for a complete breakdown of responses), including that participants chose CIS because they were asked

by someone to find information or because they wanted feedback or other opinions in order to make a better decision. The other responses received for this question, however, departed from the results in the Evans and Chi study. This may be due to population differences between undergraduate students and what sounds like a primarily working professional population in the Evans and Chi study. While the most cited reason the undergraduate students in this study chose to search collaboratively was because the searchers were already in the same location discussing the question at hand. The Evans and Chi work, however, reported that participants were seeking out face-to-face interactions with others much less frequently than using other means of communication and that very few participants reported conducting the actual search in a collaborative environment; most of the time the actual search was done individually and the collaboration came before or after the search.

Additional reasons for CIS in this study of undergraduate students include: finding results was faster and more efficient, all the searchers had a stake in the results, mutual curiosity, and it was easier to discuss the results. These reasons indicate that the participants had some greater reason for carrying out a collaborative search, whether it was to save time or because all group members were interested in the results. Since this study specifically asked participants about their last time using collaborative search, results may have varied somewhat from the Evans and Chi study which examined the last time a person searched altogether. Both studies found that many participants were involved in this type of search, but because of the somewhat different focuses they were not always directly comparable.

Triggers. One aim of this study was to find out what triggers caused someone to engage in CIS rather than searching alone. The Reddy and Spence (2008) research done on workers in an emergency department, determined through interviews and observations that the following situations triggered people to collaborate to find information: Lack of immediately accessible information, complexity of the information need, and lack of expertise. In an earlier study done by Spence, Reddy, and Hall (2005), a survey was done to ask academic researchers about their CIS behaviors and motivations; this survey listed the same triggers as in the Reddy and Spence (2008) study and asked researchers to agree or disagree on whether it was a reason they participated in CIS. Both of these studies differed from this study of undergraduate students in that they both were aimed at behavior in professional environments. While the Spence, Reddy, Hall (2005) study also utilized a survey it did not ask about a specific or most recent instance of CIS that the participants should recall, but asked about their CIS habits in general. The Reddy and Spence (2008) study analyzed actual events of CIS, but done through observations and interviews rather than a survey.

In this study of undergraduate students, most of the reasons given by participants were very different than those from the academic researchers (see Table 2 in the results section for a complete breakdown of these responses). The most similar response given by the undergraduate participants was that some indicated they "Wanted feedback/Desired other input to make a better decision", similar to the reasoning for the academic researchers and emergency department workers in the other studies in that they were seeking out someone with a different expertise. While the study results of undergraduate students do not completely follow those of the Spence, Reddy, and Hall

(2008) and Reddy and Spence (2005) studies, it is possible this is because the study of undergraduate students was looking at the last occurrence of CIS regardless of the context. Searches occurred for a variety of reasons, many of which seemed of personal interest to the searchers rather than related to a professional need or experience. It may be that different populations of people in particular environments simply have different reasons for collaborating during the search process.

The triggers for CIS given by the undergraduate students has some similarity to the motivations determined in the study by Fidel, Pejtersen, Cleal and Bruce (2004) and their analysis of a single CIS event part of a greater study setting. Similar to the undergraduate students, this study of an engineer and the process he goes through to seek out information found "They are looking for informal some feedback to their ideas, and opinions about the decision they are about to make, which could be elicited through the CIR process" (p. 951). This is similar to the undergraduate response of "Wanted feedback/Desired other input to make a better decision".

The study also listed a number of other motivations that the undergraduate population in question did not report. One reason this may have occurred is because the undergraduate student study focused on online searching, whereas the Fidel, Petjersen, Cleal and Bruce study considered "information retrieval" to "include all activities that were taken by actors to resolve an information problem". This is not necessarily through online search, and could include some kind of collaboration done to fulfill some information need. This may be why this study had some additional motivations that were not identified in the undergraduate population, such as "They are novices, new in the organization, or when they are in an unfamiliar situation", "They need to access tacit

knowledge", or "Most of the information they need is not documented" (p. 951). It is possible that the undergraduate students did initiate CIS for some of these other reasons, but since they were self-reporting answers rather than being observed it may be that they did not even realize it. Also, similar to the other studies the Fidel, Petjersen, Cleal, and Bruce study focused on a professional setting and related events. The undergraduate students reported on a variety of searches, including informal and personal events. This may cause differences in the motivations as well, but additional research would need to be done to confirm this.

