Scholarly use of information:
Graduate students’ information seeking behavior

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Abstract

Introduction. This study explored the graduate students’ information behavior as it informs their process of inquiry and scholarly activities.

Method. In depth, semi-structured interviews were conducted with one hundred graduate students representing all disciplines and departments from Carnegie Mellon University.

Analysis. Working in pairs, we coded transcripts of interviews into meaningful categories using ATLAS.ti software. A combined use of quantitative and qualitative analysis reduced subjectivity.

Results. Graduate students often begin with a meeting with professors who provide direction, recommend and provide resources. Other students help to shape graduate students’ research activities, and university library personnel provide guidance in finding resources. The Internet plays a heavy role; though students continue to use print resources. Convenience, lack of sophistication in finding and using resources, and course requirements affect their information behavior. Findings vary across disciplines and between programmes.

Conclusion. Libraries can influence students’ information behavior by re-evaluating their instructional programmes and provision of resources and services. They can take a lead by working with academic personnel to guide students.
Scholarly Use of Information: Graduate Students’ Information Seeking Behavior

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Introduction

Nearly all information resources have increased, at times dramatically, over the last several years. In the United States from 1999 to 2002, books (original print) have increased by 83% while online scholarly journals nearly doubled from 1997 - 2001 (Lyman and Varian 2003). Faced with increasing competition from such a major information source as the Internet combined with patron demands, the average library budget that is spent on electronic materials has increased almost fourfold, from an estimated 4% in 1992-93 to 13% in 1999-2000 (ARL 2005: 7).

For academic libraries to adequately address the changing information needs of its students, they need to know more about the information that students use and value and what influences their information searching, obtaining, and use. To address these questions this study explores graduate students' information seeking behavior as they pursue their scholarly activities—the role of people, the Internet, the academic library, and other influences.

Problem statement

The purpose of this study is to describe the graduate students’ information seeking behavior and their use of information to support their process of inquiry and scholarly activities. We use information behavior, as described by T.D. Wilson, to be ‘those activities a person may engage in when identifying their own needs for information, searching for such information in any way, and using or transferring that information’ (1999: 249). More specifically this study was designed to explore the following questions:

- How do graduate students seek and obtain information, and what are the related issues?
- What information resources do graduate students value, and where do they find them?
- What role do people have in graduate students’ information seeking?
- What other factors influence graduate students’ information seeking behavior?

Related studies

Consistent with Wilson’s definition, Pettigrew et al. define information behavior as the study of how people need, seek, give and use information in different contexts, including the workplace and everyday living (2001). In the context of this study, we use information behavior as it applies to graduate students as they seek, search for, and use information to support their scholarly endeavors, focusing primarily on their research process. Our large sample will enable us to explore and compare the differences among disciplines. A multidisciplinary, qualitative study that focuses on graduate students as they conduct their research and process of inquiry is lacking in previous studies.

Other studies have focused on information behavior of high school, college, university students, and professionals. Two recent national studies looked at information behavior in colleges and universities. Both studies corroborate that the Internet and libraries’ online resources play a heavy role in participants’ information seeking. The first, Dimensions and Use
of the Scholarly Information Environment conducted by the Digital Library Federation (DLF) and the research firm Outsell, Inc., focused on information use of students and faculty members at colleges and universities (Friedlander n.d.). Using structured, telephone interviews, this study surveyed 3,234 faculty members, graduate students, and undergraduate students from colleges and universities on how the Internet affects their scholarly work, and the consequences it might have on campus libraries. This study examined such issues as what information resources support scholarly work, how users find information, and what problems are encountered.

The second national study of interest was from Online Computer Library Center (OCLC) which commissioned Harris Interactive to conduct an online survey of college and university students—the *OCLC White Paper on the Information Habits of College Students* (2002). The objective of this study was to describe college and university students’ views of successful information delivery. This study examined such issues as what students think about the information on the Internet, in the library, in print; how they access information; and what they value. A number of smaller studies exist on the information behavior of students and professionals (Foster 2004, Kerins, Madden, and Fulton 2004; Fidzani 1998; and Steinerova and Susol 2005). These studies focus how students, primarily undergraduate, and/or professionals in specific fields or disciplines seek information and the related issues. Few previous studies have concentrated attention on the research process of graduate students.

Previous major studies were based on the survey approach or structured interview to gather information. We will use a qualitative research approach to add depth to these previous studies. To extend the current research and concentrate on the segment of the student population that is most highly engaged in the research process, this study focuses entirely on graduate students and their process of inquiry or research as it relates to their information seeking behavior. Based on anecdotal information from librarians and academic faculty, this study recognizes that graduate student information behavior might differ among disciplines; therefore we will look at disciplinary differences as they relate to students’ information behavior.

