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A Research Method to Investigate Information Seeking using the Concept of Information Horizons: An Example from a Study of Lower Socio-economic Students' Information Seeking Behavior

by

Diane H. Sonnenwald[1]

Barbara M. Wildemuth[1]

Gary L. Harmon[2]

[1]School of Information and Library Science
University of North Carolina at Chapel Hill
100 Manning Hall, CB #3360
Chapel Hill, NC 27599-3360 USA
(919) 962-8065
dhs@ils.unc.edu; wildem@ils.unc.edu

[2]Department of Biology
Elizabeth City State University
Elizabeth City, NC 27909 USA

Contact Author: Diane H. Sonnenwald

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Abstract

As research questions and topics in information studies evolve, there is a continual need to seek out innovative research methods to help us investigate and address these questions. This paper presents an emerging research method, the creation and analysis of information horizon maps, and discusses the use of such maps in an ongoing research study. Sonnenwald's (1) framework for human information behavior provides a theoretical foundation for this method. This theoretical framework suggests that within a context and situation is an 'information horizon' in which we can act. Study participants are asked to describe several recent information seeking situations for a particular context, and to draw a map of their information horizon in this context, graphically representing the information resources (including people) they typically access and their preferences for these resources. The resulting graphical representation of their information horizons are analyzed in conjunction with the interview data using a variety of techniques derived from social network analysis and content analysis. In this paper these techniques are described and illustrated using examples from an ongoing study of the information seeking behavior of lower socio-economic students. These techniques are compared to other techniques that could be used to gather data about people's information seeking behavior.

INTRODUCTION

As research questions and topics in information studies evolve, there is a continual need to seek out research methods to help us investigate and address the research questions. For example, in the early 1990's discussion regarding the applicability and use of qualitative research methods emerged (e.g., 2), and there has been ongoing discussion about applying a variety of research methods, such as social network analysis (3), that originated in other fields to research questions of interest in information studies. Most recently there has been discussion about integrative approaches that use multiple research methods (e.g., 4, 5). While it is important to seek out, apply and adapt research methods that emerge in other fields to help us investigate and create new understandings and knowledge concerning information seeking, it can also be fruitful to create and test new methods that are specifically designed to address research in information seeking.

This paper presents one such method, the creation and analysis of information horizon maps, and discusses its use in an ongoing research study. Participants in an electronic mentoring project were asked to draw maps of their information horizons, i.e., the information resources they routinely use, and concurrently to explain their maps. This paper describes this data collection technique and associated data analysis techniques, and evaluates it in comparison to other techniques that might be used to gather data about people's information seeking activities and the resources used during those activities.

RESEARCH METHODS IN INFORMATION SEEKING STUDIES

A goal of any research method is to provide a valid and reliable way to collect data that help answer the research questions or provide insight into the topics of interest to a community of scholarship. In the information seeking field, researchers typically focus on the information seeking process, resources individuals or groups of individuals use when seeking information to resolve a problem or when seeking information serendipitously, and/or outcomes of the information seeking process (e.g., see the collection of papers in 6 and 7). This research has illustrated that the process of information seeking may involve indeterminate sequences of events, and that a variety of factors may influence events, including the resources selected and used.

Methods typically used to investigate these issues include psychometric measures, surveys, interviews, think-aloud protocols, and direct observation. Each of these methods (or techniques) has advantages and disadvantages (see Table 1). Surveys, structured interviews and psychometric measures provide quantitative data on specific variables of interest but this type of data typically does not

capture the dynamic nature or complexity of many information seeking situations and contexts. Semi-structured or ethnographic interviews can provide data concerning the complexity and dynamic nature of information seeking, however it can be difficult to gain access to study participants and it can be time and labor-intensive to collect and analyze interview data. Think-aloud protocols provide data about participants' behavior and cognitive reasoning while performing a task. However, they can only be applied to tasks that occur over relatively short periods of time, and thus may be more applicable to information retrieval tasks using a particular information retrieval system or set of tools. In comparison, direct or participant observation can provide data about information seeking behavior as it occurs in field settings. When information seeking behavior occurs over time and in multiple locations it can be difficult to collect observation data.

Table 1. Advantages and Disadvantages of Existing Research Methods in Information Studies

Method	**Advantages**	**Disadvantages**
Psychometric measures	Provide quantitative data that can be analyzed with statistical data analysis methods; reliability and validity can be demonstrated	Difficult and labor-intensive to develop instruments that are reliable and valid
Surveys & Structured interviews	Provide quantitative data that can be analyzed with statistical data analysis methods	Data provided does not easily capture the dynamic nature or complexity of many situations or explain participants' perspective
Semi-structured & ethnographic/open-ended interviews	Interviewer can dynamically respond to and ask additional questions from each study participant; can ask about participants' perspective	Can be difficult to gain access to, and confidence of, study participants; time consuming to conduct interviews and analyze data; participants are asked to recall events, processes
Concurrent think-aloud protocols	Provide data about participants' behavior and cognitive reasoning while performing a task	Can only be applied to tasks that occur over relatively short periods of time; verbalization may perturb cognition or task performance
Direct/participant observation	Provide data about participants' behavior	Difficult to gain access to sites & requires large investment of time for observations; does not provide insight into participants' perspectives or cognitive reasoning