Difficulties. The Fidel, Pejtersen, Cleal, and Bruce (2004) study also compiled a list of challenges their subject experienced during the CIS process. These challenges had some similarity to the difficulties reported in this study of undergraduates:

- Actors have different stakes in the process, or have different priorities and Some actors are less familiar with the problem than others. (Similar to "Group members did not always contribute equally/fairly".)
- Much of the information is retrieved simultaneously by different actors. (Similar to "Sometimes it is not clear what other team members are doing/finding.")

The Fidel, Pejtersen, Cleal, and Bruce (2004) study also reported that someone with less experience or knowledge will initiate collaboration with others who have more experience; then the primary searcher has to determine which others to involve in the process. In many of the cases for the undergraduates, it seemed as though the group of people involved in the collaborative search was either predetermined (such as for a school assignment) or an information need came up among a group of people already gathered together. One participant was searching for information on depression for a

friend, and came across an abundance of results so sought help from a former professor. This was the only incident of this kind reported by the undergraduate participants. Because a survey was used for this study rather than observations or interviews, the perspective of all team members could not be observed which made for a one-sided representation of the collaborative seeking event. The Fidel, Pejtersen, Cleal, and Bruce (2004) study focused on only one team so was able to collect information on the event from all the people involved, shedding light on different aspects of the process.

Collaborative Search Characteristics. The final research question in this study was to explore the basic characteristics of collaborative information seeking in general in contrast to what has been found in other studies. One study in particular by Hansen and Järvelin (2005) studied a patent office and the collaborative seeking activities that occurred there. This study differed from the undergraduate study because like the Fidel, Pejtersen, Cleal, and Bruce (2004) study it focused on general information seeking rather than solely on online searching. The Hansen and Järvelin study categorized the collaborative activities as either being "document-related" or "human-related". Document-related activities relate to "creating or using documents (electronic or paper-based)" (p. 1110). Human-related activities are those that "directly use knowledge possessed by other humans" (p. 1111). The activities the researchers put into these two categories do have some similarities with the types of activities performed by the undergraduate students in this study. For example, document-related activities that are similar include: shared information seeking and retrieval strategies; sharing decisions, judgments, and assessments; communicating and sharing of personal and subjective opinions in written form; log history. These were certainly activities that the

undergraduate students reported; keeping a log history was very infrequent, with one person indicating that they saved the instant messenger logs from the related electronic discussions. For the human-related activities, similar activities as reported by the undergraduate participants included: sharing search strategies; sharing division of tasks; sharing, or asking for, external and internal domain expertise; end product creation; sharing internal experience. While the specific instances of these activities as described by Hansen and Järvelin of the patent office employees is certainly different than those instances reported by the undergraduate students, there are some definite similarities in the types of activities performed.

Study Implications

Since collaborative information seeking has been gaining additional attention in research in recent years, studying other populations in different ways will hopefully strengthen the conclusions made and make them more generalizable to the population as a whole. The undergraduate student population has not been studied often in this context, even though they have grown up with technology around them and may have a greater familiarity and comfort level than other populations.

The results of this study indicate that collaborative information seeking is utilized often by undergraduate students in a variety of ways. While undergraduate students are a separate and distinct population from the various professional populations under examination in other CIS work, there are definitely similarities in how these different populations approach CIS, the difficulties they encountered, and the motivations they had for seeking out CIS. Many of the reported searches were not complex in nature and required only a simple answer. CIS was still employed in these instances for a variety of

reasons, including mutual curiosity or the fact that a group of people was together discussion a question and so decided to search for the answer.