**Methodology**

We used an exploratory qualitative research approach with semi-structured, in depth interviews. Qualitative research provides a deeper understanding of the issues and insight into the process we are studying. Sharan B. Merriam in *Qualitative Research and Case Study Applications in Education* explains that, ‘Qualitative researchers are interested in understanding the meaning people have constructed, that is, how they make sense of their work and the experiences they have in the world’ (1998: 6). Joseph A. Maxwell maintains that qualitative research is useful to understand the experiences of graduate students, the context in which they act, the influences on their behavior, and the processes surrounding their behavior (1997).

Qualitative research provides the opportunity to explore, not only the participant’s actions, but their perceptions of the search process consistent with Dervin’s view of information seeking as a process of sense-making where a person finds meaning which fits in with his previous knowledge thus forming a personal point of view (1983). Kuhlthau proposes a model for the information search process (ISP) based on her previous work (Kuhlthau 1983, Kuhlthau 1988b, Kuhlthau 1988c, Kuhlthau 1989, and Kuhlthau et al. 1990). The model
considers the affective (feeling), cognitive (thoughts), and physical (actions) realms as stages in the ISP. Kuhlthau’s work is based on Kelly’s (1963) personal construct theory which describes a person’s affective experience as they gather information. Using in depth, semi-structured interviews with graduate students, we were able to explore the three realms of the search process—affective, cognitive, and physical.

Sample

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Masters No.</th>
<th>Masters %</th>
<th>Doctoral No.</th>
<th>Doctoral %</th>
<th>Total No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts and Architecture</td>
<td>12</td>
<td>75%</td>
<td>4</td>
<td>25%</td>
<td>16</td>
</tr>
<tr>
<td>Business and Policy</td>
<td>10</td>
<td>91%</td>
<td>1</td>
<td>9%</td>
<td>11</td>
</tr>
<tr>
<td>Computer Science</td>
<td>2</td>
<td>14%</td>
<td>12</td>
<td>86%</td>
<td>14</td>
</tr>
<tr>
<td>Engineering</td>
<td>7</td>
<td>27%</td>
<td>19</td>
<td>73%</td>
<td>26</td>
</tr>
<tr>
<td>Humanities</td>
<td>5</td>
<td>25%</td>
<td>15</td>
<td>75%</td>
<td>20</td>
</tr>
<tr>
<td>Sciences</td>
<td>0</td>
<td>0%</td>
<td>13</td>
<td>100%</td>
<td>13</td>
</tr>
<tr>
<td><strong>TOTAL STUDENTS</strong></td>
<td><strong>36</strong></td>
<td><strong>36%</strong></td>
<td><strong>64</strong></td>
<td><strong>64%</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Table 1: Graduate student sample*

The sample was drawn from the population of graduate students enrolled at the Carnegie Mellon University. Our goal was to select a sample of students that represented masters and doctoral students, all colleges (seven), and all departments (thirty-three) of the university. With guidance from the university’s Eberly Center for Teaching Excellence, we decided on a sample of one hundred graduate students. We would be able to represent every department with at least two students (larger departments would have more), and we would have an easy number to work with. Though our sample (one hundred) is large for an interview study, we wanted to represent all colleges and departments of the university and still have the benefits of a qualitative study.

We used a random sample of the population of graduate students to select 84% (eighty-four students) of the sample (22% of those sent an invitation agreed to participate). However, some smaller departments were not represented by random sampling. To adequately represent all departments, the final 16% (sixteen students) were selected by contacting all graduate students in poorly represented departments and inviting them to participate in our study. Students were offered a monetary incentive (twenty dollars for each student) to participate.

The final sample consisted of one hundred graduate students representing all Carnegie Mellon colleges and departments. The sample included primarily doctoral students (64%) with the exception of business and policy (9% doctoral) and arts and architecture (25% doctoral). The disciplines represented in this study are arts and architecture (sixteen), business and policy (eleven), computer sciences (fourteen), engineering (twenty-six), humanities (twenty), and sciences (thirteen).
Data collection

We used in depth, semi-structured interviews. The interview design was based on an earlier online survey of the population of graduate students and a review of literature. Three interviewers conducted one hundred face-to-face interviews (one participant interviewed by one university library interviewer), to explore the research questions. Interviewers used a written script (see appendix) of questions and probes, but they could stray from the script in order to further investigate responses by graduate students. As explained by Merriam, interviewing is necessary when direct observation is not possible or reasonable, or when one is interested in ‘past events that are impossible to replicate’ (1998: 72). In this case the interviews provide a means of exploring the past as well as the current information seeking behavior of graduate students. They also provide a means of exploring the topic broadly while still retaining a comparable structure that enables a better frame of comparison when analyzing the responses.

Interviews were conducted in March 2004 through June 2004 either in a private space within the university library or at other campus locations. All interviews were audio recorded with the average interview taking twenty-one minutes. Interview times had a median of twenty minutes with a standard deviation of 8.41 minutes.