Because these methods have both advantages and disadvantages, researchers in our field have begun to use two or more research methods within a study or across a series of studies to gain a more complete understanding of human information behavior. For example, Sonnenwald and Iivonen (4) discuss the motivation and validity of such an approach and propose a multiple method research framework, and Bradley (8) comments on the value of using multiple data sources in order to gain perspective. In sum, using multiple methods provides more data and different types of data; in addition,

multiple types of data analysis techniques can be used on the different types of data with the goal of gaining a more comprehensive and valid understanding of human information behavior.[1]

In addition to applying multiple existing research methods, researchers studying human information behavior should consider developing, and evaluating, new research methods that are specifically designed for such research. By considering what we know about the strengths and weaknesses of existing research methods, how multiple methods can complement each other within a study or across a series of studies, and the type of research questions and topics we wish to ask, we can create new methods that provide reliable and valid means to collect and analyze data that is of specific interest to our field. One novel method for investigating people's perceptions of their information horizons was developed in the current study.

INFORMATION HORIZONS MAPS: AN EMERGING RESEARCH

Theoretical Background

To design and develop a new research method we used Sonnenwald's (1) framework for human information behavior as a theoretical foundation. This theoretical framework suggests that within a context and situation is an 'information horizon' in which we can act. For a particular individual, a variety of information resources may be encompassed within his/her information horizon. They may include social networks, documents, information retrieval tools, and experimentation and observation in the world. Information horizons, and the resources they encompass, are determined socially and individually. In other words, the opinions that one's peers hold concerning the value of a particular resource will influence one's own opinions about the value of that resource and, thus, its position within one's information horizon. Interactions with others will make one aware of their opinions, and so are likely to cause changes in one's information horizons. For example, in an academic context, a teacher may recommend a journal to a student, thus adding that resource to the student's information horizon when the teacher has a positive influence of the student.

Thus the concept/theory of information horizons suggest that certain types of data are important for increasing our understanding of human information behavior. These data include decisions made and activities undertaken during the information seeking process; when and why information resources, including individuals, are accessed (and not accessed); relationships or interconnectedness among information resources; individual preferences and evaluation of information resources; the proactive nature of information resources; and the impact of contexts and situations on the information seeking process.

The methodological question addressed by the current study is whether study participants would be able to articulate or describe their information horizons graphically and verbally. Such graphical and

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[1] Of course using multiple methods increases the resources and time needed to collect and analyze data. These resources and time may not always be available to researchers.

verbal articulation could provide an extremely rich view of people's information horizons and information behavior in general.

Data Collection Methods

We used this combination of graphical and verbal articulation of information horizons when conducting a study evaluating the impact an electronic mentoring program may have on students in lower socioeconomic areas (9). The study participants included 11 undergraduate students attending an historically minority university in a rural, economically-depressed area in the U.S., and 9 corporate scientists who worked for a major corporation located in the northeast U.S.

The students' ages ranged from 19 to 23 years of age;[2] they were juniors and seniors with (self-reported) grade averages of C to A/A+, with an overall average of B/B+. There were 9 female and 2 male students; their career goals included careers in physical therapy, medicine, forensic science, nursing, teaching and research; some were "undecided" with respect to their career goals. All students were African-Americans. They were enrolled in a course titled, "Frontiers in Biology," an elective, advanced undergraduate course in molecular biology. This course was selected to participate in an E-Mentoring project based on the university department and faculty preferences. The course provided a context for our research, and was not selected based on course content, student qualifications, etc.

Each participant was asked to describe specific information seeking situations. Specifically, they were asked to describe a recent information seeking situation for each of several particular contexts such as science courses, science careers and scientific work projects. Study participants are also asked follow-up questions about the recent situation. The follow-up questions serve to encourage, or prompt, the participant to provide details about the situation. These details included: the type of information needed; why that information was needed; which information resources (including individuals) they accessed, why and in what order; whether they were satisfied with the outcomes; how the information was used; what they would do similarly the next time; and what they would do differently the next time. Appendix A lists the questions that were used to illicit this information.

In addition to discussing a recent information seeking situation, participants were also asked to describe incidents when it was: difficult to find information; easy to find information; very satisfying to seek information, and very dissatisfying. For some participants there was overlap among these incidents, e.g., a difficult incident may also have been very satisfying from the participant's perspective. When this occurs, a simple follow-up question asking for a little more detail generally suffices. When the incidents are unique, i.e., not previously mentioned, follow-up questions, as described above, were used to encourage the participant to provide details about each incident. For some participants, of course, some or all of these follow-up questions were not necessary because they proactively provided the details in their descriptions.

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[2] With a mean of 21 years of age.

These interview questions built on Flanagan's critical incident interview technique (10) and the semi-structured, or open-ended, interview technique (e.g., see 11). In our approach, their purpose was to encourage the study participants to describe their information seeking processes, information resources, and evaluation of these resources and processes. They also prompted a study participant to recall past information seeking situations and helped ensure that their responses were as comprehensive as possible.