Limitations of Study and Method

General Discussion. The method utilized to collect data in this study was an online survey. The survey method was selected because it ensures that all the participants are asked the same questions and have the same opportunity to answer each one. Also, surveys are a quicker way of gathering data than interviews or observation, in which each participant would have to schedule an hour or two to meet with the researcher. This would greatly limit the amount of responses that could be obtained. In this study, each participant will be able to respond to the survey at a time and location most convenient to him or her. The consistency of survey questions throughout all participants is what lends reliability to this method.

On the other hand, this method has limitations as well. While surveys are high in reliability, they are lower in validity. Because the survey was self-administered, the participants did not have a chance to ask any questions or get clarification on what a particular question means. There is no guarantee that the questions being asked will appropriately inform the concepts being studied. Also, there could be additional relevant information about the topic that the participants could share if they were questioned in-person during an interview or their information seeking process was observed directly.

Study-specific Discussion. In addition to the disadvantages mentioned above of the general study methods, this particular study has several limitations as well. This study depended on memory and the ability of participants to accurately represent the

collaborative information seeking event. In some cases these events may have been some time ago and the details asked for in the survey may no longer be as clear.

The number of students that responded to the survey was small and the results are not necessarily generalizable to the population as a whole. Further research would need to be done to determine whether these results are consistent with the greater population. Also, it is unclear what type of experience participants had with online search either individually or collaboratively, but as the level of experience was not measured it is unclear what kind of difference this made to the responses.

Another limitation to the study was in the question construction itself. Since few participants were likely familiar with the jargon associated with the field of collaborative information seeking, special care had to be taken to word the questions in a way that they would make sense to someone of limited knowledge. Even so, it was obvious that some of the participants did not fully understand some of the questions. Since the study was done using an online survey, participants did not have the opportunity to clarify question meaning or ask any questions as they would have had for interviews.

This study is also limited in that the reported data is from the point of view of a single person, even though the search experience actually involved other people. This means that the information reported could be biased or one-sided, and additional useful information could have been discovered by having information from an entire group. Unfortunately this is one of the drawbacks of using a survey to gather data; while a greater amount of information can be collected, it is not necessarily a truly objective representation of the events that occurred.

Potential Future Research

The survey used in this study could probably use some modifications based on the responses given by participants. The question that asks participants to describe the steps they took to resolve the search task could potentially be broken up into multiple questions. Separate questions could be used for specific search engines, types of organizational tools, and methods of communication between the group members. Dividing this question into distinct, more specific questions may help to gather more useful data about the actual collaboration that took place. It would also be helpful to remind participants as the survey progresses that they should still keep in mind the last collaborative search event they were involved in, rather than their experiences in general. In particular this was true of the question that asked participants about the difficulties they experienced with CIS; some participants responded very generally and it did not sound like it necessarily applied only to the specific instance of CIS in question.

It would also be interesting to utilize the survey method against other populations, such as in Mechanical Turk as was done in the Evans and Chi (2008) study. Additional attempts at surveying other populations with similar questions could possibly strengthen the reliability of the survey method when studying CIS.

In addition to studying other populations, further research could be done on undergraduate students using other methods. By studying undergraduate student collaboration more closely such as through interviews and observations as was done in a number of the other CIS studies, it would hopefully reinforce the results collected in this particular study.

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Appendix A: Survey Instrument

This questionnaire is aimed at finding out more about your experience looking for information on the web with other people.

For example, this could include doing any of the following with at least one other person: searching for information for a class project, looking up movie times, searching for a birthday present, or looking for health-related information for a relative that doesn't know how to use the web.

This type of activity could include (but is not limited to) determining the exact information problem, searching out the desired information, or sharing the information once it has been found.

For the purposes of this questionnaire, a 'group' is considered to contain two or more members, where one member would be you.

Are you currently enrolled for the Fall 2009 semester?

- ○ Yes
- ○ No

What is your current year in school?

- ○ Freshman
- ○ Sophomore
- ○ Junior
- ○ Senior
- ○ Other – Please Specify: _____

Are you a full time or part time student?

- ○ Full time
- ○ Part time

What is your major?

Have you ever searched for information online with others or for someone else?