Data analysis

With such a large sample, we were also able to combine the benefits of qualitative analysis with quantitative analysis. As suggested by Michelene T. H. Chi of the Learning Research Development Center of the University of Pittsburgh, by integrating qualitative and quantitative analysis of verbal data ‘the interpretation of the results is less subjective’ (1997: 271).

All transcribed interviews were coded into meaningful categories using the qualitative data analysis software, Atlas.ti (Muhr 1998). For example the quote, ‘I would then go to Amazon.com and buy the book’ was coded S_Websites. Using this method of coding, we were able to apply both qualitative and quantitative techniques to analyze the verbal data, that is, ‘this quantitative-based qualitative approach basically operationalizes one’s subjective impression by coding the verbal evidence for that impression and comparing the frequencies of the codes quantitatively’ (Chi 1997: 277). The quantitative analysis of results provides a basis for comparison among disciplines as well as an overall summary of the study.

We used four researchers, who were trained in coding, to code transcripts. After coding five transcripts (Coders A and B each coded the same five, and Coders C and D coded another five) the group met to discuss the codes and to check the consistency between partners and the pairs. We repeated this step by coding five more transcripts. When we were satisfied with the consistency of coding, all of the remaining transcripts were coded. Researcher A coded forty transcripts while Researcher B coded the same forty transcripts. We then joined the coded transcripts of A and B. Coders C and D did the same with the remaining forty transcripts. Once the transcripts were coded, we were able to analyze the data; explore the ideas expressed by the graduate students regarding their methods, behavior, and reasoning; and identify both simple and complex relationships.

It is important to note that we asked general questions rather than specific (e.g., ‘What resources do you use?’ Not ‘Do you use JSTOR?’). Though the number of responses might
be higher if we used specific questions, responses might be limited to one-word answers. We chose the general questions to get a better idea of participant behavior, thoughts, and feelings that affect their information seeking.

In the remainder of this paper, participants will be identified as P and the participant number, e.g., P1, P2 represent participant 1 and participant 2. Quoted passages will include the participant number and their discipline.

Results

The results of this study indicate that the graduate students’ information seeking behavior is influenced by people, primarily academic personnel, in addition to other students, friends, university library staff, and people outside the university. Graduate students, who rely heavily on the Internet, prefer online resources which they find on the Internet and the university library Web. They also use print resources from the university library and other libraries. A few graduate students mentioned factors which influence their search for information including convenience, speed, and time restrictions; knowledge of services and sources; and course requirements. These results are summarized in the following sections.

Influences of people

‘…with any piece of work I never bypass the people phase of searching, both for the concrete materials they’ll give you as well as the intangible ideas that come out of conversations with people.’ (P1 computer science)

Though graduate students have not yet had the opportunity to develop networks as extensive as those of their advisors and professors, they have begun the process. Advisors, professors, colleagues and university library personnel are the most influential; however, a few students have developed networks that extend beyond their own university to former and newly acquired contacts.

Academic personnel

<table>
<thead>
<tr>
<th>Academic personnel help</th>
<th>Percent of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Help from prof. &amp; advisors</td>
<td>96%</td>
</tr>
<tr>
<td>Rec’d recommendations</td>
<td>65%</td>
</tr>
<tr>
<td>Rec’d resources</td>
<td>58%</td>
</tr>
</tbody>
</table>

Table 2: Academic personnel help

Results are based on responses to general questions

Nearly all graduate students (96%) reported that academic personnel (e.g., advisors, professors, and committee members) influence their research and information seeking. This is consistent across the disciplines (86% in computer sciences to 100% in business/policy, engineering, and sciences). A meeting with advisors or key professors is often graduate students’ first step in their research process. Providing direction and guidance, academic
personnel answer questions, offer recommendations, and provide resources. They help students to build the foundation for the work that follows. One or two key papers, a classic book, or a relevant journal can lead to a whole host of resources.

‘... professors are the ones who are guiding me and telling what I should be looking at, at what point of time, and who wrote that specific piece of paper or something like that.’

(P141 engineering)

Most (65%) graduate students receive recommendations that guide their work: ‘Maybe you should look at this’ or ‘Oh, this is an interesting paper, you should use this one.’ Advisors, familiar with the professional literature, bring to the attention of graduate students materials which they have come across in their own work. They point to directions often not thought of.

‘Sometimes their suggestions are very useful, very critical to my problem.’ (P83 humanities)

More than half (58%) of graduate students receive actual resources. Using their personal networks with professionals in the field or their own or the department’s library, professors are instrumental in getting resources. They pass on journal articles, books, research papers, spreadsheets, data sets, and their own papers or those of noted authors.

‘The most critical books or central books in our field, of course somebody in the department owns, so you borrow it. It's nice because it doesn’t have a due date and it can’t be recalled.’ (P152 engineering)

Help comes through word of mouth in casual conversations and email, during research seminars, or in formal one-to-one meetings. The amount of help varies, though when the overlap in research interest between participant and advisor is great, so is the amount of help. They meet once a week, once a month or on an as-needed basis. Academic personnel put articles in graduate students’ mailboxes, pass resources out in the research group or in one-to-one meetings, or send a PDF in an email.

Students

<table>
<thead>
<tr>
<th>Student help</th>
<th>Percent of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Help from other students</td>
<td>73%</td>
</tr>
<tr>
<td>Rec’d recommendations</td>
<td>34%</td>
</tr>
<tr>
<td>Rec’d resources</td>
<td>30%</td>
</tr>
</tbody>
</table>

Table 3: Student help

Results are based on responses to general questions

Graduate students (73%) point to another rich source of help that comes from other students. This varies across disciplines (62% in arts and architecture to 82% in business and policy). About one-third (34%) reported that during research groups or in casual discussions, peers share information on reference books, Websites, articles, journals, papers, movies, and names of key people in the field. As a result, graduate students are more focused and able to design better searches, ‘You don’t need to go through and sift through a lot of materials.’
This not only speeds up the process, but recommendations are sometimes for such obscure sources that it would have been difficult to find them without help.

‘...through discussions of papers that we’re writing or materials that we’re working on, we always sort of cross reference one another and say: “Oh well, haven’t you looked at this?” or “Haven’t you looked at that?”’ (P81 humanities)

Graduate students (30%) reported that peers share actual resources. They might ‘stumble across a paper that would be relevant to the research that I’m doing’, loan a book, share print or electronic copies of magazine or journal articles, or send an email with a link in it. Some research groups have developed a shared library of materials—conference papers, tapes, and/or references.

Of particular interest is the insight that results from discussions with peers. Research groups and casual discussions are an opportunity for graduate students to talk about their research, share ideas, and get feedback all of which help to define and shape their research. During weekly meetings, ‘we just kind of sit around and bounce ideas off one another.’ In addition, more experienced students offer guidance on how to use the university library Website, library resources, and services.

University library personnel and others

<table>
<thead>
<tr>
<th>Help sources</th>
<th>Total</th>
<th>Arts &amp; Arch</th>
<th>Business &amp; Policy</th>
<th>Computer Sciences</th>
<th>Engineer</th>
<th>Humanities</th>
<th>Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help from library personnel</td>
<td>40%</td>
<td>44%</td>
<td>72%</td>
<td>29%</td>
<td>15%</td>
<td>55%</td>
<td>46%</td>
</tr>
<tr>
<td>Help from others</td>
<td>12%</td>
<td>1%</td>
<td>0%</td>
<td>43%</td>
<td>27%</td>
<td>20%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Table 4: University library personnel and others

Results are based on responses to general questions

For the technical aspects of information seeking, graduate students (40%) turn to university library personnel primarily librarians. We notice a wide range of variation across disciplines—from 15% in engineering to 72% in business and policy. One explanation for the broad range of differences could be students’ lack of experience. Ninety-one percent of business and policy graduate students, who most often sought help from librarians, are in a masters programme.

Those who seek help say university library personnel point to our relevant resources, respond to questions, announce new resources, and teach graduate students how to find resources, use the library, navigate the Website, create a more focused keyword search, or plan and conceptualize a new project. Graduate students seek help in one-to-one sessions, email, orientation sessions, research seminars, on site at the reference desk, live chat sessions, and in class sessions. Preferences vary. Some say that getting help at the reference desk directly is the easiest and most efficient, while others prefer online chat sessions which provide support when working off site.

Only a few graduate students (12%) reported developing their own network of contacts beyond the local university. However, networking beyond the university is more evident in
the computer sciences (43%) than in business and policy (0%) or arts and architecture (1%). Because the later two disciplines have the fewest proportion of doctoral students (9%, 25%), networking might be more evident as the graduate students are further into their own research and have more opportunity to meet people.

Those who are networking reported contacting personal friends locally or from other universities, former co-workers, professors from other universities, scholars in the field, or authors for recommendations and resources. Graduate students attend conferences where they establish new contacts or hear of relevant resources. They check relevant list serves. These interactions have resulted in recommendations of papers or books, names of experts who are working in the same field, and actual resources.

**Internet resources**

<table>
<thead>
<tr>
<th>Internet use</th>
<th>Percent of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>100% 100% 100% 100% 100% 100% 100% 100%</td>
</tr>
<tr>
<td>Arts &amp; Architecture</td>
<td>100% 62% 91% 79% 88% 75% 62%</td>
</tr>
<tr>
<td>Business &amp; Policy</td>
<td>100% 100% 100% 100% 100% 100% 100% 100%</td>
</tr>
<tr>
<td>Computer Sciences</td>
<td>100% 100% 100% 100% 100% 100% 100% 100%</td>
</tr>
<tr>
<td>Engineer</td>
<td>100% 100% 100% 100% 100% 100% 100% 100%</td>
</tr>
<tr>
<td>Humanities</td>
<td>100% 100% 100% 100% 100% 100% 100% 100%</td>
</tr>
<tr>
<td>Sciences</td>
<td>100% 100% 100% 100% 100% 100% 100% 100%</td>
</tr>
</tbody>
</table>

**Table 5: Use of Internet**

Results are based on responses to general questions

All graduate students reported searching the university library or non-library Internet for their resources. Though more evident in the computer sciences (91%) and less so in the arts and architecture (62%), most graduate students (77%) described the Internet as extremely useful, their primary method of searching, or the next step after meeting with advisors.

Nearly half (48%), particularly engineering students (77%), choose the Internet because it’s convenient, fast, and current. The Internet’s powerful search engines allow users to quickly search a massive amount of materials from diverse sources—scholarly journals to lecture notes in multi-disciplinary fields. With online information they can find, scan, download, and print from any location with an Internet connection. Because they can search through online versions quickly, graduate students are more likely to view papers of questionable value.

‘[Internet] It gives me a source of diversity so even though I’m searching for a business-related topic I can find it in the human arts section, an article, or humanities or from a scientific field, so on and so forth.’ (P5 engineering)

For a few (16%), especially those in the humanities (30%), using the Internet for information seeking is not without problems. They reported that the information found on the Internet was often not reliable. Results are from a variety of sources, as diversified as government Websites to ‘some graduate student writing.’ No regulated guidelines describe what can be put on the Internet; ‘there’s no sort of the governing body, if you will, for truth of information on the Internet.’ In addition unfocused searching can result in diverse and
massive amounts of information. Sorting through the results to find relevant, reliable resources can be difficult and time-consuming.

‘I’ve certainly been in situations where no one knows anything that anybody’s written on the thing so then what I’ll do is I’ll just go to the internet, …type in the term and then sort of have to weed through the junk and eventually you’ll stumble across an article that seems relevant.’ (P137 humanities)

Internet—Websites

<table>
<thead>
<tr>
<th>Internet use</th>
<th>Percent of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>WWW use (non-library)</td>
<td>97%</td>
</tr>
<tr>
<td>Google searches</td>
<td>73%</td>
</tr>
<tr>
<td>Search for Websites</td>
<td>68%</td>
</tr>
<tr>
<td>Search for paper &amp; articles</td>
<td>50%</td>
</tr>
<tr>
<td>Citation chaining</td>
<td>48%</td>
</tr>
<tr>
<td>General searches</td>
<td>47%</td>
</tr>
</tbody>
</table>

Table 6: Internet resources

Results are based on responses to general questions

For graduate students (97%) using the non-library Internet, nearly three-fourths (73%) mentioned using the Google search engine for their information seeking (50% in humanities to 93% in computer science). Most frequently graduate students (68%), particularly computer science majors (93%), search for Websites. They visit business, personal, professional, governmental, academic, and organizational Websites searching for the latest news (e.g., CNN, NY Times), online materials or references (e.g., CiteSeer, authors’ sites); to purchase materials (e.g., Amazon, eBay); for specific resources (e.g., images, statistical information, businesses information); or for resources not available in the university libraries.

‘The sites like CiteSeer have a lot of research papers on my interest area and I download the files from the Internet. Usually I first search on the Internet if I would find something appropriate to what I need.’ (P175 computer science)

Internet—Papers and articles

Though varying widely across disciplines (35% in humanities to 64% in computer sciences), half of all graduate students (50%) use the Internet (non-library) to search for online papers or articles—research papers, white papers, journal articles, and/or working papers. In many of the technical fields, authors publish their papers online and provide free access to up-to-date materials. For some, especially those in fast-paced fields, the Internet is the source for current and cutting edge information; even papers that are three or four years old can be considered old.
‘...if I’m interested in just the latest developments probably the online is much easier to find something that’s been published maybe six months ago. So maybe the library doesn’t even carry, like, proceedings on conferences.’ (P7 computer science)

Searching techniques

Methods of search vary from specific, known searches to general, open-ended searches. Students might use a known search if they might have the name of a Website, a specific journal or a citation. A known search is easier, quicker, and returns more relevant results. Known searches often begin with citation chaining, a method of following references. At other times, graduate students who know very little about their topic might start with a general search. Students use these techniques on the open Web or on the university library Web.

Citation chaining

The Internet facilitates an approach to information seeking mentioned by nearly half (48%) of all graduate students, though varying widely across disciplines (25% in arts and architecture to 64% in computer sciences). Interestingly chaining was less evident in disciplines with more masters students (25% in arts and architecture, 27% in business and policy) indicating the discrepancies might be more a function of experience than discipline.

Using a relevant article or book, graduate students track references, endnotes, footnotes, and bibliographies. This method of gathering information was defined by David Ellis as chaining, the practice of ‘following citation connections between materials’ (1989: 183). Ellis described two forms of chaining: ‘backward chaining—following up references or sources cited in material consulted and forward chaining—identifying citations to material consulted or known’ (1989: 183). One student describes it like this:

‘A paper is most useful because the footnotes or endnotes will have citations, and from there it’s sort of like a thread, so you just pull on that one and the whole thing unravels...so all I need really is one or two good leads and from there I can usually extrapolate a wealth of information.’ (P9 business/policy)

Our results were consistent with Ellis’ findings. Graduate students check citations from key materials, often provided by advisors or colleagues or found sometimes randomly in books or articles. They check who the author cites, and who has cited the article and then track those references. Articles or authors that are frequently cited gain priority status. Then graduate students repeat the process with the new list of citations.

Some graduate students (29%) use citation indexes like CiteSeer to search for full text articles and papers, valued because the database tracks the citations both forward and backward, in addition to providing the full text article. Graduate students who start with just a few well-chosen references can go deeper and deeper into the literature. Articles, especially electronic, are preferred for the ability to easily track, and thus build a related body of literature quickly.

General, open-ended searches

Nearly half of all graduate students (47%) use an open-ended keyword search usually with Google. This is most evident in business and policy (64%), a discipline with has predominantly masters students. The Internet is described as a good place to get ideas, or ‘to
know what lives on the Web, what keywords, controversy,’ or news, though the search might not always lead to resources that can be cited.

‘At least, if I have no idea about that topic or if I’m scared about the very technical aspect of that topic and I’m reluctant to read a big article on it or something, so just do a keyword search and it gives me some lecture notes or something over the Web, which gives me some idea about what the material is.’ (P76 sciences)

Often helpful when graduate students know very little about their topic, general searches are used to ‘get a feel for what has to be done,’ how much is available, or to develop a search strategy. The drawback to using a general search is that it results in a massive amount of information, much of which has questionable credibility and little relevance to the topic. Because students have to weed through diverse list of results to find relevant materials, general searches can be time-consuming.

University library

Though the non-library Internet resources are strongly evident in graduate students’ research process, the university library remains a key element. While all graduate students indicated

<table>
<thead>
<tr>
<th>University library resources</th>
<th>Percent of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Library important role</td>
<td>55%</td>
</tr>
<tr>
<td>Library Web use</td>
<td>94%</td>
</tr>
<tr>
<td>Use library databases</td>
<td>78%</td>
</tr>
<tr>
<td>Use online journals &amp; full text databases</td>
<td>61%</td>
</tr>
</tbody>
</table>

Table 7. University library online resources

Results are based on student feedback to general questions

that they use some type of library resources, more than half of all graduate students (55%) and as many as 75% (arts and architecture) said that the university library plays an important role (e.g., crucial, invaluable, significant, and huge) in their research. This is consistent across disciplines with the exception of computer science students where only 21% describe the university library as important. This apparent contradiction between the reliance on university library resources while still reporting a considerable use of the broader Internet might be explained by graduate students’ preference and use of the libraries’ online services and resources.

‘…if it’s not available online you’ll say, ‘Oh I’ll get that later, back on my way home’ or something and then I forget about it.’ (P10 computer science)

University library—Online resources

‘I think I use the library Web more. I just find that I can get what I think I need…because sometimes on the World Wide Web you’re exposed to a lot of things …it’s some graduate student writing.’ (P158 humanities)
Nearly all (94%) graduate students use the university libraries’ online services saying they are easily accessed, fast, convenient and time-saving. This varies moderately across disciplines with 79% in arts and architecture and computer science to 100% humanities and business and policy.

Using both focused searches and open-ended searches, most graduate students (78%) use the university library databases, though it varies somewhat among disciplines (50% in arts and architecture to 95% in humanities). With the exception of students in arts and architecture (19%), most graduate students (61%) prefer the online journals and full text databases. They often search for papers—research papers, technical papers, online articles, journal articles, and conference proceedings. Graduate students also reported using other online resources such as indexes, reference materials (encyclopedia, dictionary), music, images, user services, and interlibrary loan to name a few.

‘... for a lot of things the library is the fastest and best place to go, but depending on how much of a clue I have about what I’m actually doing with it, I may need to start somewhere else first. Get some names, get an idea of what’s going on and then maybe come to the library then.’ (P87 computer science)

University library—Print resources

Though most graduate students indicated a preference for online resources, a vast majority (83%) reported using the physical resources in the university library for books, textbooks, and reference materials. This is consistent across all disciplines. Graduate students (58%) also come to the library for print journals, periodicals, and magazines. This is most evident for students in the sciences (85%) and humanities (80%) than those in business and policy (27%). Interestingly, use of the libraries’ print materials is only slightly less than use of their online and full text resources, however, many resources (especially older articles, papers, and reports) are not yet available online. Students also prefer the printed book saying that reading books online is difficult.

The university library is important for DVD’s, videos, and services (e.g., interlibrary loan). Some use the library to work, to use printers, or for entertainment and their own personal interest. Only a few (5%) reported seldom visiting the physical library, though they still use the libraries’ online services. For those (14%) who say the library might not be the first place they go for resources, the library still plays a complementary or supporting role.
Other libraries

### Table 9. Other libraries

Results are based on responses to general questions

<table>
<thead>
<tr>
<th>Libraries</th>
<th>Percent of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Interlibrary loan</td>
<td>58%</td>
</tr>
<tr>
<td>Univ. of Pittsburgh</td>
<td>52%</td>
</tr>
<tr>
<td>Local public libraries</td>
<td>16%</td>
</tr>
</tbody>
</table>

When needed resources are not available in the university libraries, graduate students (58%) supplement by using the libraries’ interlibrary loan services to borrow from other libraries. This varies across disciplines with students in the humanities (75%) using the interlibrary loan services the most and business and policy students (36%) the least. Graduate students (52%), especially those in the sciences (85%), also find resources in nearby University of Pittsburgh. Though only a few (16%) reported using local public libraries, use was concentrated in one discipline. Half of all students in arts and architecture reported using local libraries.

### Contributing factors

<table>
<thead>
<tr>
<th>Factors &amp; barriers</th>
<th>Percent of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Need convenience, speed</td>
<td>58%</td>
</tr>
<tr>
<td>Lack of knowledge</td>
<td>42%</td>
</tr>
<tr>
<td>Course requirements</td>
<td>28%</td>
</tr>
</tbody>
</table>

Factors, some outside of the university libraries’ control, affect graduate students’ use of libraries, library resources, and library services. The factor most frequently cited by graduate students (58%) was preference for convenience or the need to have information quickly as affecting their use and choice of resources, libraries and services. This varied across disciplines (46% in sciences to 65% in engineering, humanities). Some avoid using local libraries or the university library (parking is difficult, takes too much time). Others reported preferring online journals or online papers to the traditional paper copies because online is faster and easier. They avoid interlibrary loan because it takes too much time and a few say they are too lazy to set up remote access to university library resources or go to the library and photocopy an article.
'... as a masters student or as an early Ph.D. student rushing through a course I might need a book and I need it today, and if I can't get it today then forget it because the paper's due two days from now. As a dissertation Ph.D. student I can say well, in the next 4 weeks I need to have 70 books covered.' (P71 humanities)

Graduate students (42%) reported that lack of knowledge of existing services or resources or trouble finding and using them affected their information searching and use. This affected graduate students, mainly masters students, in business and policy (64%) the most. Graduate students reported that they didn’t know about services such as EZ Borrow (an interlibrary borrowing system), SFX® (a linking service for electronic resources), how to set up remote access, or other university library resources. Graduate students reported having trouble finding relevant information— the university library Website is confusing, relevant databases are hard to find, search engines are inadequate, obscure or older materials are difficult to find, or narrow or interdisciplinary fields of study are in short supply of materials.

'I feel like there’s information in all of these drawers, and I don’t know which drawer to open.' (P 178 business/policy)

For some (28%) information seeking is related to coursework; they aren’t involved in an extensive research project, most evident for the predominantly masters students in business and policy (55%). A few (11%) are overwhelmed by all they have to do, impatient and want information quickly, or are reluctant to learn something new. Because of cultural differences or problems with English, some are reluctant to ask questions or talk to strangers.

**Discussion and recommendations**

Findings indicate that information seeking behavior of graduate students is both random and organized. The random motions of information seeking are in effect during the planning stage, when choosing an area of focus, developing a search strategy, or general browsing for background information or a general idea of their field of research. The organized information seeking behavior includes regular planning sessions with an advisor, planned search strategies, and use of citation chaining. The information seeking behavior of graduate students is iterative and becomes more refined and organized as they become more knowledgeable in their field of research. Findings also indicate that information use varies among disciplines and by programme (masters, doctoral).

As found in previous studies (Foster 2005, Kerins, Madden, and Fulton 2004, Hirsh and Dinkelacker 2004), people play a central role in graduate students’ searching and finding information. They meet formally or casually throughout graduate students’ process of inquiry. Professors and advisors, who perform the most influential role, recommend and supply resources. They offer guidance, answer questions, and provide ideas and direction. Peers and colleagues, meeting casually or in research groups, also extend recommendations, share resources, and provide feedback. University library personnel provide key services and instruction in how to use and evaluate resources, design search strategies, learn about available resources, and understand how to use the library and library Web, though we see differences among disciplines.

The Internet plays a heavy role in graduate students’ search for information. The majority of students indicated a preference for information that is available online using university library resources and/or the broader Internet resources. When graduate students use the
Internet, searching for and obtaining information are simultaneous and enable them to work in their offices or homes.

All reported using Web resources (library and non-library) though the perceived importance of the Web varies among disciplines. The broad range of differences among technology and non-technology disciplines is most noticeable in Web use. With the exception of problems mentioned by a few, graduate students value the Internet because of its powerful search functionality that enables searching enormous amounts of information. They reported using Google for a general or known search for information. Though disciplines vary widely, this is especially evident in the technology-based disciplines.

Nearly half of all graduate students use citation chaining to build a body of literature. Using relevant resources, students check references, bibliographies, endnotes and footnotes for other sources. They repeat their search using this new list of sources. Chaining enables students to search for a known citation and limits their need to use a general search that returns a huge amount of resources that are difficult and time-consuming to search.

Graduate students use both print and electronic resources that are available through the university libraries. They search university library databases and indexes, online journals and other online resources for online articles, conference proceedings, reference materials, images and other materials. Graduate students use the libraries’ print resources, as well, citing use of books, print journals, and other materials. When they are unable to find the information they need using the university libraries, some students request items using the libraries’ interlibrary loan service, use materials from local universities and colleges, or from other public libraries.

Consistent with previous research (Ellis 1989, Steinerova and Susol 2005, Kerins, Madden, and Fulton 2004, OCLC 2002, Kulviwat, Guo, and Engchanil 2004), graduate students’ searching is influenced by convenience, speed, and ease of access. These factors affect their choice of libraries, library services, and information resources. A barrier to graduate students’ search for information is knowledge about or access to resources. The differences between masters and doctoral students are evidenced by students’ lack of sophistication in their knowledge of resources and development of searching skills. Graduate students choose the resources and services that are most convenient and provide fast access.

The findings of this study have many implications for academic libraries as they relate to and inform the information behavior of their students, most specifically university library instruction, availability of resources, education of students, and instructional leadership among academic personnel. Graduate students rely on library personnel for help finding and using resources and they also rely on academic personnel. This places librarians in a key position to affect students’ and faculty information behavior. Not only can libraries evaluate and improve their own instructional services, but recognizing the influence of academic personnel, libraries can influence faculty’s instructional services which relate to students’ information behavior:

- Accessibility is a key factor that affects graduate students’ choices of resources and services. Libraries need to strive to provide more electronic resources that are easily accessed within a user-friendly environment.
• Though graduate students might have considerable experience in the process of inquiry, they are still new to their current university library. Libraries need to create awareness among graduate students about the services and resources that are available and how to use them.

• The considerable increase in the number of available resources makes it even more difficult to find them. Libraries can provide navigational aids available at all times that describe the physical library and the electronic library resources.

• Graduate students have varying abilities and experience related to finding and using resources. Libraries can provide instruction throughout the term for students at all levels, targeting students who are not familiar with American libraries.

• Libraries need not assume the entire burden of instruction. Libraries can, however, take a lead and work with academic personnel to help educate them as to what resources are available and how to find them.

Summary

This multi-disciplinary study explored the information seeking behavior of graduate students. The findings indicate that people, especially academic personnel, play a central role. Students rely heavily on the Internet as well as the university libraries’ online resources for information, though still using the physical library for hard copy materials such as books, journals, and papers. A few graduate students mentioned influences such as difficulty locating information or the need for convenience and speed. This paper provides an overview of the complete study and findings as well as a comparison of the similarities and differences among disciplines. We plan to look more closely at specific areas of the study for an in depth examination of trends and patterns in the responses.

This study not only provides insight into graduate students’ information behavior, it also raises some questions. Though in depth, semi-structured interviews offer an excellent method for investigating the current and past information behavior of graduate students, they rely on long-term memory for recall and lack specificity on some variables. Further exploration in a follow-up study that might decrease the need for long-term memory (think aloud protocols) or one that can generate more specific information (online structured survey) can add further depth to this study.

Acknowledgements

We would like to thank Susan Ambrose and Anne Faye of the Eberly Center of Teaching Excellence for their guidance in designing this study. We also thank Gloria Henning for her considerable help with the interviews.
Appendix: Graduate student interview script

1. Tell me about your research interests, what research have you completed or plan to complete? What kind of materials have you used or do you plan to use? Where do you find these materials?

2. Describe how you go about finding appropriate materials?

3. What role does the Internet play in finding your research materials? Tell me more about this.

4. How useful to you are professors and fellow students for obtaining materials? What kinds of materials? How often?

5. Tell me whether and how you use the University Libraries’ online resources. If NO - Why not? If YES - How convenient is that? Do you bookmark databases or journals or do you access these through the libraries’ Website?

6. Can you describe the importance of the University of Pittsburgh libraries for your research in terms of traditional materials like books, journals, and microform? For electronic materials? Will their restrictions on the use of their electronic materials affect your research?

7. How reliant are you on interlibrary loan to obtain needed research materials? How does ILLiad work for you? How does EZBorrow [formerly PALCI] work for you?

8. How do you distinguish between searching for and obtaining materials?

9. What role does the University Library play in your research or educational work?

10. How could your information seeking or obtaining experience be improved?

11. Is there anything you would like to add?
References