The interview questions were followed by a graphical representation, or drawing, task. In this task, each participant was asked to draw a map of his or her information horizon including all the information resources described to that point in the interview, and adding any additional resources that might be used by the participant. Following is an excerpt from one of the interviews, asking a study participant to draw his information horizon.

> **"Interviewer:** One other thing that we're trying in this study is that we're asking people if they could draw what we're referring to as their information horizon or information horizon map: to put yourself on this piece of paper, and then draw in the people and other resources that you typically access when you're either seeking information for your courses or for your career. And if you could indicate which ones you might go to first, or you could go to several simultaneously, or which ones you prefer – and talk about it as you're drawing it.
> **Study Participant:** Okay; in the middle, `course it's me.'"

Participants were also encouraged to talk about and explain their drawing as they created it. Follow-up questions encouraged participants to provide details about their information horizons. Examples of follow-up questions included:

> "Do you use any other resources?
> When, or why, would you go to this particular resource after/before going to this other one?
> Do any of these resources proactively provide you with information? Or suggest other information resources to you?
> Previously, you mentioned xyz resource. Would you include them/it on your information horizon? Where? Or, why not?"

In late August and early September 1999, the students participated in interviews described above.[3] Examples of information horizon maps drawn by two students are illustrated in Figures 1 and 2. All students were able to describe their information seeking incidents and create a graphic representation of their information horizons.

[3] The interviews included additional questions focusing on mentoring and electronic mentoring, and thus it is difficult to estimate the length of time spent on discussing information seeking incidents and the information horizon maps. However, in general the interviews lasted a total of 45 to 75 minutes.

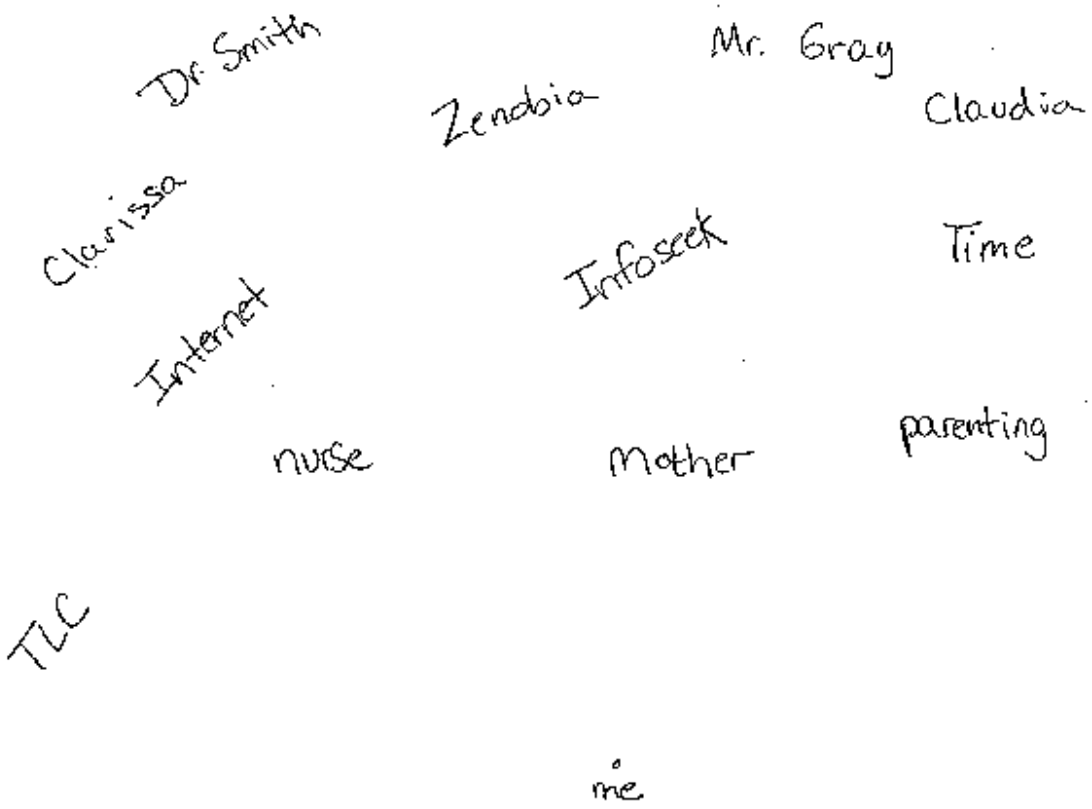
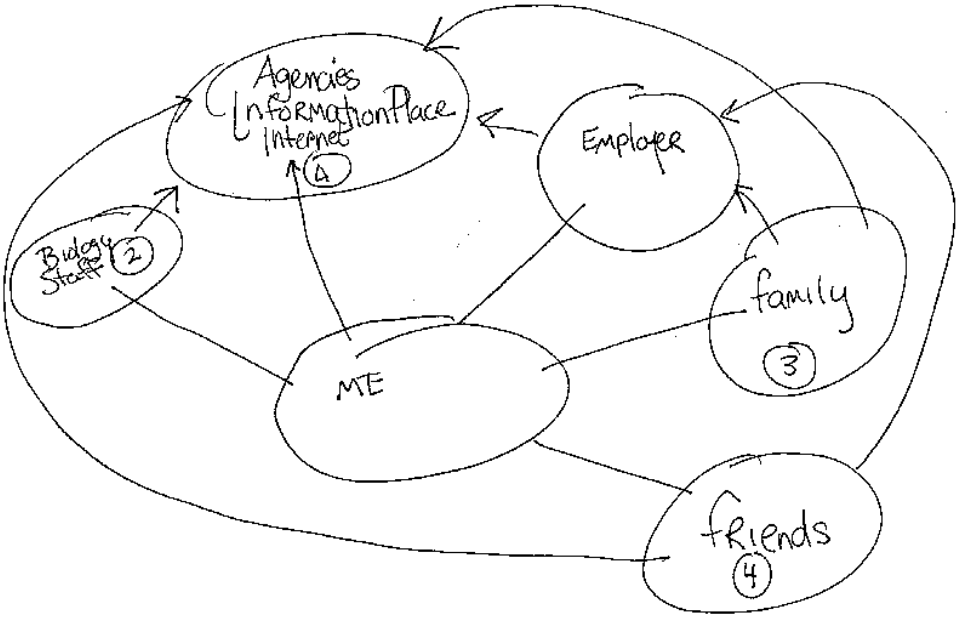


Figure 1. A student's graphical representation of their information horizon

Figure 2. Another student's graphical representation of their information horizon



Example of Data Analysis

A first step in analyzing the graphical representations of the students' information horizons was to transfer the graphical representations to a matrix where the rows represent the information resources used by students and the columns represent each student. The cells of the matrix are populated with numbers that represent each student's preferences or order of access among the information resources. When a student's information horizon map, or graphical representation, was unclear, the interview transcript was consulted for clarification. For example, a few students had identified "journals" and/or "books." In these cases, their interview transcripts were consulted to determine if these should be separate categories or if they were part of a larger category such as "university library." In this set of data, these references all referred to journals and books in their university library or another university library. The matrix resulting from this analysis is illustrated in Table 2.

Table 2. Matrix illustrating students' preference order of information resources

	AL	DB	KM	AR	DeK	ME	DoK	JI	DaK	JE	YE	*# students*	*Total times mentioned*
Internet	1	2	1	1	2	1	2,4,6,8	1	1	1	1	*11*	*14*
Faculty		1	2	4	2,4	2	3	2		2		*8*	*9*
Friends			3	3		5	7	1			3	*6*	*6*
Univ Library	3	3			3				2	3	4	*6*	*6*
Experts	2				1	4		2		2		*5*	*6*
"Info Places"	1						2,4,6,8	2		2		*4*	*7*
Family				1	1	3	5					*4*	*4*
Other Univ Libraries	4							1		4		*3*	*3*
Employer							1,6,8				2	*2*	*4*
Local Library	5									5		*2*	*2*
Popular Magazines				1,2								*1*	*2*
TV				1								*1*	*1*
University Catalogs								1				*1*	*1*
Links among students and resources	*7*	*3*	*3*	*10*	*9*	*5*	*18*	*16*	*2*	*9*	*4*		

The matrix can also be thought of as a two-mode social network (12) in which the study participants are one mode and their information resources are the second mode. Unfortunately measures of centrality and centralization have not been developed for two-mode networks (12). However we can extend social network and graph theory to suggest trends among information resource preferences, and analyze the preference links and lack thereof to show interconnectedness among information resources.

Identification of Information Resources in Students' Horizons

As illustrated in Table 2, the undergraduate students reported they used 13 different information resources including the Internet, university faculty, friends, "information places," experts, their university library, family members, popular magazines, other university libraries, television, employers, and university catalogs when seeking information related to their courses and careers. The term, "information places," refers to specific locations that contain information the student needed. As one student said:

> "So I try to go directly to an information place…Examples [are] a doctor's office or health department office."

Other examples of information places included career centers and hospitals. "Experts" included authors of papers, people who had suffered from the disease the student was investigating, mentors assigned through an on-campus program, and professionals working in a career that interested the student or was expert in the topic of their assignment. "Other university libraries" included special and general academic libraries that were at least a 90 minute drive from their university.

Relationships among students and information resources

The matrix shows that four of the 11 (36%) students had more than one first choice for information. Eight of 11 (73%) students mentioned the Internet as their first choice. Other first choices include family (2), faculty (1), friends (1), information places (1), experts (1), popular magazines (1), and television (1). This illustrates the variety in these students' information seeking strategies or preferences. It also indicates the important role the Internet can play in providing information to lower socio-economic students who are often first generation college students, and whose physical access to information resources may be limited.

The matrix also shows patterns of students' preferences or order in which they typically access information resources. For example, one student, DeK, reported a preference for accessing experts, faculty and the Internet, the university library, and then back to faculty for information. Students' information seeking patterns included a *sequential chain* of preferences of 2 to 5 resources (e.g., see DB, KM, ME, DaK and YE). They also included a *breadth-first* pattern where multiple resources were preferred or accessed initially (e.g., AL, AR, DeK, JI and JE.) For our purposes a breadth-first pattern included those sequences with more than one resource identified in the first or second rank or tier (when there was more than three ranks/tiers of preferences). A third pattern was *cyclic* in nature; it contained multiple loops among information resources, e.g., see DoK where preferences vary back and forth among several types of resources. A fourth pattern contained multiple resources at multiple levels of preferences, and may be thought of as a *branching or fan* pattern. For example, see JI where multiple first and last preferences were identified. These data illustrate the complexity and variety in information seeking patterns. In information studies this type of data could provide insights into how access to multiple information resources could be or should be integrated in information systems to support users' preference patterns. It could also be integrated into educational courses whose goal is to teach information searching strategies.

The graph in Figure 3 and data in Table 3 can also be used to identify types of nodes as done in social network analysis. Four types of nodes used in social network analysis are *isolates* (no arcs to or from a node), *transmitters (n*o arcs coming into a node but arcs coming out of a node), *receivers* (arcs coming into a node but no arcs going out of a node), and *carrier* or *ordinary nodes* (arcs coming into and

out of a node) (12). In our case, isolates and transmitters are not possible unless we ignore the links drawn between the study participant (self) and the first resources used.

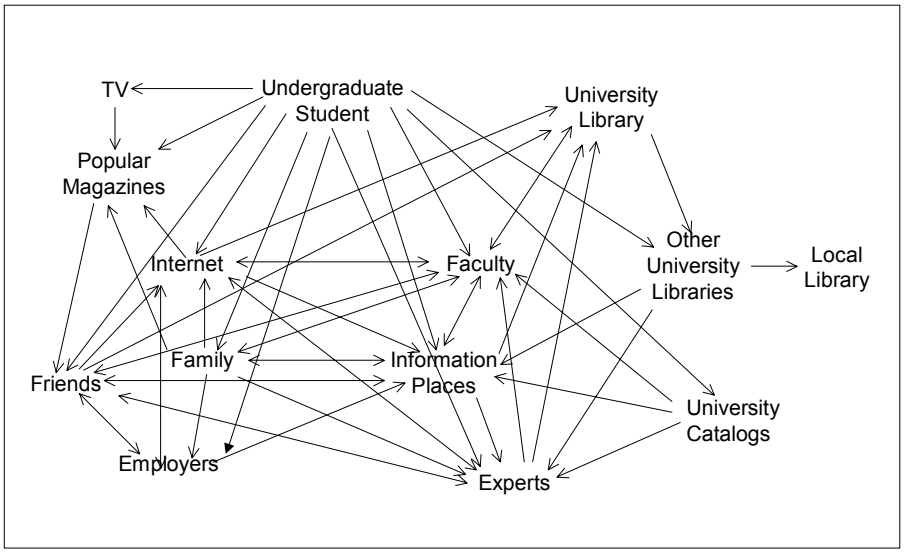


Figure 3. Network of Information Resources for Students

Table 3. Links between nodes as representing node types

	Total times mentioned	Total # links	Unique links	Outgoing links	Incoming links	Node type
Internet	14	20	8	13	7	Recommending
Faculty	9	19	7	7	12	Focusing
Friends	6	13	6	7	6	Balanced
Univ Library	6	11	6	3	8	Focusing
Experts	6	12	8	4	8	Focusing
“Info Places”	7	14	9	5	9	Focusing
Family	4	8	6	6	2	Recommending
Other Univ Libraries	3	7	5	5	2	Recommending
Employer	4	6	4	3	3	Balanced
Local Library	2	2	1	0	2	Ending
Popular Magazines	2	4	4	1	3	Focusing
TV	1	1	1	1	0	Starting
Univ Catalogs	1	3	3	3	0	Starting

For understanding information seeking behavior, several of these terms are not descriptive or necessarily meaningful. The terms, transmitter, receiver and carrier, have their origin in communication; these nodes transmit, receive or "pass on" communication among nodes (which represent actors in social networks). In information seeking, these nodes are information resources that play a role in an information seeking process or have a preference rank in a process. In this sense, a receiver is an *ending resource* in an information seeking process. A transmitter is a *starting resource.* A carrier has a balanced role in the process, and can be thought of as a *balanced resource*. For example, as illustrated in Figure 1, university catalogs and television are starting resources because students reported only going to these resources first; they did not go to them after accessing other information resources. An ending resource is the local library (a receiver); students did not report going to any other resources after going to a local library.

In addition, the relationship between the number of incoming and outgoing arcs is interesting. As illustrated in Table 3, family, the internet, and other university libraries have more outgoing than incoming arcs or connections to other resources. These resources can be thought of as *recommending resources*; they are a starting point and either recommend other resources directly and/or do not provide the complete information the individual is seeking because in either case, the individual continues to access additional resources. As further illustrated in Table 3, faculty, information places, experts, university libraries, and (to a lesser extent) popular magazines have more incoming that outgoing arcs. For these resources many paths lead to them; fewer paths lead from them. In this sense they narrow the information seeking process, and can be thought of as *focusing resources*. The classification of the information resources in our current study is shown in the last column of Table 3.

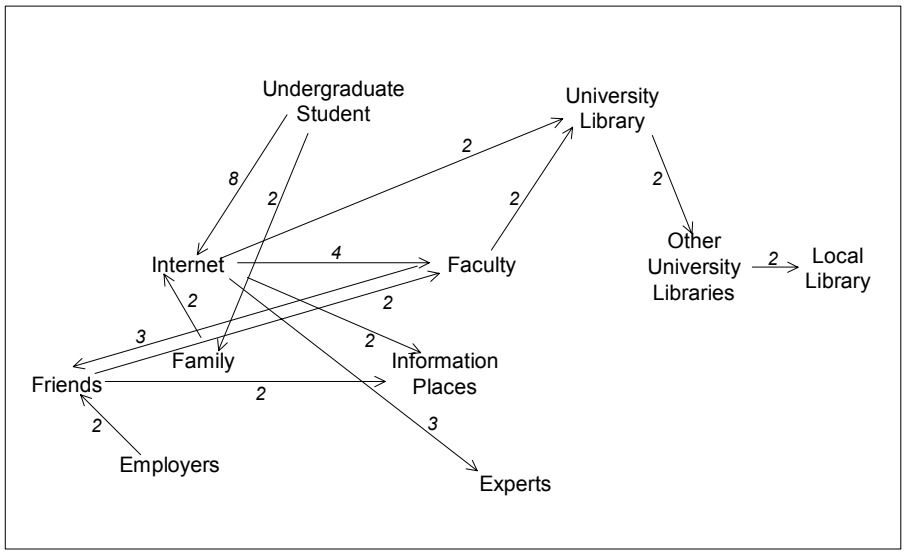


Figure 4. Stronger Connections (links >1) among Information Resources

Relationships among information resources

While Figures 3 and 4 illustrated the connections among information resources, Table 4 focuses on the *lack* of connections among some of the information resources. The lack of some connections is to be expected; for example, it is not surprising that there are no connections between university faculty and popular magazines or television. However, it is somewhat surprising that there is not a connection between faculty and employers, and no outgoing connection between faculty and experts. These may be two resources faculty should consider suggesting as information resources in the future.

Table 4. Relationships among information resources and "incoming" and "outgoing" connections

Resource	No Connections with:	No Outgoing Connections with:	No Incoming Connections with:	Incoming & Outgoing Connections with:
Faculty	Employers Local libraries Other univ libraries TV Popular magazines	Experts Univ catalogs		Info places Internet Univ library Friends Family
Internet	Univ catalogs Other univ libraries Local libraries TV	Family Friends	Info places Popular magazines Univ library	Faculty Experts Employers
Info Places	TV Popular magazines Local library	Employers Internet Other univ libraries Univ catalogs	Univ library Experts	Faculty Family Friends
Friends	TV Local library Other univ libraries Family Univ catalogs	Popular magazines	Univ library Internet	Experts Info places Employers Faculty
Experts	TV Popular magazines Local libraries Employers	Univ catalogs Other univ libraries Info places Family	Faculty Univ library	Friends Internet
Univ Library	TV Popular magazines Local libraries Employers Family Univ catalogs	Experts Info places Friends Internet	Other univ libraries	Faculty

Another surprise is the lack of outgoing connections between information places and the internet. One information place mentioned by several students was a career center; the data suggest that the career center either does not recommend the internet, employers, university catalogs and other university libraries as potential resources to students, or else the students have already investigated these resources before coming to the career center and they find no new information to suggest they should access the resources again. Information places appear to be much more closely connected with local, face-to-face information resources, such as faculty, family and friends. These types of insights could be used to further investigate the current role and possible future roles for information places.

The data further suggest that the library does not recommend or suggest employers, local libraries, university catalogs, experts, information places, or internet resources to students. These data combined with data from Table 3 that show the university library as sixth in terms of the number of connections with other resources indicate that the university library is not a preferred resource and is not well integrated with other information resources in students' information horizons.

INFORMATION HORIZON MAPS IN RELATION TO OTHER DATA COLLECTION TECHNIQUES

In the current study we also surveyed students regarding their use of information resources. The responses from this survey item can be compared with the results from the analysis of information horizon maps in order to assess the validity of the maps. One would expect that there would be a high level of agreement between the survey results and the maps, in terms of the identification of those resources most frequently used by students.

Comparison with Survey Data

Via the survey, students were asked to identify information resources they had used in the previous two months. The information resources included in the survey questions are shown in Table 5, and were adapted from the survey used by Rice and Tarin (13). The survey results would indicate that the most frequently used information resources included scholarly/professional materials from printed indexes and from the World Wide Web and resources acquired from the university library via searching the catalog or browsing the shelves. However, the information horizon data illustrates that study participants considered a wider range of information resources than we, as information professionals and researchers, typically consider in our studies. For example, students referred to the Learning (TV) Channel, *Time* magazine, university catalogs, aunts, uncles, employment services, career centers, *Parents* magazine, alumnae, doctors' offices and hospitals as information resources (in addition to more traditional information resources such as the internet, faculty and university libraries.) Although in information studies research we typically consider these alternatives as information resources with respect to leisure activities and

other non-academic or non-career-related information needs, it is rare that they are considered and included in questionnaires for academic and career-related information needs. It is difficult to imagine how researchers could develop a survey question to capture the variety and richness of the information resources used by these students (and, by extension, other populations and samples). For example, in a more recent study replicating the one described here, a study participant described praying to God and placed "God" at several points in their information horizon. It is difficult to imagine we would ever have sufficient insight to add "God" as a possible response in an information needs survey question. Or, even if we did have such insight, other study participants may object, questioning the motives of the questionnaire and research in general, and elect not to participate in the study.

Table 5. Survey responses reporting information resources recently used by students

	Students	
	n	*%*
1. Browsed materials in corporate/university library	5	*45%*
2. Studied materials in corporate/university library	3	*27%*
3. Borrowed materials from corporate/university library	2	*18%*
4. Photocopied materials from corporate/university library	3	*27%*
5. Searched online library catalog	5	*45%*
6. Searched for scholarly/professional materials in printed abstract & index services	7	*64%*
7. Searched for scholarly/professional materials via CD-ROM databases	0	
8. Searched for scholarly/professional materials from the World Wide Web	7	*64%*
9. Received preprints or drafts of papers from colleagues/professors	0	
10. Shared scholarly/professional interests with colleagues/peers in face-to-face communication	4	*36%*
11. Shared scholarly/professional interests with colleagues/peers in electronic communication	1	*9%*

Furthermore, the information horizon map provides data about the information seeking process, in particular, about relationships among information resources or individuals' preferences for information resources at various times during the information seeking process. Survey questions could ask about individuals' preferences for information resources, e.g., asking participants to rank-order information resources based on their preferences. However, survey questions cannot easily capture data concerning the process. For example, it is difficult to imagine how survey questions could provide data that reflects DoK's information seeking behavior (see Table 2) with its "back and forth" pattern among multiple information resources.

Comparison and Synergy with Interview Data

In this study, the drawing of information horizon maps followed reasonably extensive semi-structured interviews concerning particular information seeking incidents. These interviews helped prompt the study participant in thinking about information needs and information seeking behavior in preparation for creating an information horizon map. In addition, we used open-ended interview questions to ask participants to more fully explain their maps as they were being drawn, e.g., to clarify pictures or text we could not understand and to explain their choices as necessary. Thus, graphical representations of information horizons and interview questions combined to provide a rich data collection technique.

An additional advantage to this method is that through the information horizon map or graphical representation, the study participants provided a synthesis of their information seeking behaviors. In this way, the study participants were assisting in data analysis or at a minimum helping to make data analysis easier. For example, an alternative approach would have been to analyze the interview data and synthesize descriptions of information seeking situations in an attempt to construct a generalized model of a study participant's information seeking behavior. The information horizon map provides such a synthesis, easing the burden of data analysis for the researcher. The study participants could also have provided verbal syntheses without creating graphical representations, however, for many participants it appeared that the graphical representation aided participants in creating such a synthesis. This aid may be more important as the participant's information horizon increases in complexity.

Comparison with other Graphical Data Collection Techniques

Graphics or drawings have been used as a valid and reliable data collection technique for many years. Perhaps the most common graphical data collection technique is asking study participants to draw a line to indicate the strength of their feelings or their position concerning a particular issue. Typically a study participant is given a graphical scale with labeled endpoints, and asked to indicate their position concerning an issue on that scale (e.g., see 14.) This technique has also been applied in assessing users' judgments of the relevance of retrieved documents (15). Alternatively, study participants are asked to draw a line (or shade in a bar) themselves, with the line length indicating the participants' perspectives. Byström (16) used this technique to ask study participants to indicate how well they knew a task process and information required for the task. In a variation of this approach Bytsröm (16) asked study participants to place themselves on a staircase; the lowest and highest positions on the staircase indicated the participant's level of expertise in a decision-making situation. In addition, she asked participants to indicate the complexity of the task on a meter scale.

Timelines are a graphical data collection technique more closely related to the technique presented in this paper. From a cognitive science perspective, timelines could be seen as representing the study participant's procedural knowledge about their own information seeking activities, while an information

horizon map could be seen as representing their structural knowledge of those activities (17). In one study, Scull, Milewski and Millen (18) asked study participants to create an historical time line that illustrated their personal experiences using the Internet from their use to the present. Participants were also asked to draw an early and recent map of the Internet, as they understood it. Participants were also given small stickers to add to the drawings. The stickers suggested various emotional states such as happy, frustrated or sad. Participants were encouraged to talk about their timelines as they created them. In addition, participants were asked to do a "think-aloud" Internet search task. Scull, Milewski and Millen analyzed the interview data to identify themes regarding individuals' expectations of the Internet. They do not indicate which data source (timeline, interview, think-aloud task) provided insights into the themes, nor do they provide or suggest an analysis of the timelines as we propose. The sense-making timeline interview method (19) also asks study participants to create a timeline and prompts participants for information about events reported on the timeline.

In comparison, we asked semi-structured interview questions about specific types of information seeking situations and then asked participants to synthesize their information seeking behavior in a graphical representation. It was interesting to note that, while subjects were asked to draw a map of their information horizons, rather than provide a sequential description (i.e., timeline) of their use of information resources, many of them did describe the chain of events associated with their movement through their information horizons. Future use of this technique should explore the strengths and weaknesses of a spatial representation of an information horizon versus a sequential representation of the participant's movement within the horizon.

The Validity and Reliability of Information Horizon Maps

To begin exploring the validity of information horizon maps, we compared the interview data concerning most recent, most satisfying and easiest information seeking situations with data from the maps. If information horizon maps are valid constructs, then they should have a high degree of overlap with the information resources mentioned by study participants when answering the semi-structured interview questions concerning information seeking situations. Analysis of the interview data and comparison with data represented graphically on information horizon maps showed that five information resources mentioned in response to the interview questions were not included on the corresponding map. That is, five students each mentioned one resource that they did not include on their information horizon map. There were a total of 70 instances of resources described on the maps. Thus the information horizons maps captured approximately 93% of all information resources mentioned by study participants. Those resources mentioned but not included were the university library [2], textbooks [2], and information places [1]. We can hypothesize that the university library may have been omitted because study participants (and faculty at the university) generally expressed dissatisfaction with the library. Many said the reference staff were not knowledgeable about biology and could not help them; others said they felt

uncomfortable in the library due to rules and procedures enforced there; and others said they did not have many biology resources in the library. With these attitudes it may be expected that participants may omit the university library from their information horizon. It is less clear why textbooks and an information place were omitted, and further investigation is needed.

We propose two refinements that may improve construct validity. In this study we asked participants to draw an information horizon that included both scientific (biology) information seeking and career information seeking. Because these are different contexts,[4] we propose study participants should be asked to draw separate maps for each context. Furthermore, we propose they should be asked to create the maps immediately after discussing information seeking situations within those contexts. In the current study, we asked participants to discuss information seeking situations first within the context of scientific work, and second, within the context of seeking career-related information. Then, we asked study participants to create a map that included both contexts. In retrospect, we believe it would have been better to ask participants to create a representation of their information horizon immediately after discussing the information seeking situations in a particular context. This may help increase the validity of the graphical representations.

Representative reliability (20) refers to the reliability of a technique across groups. We began investigating the representative reliability of this method with scientists working in major corporations. Early results indicate scientists are also able to create graphical representations of their information horizons. Additional research is required to investigate the reliability of this method. One approach is to repeat the data collection process within a short period of time with the same study participants. The period of time elapsed between data collection incidents may be critical if study participants' information horizons change due to personal growth or education, significant changes in task or job requirements, or the addition of available information resources.

SUMMARY

Information horizon maps are one method for gathering data about people's information seeking activities and the resources used during information seeking incidents. In the current study, they were used in combination with semi-structured interviews that elicited descriptions of particular information seeking incidents. Following these interviews, study participants (college students participating in an electronic mentoring program) were asked to draw information horizon maps, concurrently describing their contents. This was a first attempt at using this data collection method for this purpose. While it is

[4] The definition of "context" used here is "the quintessence of a set (or group) of past, present and future situations." (Sonnenwald, 1999). There is usually some shared understanding of a context by its participants (and outsiders); this shared understanding need not be identical or complete.

clear that more refinement of this data collection technique is needed, the preliminary results suggest its promise for studies of information seeking.

In particular, this data collection seems to have several advantages over other techniques. The combination of graphic and verbal representations of the participants' information horizons provided much more breadth and much more depth than is possible to attain through use of the more traditional surveys of people's resource use. The maps consolidate the information reported in multiple specific information seeking incidents, thus integrating the generality of the map with the specificity of critical incident reports. This technique is much less labor intensive than direct observation of people's information seeking activities. Finally, the method itself (incorporating both verbal description and graphical representation) provides data triangulation, thus improving its validity. Our own work will explore and evaluate the use of this technique further, by applying it to studies of graduate students (rather than undergraduates, as reported here) and corporate scientists. It is also important for others to incorporate it into their own studies and evaluate its applicability to other situations and other groups of people.

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Appendix A. Questions to Collect Data Concerning Information Situations

1. Could you think about when you recently needed information about … [fill in the context here, e.g., for your biology classes]?
   Follow-up questions to illicit additional details about the situation:
   - What information or type of information did you need?
   - Why? [Try to learn about the context of that information need and the situation that gave rise to it.]
   - Who did you go to for help or what resource(s) did you use to find the information you needed?
   - What did you do next? [Try to learn about their information seeking process and how they used the information they found, e.g., if they successfully resolved their information need.]
   - Were you satisfied with the outcomes? How did you use the information?
   - Would you do it this way again (if you needed similar information at a later point in time)? If not, what would you do differently? [trying to learn about if their information seeking process/information horizon changed as a result of this experience.]

2. Could you think about a time when it was particularly difficult to find information you needed?
   Alternative wording: In general, what type of information is hardest for you to obtain? Why?
   Use follow-up questions from Question 1.

3. When it was particularly easy?
   Alternative wording: In general, what type of information is easiest for to obtain? What makes it easy to get?
   Use follow-up questions from question 1.

4. When looking for information was particularly dissatisfying? I.e., a dissatisfying experience
   Use follow-up questions from question 1.

5. When getting information (finding information you wanted/needed) was very satisfying?
   Use follow-up questions from question 1.