- ○ Yes
- ○ No

(NOTE: For those participants who answered NO to the question above about whether they have ever searched for information online with others or for someone else, they were shown the following questions.)

Are there any particular reasons why you have not searched for information on the web with (or for) others?

Are there instances for which you think searching for information on the web with (or for) others would be useful? If so, please describe them below.

Participants in this survey are eligible to be entered into a drawing for one of five $20 Amazon.com gift certificates. If you would like to be entered into this drawing, please enter your email address in both fields below. Otherwise leave them blank.

Email Address:

Please verify your email address:

(NOTE: For those participants who answered YES to the question above about whether they have ever searched for information online with others or for someone else, they were shown the following questions.)

Have you ever looked for information on the web with someone else in any of the following ways? Select all that apply.

☐ You and at least one other person searched for information separately and discussed your results at a later time.

☐ You searched for information with someone while physically in the same location and shared a computer or other search device (e.g., mobile phone).

☐ You searched for information with someone while physically in the same location but used separate computers or other search devices.

☐ You searched for information with someone while chatting online or talking on the phone with them.

☐ You searched for information on behalf of someone else while that person was not present during the search, but you informed them later about the results.

Of these methods of searching for information with others, which have you done the most often? Select only one.

○ You and at least one other person searched for information separately and discussed your results at a later time.

○ You searched for information with someone while physically in the same location and shared a computer or other search device (e.g., mobile phone).

○ You searched for information with someone while physically in the same location but used separate computers or other search devices.

○ You searched for information with someone while chatting online or talking on the phone with them.

○ You searched for information on behalf of someone else while that person was not present during the search, but you informed them later about the results.

For which types of tasks below have you searched for information with others? Select all that apply.

☐ Work Tasks
☐ School Tasks
☐ News and Current Events
☐ Entertainment and Hobbies
☐ E-commerce/Product Reviews/Shopping
☐ Health and Exercise
☐ Other (Please specify): _____

Think of the last time you searched for information with (or for) at least one other person. The remaining questions will ask you about this particular instance.

What was the purpose of the search?

What type of information were you trying to find?

When did this occur?

- ○ A few days ago
- ○ Last week
- ○ Last month
- ○ Last year

With how many people did you work (including yourself)?

- ○ 2
- ○ 3-4
- ○ 5-6
- ○ More than 6

Why/How did you decide to search for information with others, rather than on your own?

Did you search for information about this topic by yourself before teaming up with the group?

- ○ Yes
- ○ No

Did you search for information about this topic by yourself after the group work ended?

- ○ Yes
- ○ No

Approximately how many sessions were required to complete the overall search task?

How long did it take you and your partners to finish the overall search task?

- ○ One hour or less
- ○ A few hours
- ○ A day
- ○ A few days
- ○ A week
- ○ A month
- ○ A few months (or a semester)
- ○ More than a few months

For this search, what amount of information did you need to resolve the information need?

- ○ A single answer
- ○ A single document
- ○ Multiple documents
- ○ Other - Please specify: _____

Did you consider the overall search successful? Why or why not?

Now, I'd like to ask you about the steps you executed to resolve this search task.

First, describe the steps you took to resolve the search tasks, including the tools you used (such as search engines, communication tools, organizational tools, etc.)

Second, describe the interactions that occurred between you and your partners by answering the following questions.

Did you divide the work?

- ○ Yes
- ○ No

If you did divide the work, how did you divide it and how did you decide who would be responsible for the different sub-tasks?

If you did not divide the work, why not?

How did you determine whether the items found were useful?

How did you determine when to stop searching?

Were you satisfied with the group interactions? Why or why not?

Did you find working with others difficult? Why or why not?

Did the information you need to resolve the search task change as you searched? For example, did you revisit the problem and refine or change the topic or focus? If so, how?

Is there anything else you would like to tell me about your experiences searching for information on the web with other people?

Participants in this survey are eligible to be entered into a drawing for one of five $20 Amazon.com gift certificates. If you would like to be entered into this drawing, please enter your email address in both fields below. Otherwise leave them blank.

Email Address:

Please verify your email address: